Olli-Pekka Hilmola & Eugene Korovyakovsky (Editors)

NETWORKED LOGISTICS AND PRODUCTION AT SOUTH-EAST FINLAND, ST. PETERSBURG AND LENINGRAD OBLAST

Published with the Financial Support of European Union Tacis Neighbourhood Programme

EUROPEAN UNION

LOGNET

LAPPEENRANNAN TEKNILLINEN YLIOPISTO
LAPPEENRANTA UNIVERSITY OF TECHNOLOGY

TEKNISTALOUDELLINEN TIEDEKUNTA
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RESEARCH REPORT

LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
Department of Industrial Engineering and Management
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Research Report 211

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Foreword

Currently we are living through very interesting times as economic growth all over the world has changed into decline, and industrial competitiveness and collaboration is being sought for help in this situation. For larger Europe this means that we need to improve our financial and non-financial performance through networked production approach, where old habits and vertically integrated working models are being changed into collaboration across the borders and organizations. In Northern Europe one particularly interesting and lucrative place is Finnish-Russian border area, where companies could serve to some extent middle sized "near-by market", but also supply advanced high tech products into Central Europe, and other continents. During our project execution time we have found e.g. green energy related metal industry to be one promising avenue for this; for South-East Finland this new industry has created hundreds of new working places (during time period of recent year), while also Russian side (e.g. Vyborg) has aided this industry as a very important supplier of components and semi-finished items. Russia also holds significant importance in the production of raw materials for metal industry.

During the execution of Lognet project we have found that transportation infrastructure has improved as transportation volumes have considerably increased (e.g. St. Petersburg, Helsinki, Kotka and Hamina handled more than 3 million containers during year 2008), but much remains to be done in the future. Generally in both cross-border areas new warehouses have been constructed, but they mostly rely on road transport, and internally there exist much to be done to improve the efficiency of these entities. As a one promising avenue we see ERP systems, which should be adapted more intensively on all sizes of logistics service companies. This is also increasingly educational issue, where intensive courses among traditional university type of teaching have been analyzed to be most efficient approach to train industrial employees. However, as one improvement area might be modern IT, we have found during our research project execution time that funding of e.g. new rolling stock and generally other parts of infrastructure remains to be important future competitiveness issue. As a one option researchers identify incremental privatization and deregulation of railway markets in Russia, which e.g. recently enabled modernization of oil and other raw material related railway rolling stock through private undertakings. Even if industrial competitiveness in industrial context is often tied on logistics operations of freight, our completed research also shows that passenger transports is growing within border-zone area.

Last, but not least, we would like to express our gratitude for authors of this volume, for making important contribution in the cross-border logistics. We are also indebt for assistant editors of this volume, namely Milla Laisi, Juha Saranen and Bulcsu Szekely. Also European Union and Tacis neighbourhood programme funding is well appreciated.

In Kouvola, Finland & St. Petersburg, Russia during February 2009,

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Prof. (act.), Docent, PhD

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Head of Department, Dr.

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Estimation of Opportunities of Technical Realization of the Project "Common Information Area of Transport and Logistics Complex"

Andrej Simushkov

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Abstract
The trends of the modern international transport market in the information interaction are turned to the development of the business partners' information systems. The using of isolated information systems to operate between the different modes of transport, as well as on the border terminals, duplicates of operations, complicates technologic process and increases the handling time and transit time of goods. Creating the Common Information Area of transport and logistics complex will help implement the latest developments in the field of IT, which offer fundamentally new opportunities for the management of all areas of transport interaction. For its effective implementation, the Common Information Area will be able to involve the different technical possibilities existing in the operating information systems. They are:

- The using the equipment of satellite navigation systems (GPS NAVSTAR, GLONASS, Inmarsat, Globalstar) to find the location of the facility
- The using bar-coding to manage storage facilities and to control the goods in the terminal complexes
- The using the database clusters and GRID technologies – the systems which work with parallel versions of databases and are used by CRM, MRP, ERP and CSRP systems, as well as transactional databases
- The using the mechanism «TCO» for the selection of general software
- The using special software: electronic atlases and maps, GIS packages for the development of delivery routes, fleet management systems (FMS), accounting and financial analytical systems, systems for managing the warehouse, etc.
- Methods and devices to develop complex integrated ICT. CASE technology and equipment
- The implementation of wireless networks. WAP technology and their abilities to manage the business. The global mobile communication
- Organizing and managerial capabilities of global information networks: The monitoring of goods and communication by the Internet; electronic freight; electronic payments; such technologies as: e-business, e-mobility, e-logistics, etc., and mobile office and mobile Internet.

Key words: ACS, GRID technologies, GIS packages, e-logistics, Common Information area

1. Introduction

The trends of the modern international transport market in the information interaction are turned to the development of the business partners' information systems. The using of isolated information systems to operate between the different modes of transport, as well as on the border terminals, duplicates of operations, complicates technologic process and increases the handling time and transit time of goods.

Creating the Common Information Area of transport and logistics complex will help implement the latest developments in the field of IT, which offer fundamentally new opportunities for the management of all areas of transport interaction.

All features, which information systems have and which will allow creating the Common Information Area can be divided into two types:

1. The technologies that can be used to systematize the business processes that improve the quality of the staff of logistics and transportation companies;
2. Technical solutions of scalable integration and the possibility of the using of outsourcing to reduce the costs of the maintaining information infrastructure.

One of two variants can be chosen to access the Common Information Area. The first is to access by the Internet using WEB-technology and WEB-interface. The second is to install the long-distance platforms and to communicate databases. These variants both involve the using of publicly available information as well as integration with existing information systems of logistics companies of the region.

If some functions are duplicated, the user will be able to take the most convenient decision, and then he will have an opportunity to change his decision towards the most convenient product. As the Common Information Area is a large complex of technical and technological solutions while being the flexible instrument for the managing of transportation and logistics systems, the user will be able to make his unique information system, integrated into the Common Information Area. For its effective implementation, the Common Information Area will be able to involve the different technical possibilities existing in the operating information systems. They are:

- The using the equipment of satellite navigation systems (GPS NAVSTAR, GLONASS, Inmarsat, Globalstar) to find the location of the facility;
- The using bar-coding to manage storage facilities and to control the goods in the terminal complexes;
- The using the database clusters and GRID technologies – the systems which work with parallel versions of databases and are used by CRM, MRP, ERP and CSRP systems, as well as transactional databases;
- The using the mechanism «TCO» for the selection of general software;
- The using special software: electronic atlases and maps, GIS-packages for the development of delivery routes, fleet management systems (FMS), accounting and financial analytical systems, systems for managing the warehouse, etc.;
- Methods and devices to develop complex integrated ICT. CASE-technology and equipment;

- The implementation of wireless networks. WAP-technology and their abilities to manage the business. The global mobile communication;
- Organizing and managerial capabilities of global information networks. The monitoring of goods and communication by the Internet. Electronic freight. Electronic payments. Such technologies as: e-business, e-mobility, e-logistics, etc. Mobile office and Mobile Internet.

2. The Problems of the Implementation of the Common Information Technology in Logistics

One of the main tasks of modern ICT is to ensure the timely delivery of information of necessary quality in order to achieve the effectiveness of the management decisions. The problems of building an integrated information system are known:

- heterogeneity of information sources;
- variety of business tasks;
- technical (hardware) heterogeneity;
- different levels of the users` training and the diversity of requirements for interface.

At the same time, enough experience of developing the systems for the management of large companies has been accumulated abroad. This experience allows representing requirements for the structure, contents and functions of the main modules of the Common Information Area to manage transport and logistics chains.

3. Information Technology and Solutions, They Are Based

Navigation System GPS

Using the equipment of the satellite navigation system GPS NAVSTAR (GPS, ГЛОНАСС, Inmarsat) to find the location of the facility, the information system will allow tracing the route of vehicle, aircraft or container with important cargo in detail.
The abilities of GPS monitoring:

- To monitor the movement of the whole fleet and the each unit of fleet

- To order routes and areas of movement of objects
- To control any action of employees
- To manage the transport devices

To solve the problem of integration of different systems it is possible to implement the complex solution, consisting of a set of segments:

- navigation segment
- segment of transferring special data in real time
- segment of visualizing the movement of various transport units in real time
- segment of data processing and transferring records
- segment of managing specialized devices
- segment of archiving data

Navigation segment is based on the using of ground navigation equipment GPS (GLONASS). The basic GPS receiver is installed permanently, and mobile ones are placed on vehicles, loaders, boats, locomotives, mobile points of access for employees and other moving units. The segment of transferring special data is based on the using of the special communication systems. Basic receivers as well as mobile ones are fitted up with receive-transmit complement. Segment of visualizing the movement is based on the using of incoming information about the location of objects and coordinates of digital models of objects. It is installed as special software.

Wireless networks - WLAN

Increasing number of mobile users is naturally followed by intensive development of wireless communication technology. This is particularly true for the wireless network or the so-called WLAN-network (Wireless Local Area Network), which has the following characteristics:

- Network is quickly deployed, that is very convenient for working away from the office, warehouse and terminal;
- The users of mobile devices while connecting with local wireless network can easily navigate within the existing network zones;
- Speed of modern network is quite high (up to 54 Mb / s);
- The wireless network can be successfully connected with the cable network by the additional equipment.

The role of a network node can be played by PC, laptop, PDA as well as special device "access point" or "Access Point", which provides the access to the cable segment of network Ethernet, Internet or other Common Information Area computer (CIA).

The implementation for PDA (WAP + GSM + GPRS)

CIA will have an opportunity to work with a personal digital assistant (PDA). This version is very convenient because it is possible to use with any carrier which supports the Internet.

Security

The problems of security and data protection are very important for scalable systems. The following methods can be provided to protect transmitted data:

- the authentication and access control (using MAC addresses, Media Access Control ID): each adapter has a completely unique code set by the producer;
- the using the keys SSID (Service Set Identifier);
- the encrypting of data.

WPA protocol can be installed in the most of existing devices (access points, network cards) to access control by the software updating.

4. Information Capacities

Considering distributed contemporary architecture it becomes clear that the task of separation of business processes for many application servers has been almost resolved. Moreover the process itself and sharing protocols between servers of applications and between different modules are standardized (Simple Object Access Protocol (SOAP), Web Service Description Languages (WSDL) and Universal Description, Discovery and Integration (UDDI)). The development of the computer industry is upon ascending spiral, and one of its turns is the process named «centralization – decentralization»: from mainframes through the client-server approach to the architecture of distributed computing and Web services. On this turn the problem of consolidation of server resources is raised again leading to the saving of service means. Contemporary consolidation does not require the concentrating resources in one case. Some segments of the system may be situated on the different continents and consolidation can be realized by the management system of a new generation (OpenView). In addition, the

virtualization of resources is possible in the form of partitioning. Today both physical and virtual systems of partitioning are available. It means that resources, which are located on the same server, can be safely isolated one from another and dynamically access information without creating problems.

Cluster - technology

To build deployed information area cluster technology may be used. Cluster is a modular multiprocessor system, established on the basis of standard computing nodes associated by high-speed communication environment. Database clusters are systems, which work with the parallel versions of databases and are used for CRM-and ERP-systems as well as transactional databases. Cluster technology can also be used for distribution of the large flow of queries on many servers. Such decisions are often used to support Web-sites with dynamic content, constantly seeking to databases (of search engines). Depending on the size of the service, distribution download clusters can have a number of nodes. Some nodes (of server) are associated by a high-performance base (such as «Fibre Channel» or «InfiniBand») and managed through the ordinary TCP-IP network or such higher connection as «Myrinet». Cluster architecture of solutions provides users of computing systems with super-computer level of performance some essential advantages:

- the most profitable balance of price and performance;
- an excellent opportunity to expand performance by the addition of standard computing nodes;
- high fail-safe feature;
- simplicity of service;
- low cost of ownership (TCO).

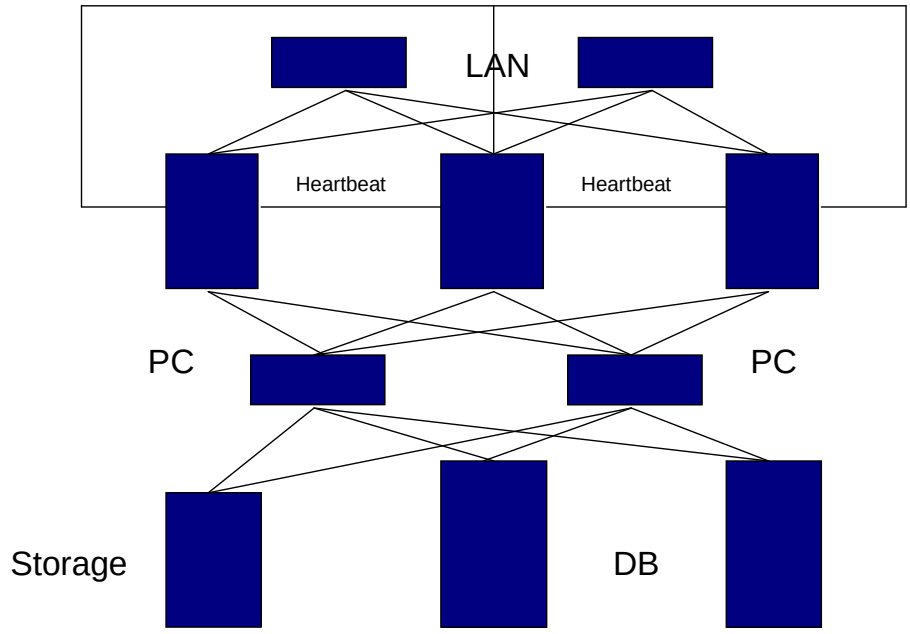

Figure 1. Mixed cluster

The types of clusters:

- high performance.
- high – availability.
- mixed.

Mixed clusters combine features of high performance and high availability systems. Nodes are associated by high performance channel of data transmission, all components are duplicated. These clusters are the best for using in the major DATA centers of companies (because of its reliability, performance and scalability). Systems with load balancing are considered to be mixed clusters too. The task of such clusters is to treat with a number of customer requests using client – server technology. It can be used for example, when working with corporate databases, supporting by HTTP and FTP servers, and so on. It is necessary to solve the problems of maintenance and management before working with cluster complexes. The following programming tools can solve the problem of «great system» by neutralizing differences between the cluster and systems with shared memory (SMP):

1. Tools for the installation of software at the cluster: creating the repository, updating versions (SystemImager, LCFG).
2. Tools for the regular administrating clusters: monitoring of equipment, monitoring of critical events (Big Brother); monitoring of performance (Ganglia, Cluster Command Control).
3. Cluster Management System of batch processing. Local integration in multiprocessor complex is realized with the using of Resource Managers by Cluster Management System or Management System of batch processing (PBS, Sun Grid Engine (SGE) and Condor are free; LoadLeveler and LSF are commercial).
4. Integrated software for clusters. Model Single System Image (SSI) is a common operating system for all clusters.

5. GRID Technology

GRID (GRID, Business Grid) is considered to be one of the variants of building deployed information area and it is an advanced direction of IT technology. Although it has not yet translated into industrial standards, all countries – the leaders of the IT market – have the government programs of developing GRID-technologies to:

- integrate information capacities. The integration of heterogeneous computing systems into a common area with a dynamic allocation of resources among applications;
- integrate storage capacity. Something like geographically distributed RAID-systems;
- integrate data sources, such as integration into a single virtual database of different databases, distributed geographically, implemented at different hardware platforms and principles.

In addition to the integration of computing resources GRID technology allows to integrate different storage of keeping information and databases for creating the common information area. GRID systems are widely spent in conditions of open information resources.

GRID is a geographically distributed infrastructure, combining many different types of resources, which can be accessed by the user from any point, irrespective of their locations. Using GRID-system user will be able to get clear scalable data warehouse with a guaranteed

quality of service (protection, preservation, access speed) and standardized mechanism of exchanging various types of data (files, tables, arrays). GRID system will be able to provide the following specifications.

- the volume of data storage systems is at least 300 TB;
- the total performance of all computer subsystems is at least 2 TFlop;
- bandwidth data transmission network - at least 2 Gbit/sec.

6. The Integration through the Internet - E-integration of Logistics

At an early date Internet technology can become the most effective to create and support the internal information infrastructure of transportation and logistics companies. These technologies are implemented in new versions of corporate information systems companies, which organize their activities according with the principles and schemes of classical logistics and realize the following typical business - tasks:

- creating a brand;
- development of visual elements, making the product, service or company unique in the perception of the target audience;
- increase the value of the brand through a system of graphics identification.

As part of the Internet corporate website, information and service portal, special sites for mobile devices, sub for various areas of business can be opened. This environment is really suitable for building commercial sites (B2B-systems), the implementation of partnership programs and e-learning. The most obvious form of organization web space is a scheme involving the interaction of three conventional media:

- public internet-systems, which are opened for unlimited number of users;
- partner extranet-systems, i.e. systems which only the registered and authenticated users can access;
- internal intranet-systems (such as corporate portals) to house interaction.

7. Conclusions

Contemporary modular approach to the solving the problems of automated management allows to implementation of industrial, type safe technology. Typing of operations and the high frequency of its occurrence are the foundation of the high effectiveness of the modern systems. Using the new developments and technologies, combined with modern ERP-system, allows deploying IT solutions. These solutions provide the co-management of business and technological processes of the Common Information Area of transport and logistics complex.

The Theory of Warehouse Systems

Oleg B. Malikov

Saint Petersburg State Transport University, Russia

Abstract

Modern mechanized and automatic warehouses are very complicated technical objects that feature with many parameters, a lot of technical decisions and operate under stochastic flows of arriving and dispatching cargoes. So, they run in all the time changing conditions of cargo volumes, handling equipment and employees used, trucks and railway cars processed etc. Special theory is needed for the research and management of these complex technical objects. Some parts of the Theory of Warehouses Systems (TWS) are considered in the article.

Keywords: Warehouse, system, General System Theory, Material flow, Logistics, Supply Chain

1. Introduction

Modern mechanized and automatic warehouses are very complicated technical objects: they are rigged with specific complex equipment (racking systems of various performance, industrial trucks and stacker cranes with automatic control, automatic conveyor systems and automatic guided vehicles - AGV, means of robotics, palletizes, computers and on-line electronic data exchange systems etc). They are characterized with hundreds of various parameters and display stochastic sort of activity. In every case of reconstruction or building some new warehouse a lot of options, with different parameters and economical characteristics are possible.

Therefore, the most fruitful approach for the modern warehouses creating is to represent them as complicated stochastic systems in accordance with Theory of Warehouses Systems (TWS) that was worked out of this author of this article in the late 80's. The General Cybernetic Theory of Systems (GCTS) was applied as a foundation of this theory.

2. Warehouse Systems

Purpose of Warehouses

A warehouse should be considered as a system, i.e. as a complex of connected components – definite technological areas, having been created for reaching unified objective. According to GCTS various parts of the object under consideration could be taken as components of the Warehouse system. The most productive approach, however (as research had displayed), was

proved to select technological areas as components of the warehouse systems. The basic aspect of TWS is the purpose of creation and functioning of a warehouse.

Common, or at any rate very wide spread opinion is that warehouses are created for storage or perhaps – for storage and proceeding of merchandise. This opinion however does not explain what the merchandise should be stored or proceeded for. It is known certainly, that no product or merchandise is manufactured just for storage. They should move to the consumers.

In order to understand the real objective of a warehouse creation it is necessary to consider a supply chain that always consists of 2 sorts of elements: warehouses and transport links, connecting these warehouses (Figure 1). Analyses of logistic systems shows, that any well organized logistic chain and every transportation process starts and terminates at some warehouses (W_1, W_2 in Figure 1b).

A warehouse always interacts with two type of transport – first T_i, that delivers cargoes to the warehouse and second T_o, that delivers cargoes from warehouse to customers (they can be the same or different modes of transport) – see Figure 1c. Certainly the whole amount of inbound materials flow per rather long period (for example per year) Q_i should be equal to the whole amount of out-bound materials flow Q_0.

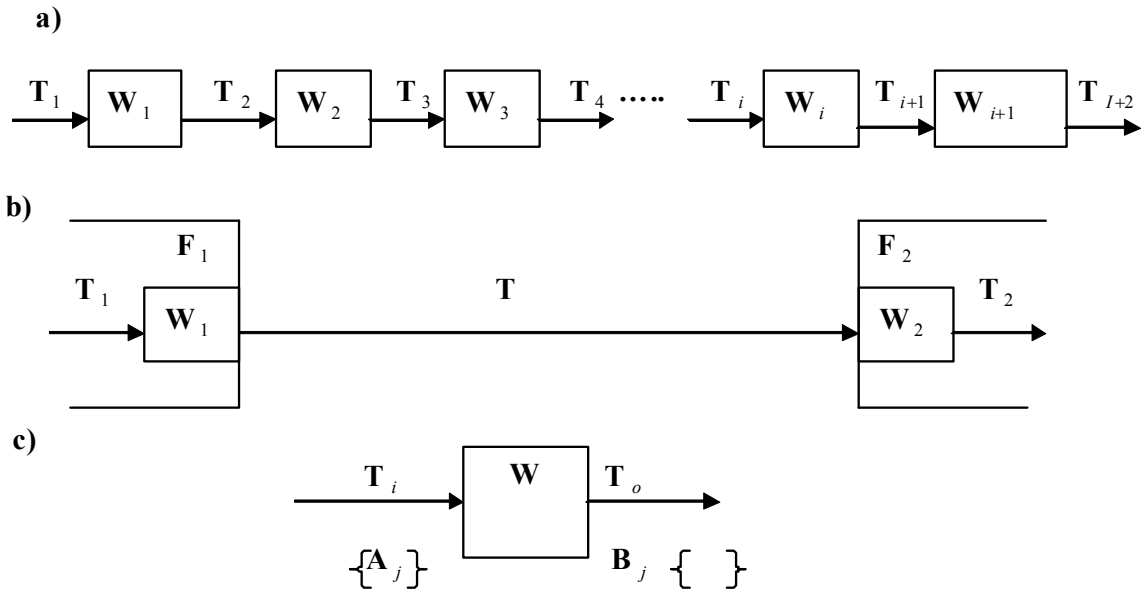

Figure 1. Logistic chain (a) with components - transport T_i and warehouses W_j, the simplest transport process (b) between two any facilities F_1 and F_2 with warehouses W_1, W_2 and scheme of warehouse W interaction (c) with in-bound transport T_i and out-bound transport T_o

Material flow, however, is characterized not only with this single parameter – the whole amount of cargoes, delivered to or dispatched from warehouse for a year, although this one is a very important one. Main other features of a material flow are as follows:

- amount of transport batches (these may be very different), arriving and dispatched from warehouse;
- number of different denominations of cargoes in transport batches;
- type and features of transport tare and packing of cargoes;
- type and features of freight transport units (pallets, containers), which cargoes arrive and dispatch in ;
- time of arrival and dispatching of transport batches, regularity and conformity of these processes to some rules;
- time intervals between arrival and dispatch of transport batches and their regularity.

Comparison of these characteristics of in-bound and out-bound goods flows display that they may be different from each other. So, although the whole amount of arrived goods to warehouse for some long period Q_i would be equal to the whole amount of dispatched goods from the warehouse Q_o for the same period, other elements of multitude (A_j) of in-bound flow parameters can not be equal to the appropriate elements of multitude (B_j) of out-bound flow parameters (see Figure 1c).

So, the warehouse changes or transforms some of the flow parameters, mentioned before. For example, amount of the transport batches can be changed from big to the small ones – if goods come to warehouses with big batches in heavy-duty long distance trucks and deliver to customers with small batches in little local trucks. At the same time the number of goods denominations in transport batches can lessen dramatically. Moreover, if the warehouse under consideration is of a Logistic Center type goods can be unpacked in it and stored in some other or even special tare, pallets or containers. In that case characteristics of packing and freight transport units can be transformed as well, when goods are retrieved from storage area and transport batches are prepared for delivering to customers.

Time characteristics of transport batches dispatched from warehouse also are different from these of transport batches, when the batches have arrived to the warehouse. This time difference creates term of cargo storage in the warehouse (τ), which is needed to receive requirement for this specific good, pick it from stock, pack and include in some transport batch for delivering to customer. Therefore, the storage of cargo is not some self-purpose, but

only one of many technological operations (about 40), which fulfilled with cargoes in warehouses.

The objective of these operations is to transform characteristics of material flow, as has been explained earlier. So, warehouses are organized in the points of transport networks, where transformation of material flows is necessary. But a question arises: why and what for this necessity appears?

Transport network consists of a number of different transport systems, with their specific constructions, performance, organization, functioning and sort of control. Going through these different transport systems cargoes, goods, products on their way from manufacturers to customers adopt specific characteristics of these systems.

So, flows of finished products come to factory products warehouse by means of inner factory transport with some multitude of parameters. These parameters are suitable for products manufacturing and industrial transport, but do not match to railway or outer road transport, that has to deliver these goods to Logistic Center or directly to a shop or super-market. And this multitude of the goods parameters can not be suitable also for these shop or supermarket (for example, in relation of amount of goods in the transport batches, their contents and goods denominations, dimensions of separate packages and parcels, time, type of transport tare and packing , time of dispatching, other conditions of goods delivering etc.).

Therefore, the finished products warehouse of factory has to transform the products flow so as it would confirm to all requirements of goods receivers. That will be its purpose and assignment – to adapt parameters of the goods flow outgoing from the warehouse for the best following transportation of the goods. In the same manner freight terminal at a railway station or maritime port, warehouse of a Logistic Center, warehouse of raw materials, semi-finished components at factory etc. can be considered.

To the warehouse of materials and unfinished components of a factory these materials come by rather big transport batches, in transport packages or containers and not very often (not every day, for example). These characteristics of the in-bound material flow almost always do not match the technological proceeding of factory that needs the raw materials and unfinished components to be supplied in lesser batches, completed according to technological process and delivered to the particular point in determined time. Therefore, the warehouse of materials and unfinished components should change the parameters of the material flow in such a way, that they in the most degree would appropriate to the needs of the technological process of the factory. So in this case the objective of the warehouse is to transform the flow

for the best consequent using of the materials and unfinished components, arrived to the factory.

So, we can declare that warehouses of various types and assignations are created in the points of interaction of different transport and industrial systems with an objective of material flow transformation for the best consequent transportation and/or using goods. Temporary storage and handling cargoes at the warehouses are just some of its proceeding operations, fulfilled for changing of parameters of the materials flows.

Transformation of material flow is only one side of a warehouse objective. The other one is to do this transformation with the most efficient way, i.e. with the least spending of 6 main resources, which we have in our real natural environment: space, time, materials, energy, labor and money. This part of the warehouse objective is reached by competent, professional projecting of the warehouse, which is known to experts in this field of knowledge.

According to TWS a warehouse should be analyzed (existent warehouse due to reconstruction) and created (new warehouse) as technical system, consisting of following elements-technological areas (see Figure 2):

- Area of unloading cargoes from transport, delivering them to the warehouse (unloading dock or depot) – UD;
- Area of temporary storage of cargoes, which arrived to the warehouse and for some reasons can not be received yet to authorized storage in the main stock (TSA);
- Area of reception and sorting of arrived cargoes with quantity and quality (RSA);
- Main stock area (MSA);
- Area or subsystem of picking and retrieval of dispatched goods (PRA);
- Area of picking and completing of orders with dispatched goods (PCA);
- Area of temporary storage and preparation goods for dispatching from the warehouse (TSD);
- Area of loading to transport cargoes, dispatched from the warehouse (loading depot) – LD;
- Inner warehouse transport, that moves cargo while processing between technological areas and therefore unites all these areas in a system (IWT);
- Subsystem of automatic control (SAC).

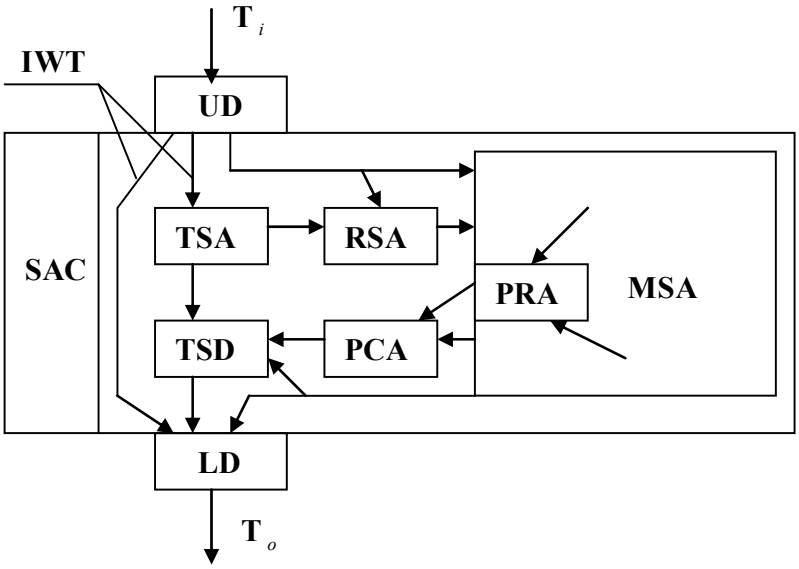

Figure 2. Structure of a warehouse as a facility for material flow transformation, consisting of elements - technological areas

Each of these components of a warehouse system has its own technology, equipment and purpose of functioning. But there is one general system objective, which all the components operate for. This is the united objective of creation of the warehouse – to transform the determined material flow in a specific way with the least spending of mentioned above six resources. That is known as synergetic effect in the General Theory of Systems.

While operating the warehouse system interacts with environment, which consists of a number of outward systems. This interaction with surrounding systems should be planned so as it helped the warehouse system to reach its main objective of material flow transformation.

Formalization of the Functioning of a Warehouse

Practically this interaction the warehouse system with the environmental systems represents mutual transferring material and informational flows, which make the warehouse to pass upon this influence from one its state to another. The number of these states may be very large, and they are characterized with types and amount of technological operations to be carried out at the moment, cargoes to be stored and processed, delivered to and from the warehouse, picked, sorted etc.

At the same time the state of the warehouse system influences on the busy condition of its personal, forklift trucks, cranes, conveyors, occupation of its stock, racking and other warehouse equipment. Ability of the warehouse system to be in some state W_i can be valued with its appropriate possibility $P(W_i)$.

Procedures of warehouse systems transitions from one states to the other ones are illustrated in Figure 3 in a simple form, where only 4 states are shown, which are explained also in Table 1.

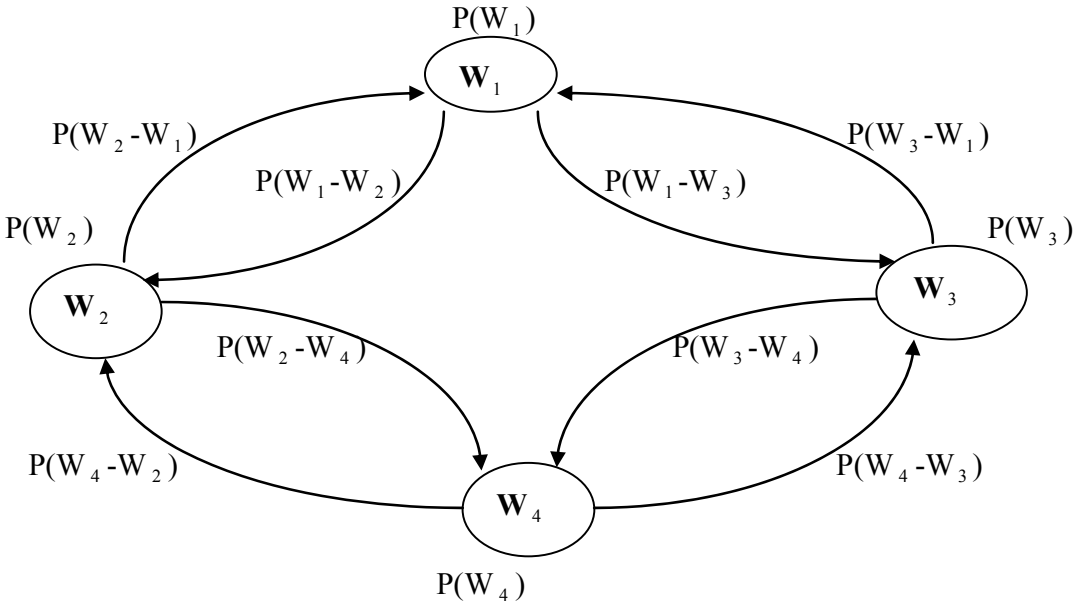

Figure 3. Graph of states and transitions of a warehouse system (4 states and 8 transitions illustratively) and their appropriate possibilities

Functioning of warehouse system can be represented in formulized sight also as a matrix of transition possibilities:

$$P_{ij} = \begin{vmatrix} P_{11} & P_{12} \ldots P_{1i} \ldots P_{1n} \\ P_{21} & P_{22} \ldots P_{2i} \ldots P_{2n} \\ \ldots\ldots\ldots\ldots\ldots\ldots \\ P_{j1} & P_{j2} \ldots P_{ji} \ldots P_{jn} \\ \ldots\ldots\ldots\ldots\ldots\ldots \\ P_{n1} & P_{n2} \ldots P_{ni} \ldots P_{nn} \end{vmatrix}$$

Possibilities disposed in the main diagonal of the matrix can be used for calculation of possibilities of remaining of the warehouse system in the same states. This method of formalization of warehouse system functioning can be used for its research and optimization.

Table 1. Main 4 states of a warehouse system (without taking into account inner warehouse operations)

Code of state	Description of states	Designation of states	Operations carried out		Possibilities of states
			Loads reception	Loads dispatch	
1.	There is no work at warehouse	W_1	0	0	$P(W_1)$
2.	Only unloading is fulfilled	W_2	1	0	$P(W_2)$
3.	Only loading is fulfilled	W_3	0	1	$P(W_3)$
4.	Loading and unloading are fulfilled at the same time	W_4	1	1	$P(W_4)$

Using this formal representation of the warehouse system activity, as shown here, it is possible to compute necessary quantity of material handling equipment, for example – fork lift trucks for a warehouse:

$$r = \sum_{i=1}^{n} r_i * P(W_i) \quad ,$$

where r - number of fork lift trucks or other equipment;

n - number states of a warehouse (in this example n = 4);

$P(W_i)$ – the Possibility of the i- state of the warehouse system.

Example of Application

Here is an example of application this method for computation number of forklift trucks under ever changing conditions of cargo loading and unloading at a warehouse (Table 2).

Table 2. An example of forklift trucks number computation at warehouse changing its states during operation

State Code i	Description of states	Hours of states T_i	State Possibility $P_i = T_i/24$	Trucks number in states r_i	Real trucks number $\sum r_i * P_i$
1	No work at warehouse	7	0,29	0	0
2	Only cargo unloading	3	0,13	5	0,65
3	Only cargo loading	9	0,37	3	1,11
4	Loading & unloading	5	0,21	7	1,47
	Total	24	1,00	-	3,23

It is necessary to equip the warehouse under these conditions with 4 forklift trucks. Results of the warehouse system operation should be compared with the objective having been set, while it has been projected. So, the main stages of analyzing or projecting a warehouse as a complex stochastic technical system are the following:

- Objective setting (it should be single);
- Selecting and determination of elements - technological areas (including options);
- Selecting and determination of warehouse structure, as various connections between system elements (including options);
- Research and analyze system functioning (including its simulation);
- Research and analyze system interaction with environmental systems (also with its simulation);
- Analyze results of the warehouse system performance and operation in comparison with the objective having been set.

3. Sphere of Application of the Methodology

In is interesting to point out that this general methodology can be used, while creating or analyzing other technical and social objects in various fields of industry or society, which receive a flow of some objects with one set of parameters, proceeds it through its structure and gives it away with some other values of parameters.

There are plenty such objects in many kinds of industries; trade, building, transport, social spheres etc. (railway stations, marine ports, parkings, garages, sport and cultural objects, shops and markets etc.). These objects do not produce some new products, but all the same are very useful and important in their sectors of economy and in logistics chains. Profound analysis, however, shows that all these objects are very alike in their nature and action and can be considered, created and optimized with the same approach. These objects may be named "transforming systems" and considered on the base of the same methodical principles, as warehouse and storage systems.

Certainly, for every specific kind of the transforming systems some more profound research and descriptions should be required, because of their wide variety and peculiarities. These scientific works and researches would allow to discover more features of this new methodology.

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Transportation System Selection in International Supply Chains - Case Russia

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Abstract
Specialization, higher competition and global markets have resulted on situation, where industrial companies need to transform their operating structures to more lean (efficient), but also being able maintain their agility (flexibility for changes in order that profitability is assured). According to previous research leanness and agility are not necessarily opposite paradigms in manufacturing companies. However, in developing economies implementing leanness, and having responsive logistics performance is characterized by fusion of macro logistics (governmental) and business logistics issues. Our four case studies verify literature findings, and shed some North-European and Russian perspective on the transportation system selection in developing economies.

In practice international supply chains in Russia need to compromise both in terms of leanness and agility. Currently road transport seems to be better able to serve the requirements of the customers in terms of frequency and speed. However, custom procedures reduce its efficiency. The unpredictability of the changes in custom procedures and location of customs facilities makes international supply chain planning more difficult. Currently railways are considered reliable but slow. In the future the share of rail transports will increase, there seems to be efficiency improvement potential by simply changing communication procedures.

Keywords: Lean production, emerging economies, transportation, Northern Europe

1. Introduction

Globalization has made increasingly difficult for companies to set out the tradeoffs inherent in their objectives; optimizing simultaneously productivity, profitability and cost efficiency in an effort to increase quality of operations and customer satisfaction (Agarwal 2006; Helo et al. 2006; Mahidhar 2005; Berg et al. 2005). Introducing liberalizing policies by governments enhance further the mobility of capital, and the state of competition that in turn create increase the level of uncertainty and risks involved in global manufacturing (Heynitz 2006; Helo et al. 2006). The essence and consequences of globalization on the international division of work within the context of production network has been investigated by Szekely et al. (2008). Our study concentrates on transport system selection in international supply chains involving developing economies – in our case Russia.

In this research work analysis is focused on several companies through a descriptive case study approach. Four enterprises examined represent different industry sectors all operating internationally. The aim is to gain insight in choosing transportation systems and the way they evolve in an international context. The empirical data needed is gathered from multiple sources, however, the greatest emphasis being on in-depth interviews in which a key person is

involved from senior management at the firms included in this scrutiny. Research approach is mostly qualitative, while some key quantitative measures are included in the case descriptions. We follow in this research work inductive research process.

This research is structured as follows: In the following Section 2 we review literature from lean production and the role of transportation in a networked global environment; our literature survey is also extended into developing economies to highlight problems faced by production networks in this context. Following Section 3 introduces used research methodology with respect of four case studies conducted. Thereafter, in Section 4 four cases are introduced, where first case represents Russian company operating in subcontracting industry followed by end product manufacturers from Finland. In the final Section 5 we conclude our work, and propose further avenues for research.

2. Literature Review on Globalized Production Networks

One of the main themes of industrial manufacturing today is supply chain integration. Lean thinking is arguably the dominant paradigm through which competitiveness is being achieved. Originally the concept was invented by Toyoda family within Toyota car manufacturing process, when internationalization and cash flow were the main themes during 60's – often the father of this system and thinking is argued to be Toyota car manufacturing executive during that period of time, Taichi Ohno. The primary goal for firms is to create lean enterprise organizational structure by eliminating all kinds of waste in the value chains (Papadopoulou et al. 2005; Berg et al. 2005). This management approach is used also in the service sector for example by banks, insurance companies, etc. The implementation requires a long period of time as the fundamental principles have to be absorbed by everyone in a firm from the operational level to the strategic one. The idea is to set up a close, but flexible integration layer between these two levels in an enterprise so that continuous improvements would be possible in business processes.

According to Szekely et al. (2008) there seems to be some confusion on how lean thinking is to be applied. These facts come through even research initiatives that have been carried out and the core issues are the lean and agile characteristics of supply chains (see Hines 2006, Papadopoulou et al. 2005). In theory the characteristics of lean against agile supply chain are seemingly clear, but at the same time in practice empirical studies illustrate a mixed picture (see Yusuf et al. 2004): Lean supply chain models at some point lead to greater flexibility and

less cost savings than the ones of agility oriented. It seems that the concepts of leanness and agility are of same cradle, but these theories are constantly under pressure of globalization and that is the path how the term “leagile” was born. As nowadays products and services merge in a growing extent and hybridization with mass customization are commonplace (see the automotive industry) production networks will become even dynamic and flexible. Intelligent business process software engines such as ARIS Platform by IDS Scheer AG will streamline and automate the lean enterprise so that with fewer resources one could achieve more output within a virtual environment setting (Gunasekaran et al 2008; Saad et al. 2007). In so inter-functional multi-skilled teams will have to take a central role in production networks (Davenport et al. 1990; Hammer 1990).

According to Naim et al. (2007) transport is a key function in the supply chain as it acts as a physical link between customers and suppliers, enabling the flow of materials and resource. A critical component in implementing lean production structures is an adequate transportation and logistics infrastructure (Vieillescazes, 2007). The degree of flexibility will be dependent on the environment in which the carrier finds itself in and is primarily based on the degree of uncertainties to be faced in customer demand, supplier performance, the carrier’s own internal processes and the transport infrastructure.

Wilson (2007) has investigated how disruptions in transportation affect supply chain performance. In the modelled five-echelon supply chain, the effect of interruptions depended on the location of the interruption and the ordering policy applied. According to the article shipping across international borders increases the risk of disruptions. Strategies for protecting against disruptions include holding additional inventory, finding alternative suppliers or routes and applying Vendor Managed Inventories.

According to Fearne and Fowler (2006) lean measures performance generally at the task level. However, given the complexity and uncertainty of most large construction projects, measures that improve efficiencies in specific functions may compromise the ability of the project to be delivered effectively. In construction (in)efficiency of transportation is measured in terms of the amount of lorry movements that involve part loads, the distance travelled and the amount of time spent waiting on-site. In some cases, however, the suppliers might not have sufficient number of orders to aggregate into a full load. Furthermore, waiting on site might be advantageous, if rush-hours in traffic can be avoided.

A study by Wu (2003) indicates that lean suppliers are not only able to reduce their inventory level significantly, but they also spend much less in emergency shipping and no more on routine shipping. In the US lean suppliers with an average distance of over 400 miles

can still achieve competitive logistics advantages. A large number or research on the inventory impacts of uncertainty has been conducted. However, research about supply chain uncertainty from a transportation perspective has been conducted on a conceptual level just recently (see Rodrigues et al., 2008).

Gulyani (2001) suggest that a poor transportation system affects total logistics cost in a supply chain not only directly through higher transportation cost but more importantly via high inventory levels which are needed to overcome the unreliability and inefficiency in supply. Furthermore Gulyani (2001) argues that a poor transportation system might lead to geographical clustering of manufacturing industries.

According to Towill (2005) bullwhip affects transportation capacity need more than the actual demand amplification is. The ideal from a lean perspective would be to stabilise demand and right size the assets accordingly. However, transport provision often has to be reactive to fluctuating demand and hence it makes sense to pursue horizontally collaborative solutions.

According to Baker (2007) inventory is a common risk mitigation strategy against the possibility of random demand variability and transportation delays. If transportation distances are longer, the typical transportation batch is increased. International supply chains may be particularly vulnerable owing to such factors as the geographic area covered, the transport modes used, political/border factors and environmental issues.

Currently hierarchical structured economical entities and extensive regulation by governmental agencies inhibits the positive externalities emerging from effective transformation of core industries of a society, such as transport and logistics management (Hilmola et al. 2008; Saad et al. 2006). In order to be able to utilize in a larger extent lean concepts it would be essential to have more direct foreign manufacturer or supplier relationships with local actors in a developing country. This might realized either through establishing foreign facilities in the regions targeted, or giving a chance for a foreign operator to acquire a manufacturer (supplier) / a set of manufacturers (suppliers) in a transitional economic area (Lorentz 2008). At the same time it is important to have more direct distribution channels and international supply chain partnership agreements within a context of promoting more open market policies by governmental agencies (Lorentz 2007). The set up of further international scale investment research projects along transportation corridors, while securing the finance for capacity investments as needed are also a priority from the viewpoint of waste and delay elimination (see Vieillescazes 2007).

3. Research Methodology

Four cases represented in this research work are outcome from the research project concerning intermodal transportation solutions within Southern Finland and larger St. Petersburg region in Russia (Leningrad oblast). Case companies from Finland and Russia were selected due to the reason that they have presence in target regions in sales, distribution and manufacturing terms. Finnish and Russian cases were completed with qualitative management interviews. Interviews in these cases took 1.5-2 hours, and were concentrated on transportation, transportation mode selection and distribution issues. Interviews were completed during spring 2008, and are the input for European Union funded project Lognet, which is funded by Tacis neighborhood programme. Three of the case companies in our research work are medium sized and not publicly listed, while one represents an organization being publicly listed, and has several billion USD size in terms of sales. The cases reported in this paper are verified by company management, in order that we have drawn correct conclusions from interviews.

4. Case-Study Analyses

Subcontractor Operating in Vyborg, Russia

Closed Joint Stock Company Trafo (ЗАО ТРАФО) was established in 1994. It is a foreign-owned Russian manufacturer of customer designed transformers and chokes for switching power supplies. It also subcontracts wire harnessing for numerous international Original Equipment Manufacturers (OEMs).

Trafo manufactures inductive components and performs electro-mechanical assembly. Company's clients include Nokia, ABB, Ericsson, General Electric, Elcoteq, Kone and Videoton (CJCS Trafo, 2008). The production facility is located in Vyborg, Russia, close to the Finnish (EU) border and the Imatra warehouse. As presented in Figure 1, all raw material travels through Imatra warehouse. Trafo sells worldwide, also raw materials are bought globally. Production is mostly exported to or via Finland, but some clients exist also in Russia. Sales management is located in Helsinki.

The company employees 30 people in administration, three at the warehouse and from 150 to 200 people in production, depending on the amount orders placed by their customers.

Distribution and tactical as well as strategic level decision-making of logistics is completed in Finland, basically in Helsinki and Imatra premises. Reason to operate in Vyborg is relatively simple - salary level of workers (mostly women - also the case in electronics industry in general) in production unit is ranging from EUR 300 to EUR 500 per month. This is very low for example in Finland equivalent workers salary is 6-8 times higher.

Company uses an integrated Enterprise Resource Planning (ERP) system supplied by SCALA (the brand name for Epicor Software Corporation in CIS-countries), to control activities, complete needed administrative tasks (purchase order, sales order, manufacturing capacity management) and inventories across its operations. This system can be accessed from Helsinki; Imatra and from the factory in Vyborg as well. The official documents related to the business contracts that are needed by custom officials are transferred to Kotka to DHL.

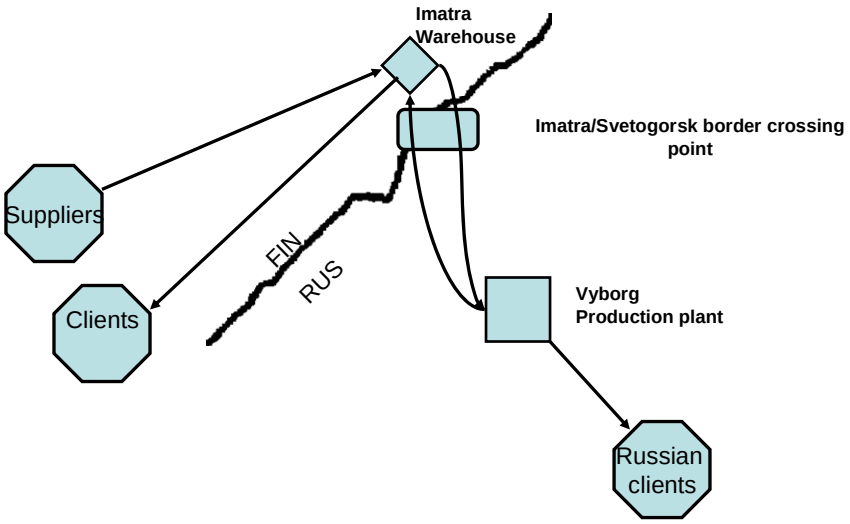

Figure 1. Component, semi-finished and finished product flows of the CJSC Trafo.

The company uses its own transportation fleet for transports between the Imatra warehouse and the production plant. In case of capacity shortage, additional transportation services will be bought from Vyborg. Own fleet consists of two smaller lorries with carrying capacity 1300 kg, one larger lorry with carrying capacity of 4300 kg, one 30 ton truck and four trailers. This enables that three trailers can be loaded or unloaded, while one trailer is on the road. The smallest vehicles are used mainly for transporting small size transformers and related items. For customer deliveries Trafo employs different transport service providers depending on the situation. Case company informed that during the last decade demands of

Finnish and international clients have changed in a way that more frequent deliveries are needed.

Trafo produces only to order. The monthly production volume does not change considerably during the year. Typically 90 percent of the raw materials in Imatra warehouse spend there less than a week. However, orders and deliveries in June, July and August are affected by the summer holidays. The production in this period serves the longer, up to one year orders, balancing the fluctuation of demand. In this case the orders placed by the customers are gathered together for a period of a month and only after that they are delivered. As a result there is increasingly limited space at the warehousing facility in Imatra towards the end of the summer.

The single biggest problem perceived by the workers at Imatra warehouse is the time needed for the flow of materials from Finland to Russia. In the month of May 2008, the eastbound vehicle transit was moved to the Imatra/Svetogorsk border crossing point. This has affected the waiting time on the border. Trafo has reacted by scheduling its transport to Vyborg for Mondays and Wednesdays. The time needed for transit from Imatra to Vyborg is usually approximately five hours and the return trip is made on the same day. These weekdays are chosen to avoid eastbound transit traffic queues, which are mainly concentrated on the weekends. In case of urgent deliveries smaller lorries are used as they are not required to wait in queue.

Border-crossing cargo has often difficulties with transported quantities, e.g. if documents inform that 1000 metal sheets are transported to Finland, and lorry is carrying 1001 sheets, transportation is severely interrupted and process bureaucracy is enormous and takes long time.

Furthermore, the lower salary does not directly translate on higher profits and efficiency. Benefits could be easily eroded with additional inspections, while control of production related operations in Russia is very intensive; customs, finance inspection, working conditions, fire department etc. frequently visit production facilities (for more see Hilmola, Abraha & Lorentz 2008).

Finnish Marina Industry Company Supplying Products to St. Petersburg and Russia

Steel end-product company Q-tech is a dynamically expanding global company specializing in marina and pontoon construction industry. Variety of solutions ranges from light timber pontoon to heavy breakwaters complemented by wide selection of marine accessories. The firm was established in 1994, in Q-tech Group there are altogether 16 subsidiaries employing

at the end of 2007 over 250 people. Production facilities are found in five countries: Finland, Latvia, Croatia, Portugal and United Arab Emirates, while their distribution network with dealer agencies covers 30 countries. Manufacturing factory is about to being launched in Turkey and sometime in the future significant investments into a production site are expected also in Russia.

The company minimizes its costs incurred by complex project oriented orders by employing manufacturing to stock, based on forecasts made in early winter and covering three-four months until the summer, which is the busiest time for pontoons. The production capacity is fixed to a specific level and is used in a stable manner all through the year. The components needed for products are transported in small batches in a continuous manner to the place of assembly and to stocks as needed. For example, from Finland to Latvia every week two to three trucks are loaded with components and final products. There is only one exception: Russia to where customers are obliged to search for the transportation service on their own.

Besides these measures evaluations are carried out in each delivery concerning the quality – cost dimensions of transportation service offer and by opting for the most optimal one available on the market. All the transportation planning tasks are assigned to one person. In addition there is a plan to take into full scale use in the near future the enterprise resource planning system of Microsoft Navision that will lower the costs of coordination inherent to production and transportation. As the diffusion of the company will be based on organic growth and acquisitions of other producers, there is a great need for an agile process of supplier and producer collaboration platform, which could be based on Collaborative Planning, Forecasting and Replenishment framework. The final objective is to reach a state of flexibility, where it is possible to launch order fulfillment strategy of *engineering to order* (ETO). At Q-tech currently the distribution, manufacturing and sourcing activities are implemented regionally, while the predominant buffering method is keeping stock at premises of dealers. At the moment the supply chain structure in which Q-tech is part of can be seen as "*modularized*", i.e. with high level of modularization, but low level of postponement (see Figure 2 in below).

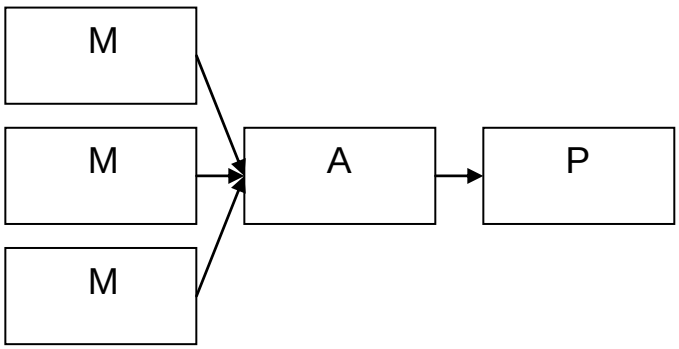

Figure 2. Supply chain structure of Q-tech (M = manufacturing, A = Assembly, P = Packing). Source for reporting structure: Tuominen et al. (2006: 44)

Within the next five years the majority of production is going to be transferred to lower labor cost countries such as Russia and Turkey, near to emerging potential markets to minimize the distance between suppliers and the final customers. In so the majority of final goods will be distributed to Mediterranean Sea region and Russia at the beginning of the summer, while components will be supplied during the winter from Portugal, Latvia and United Arabic Emirates. The entities in Finland will take more of role of a coordinator and will be a place mainly for research and innovation activities.

On land the only transportation mode is the truck, while on longer distance sea vessels are occupied. Railway is not used at any extent though in theory it should be quicker than sea transport and more environmentally friendly causing less congestion than the road. No transports vehicles in the ownership of the company exist. The trucks or vessels needed are accessed through leasing contacts. For not opting rail, the main reason is that the components pertinent to marina or pontoon solutions are sensitive and have special requirements with regard to conditions during transferring that are not met by rail wagons. In addition it was indicated that rail can not integrate cost efficiency with flexibility in relation to delivery.

Finnish Metal-manufacturer Supplying Products to Construction and Mechanical Engineering Industries in St. Petersburg and Russia

The case company supplies metal-based components, systems and integrated systems to the construction and mechanical engineering industries. The company has operations in 26 countries and employs 15,000 people. Net sales in 2007 were EUR 3.9 billion in total. According to the annual report for 2007, 21 percent of the net sales are from Central Eastern Europe, Russia and Ukraine.

The company has a steel works in 12 production facilities in Finland, Sweden and Ukraine. Local production and insight into building practices translate into speed, quality and delivery accuracy. Investments aim at providing total deliveries of highly prefabricated construction products made near the customer. The company considers delivery accuracy to be one of its strengths. According to the company Russian customers expect a high service level.

In Russia the company imports its products to St. Petersburg and Moscow itself and sells them locally. The customs procedure requires that the products are physically transported to the customs area. It is also possible to transport the products further to their customer without an additional unloading/loading procedure. On the other hand, the terminal area can be used to refinement of the products. In summer time the volume of exports to Russia is around 60 trucks loads per week. Roughly 40 of these are transported to St. Petersburg, while the rest go to Moscow. The road transport is outsourced. The company uses several transport companies and signs long term contracts.

The main material flow between production facilities is concentrated between Southern Finland and Ukraine, which is served by a train connection through Russia. The distance is 2400 kilometers, the travel speed of the trains is around 300 kilometers a day. The annual volume transported on the route is currently 20-30 000 tons. A one day decrease in the turn time of wagon would equal a 6 000 tons transportation capacity increase. Materials are partly transported to both directions; raw materials and ready products. The order lead time of a train on the route is 2 weeks, as the international information exchange between the countries involved is based on sending faxes. Special wagons used in rail transport and they are long time contracted by the company. Basic coal wagons with wooden fittings require a lot of time and expensive fitting materials. Furthermore, the timber supports does not always last the coupling procedure of the wagons used in Russia.

The company is satisfied with the service offered by the railways including handling of documents and tracking services. The company considers that train has an advantage over road transports on distances over 200 kilometers. One advantage of rail transports is the avoidance of traffic jams on the border, while the main challenge facing rail transports is communication and lack of unloading terminals. A potential way to speed up the total travel time has been carried out by organizing the import customs procedure. The information about an arriving train should of available to all parties in the terminal. This could enable the seamless collaboration of the different parties: cranes, custom officers and the local station officer. The overall efficiency of train transports would improve, if terminals would have rail

access. The rail transport system lacks an inbuilt incentive system to ensure the improvement of the lead time of the wagons. Whereas in road traffic the driver companies the vehicle, rail wagons can be left on the tracks.

Finnish Steel-combination manufacturer Supplying Products to Construction Projects in St. Petersburg and Russia

The case company, a Finnish steel-combination manufacturer supplying products to construction projects in St. Petersburg and Russia, was established in the 1980's. In 2007 the turnover of the company was 81.3 million euros, the company has 260 employees. The majority of the turnover comes from Finland and Sweden, while Russia accounts for 5-15 percent of the turnover. Steel frames are the largest product category. The annual production volume of the company is 20 to 30 thousand tons. The company has several production plants in Finland and Sweden. Currently no production capacity in Russia exists.

Logistics cost is taken into account already in product design phase. The products are configured for each project. In the design, the dimension of the modules and the total load carried by each vehicle needs to be considered. For Russian road traffic, it takes up to 3 weeks to receive a permit to transport oversized loads. Permits are costly and are granted for a specified vehicle.

The company does not own transportation equipment. Transports to St. Petersburg and Moscow are completed using road transports. For loading of trucks the company reserves 1 day, for unloading at the site 2 days are reserved. The turn to Moscow takes a week, two trips to St. Petersburg can be made in a week. The transportation companies are selected for each project separately. The company aims at fixing the transport price for each project for the whole life time of the project.

The company considers delivery lead time, reliability of delivery and the quality of planning to be their strengths. Construction projects follow a weekly schedule and products are delivered to the site according to JIT-principle. There is no storage after production. However, if the site requires similar components over a longer period of time, they may be produced in a batch, and stored temporarily at the production facility. Typically detailed planning is still ongoing as building on the site has already begun. There might be several projects on the way at the same time.

The company completed recently a production facility project, which production phase took four months and required over 200 truckloads. Although rail has been used for more distant destinations (Almaty), rail transports do not fulfill the requirements of construction project in terms of flexibility. Furthermore, often the projects locations do not have access to railroad and additional handling of the products harms the products.

5. Discussion

In Table 1 a summary of the transport strategies of the case companies is presented.

Table 1. Summary of the transport strategies of the case companies

Case company	Subcontractor	Marina Industry Company	Metal-manufacturer	Steel-combination manufacturer
Transportation mode	road	customer takes care of delivery, typically road	road except rail for the flow between two manufacturing units	road
Fleet ownership	in procurement and distribution outsourced, own fleet between warehouse and production	customer takes care of delivery	road outsourced, owns some rail wagons	outsourced
Challenges	lengthy customs procedure at border	varying transportation requirements	delivery lead time	special transports costly and reduce flexibility
Adaptation strategy	transports in the beginning of the week, use of smaller vehicles	customer takes care of transportation	improving information flow	product design
Considerations of alternative modes	might use rail in the future	rail not considered due to lack of flexibility and product sensitivity	railway access a criteria for new locations	rail lacks flexibility and access, additional handling harms products

Considering the large population of the St. Petersburg area exceeding 6-7 million inhabitants and the huge market and labor force potential offered by it, the across-border business networks and subcontracting possibilities have not yet been realized by the Finnish companies. Furthermore, some of the companies let their customers to take care of transportation.

The speed and reliability of the transports and on the Finnish-Russian border could be improved by a block train connection between Vyborg, Russia and South-Eastern Finland. Such improvements in the infrastructure would enhance regional collaboration by strengthen manufacturing networks of even smaller sizes.

6. Conclusions

Based on the interviews conducted in the case companies, the recent development and economic growth in Russia has affected the transportation sector. The customer requirements have currently set higher standards in terms of speed, frequency and reliability of delivery. Currently road is the preferred transportation mode over shorter, up to several hundred kilometer distances.

On the Russian transportation market road transports are typically outsourced. Only one of the case companies owned road transportation capacity. The company used this fleet to serve the critical 2-way material flow between the warehousing and production facilities. Because the material flow is stable the utilization of the fleet is high. Also this company relied on outsourcing other road transportation tasks. As the Russian road transportation sector is highly competitive, transport companies and prices are reviewed on regular basis. However, in case of longer projects, the aim is to reduce the risk by fixing prices for the duration of the project.

Custom clearance and documentation requires special attention from the companies. If the cargo does not equal the documents exactly, delay might be incurred. Based on the interviews, some companies have adapted their weekly transportation schedules to minimize queuing on the border. In urgent express deliveries, smaller vehicles are used to avoid queues totally. The customs procedure and the nature of the competition on Russian road transportation sector affect the service portfolio of some smaller companies. In case of the pontoon manufacturer, the customer takes care of transportation. On the other hand, the metal manufacturer

interviewed imports it products to Russia and sells them locally; as it wants to be develop a local brand.

In some industries, the legislation concerning road transports affects already product planning. Oversized transports require special permits. These costly permits reduce the flexibility of transports as the lead time getting such permit can up to 3 week. In case of vehicle break-down these can lead to reduction in reliability as each the permit is load and vehicle specific.

The companies see rail as a reliable, but inflexible transportation mode. Its applicability is reduced by limited of access of the railway network. Thus, additional handling is required, which in turn increases cost and risk of damage. In some cases, the Russian train building procedure adds to the damages of the cargo; the wagons are connected at a speed of 5 km/h. Currently rail is favoured by larger and continuous material flows over longer transport distances. Companies consider rail transports as an option for transportation in the future – also over shorter distances. Even a 35 km leg could be served by two weekly block trains avoiding customs queues on the road. Another of the case companies uses access to rail network as a selection criterion when choosing new terminal locations.

In practice international supply chains in Russia need to compromise both in terms of leanness and agility. Currently road transport seems to be better able to serve the requirements of the customers in terms of frequency and speed. However, custom procedures reduce their efficiency. The unpredictability of the changes in custom procedures and location of customs facilities makes international supply chain planning harder. Currently railways are considered reliable but slow. In the future the share of rail transports will increase, there seems to be potential efficiency improvement by simply changing communication procedures.

The Russian economy is growing fast. Typically the volume of transports rises even quicker than GDP (Quinet & Vickermann, 2004). The Russian government supports this development by investing heavily in infrastructure. In order to be able to improve the platforms for more sophisticated lean manufacturing networks, developing economies first have to implement liberalizing reforms into core industry sectors, such as transportation and logistics. The success of international supply chains on Russian territory will partly depend on how investments and changes in procedures affect both the speed and the reliability of the flow of traffic on the borders. According to Quinet and Vickermann (2004) the level of economic development is connected to level of transportation infra- and infostructure. Russian and Chinese markets are so attractive that enterprises are not afraid of investing more in those developing regions of the world. It will be interesting to see if the Russian initiative

in improving the national transportation system will further increase the polarization of regional industrial development between the large metropolitan centers of Moscow and St. Petersburg against the rural areas. (See Quinet & Vickermann, 2004; Guliani 2001)

As a further research in this area, we have intention to continue with the topic of transportation documentation in the cross-border area – this was identified as one stepping stone in the company interviews. This does not only concern transit import to Russia, but also export of items and then items, which start from Finland continue to Russia to be processed and thereafter return to Finland for packaging and final delivery. During the last decade time border traffic has concerned mostly import of item to Russia through EU harbours and transportation systems overall, but in the near future this flow could turnaround favouring more industrial needs and outbound traffic from Russia to Europe rather than other way around.

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Research Note: New in Heat Engineering Calculations of Refrigerator Transport Modules

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Definition of amount of heat or power of the thermal stream acting in a cargo placement of the isothermal transport module (the car, the container) from an environment and a cargo, concerns to heat engineering to calculations. Such calculations are necessary at the decision of various design and operational tasks of refrigerator transport to which it is necessary to carry:

- Definition of settlement thermal loading on the designed refrigerating-heating equipment of refrigerator transport modules (RTM).
- Definition of thickness heat-insulated a material in protecting designs of cargo placements.

The analysis and forecasting of the probable reasons of infringement of conditions of the transportations leading damage of products. Estimation of extreme conditions of transportation of a cargo (failure a diesel engine-generator, refrigerating or heating installation, revealing of the reasons of infringement of a temperature mode):

- Establishment of deadlines of transportation of perishable cargoes in transport modules.
- Definition of the actual charge of diesel fuel in economic calculations (definition of spheres of rational use of transport modules in various modes of operation, including the conditions of the transportations, which have been not stipulated by normative documents).

In all heat engineering calculations consider influence of random factors on heat-exchange processes in system *an environment - the transport module - a cargo*, for example, fluctuation of temperature of external air, a direction of a wind, etc. For the account of these factors at definition heat gain usually apply the likelihood approach providing demanded (depending on an object in view) reliability of calculations**.**

So, in calculations of power of heat arrival for the design purposes usually consider the limited quantity casual and even not casual factors. Therefore for such purposes reliability

heat engineering calculation undertakes in high limits (0.98 … 0.999) that results have turned out overestimated.

The decision of operational and economic tasks sometimes demands performance of more exact heat engineering calculation. Here high reliability of calculation is not meaningful. Accuracy of calculation consists in necessity of the account and formalization of group of the important factors on which essentially depend speed of course heat-exchange processes in a cargo placement of the transport module and, accordingly, results of calculation of power of thermal streams. It is necessary to carry to such factors:

- Temperature pressure (a difference in temperature of external air and average value of the appointed temperature mode of transportation);
- Actual temperature of a cargo before loading;
- Amount of a cargo;
- Degree of density of a stack and porosity of container;
- Intensity of the biochemical heat allocated by fruits and vegetables;
- Type of the transport module and system of distribution of air in cargo placements.
- Kind and mode of air circulation in cargo placements;
- Factor of a heat transfer of protecting designs of cargo placements;
- Falling of power of refrigerators at heats of external air;
- Actual service life of the transport module, etc.

The degree of influence of these factors for speed of course of heat-exchange processes untill now is poorly investigated. It creates the certain difficulties in performance exact heat engineering calculations by transportation not cooled fruits and vegetables.

It is necessary to notice, that in Russia volumes of rail transportation not cooled fruits and vegetables reach 100 % especially during mass preparations (July - September). It is caused by absence in points of preparation of fruit and vegetable production of infrastructures, which would provide appropriate preparation of a cargo for delivery, including refrigerating processing. The reason for that is the heritage of according to plan-distributive system of managing in the former USSR. In the pre-perestroika period the Soviet government purposely did not finance manufacturers of agricultural production on development of procuring refrigerators with the purpose not to allow independently disposing of the grown up crop.

Therefore by working rules of transportations of perishable cargoes the temperature of fruits and vegetables, shown to transportation in RTM, is not normalized, and cooling of such

cargo along the line is obligatory. It leads to additional power resources on cold supply which in RTM manages in six and more times more expensively, than in stationary refrigerators.

Also it is known, that power expenses for work of diesel engines and refrigerating machinery at cooling fruits and vegetables in a way make 70 % and more from the general expenses of a cold for repayment of all external and internal heat arrival. They directly are connected with conditions of course heat-exchange processes in system *an environment - RTM - a cargo* and determined, as a rule, on the basis of exact heat engineering calculations. Power of a thermal stream from fruits and vegetables at cooling usually determine under the known formula:

$$Q_{\Gamma} = \frac{\left(C_{\Gamma} G_{\Gamma} + C_T G_T + C_{c.\Pi} G_{c.\Pi}\right)\left(t_{\Gamma.\Pi\Pi} - t_E\right)}{3600\tau_{\Gamma}}, \qquad (1)$$

Where $C_г$, $C_т$, $C_{с.п}$ — accordingly a thermal capacity of a cargo, container and means of packing of a cargo, Kjoule / (kg·°C); $G_г$, $G_т$, $G_{с.п}$ — accordingly weight of a cargo, container and means of packing of a cargo, kg; $t_{г.п.п}$ — temperature of a cargo after loading,°C; $t_в$ — average value of a temperature mode of transportation, °C; $\tau_г$ — duration of cooling of a cargo (in this case fruits and vegetables), h.

In expression (1) initial parameters, except for $\tau_г$, always it is possible to measure all, and size $\tau_г$ can be determined only in speed of cooling of a cargo which, long time did not give in to formalization as above listed factors on which it depends, practically have not been investigated. Therefore, at definition of power of a thermal stream from fruits and vegetables at cooling value $\tau_г$ always accepted equal 60 h according to the maintenance instruction five-carload refrigerator unit and independent refrigerator cars. This specification has been established as average for given types RTM by practical consideration half a century back with reference to conditions of transportation of not cooled fresh fruit in quantity 25-30 ton gross with reference temperature 18-20°C. Fruit kept within in board boxes and were placed in cars by an air-penetrable stack. Skilled transportations it was carried out during the summer period of year at day time external temperatures 15-25°C. The traditional approach to definition of power heat arrival from a cooled cargo in RTM can be justified complexity of formalization of calculation $\tau_г$.

Results of supervisor-experimental transportations of the perishable cargoes lead by scientists of PGUPS-LIIGT during with 1983 on 1994 on five-carload refrigerator units

different types, have shown, that actually duration of cooling fruits and vegetables $\tau_г$ essentially differs from applied in heat engineering calculations of normative values up to five times in greater side. Besides, has been established character of repayment of heat gain by refrigerating machinery. So, by the first it is always repaid heat gain from working fans-circulators. Then are compensated heat gain through protections of a body of the car, including solar radiation, and due to infiltration of an air. Own weight of the car is cooled. Simultaneously with it, but less intensively, heat gain are repaid from "breath" of a cargo and due to its thermal processing. And the cargo is extremely slowly cooled, if it is shipped by a dense stack.

Example. In 1985 supervisor-experimental transportation of not cooled early potato in five-carload refrigerator unit of construction of the Bryansk machine-building factory between station Manuela (former Transcaucasian railway) and station Vyborg. Production delivered on station motor transport directly from a field in grids with temperature 19°C. Loading string bag in cars was carried out on special conditions by a dense stack with preliminary stacking empty boxes on floor lattices (Fig. 1). The cargo followed up to Vyborg 13 day at a temperature mode 2 … 5°C. On an unloading the temperature of a potato has made on edges of a stack 5 … 7°C, in the center not below 12°C. Actually the cargo was not cooled up to demanded parameters.

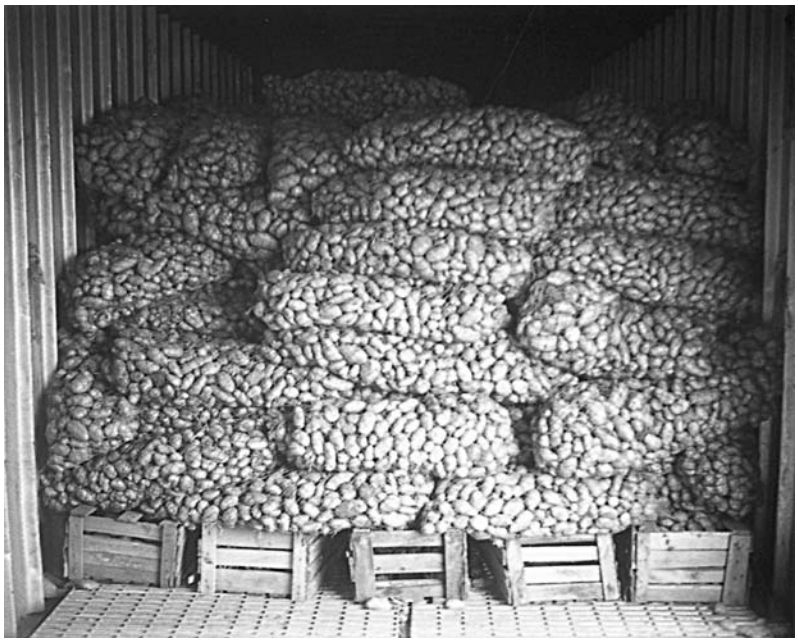

Figure 1. Stacking of a potato in string bag on special conditions.

This example unfairly overestimated results of calculation needed powers energy and a refrigerating machinery prove to be true if to use average specification $\tau_г$ = 60 h. The

multifactor analysis and generalization of results of supervisor-experimental transportations have allowed formalizing calculation $\tau_г$ by means of empirical expressions and the factors resulted below. Thus three new characteristics of heat-exchange processes have been revealed and formalized at cooling a cargo in a way:

- Speed of initial cooling of free air in a cargo placement ($b_в$), °C/h;
- Speed of heat emission of a cargo ($m_г$), °C/h;
- Speed of cooling of a cargo ($b_г$), °C/h.

Speed of initial cooling of free air in a cargo placement of the transport module can be determined under the empirical formula:

$$b_в = \frac{14.1\ k_м \cdot k_б}{(0.32 + q_{бр}) \cdot k_ш \cdot k_т}; \qquad (2)$$

Where numbers - the empirical factors received by statistical data processing of supervisor-experimental transportations of perishable cargoes; $k_м$ — the correction empirical factor considering change of speed of cooling of air by refrigerators from a temperature pressure through protections of a cargo placement; $k_б$ — the same, from a degree of biochemical thermal emissions of fruits and vegetables; $k_ш$ — the same, from a degree of density of a stack of a cargo; $k_т$ — the same, from a degree of porosity of container; $q_{бр}$ — technical norm of loading of the car or the container, ton gross (in view of weight of container and means of packing).

Correction factors used in the formula (2) consider influence of various factors on speed of course of heat-exchange processes in cargo placement of RTM. Their sizes also are certain by statistical processing skilled data. So, the factor $k_м$ considers influence of temperature of external air and power of refrigerating machinery depending on it for speed of cooling of air and a cargo in the transport module, its size can be calculated under the formula:

$$k_м = 6.364 \cdot 10^{-2}\ (\Delta t_м - \Delta t_р) \cdot exp\ (-0.1 K_р \cdot \Delta t_р),$$

Where numbers - empirical factors; $\Delta t_м$ — the-maximal temperature pressure through protections of body RTM at which useful work of refrigerators stops, $\Delta t_м$ = 55 … 70 K (depending on type of the car and year of its release); $\Delta t_р$ — a settlement temperature pressure

through protections of body RTM (a difference between settlement temperature of external air and a temperature mode of transportation,), K. With $\Delta t_р = \Delta t_{м.}$, $k_м = 0$; $K_р$ — settlement factor of a heat transfer through protections of cargo placement RTM, Wt/(м^2·K):

$$K_р = K_{р.п} \cdot \mu_о,$$

Where $K_{р.п}$ — passport value of settlement factor of a heat transfer, Wt / (м^2·K); $\mu_о$ — the factor considering change of properties of protecting designs of cargo placement RTM due to speed of movement, change of properties of insulating materials in time, accuracy and disorder of values of factory parameters insulating materials, a temperature pressure, speed and a direction of a wind. Influence of these factors is considered by reliability *(P=0.90)*. Size $\mu_о$ can be determined:

$$\mu_о = exp\ (0.85P^4)$$

The factor $k_б$, considers change of speed of cooling fruits and vegetables from intensity of biochemical heat allocated by them, it can be determined under the formula:

$$k_б = 1.05\ exp\ (-6.1 \cdot 10^{-4} q_б),$$

Where numbers - empirical factors; $q_б$ — average power of thermal emissions by fruits and vegetables during cooling, Wt/ton:

$$q_б = \frac{q_о\ [exp\ (\chi \cdot t_{г.н}) - exp\ (\chi \cdot t_{г.к})]}{\chi \cdot (t_{г.н} - \chi \cdot t_{г.к})}, \qquad (2)$$

Where $q_о$ — specific thermal emissions of one ton of fruits and vegetables at temperature 0°C, Wt/t; χ — temperature factor of a cargo, K^{-1}; $t_{г.н}$ — temperature of a cargo in the beginning of transportation, °C $t_{г.к}$ — the same, in the end of the transportation, accepted equal to average value of a temperature mode of transportation, °C.

The factors describing change of speed of cooling of a cargo from a degree of density of a stack $k_ш$ and porosity of container $k_т$, determine under formulas:

$$k_{ш} = 0.4 + 2.2\ (1 - \rho_{ш})^{0.8};$$

$$k_{т} = (0.36 + 1.6)^{0.2},$$

Where numbers - empirical factors; $\rho_{ш}$ and $\rho_{т}$ — accordingly a degree of density of a stack of a cargo and a degree of porosity of container, a share of unit (Tab. 1 and 2). Speed of heat emission of a cargo $m_{г}$ and speed of cooling of a cargo $b_{г}$ can be determined under formulas:

$$m_{г} = \frac{2.94\ k_{ш} \cdot k_{т}}{1.9 + q_{бр}},$$

$$b_{г} = m_{г} \cdot k_{м} \cdot k_{б} \leq m_{г},$$

Table 1. The characteristic of density of a stack of a cargo

Kind of a cargo, container and means of packing, way of formation of a stack in a cargo placement	The Degree of density of a stack ($\rho_ш$)
Not packaged cargoes in bags and the grids, laid:	
Dense stack	1.0
Upright in some circles	0.9
Not packaged cargoes in the wooden and cardboard boxes, laid:	
Dense stack	
Is dense-vertical stack	1.0
Vertical stack with a lining lath	0.9
In the chess way	0.8
	0.7
Not packaged fruits and vegetables in boxes-trays	0.5
Not packaged cargoes in flanks, cans, drums, tubs and flaskes capacity:	
Up to 50 l	
50 … 100 l	0.8
From above 100 l	0.7
	0.6
Meat frozen in carcass, half-carcass, quarters, and also in a sling-packages, laid by a dense stack	0.9
Meat cooled in carcass, half-carcass, the quarters, suspended on hooks of the car, the container	0.2
Cargoes in packages at dense loading with use:	
Box pallets	0.7
Rack-mountable pallets for tare cargoes	0.8
The same, for the cooled meat	0.3
Flat pallets with factor of filling of the pallet 1,0	0.9
The same, with factor of filling of the pallet 0,9	0.8
Cargoes in packages at is dense-vertical loading with use:	
Box pallets	
Rack-mountable pallets for tare cargoes	0.6
Flat pallets with factor of filling of the pallet 1,0	0.7
The same, with factor of filling of the pallet 0,9	0.8

Table 2. The characteristic of porosity of container and means of packing

Kind of container and means of packing	The Degree of porosity of container ($\rho_т$)
Box closed continuous from a cardboard and plywood without apertures for ventilation of air	0
The same, with apertures for ventilation of air	0.10
Box plywood closed from board by slat with gleams for ventilation of air	0.15
Box veneer sheet-cardboard closed	0.25
Box closed from board by slat and veneer sheet with gleams between rods no more than 1 sm	0.30
The same, with gleams 2 … 3 sm	0.40
Box-tray wooden opened	0.80
Bags, fabric	0.20
The same, paper	0.10
String bag kapron, cotton-fibrous and jute at stacking upright with gleams for ventilation	0.9
The pallet box from a cardboard and plywood without apertures for ventilation of air	0
The same, with apertures for ventilation of air	0.10
The pallet box metal-wood, collapsible	0.60
The pallet box collapsible mesh with a cover or without a cover	0.9
The block-package in impenetrable polymeric shrink-wrap without apertures for ventilation of air	0.10
The same, with apertures for ventilation of air	0.25
The cargoes transported without container and packing	1.0

Speed of heat emission of a cargo $m_г$ is the characteristic limiting speed of cooling of a cargo, $b_г \le m_г$. By means of characteristics $b_в$. and $b_г$ it is possible to determine duration of initial cooling of air ($\tau_в$) and a cargo ($\tau_г$) in cargo placement RTM, h:

$$\tau_в = \frac{t_{в.п.п} - t_в}{b_в};$$

$$\tau_г = \frac{t_{г.п.п} - t_в}{b_г} \qquad (3)$$

Where $t_{в.п.п}$ — temperature of free air in cargo placement of RTM after loading, ^{o}C. Its value can be accepted equal to temperature of a cargo after loading ($t_{г.п.п}$), as after initial circulation of free air in a cargo placement of temperature of air and a cargo are levelled. Substituting the formula (3) in expression (1) we shall receive:

$$Q_г = (C_г \cdot G_г + C_т \cdot G_т + C_{с.п} \cdot G_{с.п})\, b_г\, 3600^{-1}.$$

Materials resulted in article allow in a complex and to solve authentically tasks of research character at modeling of heat-exchange processes in system *an environment - a cargo - RTM*.

Using of the Technique Expert Method to Diagnose the User Interface of the Railway Transport

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Abstract
The widespread use of information technologies and systems software allows JSC «Russian Railway» occupy leading positions in the field of transport. The specificity and relevance to software decisions on the railways requires maximum use of all available technology to date. However, the result of the use of computer technology depends not only on functionality decisions, but also on the quality of software products. A lot of media system of information presentation and interaction between them in various ways affects perceptions and thinking of the user. Specific characteristics of multimedia are potentially heavy perception, structural and semantic complexity, a large amount of information transmitted through the system. Juggling presented in multimedia applications of information are often an integral part of the user. Thus, there is an urgent need for expert evaluation and testing of user interfaces with respect of all different kind of software used on railway transport. The proposed methodology for assessing user interfaces is designed to solve this problem. Its application to such systems as «ETRAN» and «ALS» showed possibility of improving their users interface with respect of working hours, on average, more than 50%. A systematic approach to the use of techniques to assess user interface allows user to achieve the following objectives: substantial savings in using the software, the savings by reducing training time and errors in the usage phase, increased efficiency of systems, reducing the negative emotions of the user, increased productivity of the systems and increased ease and comfort of use with the product.

Keywords: ICT, ACS, international traffic, information interaction, Common Information area**.**

The widespread use of information technologies and systems software allows JSC «Russian Railway» occupy leading positions in the field of transport. The specificity and relevance to software decisions on the railways requires maximum use of all available contemporary technology. However, the result of the use of computer technology depends not only on the functionality decisions, but also on the quality of software products. A lot of media system of information presentation and interaction between them in various ways affects perceptions and thinking of the user.

One of the recognized world approaches to the design software is UML. The process of manufacturing software (Software Engineering Process, SEP), also known as the process of software development (Software Development Process), which determines *what*, *when* and *how* is in software development. This is a process, in which the user requirements become

available software systems. Unified Process software development (Unified Software Development Process, USDP) – this is SEP from authors of UML. Usually it is called the Unified Process or UP.

Draft UML was creating to provide both visual language, and the production process of software. What is known as UML process, is illustrative part of the project, and UP, a process. Please note that the UML has been standardized, but UP is not. Therefore, there is no SEP standard for UML. Thus, there is no single global standard for the development of software (under the concept of UML). Each company should have to create internal developing documents regulating the process. This situation became for several reasons: firstly, IBM Rational Software – in practice is the exclusive company that clearly describes the entire production cycle for the production of software (IBM Rational Unified Process), identified all possible types of documents accompanying the draft, and which set up all roles strictly (input / output documents, Templates of documents, etc.) of each project participant. Meanwhile, not so many companies have gone down this path.

The lack of unity and unification in the process of producing software leads to negative consequences. In this way we have any GOSTs and ISO for the documentation requirements, technical tasks and to own software package, but they mostly reflect the functional side. Thus, GOST 24.103-84 «Automated control system Guidelines» does not regulate the requirements for the user interface. For another hand IBM RUP pays much attention for the user interface. The only document regulating the ergonomic impact of user interfaces in Russia is SanPiN (sanitary regulations and standards). However, no requirements for usability of user interface SanPiN exist. The ability to make decisions about final visual mode is on the software developer.

Often, software developer makes a choice of user interface build on standard solutions. Using into their development powerful software tools, is no guarantee of a positive result. The limitations of such support systems based on traditional paradigms limits the functionality of the final product.

Today the methods used to develop projects is not usually considered the need to develop user interface. This omission may be consequence to the fact that experts in the development of interfaces are involved in the project too late, when the possibility of improving the quality of interaction between the user and the product in most part is already lost. Interface suited to deal with it in the early stages of development. And if the professionals involved ends after the software is designed and defined his tools, or when a program is almost completed, the recommendations may require changes across the work performed, which of course is

unacceptable. When the project budget has been exhausted and the work plan is almost complete, the prospect out of most or even all, of design and the final code, of course, can not cause enthusiasm for the project managers. However, the development of the interface should not be postponed until the stage of technical implementation. To define the tasks for which the product is designed, first, interface design, and then start to implement it (by Jef Raskin). This is iterative process. Defining goals will change during the development of the interface. Therefore, the whole process of product development will take place in accordance with changes in the problem of the product and its interface.

International standard of software development based on a survey of users, is ISO 13407. It describes the User Centered Design (UCD) - method of product development. Characterized by active involvement of the user in the development process to achieve clear understanding of user requirements, and the proper distribution of functions between users and technology, and iterative approach and its multidisciplinary. The main issues UCD:

1. Who will be using this product?
2. What tasks will be completed by the users using the product?
3. In what context?

This method of software development of the railways is a special interest. ACS (Automatic Control System) in railway transport are generally having broad application, and increase productivity through «secret reserves» of ACS user interface, has significant benefits.The user interface is a system of rules and tools, regulatory and interacts with the user program, plays an important role in UCD. In the context of existing and put into service software special interest is the expert assessment of the real user interface. This year, with the invaluable support of IT-specialists of Russian Railways, were examined some aspects of user interfaces such systems as «ETRAN» and «ALS». The main issues in this study were:

1. Definition the effectiveness and productivity of the user interface.
2. Asking the user satisfaction, based on an analysis of the users of the system.
3. Defining fundamental ways of improving the user interface.
4. Development of proposals to improve the interface.
5. The economic rationale for implementing the changes.

When evaluating the effectiveness of the main criteria were:

1. The number of goals that the user can complete by using the product. This item should be part of the established rules and regulations.

2. The number of errors, which commits the user with the product.
3. The number of functions used by the user.

When evaluating the productivity of the main criteria were:

1. The amount of time it takes to task execution.
2. The amount of time for training with the system.
3. The amount of time spent on correcting mistakes.

In the estimation of satisfaction, we have conducted interviewing and discussion with systems users. The main issues were:

1. Is it difficult to work with the product for user?
2. How satisfied user is for the functionality of the product?
3. Do you have negative emotions when working with the product?
4. What is the overall emotional impression concerning the product for user?

Defining fundamental ways of improving the user interface was based on an analysis of the sum of information for user and elements of the existing user interface. Then, we have developed several versions - detailed prototypes of «improvement». Using the model of fast printing GOMS was determined the most successful. The economic rationale was based on a comparison of productivity on existing systems and system with improved user interface. For this purpose, from all functions, were identified most often used by the user to complete the main goals. For example, one of the pending tasks for the user's system «ETRAN» was chosen as the task of filling the consignment note.

Then, each user specific tasks divided into basic steps. The time of each transaction was made under laboratory results of model developers GOMS. For our situation - the user needs 7 minutes to fill the invoice at the best.

With constant evaluation criteria proposed user interface show results in 2 minutes 40 seconds. Consequently, the productivity of the user interface for a given function has increased more than 60%. Similar results were obtained, when we considering the user interfaces of «ALS». Increased productivity interface for a given function was over 40%. Thus, there is an urgent need for expert evaluation and testing user interfaces of all software on railway transport. The proposed methodology for assessing user interfaces is designed to solve this problem. Its application to such systems as «ETRAN» and «ALS» showed possibility of improving their users interface with the economy working hours, on average,

more than 50%. A systematic approach to the use of techniques to assess user interface allows you to achieve the following objectives:

1. Substantial savings in using the software.
2. The savings by reducing training time and reduce errors in the usage phase.
3. Increased efficiency/productivity of IT systems.
4. Reducing the negative emotions of the user, woks the product.
5. Increased ease and comfort of use with the product.

Currently we scheduled to make some test of user interfaces in other railway transport systems. Large field for research in this area are different reference systems. Indeed, the quality of information software systems dependent at almost 100% on the quality of the user interface. Moreover, the sum and desired invariance and the information provided in conjunction with the search, impose restrictions on its user interface. More visual should be research for systems such as «GID», «AS PFP».

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Research Note: Analysis of Reasons for Delay of Trains

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Period of service of locomotives and locomotive crews, consumption of fuel and electric power, amount of expenses of car-hours substantially depend on the period of stay of the trains at the section. In addition, the size of train-hours renders essential impact on the value of section speed - one of the major qualitative indicators of the train schedule. Therefore, great attention is paid to accounting and analysis of losses of train-hours on roads.

The process of movement of trains is greatly influenced by a considerable quantity of destabilizing factors causing delays of trains at stages and loss of time connected there with and therefore decreasing of section motion speed. In order to reveal lacks caused by organizational reasons, deviations from specifications of technological processes, failures of hardware and commercial defects on roads, analysis of the train sheets is carried out. As a whole, the level of performance of the train schedule reflects the degree of implementation of technology of transportation process and quality of maintenance work, efficiency of use of rolling stock and traffic throughput of railways.

Primary accounting of execution of the schedule of freight trains is conducted by train dispatcher upon departure of trains from the stations of their makeup, at passing of transit trains through technical stations and at passing of trains along dispatching sites. Each delay of a train should be reflected in the train sheet stating specific reasons for each service which has caused it. Responsibility for reliability of this information is borne by train dispatcher.

Daily analysis of train sheets made by the train dispatcher is carried out by engineers-analyzers of the service of statistics of the railway manually or with the use of automated workplace of engineer-analyzer. Data of primary accounting are reflected in the books of the analysis of the freight train sheet. In addition, the total time of delay of trains (in minutes) stating the reasons for delay of trains by each service is entered in these books. Analysis of the reasons of delay of trains is conducted by engineers-analyzers together with divisions of

road section (locomotive and wagon depots, distances of power supply and contact network, ways, alarm system and communication, stations, etc.). The results of the analysis are considered daily by the management of services to which delays of trains have been assigned, for acceptance of operative measures on non-admission of revealed breaches in future.

Engineeranalyzers on the basis of data on departure, passing and arrival of trains, as well as time of delays of trains at passage, stating quality services of railway form daily and monthly reports. As a whole during one month the statistics service draws up the report on performance of the train schedule. For freight trains it is drawn up by summing of data on subdivisions.

Traffic service "D" of the railway uses data of accounting and completes analysis of indicators of work. Engineers of "D" service can specify them by train sheets. For calculation of indicators each engineer draws forms of tables independently. The engineer for analysis of section speed of "D" service draws up the daily table of economic losses from train-hours of idle time of trains at each section and road as a whole. In the table the following is specified: train number:

- time of delay for each train;
- section, at which the delay occurred;
- service guilty in the given delay;
- detailed reason of delay of the train;
- economic expenses from train-hours of idle time in each case.

Following the results of the decade or month, summary tables of economic losses of train-hours of idle time of trains by services, directions and dispatching circles are drawn up. On the basis of the received reports the engineer analyzes performance of section speed and presents to the management of the railway results of analysis in the form of reports illustrated by schedules and diagrams of performance of the plan by section speed for the decade, month or any other accounting period. As delays of trains occur through the fault of various services, only those delays which were attributed to "D" service have been selected from the summary table. That fact that at failure by the dispatcher to reflect in the schedule of specific reasons

for delay of trains, the time of their delay according to operating instructions is also attributed to the freight service, has been also considered. According to the current "Instructions on accounting of performance of train schedule for passenger, suburban and freight trains" CCU № 919, approved by the Ministry of Railways on 30.09.02, the traffic service is attributed delays caused by:

- untimely makeup of trains sets and preparation of train documents by workers of railway stations;
- tripping-over of trains on foreign objects and materials not connected with economic activities of railways within stations;
- delays of trains by non-acceptance by railway stations if they have occurred through the fault of workers of the railway station;
- wrong adjustment of movement of trains by the dispatcher;
- failure to provide sending of locomotives and crews to made-up train sets, if they are available according to shift plan of work;
- misuse of freight control facilities.

However, not all of these reasons can be connected with poor-quality information supply of the train dispatcher. Absence or incompleteness of managerial information can cause only part of the listed reasons which are reflected in the summary table of train losses by divisions:

- delays of trains by non-acceptance by railway stations;
- wrong train movement adjustment;
- use of pusher;
- admission of preference trains;
- failure to provide sending of locomotives and crews to set trains

As a result of analysis of the summary table some data on daily distribution of quantity of delays and time of delays of trains by months and reasons for delay according to marks on train diagrams by divisions were received.

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Technical and Economic Estimation of the Basic Technological Schemes of an Overload of Perishable Cargoes on the Basis of Application of the Container-Thermos

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Abstract
For the improvement of financial stability of railways and also whole transportation sector, good performance of all applications of cargo owners on transportation of cargoes is necessary with a high level of transport service and the low operational expenses. Besides competitive struggle of the Russian railways with automobile and other types of transport demands maintenance of process of delivery of perishable cargoes to consumers in the shortest terms problem-free and appropriate quality. In this article the technical and economic estimation of the basic technological schemes of an overload of perishable cargoes is presented and analyzed.

Keywords: Perishable cargo, container-thermos, refrigerating circuit, isothermal container

1. Introduction

Active inclusion of the Russian Federation in the international trading system and the international transport corridors formed in the country, allowing to reduce terms of delivery of containers on routes the Europe - the countries of Asian-Pacific Region (APR), oblige to accelerate development of transport system of transportations of cargoes in containers, including perishable cargoes which safety of quality in many respects depends on term of delivery. In this connection, in the state program "Strategy of development of railway transportation up to 2030". Before railway transportation a task in view: - " …to capture container transportations traditional sorts of cargoes and it is essential to expand the nomenclature of the cargoes transported in containers, due to dangerous, perishable and other … ".

In the first part the analysis of a continuous refrigerating circuit and existing position on delivery of a perishable cargo is spent, and also necessary conditions for correct functioning a continuous refrigerating circuit are examined and its essential lacks are revealed. In the second part experience of application of isothermal containers for transportation of perishable cargoes on railways of Russia is examined. In the third part the analysis of types and designs of applied containers-thermoses is lead and characteristics of containers-thermoses of firm "

Dan Whitney “ and Open Company “ TPK Petersburg “. In the fourth part the basic technological schemes of an overload of a perishable cargo in the container-thermos automobile and are presented by railway transportation. In the fifth part the economic estimation of the basic technological schemes of an overload of perishable cargoes is made and the sphere of rational use of each of the presented types of transport is certain.

2. Analysis of a Continuous Refrigerating Circuit and Existing Position on Delivery of a Perishable Cargo

Separate group of cargoes make perishable. To them carry cargoes, which during delivery demand protection against influence on them of high or low temperatures of external air, care or special service during delivery. It is necessary to understand the technological process made with a cargo on the basis of transport, cargo handling and warehouse operations with a cargo from a place of its manufacture up to a place of consumption with information support as the term "delivery". Delivery of perishable cargoes has following specific features (Efimov 1998):

- Necessity of maintenance of conditions of transportation of these cargoes close to conditions of their storage in stationary refrigerators;
- Necessity of service of cargoes for a way;
- Significant non-uniformity, seasonal prevalence and big range of transportations;
- One-way transportations, high factor of empty run and rather small degree of loading of isothermal cars;
- High cost and charges on the maintenance of isothermal cars, refrigerating warehouses and devices of service;
- Special conditions by manufacture of cargo handling and warehouse works;
- A natural loss and the limited terms of delivery of perishable cargoes.

The specified features characterize system of delivery of perishable cargoes as rather expensive and multipurpose. Thus in system of delivery of these cargoes with use railway refrigerator cars the significant number of transfer reloading production takes place, that leads to infringement of a continuity of a refrigerating circuit (Figure 1) and as consequence, to downturn of quality and increase in losses of production (Gohbom 1982).

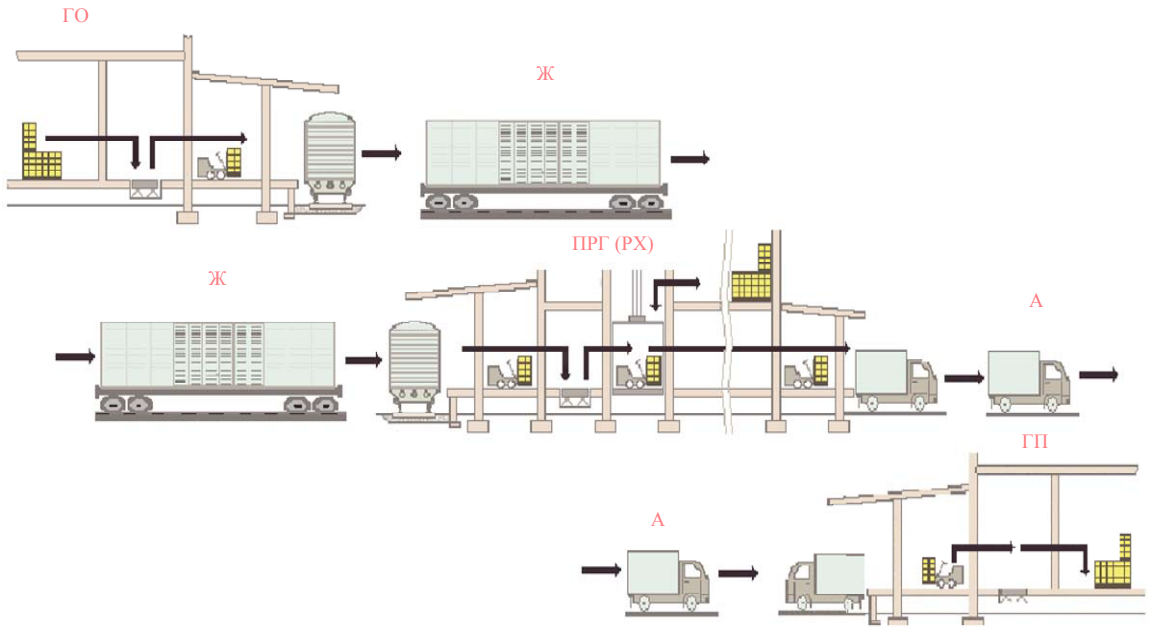

Figure 1. Existing continuous refrigerating circuit of delivery of a perishable cargo.

The certain conditions to which number concern (Efimov 1998) are necessary for correct functioning a continuous refrigerating circuit (CRC):

- An establishment of steady communications of suppliers of perishable cargoes with consumers;
- Maintenance of freight traffic in warehouse capacities and special vehicles;
- Maintenance of a deadline of a finding of perishable cargoes in CRC;
- Maintenance of a mode of transportations and storages of perishable cargoes;
- Maintenance of conformity of carrying and processing abilities of separate elements in CRC;
- Maintenance of the minimal charges on delivery a cargo from areas of manufacture in areas of consumption.

CRC - difficult complex system of delivery of perishable cargoes. It is shown in following aspects (Efimov 1998):

- Technological in which questions on a substantiation and observance of conditions of warehousing and loading, technological modes of storage and transportation are united all;

- Operational in which questions of optimum accommodation are considered, carrying and processing abilities of separate elements CRC with the purpose of creation of system of the unobstructed passing of freight traffics;
- Economic in which questions of distribution of capital investments are researched, receptions of the maximal feedback from industrial expenses for delivery of perishable cargoes;
- According to plan-administrative, studying and which development in view of introduction of the automated control system (ACS) will allow to provide the fast decision of operative and strategic tasks of CRC;
- Documentary in which questions of perfection and acceleration of registration of accompanying documents on the basis of their unification and application of the PC should be considered;
- Information in which rational schemes of passage of the necessary information and the documentation on delivery of perishable cargoes are studied and developed;
- Control and measuring where questions of unification of instrumentations should be developed, and also the parameters which are a subject measurement in different parts of CRC, standards on carrying out of examination of quality of perishable cargoes, veterinary-sanitary and quarantine supervision;
- Container-packing which covers all the sides of development and application of rational container on the basis of standard and, whenever possible, the integrated loading modules;
- Legal in which mutual relations and reciprocal obligations of participants of process of delivery of perishable cargoes are considered and questions of unification of all legal documents should be studied;
- Ecological in which questions of creation and operation of clearing constructions in places of sanitary processing a rolling stock, application of new kinds of ecologically harmless coolants on refrigerator cars are considered

Competitive struggle of the Russian railways with automobile and other types of transport in conditions of a developing market economy demands maintenance of process of delivery of perishable cargoes to consumers in the shortest terms lost-free and downturn of quality. It can be reached at strict observance of conditions of preparation, reception, loading, transportation, an unloading and delivery of such cargoes. Thus paramount value gets the decision of the

tasks directed on the maximal satisfaction of interests and needs of consignor in transportations. For this purpose it is necessary to improve not only technology of transportation process, but also all its standard-legislative basis which would go to a foot in due course (Efimov 2003).

Decentralization of a national economy has led to change of structure of freight traffics and for necessity of change of a ratio in park of isothermal cars. Occurrence fine consignors already now determines requirement for single isothermal cars which quantity is obviously not enough. Growth of small deliveries of perishable cargoes almost completely rejects use of a group refrigerator rolling stock (RRS), which will gradually be converted on single isothermal cars-thermoses (Willows-thermoses). The tendency to wide use in our country of isothermal containers (Efimov 2003) is planned.

However till now perishable cargoes transport on railways in following types of transport modules: isothermal cars (refrigerator cars, cars-thermoses, dairy tanks, tanks-thermoses, cars-tanks), covered cars, and rather limited in universal and refrigerator containers. The traditional way of delivery of a perishable cargo is use refrigerator five-carload units and independent refrigerator cars with office accommodation. These are large enough for fine sets of a cargo transport modules. Thus the unloading of production from cars and its intermediate storage on distributive refrigerators is inevitable. Thus stability of a refrigerating circuit because of heterogeneity of temperature modes and its continuity is broken at reloading operations.

At the same time on refrigerators the level of mechanization of cargo handling and warehouse works sharply lags behind a level of mechanization and automation of the basic technological processes, useful capacity of warehouse is badly used. Application of the mechanized technological processes of cargo handling, transport and warehouse works, which include all operations on a refrigerator, including loading of transport, is possible reduction of idle time of refrigerator transport by a distributive refrigerator. The problem of reduction of idle time is actual, because long idle time leads to infringement of a continuous refrigerating circuit and as consequence, to decrease in quality of products and increase in their losses (Efimov 1982).

By transportation perishable cargoes observance of a temperature mode as at imbalance temperatures perishable cargoes have property to spoil is required. Thus, it is possible to consider, that the existing system of delivery of perishable cargoes as a whole possesses a number of essential lacks and requires perfection. To provide a continuity and stability CRC, to reduce to a minimum of loss of perishable cargoes during delivery it is possible by

application of isothermal containers, which in our country still have not received due development.

3. Experience of Application of Isothermal Containers

In economy of Russia there were changes, which have found the reflection in transportation process of railway transportation. For example, there were no large-scale senders and customers of perishable products, which regulated deliveries and transportations of these cargoes by significant terms. There was a set of fine cargo owners (farmers, joint-stock companies, various companies and societies) and consumers of products (shops, public catering establishments, the various intermediary organizations). Such state of affairs was promoted by the complicated planning transportations, big and not predicted terms of delivery of a cargo, absence of appropriate service at work with client on the railway. During recent years the competition between automobile and railway transportation has noticeably increased. Railwaymen have practically voluntary transferred "motorists" freight traffics. If during Soviet time the railway transportation transported up to 95 % of cargoes now its share is no more than 60 %. Therefore, new economic conditions have led to reduction of weight of cargo transported. Now the optimum sending of perishable cargoes satisfying consumers, makes from 15 to 30 tons, and by some kinds of perishable cargoes prevail only fine and low-tonnage sendings. Production based on purchase order – the intermediate storage, accompanied significant costs is not required. Thus, it is accelerated turnover means of the cargo owner that is important at inflation available in the country.

The existing park of isothermal cars is focused on mass transportations perishable cargo for large consumers, was optimum at a planned economy, but for fine and low-tonnage sendings too big have been even single cars-thermoses carrying capacity 40 to 60 tons. Interest of consignors to a container variant of transportations has noted been in 2004 when on the Sverdlovsk railway the first terminal on processing 40-foot containers has been opened. Questions of development of a container network of Ural were discussed in the government during visit to Yekaterinburg delegations of German railways and experts of expedition firm of Germany “Transfracht”. The foreign and Moscow forwarding companies became more active in the local market. These and other events have paved the way for creation of specialized firms for development of service in container transportations (Timoshin & Marshrut 2003).

The Sverdlovsk railway has 8 container terminals for work with 20-foot containers and 3 terminals, capable to accept 40-foot containers. State Unitary Enterprise "GelDorExpedizija", being the official forwarding agent of the Sverdlovsk railway and customs broker, has own terminal at station Sverdlovsk-commodity for work with 40-foot containers. Joint-Stock Company “Ural transport company”, the forwarding enterprise at the Ural state academy of means of communication, is the official agent in Urals Mountains of firms "Transfracht" and “the Transsiberian Express train Service”, the representative of the largest Moscow company in the field of internal container transportations of Joint-Stock Company " STIM " (Timoshin & Marshrut 2003).

For creation of a real competition on railway transportation, it is necessary to solve three primary goals: to reduce terms of delivery of cargoes, to develop technology of the mixed (railway-automobile) delivery of cargoes under the scheme «from door to door» and to create necessary service for clients. And the certain steps in this direction are already made.

Until recently the serious factor constraining introduction of container transportations in scales of region, was insufficient amount of container terminals. The system of such terminals constructed even during Soviet time, has been focused on processing 3 and 5 ton containers. Currently only few stations are capable to accept and process 20 and 40 ton containers. The order of 10 terminals are equipped on access roads of clients, 3 terminals are capable to accept 40 ton containers. For comparison, in territory of Germany work about 90 terminals, capable to work with any types of containers (Timoshin & Marshrut 2003).

Thus, one of essential tasks becomes reconstruction of existing terminals. At reconstruction it is expedient to equip stations with the auto-loaders, capable to work with supersize containers. Cost of reconstruction of the average terminal can pour out in the sum nearby 2.5 to 3 million dollars, a recoupment of projects - from 3 till 5 years. Open Society "RZD" does not finance similar works, therefore for re-equipment it is necessary to involve individual investments. As the variant can be considered an opportunity of creation of container terminals on free powers of enterprises VPK, where shops stand idle, and factories pay the tax to staying idle property.

In Open Society "RZD" the new concept of creation of two affiliated societies – “Refservice” and “Transcontainer” has affirmed. JSC RZD will solve destiny of 10 thousand the refrigerator cars which have not a part of the created company. «Refservice» is branch of Open Society "RGD" since October, 1st, 2003. Now into structure of branch enter the central device and 12 isolated divisions: five refrigerator carload depots, two operational sites, five loading-unloading regional centers. The park of Open Society "RGD" "Refservice" is made

17 thousand units of a specialized rolling stock, among which with isothermal cars-thermoses and refrigerator section. “Refservice” carries out transportation more than 150 names of perishable cargoes. Its basic competitors on the Russian transport communications are autotransportations (45 % from total amounts of transportations).

According to the concept of reforming of affiliated societies in the authorized capital “Transcontainer” will platforms, containers, and also about 40 container platforms from more than 100, being at the disposal of Open Society "RGD" now are brought. However, it is necessary to notice, what for transportation of fine sets of perishable cargoes in a home market the park of isothermal containers (refrigerator and thermoses) is insignificant and demands essential updating, but what containers?

Refrigerator containers are undoubtedly necessary. However, for their transportation by rail economic to use links made from the specialized platforms equipped by devices centralized power-, cold supply, which Open Societies "RGD", unfortunately, does not have. Besides existing refrigerator installations of containers and the service car link create threat for ecological safety, being sources of harmful emissions in an atmosphere (Efimov 2005a).

New kind of transport modules on railways of Russia - containers-thermoses. They meet the requirements of the market at present. Wide use of containers-thermoses will promote return on a railway transportation of fine sets of perishable cargoes which now, basically accustom motor transport, and also will allow to increase quality of forwarding service of their transportations in the mixed message.

Therefore, development of transportations of perishable cargoes in containers-thermoses will be practically carried out from zero as today completely there is no park of highly reliable containers-thermoses. Accordingly there is no base for their repair and a current maintenance. There are no qualified experts of the necessary structure, the approved technology of use of such containers. Still much also should be created for effective work of system of transportations of perishable cargoes in containers-thermoses.

4. The Analysis of Types and Designs of Applied Containers - Thermoses

The isothermal container with demountable refrigerating machinery is applied to transportation of the cargoes demanding constant temperature. In a design of these containers requirements of Technical committee 104 International organizations are considered. The container is supplied reliable heat-insulate and on one of face walls has the valve for

connection to refrigerating system. Onboard both face walls and a roof of the container represent the multilayered panels consisting of an external layer of plywood with a covering from an artificial material, intermediate layer polyurethane and an internal layer of the polyether strengthened by fiber glass. The floor is collected from T - figurative aluminium beams with plywood flooring. Isolation of a floor is executed from polyurethane. Pockets for fork captures are stipulated. The container can be maintained as refrigerator and as a thermos.

Firm “Dan Whitney” releases standard isothermal containers of type 1C the International organization on standardization (ISO) in weight gross 20 tons from the high-quality fiber glass formed by a method of winding which is borrowed from the "know-how" of space vehicles. The method consists that on in advance prepared under the form of the container a basis high-strength fiber glass which during winding becomes impregnated with pitch is reeled up. Thus, the whole seamless box - a roof, a floor, lateral walls of the container - without what or additional connections is formed. After winding an internal layer on it the heat-insulated layer from porous polyurethane is imposed, and then atop of it the external layer of fiber glass is reeled up. The container of the standard container of type 1C makes 2155 kg, its carrying capacity of 18165 kg, internal volume 28.8 m3. The height of the modified isothermal container is increased up to 2590 mm, the weight of container makes 2200 kg, carrying capacity of 18120 kg, internal volume 30.8 m3. It is presented in Table 1.

Value of containers increases at the mixed auto-rail transportation perishable cargoes. While in service domestic experts have noted, that on quality of use they prefer containers of manufacture of the Great Britain and Germany. The Russian manufacturers should pay attention to it and to increase competitiveness on quality by manufacture of the isolated containers.

Experts of Open Company of transportation-industrial company "Petersburg" develop and make to introduction in transportation process the universal isothermal container-thermos intended for transportation of various perishable cargoes. The container is executed on the basis of the standard dry-cargo large-capacity 20-foot container (1CC) with the heat-insulated panels installed on internal perimeter of the bearing body in such a manner that excludes any contact of a cargo with an external body. On appearance (except for the external painted surfaces), to units of fastening, dimensions the container-thermos does not differ from the 20-foot container (Efimov 2005b).

For increase in durability heat-insulated panels and with a view of observance of the sanitary-and-hygienic rules shown to transportation of food stuffs in the isothermal container,

on a surface the heat-insulated panels, turned into a cargo placement, the sheeting providing safety of heat-insulated panels at mechanical influence is mounted, and also at washing or disinfection of a cargo placement.

The design of a rigid internal body and floor provides an opportunity of the mechanized loading-unloading of the container, safety of cargoes during transportation, removal of a condensate water pair before loading, resistance influence of chemical substances at infringement of integrity of packing of a cargo during transportation, high mechanical durability at influence of the shock loadings caused by moving of a cargo at sharp braking. And also, safety of heat-insulated panels during operation of the container, tightness of an internal body of the container, performance of requirements of the sanitary-veterinary bodies shown to vehicles.

The principle of fastening of a rigid internal body allows using heat-insulated panels of various thicknesses that promotes increase in deadlines of transportation due to reduction of factor of heat conductivity of heat-insulated panels. The design allows to mount heat-insulate as a matter of fact, in any rigid external body, thus, any large-capacity containers can be converted in the isothermal container-thermos. The important feature of an applied design is that it is base and allows installing in the further various devices of not machine cooling or heating. The container is completely examined by the Russian Sea Register of navigation of the Russian Federation, the state Veterinary supervision, Sanitary-and-epidemiologic service of the Russian Federation.

In a design of the container requirements of the Convention under the customs control that allows using the given container for the international transportations are considered. Universality of the given container is shown and that at transportations on a network of roads of Open Society "RZD" is not required creations of new services and divisions as large-capacity containers for a long time and are effectively used, there are fulfilled procedures of return of containers at station of a postscript, registration of railway documents, tracking along the line. Settlement service life of the container-thermos makes 12 to 15 years, a time of recovery of outlay - about 1.5 years. The characteristics of these containers are resulted in Table 1.

Table 1. The Characteristics of the isothermal container-thermos of construction of Open Company « TPK Petersburg »

The name of a parameter and unit of measure	Size
Carrying capacity, kg	20320
Own weight of the container, kg	3300
The external sizes, mm:	
Length	6000
Width	2438
Height	2438
The internal sizes, mm:	
Length	5670
Width	2130
Height	2180
The sizes of a doorway, mm:	
Width	2090
Height	2070
Volume of a cargo placement, $м^3$:	
Full	26,32
Loading	24,88
Settlement (compound) surface of protections of a body, $м^2$:	
Full	64,0
Overhead (roofs)	13,3
Lateral	13,4
Doorway	4,3
Settlement frequency rate of external air infiltration through a doorway of the container-thermos, $ч^{-1}$	0,1
Passport factor of a heat transfer, $Wt/(м^2 \cdot K)$	0,23
Specific thermal stream, Wt/ºC	14,7
Limiting values of temperature of external air at operation of the container, ºC:	
Positive	45
Negative	-50
Mechanical loading on a floor, $кN/sm^2$	0,25

Such containers St. Petersburg is planned to use on directions Yekaterinburg and further on the East, St. Petersburg - Murmansk, St. Petersburg - Moscow and further on the South. In these containers it is planned to transport:

- Thermally prepared before loading (cooled, frozen or made winter-proof) perishable cargoes with a period of storage not less than 10 day which do not demand refrigerating processing and ventilation in a way;
- Food cargoes, including having restrictions on temperature of storage;
- The cargoes of the various nomenclature supposed by rules of transportations of cargoes in universal containers.

Apparently from the analysis, the given type of the container-thermos is the most perspective for conditions of operation in the Russian Federation and in the international message.

5. Consideration of the Basic Technological Schemes of an Overload of Perishable Cargoes

Delivery of the frozen perishable cargoes with use of containers-thermoses is provided under three technological schemes (Figure 3). The first scheme (see Figure 3) provides not packaged delivery of cargoes in KKT between suppliers and consumers, motor transport. Loading of containers at the sender and unloading at the addressee is carried out without removal of the container with semitrailer.

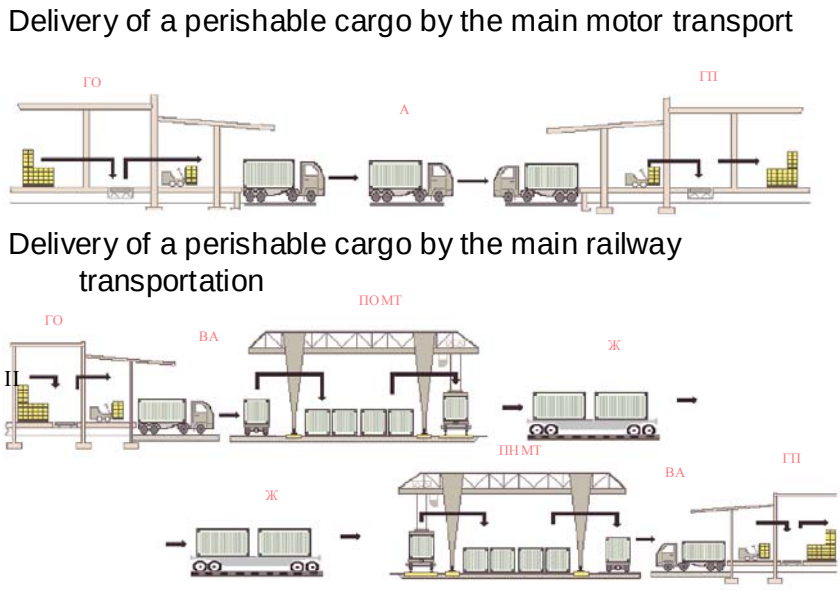

Figure 3. The basic technological schemes of an overload of perishable cargoes.

The second scheme (see Figure 3 for details) provides not packaged delivery of cargoes in KKT between suppliers and the consumers, which are not having tracks. Loading of containers at the sender and unloading at the addressee is carried out without removal of the container with semi trailer. The overload of the container from motor transport is carried out on the container terminal of station of departure and destination. To manufacture of cargo handling works with containers on terminals are applied two-console gantry cranes by carrying capacity 20 t, equipped spreader with a sliding (telescopic) frame (Efimov 1982). In offered technology of delivery of perishable cargoes in containers-thermoses variants will find application all.

6. Economic Estimation of the Basic Technological Schemes of an Overload of Perishable Cargoes

The level of railroad rates for container transportations renders appreciable influence on their development, efficiency and competitiveness with transportations by motor transport. Therefore, creation of optimum conditions for maintenance of the greatest availability of transportations of cargoes in containers on railways for all cargo owners is the important task (RZD 2003).

Meanwhile, spent from the beginning of year 1990 until 1994 inclusive indexation (increase) of tariffs for container transportations has led to significant decrease in volume of container transportations on railways of Russia, including on October railway, due to their switching on motor transport. And this switching was observed not only on short, but also on a long distance of transportations. The motor transport at spent identical indexation of railroad rates for all kinds of sendings (one-car, container and fine) had an opportunity to install on such transportations competitive enough tariffs. In this connection the decision since May 1994 to not make indexation of tariffs for container rail transportation was accepted. As a result the index of tariffs for container transportations has appeared almost in 2 times below Ist class of tariffs and more than in 3 times below 3rd class of tariffs. All this should bring, in opinion of developers of tariffs, to growth of volume of transportations in containers in comparison with transportations by one-car sendings. However, there was it not at once. Economic recession has stopped the growth of container transportations only in the beginning of 1997. Since 1998 significant growth of transportations of cargoes in containers was observed. So, in 1999 in comparison with 1998, the volume of transportations in containers

has increased on 22 %, and in 2000 in comparison with 1999 growth them has made 33.4 %. This tendency has sustained.

However, it is necessary to note, that not on all sorts of a cargo growth of container transportations was observed. So, in 2000 in comparison with 1999 approximately under 21 name of cargoes growth of volume of transportations in containers, surpassed transportations of cargoes in cars, under 4-th names the volume of transportations was kept constant, and on 16-th - growth of volume of transportations in containers lagged behind transportations in cars (RZD 2003).

In connection with creation of Open Society "RZD" it is necessary to start with those railway container transportations were not unprofitable and, simultaneously competitive with motor transport. The minimal tariffs for container transportations can be in unusual cases at a level of the charges depending on the sizes of movement. Thus it is necessary to have in view of that container transportations create overtransport effect to owners of cargoes (economy on cargo handling operations, economy on container, on intermediate storage of a cargo in warehouses, increase of reliability and safety of a transported cargo, etc.).

Considering all above listed the economic estimation of efficiency of various variants of delivery of perishable cargoes in transport logistics, both by railway transportation, and automobile, by a principle of delivery “from door to door “ is given. By results of the led calculations the summary sheet of the specific discounted expenses by each variant presented has been made**.** (Efimov 1999)

Table 2. The resulted expenses for delivery of wine by variants of logic circuits

The name of a parameter and unit of measure		Delivery of wine by the main motor transport	Delivery of wine by the main railway transportation
Expenses not dependent on distance, rouble/t		9515,04	13309,67
Payment for transportation of a cargo, rouble/t	1000 km	2662,72	1482,77
	2000 km	5325,44	2035,52
	3000 km	7988,17	2573,3
Cost of weight of a cargo during transportation rouble/t	1000 km	3203,37	1259,22
	2000 km	5310,85	2312,96
	3000 km	7418,33	3366,7
Total	1000 km	15381,13	16051,66
	2000 km	20151,33	17658,15
	3000 km	24921,54	19249,67

By results of presented to tables for presentation the schedule of dependence of tariff expenses for delivery of a cargo automobile and by railway transportation on distance up to 3000 km has been constructed.

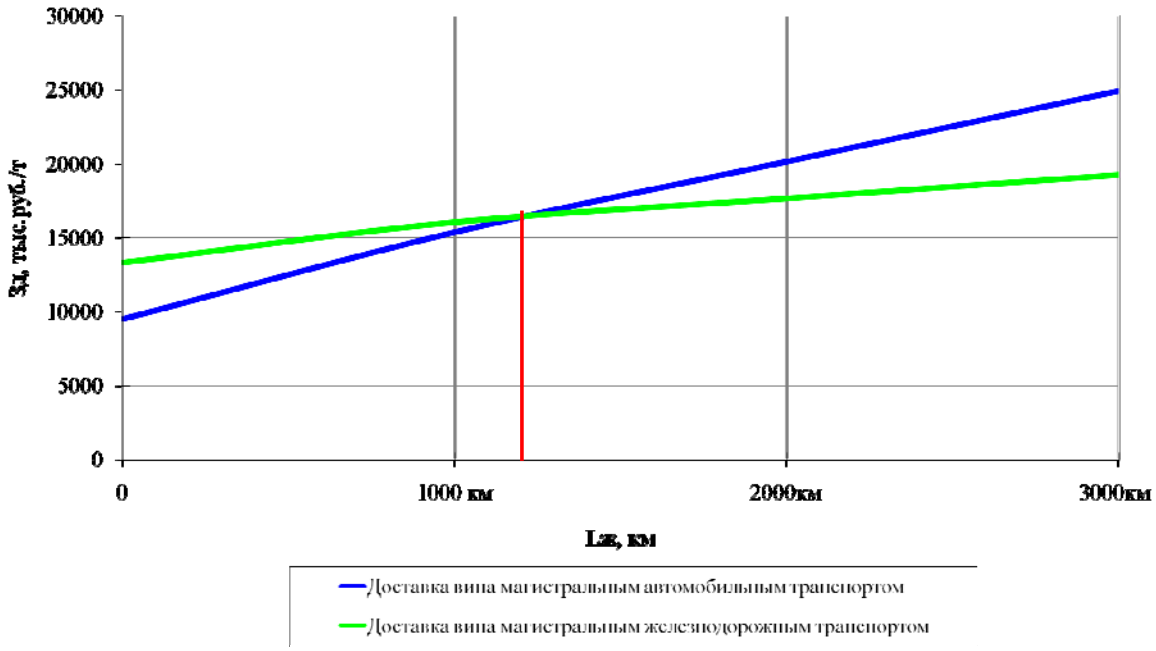

Figure 4. Economic efficiency of various technological schemes of an overload.

7. Conclusions

Results of article show, that the organization of container transportations of perishable cargoes in conditions of growth small set deliveries - one of effective forms of attraction of cargo owners to railway transport as main already now. And that is why. First, it is favourable to cargo owners due to:

- Decrease in the general charges on delivery of perishable cargoes as superfluous accumulation and storages in refrigerating warehouses of fine sets of production on carload sendings;
- Economy on railroad rates. The economic calculations executed in the project have shown, that railroad rates for distances from above 1200 км it is more favourable than automobile on the same distances;
- Maintenance of a continuity of a refrigerating circuit during all process of delivery of a cargo that promotes, to a certain extent, to preservation of its qualitative condition.

Secondly, it is favourable also to a carrier as the existing park of a specialized rolling stock for transportation of perishable cargoes with which has Open Society "RZD" now, is considerably worn out and demands expensive updating.

Thirdly, it is favourable both to cargo owners, and a carrier, and buyers as application of container technology allows to connect manufacture, storage, transportation and realization of perishable production in uniform transport-technological process by a principle «from door to door» with involving in this process of competing types of transport as partners.

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Globalization and Container Terminal Development: Reflections on Transportation Systems between Finland and Russia

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Abstract
Liberalizing economic policies enacted by governments, tighter competition, and the growing scale of global trade have lead to a situation, where container terminals must emphasize greater efficiency, while being more and more flexible in meeting customer requirements. From the literature it can be concluded that in the future network oriented metrics will be taken into practice to measure productivity and performance. In Russia achieving leanness at terminal operations is not that much dependent on space availability in the network nodes, but uncertainty related to market dynamics and procedures at custom clearance in harbors. Based on findings from the case studies, there exist great amount of free space in warehouses in St. Petersburg and customers are waiting due to market development uncertainty. Companies see the productivity improvements possibilities offered by block trains and almost every terminal has rail line connection, but those lines are in minimal use at the moment.

Keywords: Lean philosophy, container terminal productivity, transportation system, Russia, Finland

1. Introduction

Within five years from now the vast majority of cargos around the world are expected to be containerized (Parola et al. 2005). This prediction can carry significant consequences on container handling processes in ports, as the pressure achieving greater flexibility with lower costs for customers is to be managed in an increasingly turbulent global trade environment (Notteboom 2007; Vacca et al. 2007; Singh 2007; Taylor 2006; Vickerman 2006; Parola et al. 2005).

The objective of this article is to scrutinize the space for efficiency and productivity at container terminals and reflect the implications on the optimization possibilities of conditions for transportation systems between Finland and Russia. The main research question is to investigate how the specific terminal operators respond to continuous productivity enhancement requirements in the region of South East Finland and St. Petersburg. The research method is the case study approach supported with relevant body of literature analysis. The expectations of customers of becoming more responsive (lean) can be associated with a dominant trend nowadays that puts pressure on companies to achieve better quality and valued output with less input. It is nevertheless recognized in the literature well that these

kinds of lean transformation programs do not always lead to desired outcomes (Browning and Heath 2008). This is especially the case, when the models have to be operational in regions where countries are involved with different state of economic development. This research is structured as follows. In the second section a literature analysis is carried out to determine the trends of development on container terminal research with view on lean philosophy. The next section extrapolates the way this study was accomplished, followed with case studies on warehousing service providers in the great St. Petersburg region and South East Finland. Finally in concluding remarks possible research pathways to proceed forward.

2. Literature Review on Container Terminal Research

Lean strategies are a well established point of industrial development schemes as the approach widespread among practitioners and are applicable for service systems too (see Herron and Hicks 2008; Maleyeff 2006). Transportation service systems may well even contain production related activities, for example assembly tasks at warehouses in port areas. Studies to date have shown that in the near future within transportation networks the attention will be paid into a great extent onto distribution hubs (Stahlbock 2008; United Nations 2007; Deshpande 2007; Hanh et al. 2006). It has been illustrated that the duration and variation of time spent at the nodes is notably higher than that of the time spent between the nodes (Deshpande et al. 2007). Nevertheless with regard to intermodal rail transport it has to be noted that speed and other interoperability considerations are still of great concern for the seamless utilization of infrastructure even within the EU (Rothengatter 2006). The majority of works completed on internal processes of container terminals employ mathematical models, including heuristics techniques and simulation based approaches to address the best way of optimizing container handling procedures. The targeted areas of scrutiny remained in most cases still complex despite the simplification efforts and practical implications are difficult to draw as terminals are highly dynamic and stochastic logistics systems (Stahlbock 2008; Gunther 2006). Below some articles are presented on container related research within a context of transportation systems.

Table 1. Summaries on the trends of container terminal research

Author(s) / Title	Major arguments	Additional information
Stahlbock et al. (2008) Operation Research at Container Terminals. A literature update	Core elements of efficiency are the automation of in-yard transportation processes, storing and stacking as well as the application of optimization methods for intelligent routing and scheduling mechanisms.	There is a need for holistic approach with integrated optimization of operations, still real world problems are difficult to solve. Decomposing problems into smaller slices is a common technique.
Shintani et al. (2007) The container shipping network design problem with empty container repositioning	Empty containers rise handling time in ports that in turn results in excessive fuel costs for forwarding companies. In practice there is no load rejection among shipping firms due to fierce competition.	So far there was no research available that would have taken into account in an integrated manner the optimal fleet composition with specified routing characteristics covering empty container repositioning.
Deshpande et al. (2007) Simulating less-than-truckload Terminal operations	Via simulation based intelligent assignments resources can be reduced while enhancing quality of service levels in less than truckload terminals. These techniques are still rarely used in practice in the US.	Despite the need for improving supply chain response time, reliability and flexibility, nowadays 75 percent of transportation firms in the US still rely on manual procedures for decision making.
Vacca et al. (2007) Optimization at Container Terminals: Status, Trends and Perspectives	Service demand can be described as concentrated on loading and unloading operations with a high utilization of shared resources. These will cause soon serious congestion at terminals.	Specialization on a single operational problem, combination of problems with integration aspects and simulation & queuing theory applications are the three main paths of existing literature.
Gunther, et al. (2006) Container terminals and terminal operations	In solving terminal design problems multimodal interfaces, optimal terminal layout, top quality equipments, appropriate berthing capacity and real time decision making tools are needed.	Decentralized planning is the only feasible method to provide governing structures for logistics control of automated container terminals. Terminals are highly dynamic and stochastic logistics systems.
Parola et al. (2005) Intermodal container flows in a port system network: Analysis of possible growth via simulation models	It can be suggested that the outstanding bottlenecks for competitiveness of a port from the intermodal point of view are train lengths and new rail infrastructure facilitating capacity extensions.	In an unbalanced situation an increase in the sea flow results in a proportional grow on road leading to congestion. These days vessels in many cases have a capacity of well over 10000 TEU.

Based on the summaries above it seems that productivity improvement efforts at distribution networks will target the attention toward rail – maritime interface process research at ports areas and the role of road connections will become less significant in terms of global reach. In Russia the signs are already on the scheme: Russian Railways (RZD) purchased recently shares in seaports controlled by private owners in Russia and nearby the

border of North Korea in the city of Rajin in order to be able to open the route to waterway in South East Asia (United Nations 2007; Hilletofth et al. 2007; Filina 2006). Still there is a crucial need in Russia for public authorities to stimulate more competitiveness and investments into the infrastructure of port by involving private sector operators (Pynnöniemi 2008a; Hilmola et al. 2007; Vartanyan 2007; United Nations 2007; Vinod et al. 2007). With regard to container terminal construction, plans however already exist: There have been efforts made to build facilities capable of handling 3 million TEU toward 2019 (RZD Partner 2008). Due to the unbalanced development of transportation flows in the Eurasian region and likely congestion problems in the future at ports both in Europe, and in Russia, it can be argued that rail will capture larger share from the market currently hold by sea transport (Tsuji 2008; Pynnöniemi 2008b; Vacca 2007; Deshpande et al. 2007; Shintaini et al. 2007; Ivanova 2007; Vickerman 2006; Lautso et al 2005).

At the same time it seems to be evident that the institutional arrangements inside the port areas are not sufficient to provide appropriate contractual framework to guarantee the functionality of governing structures for the parties involved in terminal operations. The studies above also indicate that the application of lean principles lead to the integration of activities of the container handling procedures internal to terminals while the requirements for flexibility forces to apply more decentralized approaches to governing organizational structures. One solution presented is to search better negotiation techniques among the participants of business operators at ports so as to be able to transfer more tasks and activities from the seaports to hinterland hubs (Podevins 2007; Gronalt, et al. 2006). Additionally it can be claimed that the industry will face further consolidations with emerging few big players, while research will turn into a greater extent on optimization network productivity and eliminating trade-offs in decision making (Parola et al. 2008; Notteboom 2007; Singh 2007; Vacca 2007; Khalid 2006). To reflect the complexity in reaching the objectives in the future an integrated approach of discrete event simulation combined with lean techniques such as Visual Controls or Dynamic Scheduling might capture a more dominant position. This development scenario would be in line with lean thinking that emphasizes system aspects in scrutinizing the space for cutting cost in an effort to reach increasing level of value output. In the era of networked economy and increasing complexity, the considerations of above on lean and agile strategies only gain more significance (Gunasekaran, et al. 2008; Hilletofth 2008; Taylor 2006).

3. Research Methodology

Our work is built on case study approach, and related literature is gathered and scrutinized. The cases illustrated in this study are about companies that have extensive experience in using freight transport services within the region of South-East Finland and the larger economic area of St. Petersburg (including Leningrad Oblast). Specifically they are focusing on warehousing, transit and/or export-import freight flows and are highly experienced in managing these kinds of operations. Four operators were selected from Finland and two from Russia. An additional case presents a Finnish service provider, which recently opened its new terminal in St. Petersburg. In order to be able to draw correct conclusion on the development trends in this transport sector, interviews were accomplished with a person having a managerial position in the mentioned enterprises. Also visits onto the sites of these firms were seen as necessary. In the context of investigation several central topics were set: The manner of employing different transportation modes in managing cargo movements of incoming and outgoing distribution flows were in focus, but also numerical data on warehousing facilities were gathered in detailed format. In addition the aim was to clarify the underlying reasons for adapting the current operational management structure. The data was gathered during the spring, summer as well as autumn of 2008 and the contents of the information were verified by the target companies.

4. Case Study Analysis on Container Terminal Operations

Interterminal – Group Company, Terminal facilities of St. Petersburg (South)

Interterminal Group has two locations in St. Petersburg, located in north and south of this large city. Northern terminal (in industry area "Parnas") is specialized in frozen items (terminal space of 3000 m^2), and general cargo (terminal space of 37600 m^2), and same applies on the southern having terminal facilities for general/containerized cargo (terminal space of 66301 m^2) and frozen items (8120 m^2). Both locations have access on ring-road of St. Petersburg (partly under construction) and railways. For southern location St. Petersburg container harbor is very near-by, and containers are being transported either from First Container Terminal or Kronstadt's Moby-Dick Terminal. Interterminal is having own traction locomotive, which is serving arrangement yard movements. Currently Interterminal employees 100-200 employees at southern location, but it should remembered that customers

bring their own employees for assembly and packing operations, and whole terminal area could have additional 100-150 (at minimum) people working contemporarily. Partly these external parties work, e.g. in container yard having proximity for railway arrangement yard – currently company called Modul operates this part of terminal area, and is capable to store 4000 TEU in the yard. However, in our visit it was revealed that this arrangement yard contract will end on October 2008, and thereafter maybe new organization will take the responsibility from these operations (whole process is under negotiation currently).

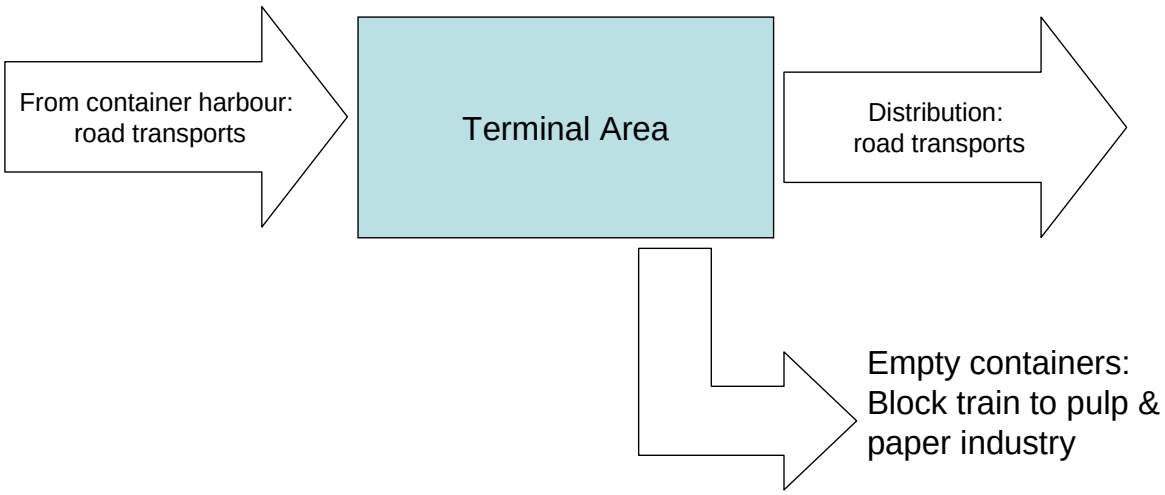

Figure 1. Transportation flows of Interterminal facilities in southern St. Petersburg.

Based on the discussion with Terminal Director Vladimir Krasovskiy getting items from container harbors is time consuming task – after sea vessel has arrived on harbor, it takes usually from 2-7 days to have containers in southern terminal, even if the distance is roughly 10 km. Competition is getting all the time harder in logistics market of St. Petersburg, and also in Russia overall; in the motor highway heading to Moscow, 5-6 new terminals are under construction. However, it was interesting to notice that some parts of southern terminal were without a use currently, since old customer changed their warehousing location. So, even if the logistics market in St. Petersburg is heating up, it does not necessarily mean that all of the space is 100 % utilized.

Interterminal uses nowadays mostly road transports for incoming items from harbor to terminal, but also outbound distribution is completed favoring this transportation mode. Reason is mostly due to transportation cost and flexibility – costs of road transports in St.

Petersburg is 20-25 % lower than railway transport, and service level of single truck is higher in changing business environment. However, interestingly empty containers are currently being transported away from terminal with railways. Director Krasovskiy argued that they do not currently have any problem with empty containers, since these are transported further on to pulp and paper industry locations, and used in their operations (export, but also domestic distribution). Krasovskiy also emphasized that logistics branch will continue to grow in Russia for next five years.

Eurosib Facilities in Predportovy (southern St. Petersburg)

In the neighborhood of Interterminal is located also Eurosib terminal facilities, which serve general/containerized cargo shipments. Covered warehouse is having size of 4500 m^2, and most of the storage area is without a roof, container yard. Facilities are having railway access, and are near of ring-road. Currently 20-25 % of harbor shipments to terminal are being transported by railway block trains, but most significant part of the transportation volume is being transferred from harbor by road transport. Reason for the dominance of road transport is the same with Interterminal: costs (approx. 10-20 % more expensive than road transports) and service level. Among railway wagons, Eurosib is having own traction locomotives, which are only serving arrangement yard (and very near proximity) movements. Traction services are still under influence and control of governmental RZD and its affiliates; private companies can't complete these yet.

Lead time performance from First Container Terminal for containers is nearly the same with Interterminal – according to marketing director of Eurosib it takes from 2-5 days to take container out of harbor. Mostly the reason is custom procedures, which can't be completed at terminal, but these should be completed in the container harbor. It is not economically feasible to any company to hold containers in the container harbor for more than 5 days, since there after holding will start bear rental costs (same procedure is applied all over the world – in Finland often 7 days). Eurosib has even planned with one customer that block train from Finnish sea harbor Kotka would be built to serve shipments for St. Petersburg region. However, this plan did not reach the feasible ground, since warehousing space constrained implementation of long container block train.

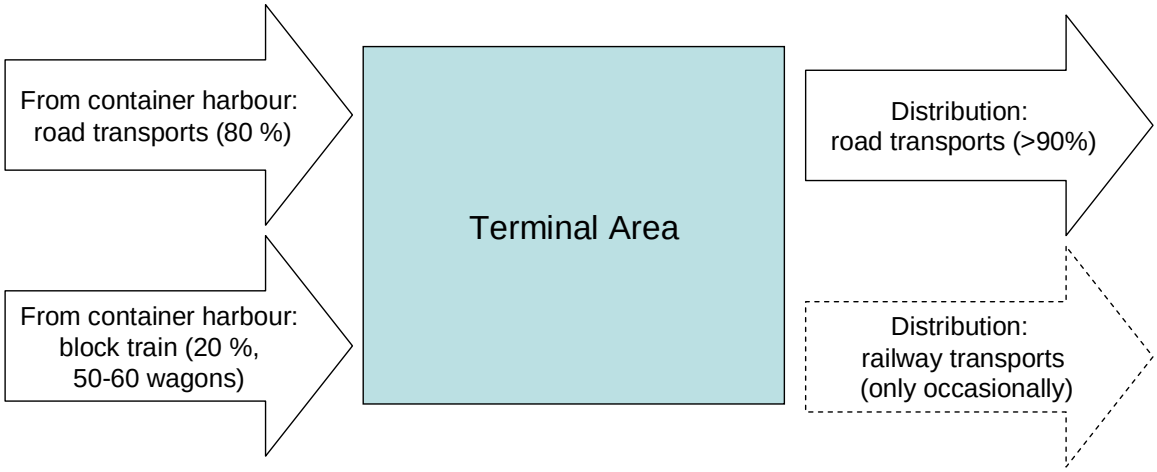

Figure 2. Transportation flows to and from Eurosib facilities in southern St. Petersburg.

Among serving St. Petersburg area, Eurosib is now enlarging its operations in serving Chinese exports to Russia – large terminal is now available at city of Novosibirsk (near of Kazakhstan and Mongolia), and it is well connected on Russian railway network. Among this, Eurosib sees that competition on logistics branch of St. Petersburg is getting harder; 0.5 million m^2 of new terminal space will be available in the near future. However, Predportovy terminal seems to be in good ground – warehouses were 100 % utilized, and were holding mostly paper industry products for different customers (some winter transportation equipment was also being stored in their warehouse too). Problem with empty containers is currently being managed in a manner that all different kind of export metals are being loaded on the containers.

Finnish Transit Terminal Operator in the City of Kotka

The company's container terminal in Kotka has a warehousing space of 28 000 m^2 in total. There is no space for freeze-items. The terminal has a railway connection; wagons can be loaded on the 400 meter long track section, which is located in a smaller (3000 m^2) not-temperature-controlled section of the facility. The track from the terminal to the port marshalling yard is not electrified. Around 100 people are employed in the warehouse area, but during the autumn peak season 150 might be needed. There are around 15-20 special fork-lift trucks, which are equipped with computers.

The major part of incoming containers arrives by maritime vessels and leaves the terminal by trucks (see Figure 3). The train connection has been used only for 2 months. Some high-value goods arrive by plane from Helsinki, and are transported to Kotka by truck. The goods leaving the terminal are typically not on pallets – it could be called as loose cargo. About 90 percent of the outgoing product flow head towards Russia, the rest to Ukraine, and other former Soviet Union states. In majority of the shipments custom procedures take place in Moscow, from where the products are sent to their final destinations. The share of direct shipments to St. Petersburg will rise in the future. Typically an outgoing shipment is collected on the terminal floor before it is loaded on a truck. Usually unloading of the containers takes place in the morning and afternoon, sometimes in the evening, customer orders are picked-up during the night and they are loaded in the vehicle in the morning and afternoon. The number of trucks leaving on Wednesday is less than on other weekdays as they would reach their destination on weekend. Customers usually want to specify the way and the company via which they want to reach the final customer, but the company offers transport solution too. The company does not own rail cars; road transportation to Russia is also mainly outsourced. Main customers are transit-customers via Finland to Russia.

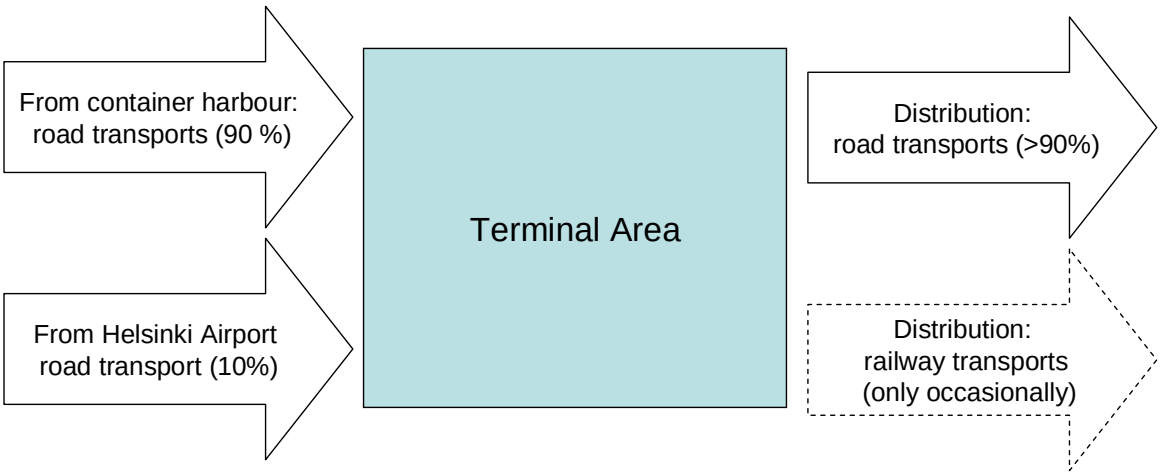

Figure 3. Incoming and outgoing transportation flows in Kotka terminal of the focal company.

Every month about 400-500 containers arrive and 200 trucks leave Kotka terminal. The first half of the year is not that busy as the latter part. During the busiest season the terminal works in three shifts. The warehousing space is in full use and new customers cannot be assigned to this port terminal. The company has about 600 000m2 of storing space in Russia; 25000 m2 of these are located in the region of St Petersburg. New terminal warehouses are

about to be built in the near future with capacity of 80-90000m2. The future demand in Russia is focusing heavily around the region of Moscow. St Petersburg will grow steadily too in terms of demand, so there is no danger that the transit traffic through Finland would cease. In the long run demand will grow in absolute terms, but relatively it might decrease as Russian port might capture a larger share of the demand. There are also warehousing facilities in the Baltic States in the ownership of the company.

Only about 5 percent of the products to be stored at the warehouse are there for over two months, the majority of good are final end products and these are only 1-2 weeks in the warehouse on average. Small fraction of the goods is raw materials. The company employs LOGIUS-software for warehouse management in all warehousing facilities. By using the same software in all facilities material handling procedures can be simplified. Every single item has a code according to which the movements and the storage location can be tracked down.

The most serious problem is conceived to be the congestion on border to Russia. The importance of train as a transportation mode in Russia will probably increase in the future. However, the speed of railway transport is low, 300 km per day and railways often are unable to provide a door-to- door service. Furthermore, currently there is a lack of usable rail cars on Russian railways. In the future Kotka might function as the backup area for St Petersburg. Currently the company collaborates with other companies e.g. by renting additional warehousing space if needed. The largest customers require even now a specific set of value added services such as packing. In the future the role of information management and collaboration in providing more flexible and comprehensive value adding services, e.g. providing total logistics solutions for customers will capture a greater share from the revenue of the company.

Same Finnish Transit Terminal Operator Facility in St. Petersburg

This warehouse that belongs to the operator described in Section 4.3 in St. Petersburg was opened in June 2008 and has currently 15 employees. The total space available for warehousing in 10000m^2 as a part of a larger complex of buildings (with 170000m^2 space) home for many enterprises. The primary objective is to offer to customers holistic service platforms. The customer base currently is narrow, but some clients that were served in Moscow are on their way to become a customer also for St. Petersburg. Nevertheless Moscow terminals seem to attract more and more customers that could opt for St. Petersburg as well

and this might stem from the fact that in St. Petersburg the custom clearance is more expensive to go through than in Moscow.

The central problem of railways from the viewpoint of operating in St. Petersburg is the slow operation speed involved and the amount of paperwork - the bureaucracy needed to manage the official documentation related to transportation management. In addition according to the company the railway network in the proximity of Moscow region is more developed. This is why the warehouse considers flexible and timely solutions a very important criterion in the future: currently the warehouse is open five days a week, but this is changing and in the future there will be cases where services will be available for certain customers seven days per week and 12 hours per day.

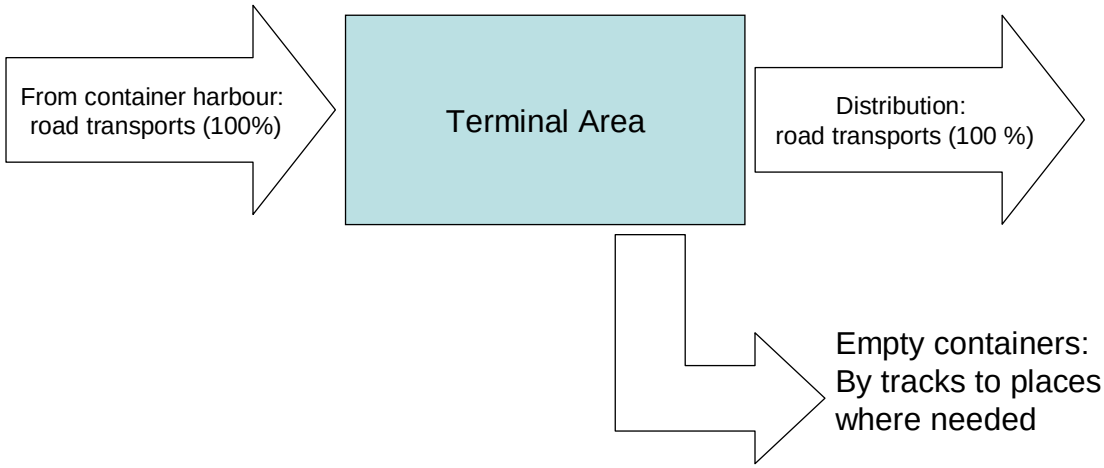

Figure 4. Transportation flows in St Petersburg terminal of the company

Customers decide what service platform they choose, still currently only road transport is employed in managing both inbound and outbound item flows to and from the terminal (see Figure 4 in above). Currently the amount of containers to be handled is minimal. As such the company does not consider that railway would be more expensive in terms of total costs of transportation, but much more improvement is needed both on the operational and the administrative side as well. In addition on longer distances rail is the only rationale option for this company.

Logistics Operator in the City of Kouvola

Company Z is a global transport provider operating all over the world. Its Russian market services are coordinated from Finland though there are administrative units in St. Petersburg and in Moscow. The company started there in 1992 and has 14 service outlets with 600

employees, but there are some sales agent partners also involved. In Russia the total warehousing capacity is 50.000 m^2 including both A and B level storage services. In addition the company owns 250 mega/euro trailers for carrying out the services. The most important issues to be improved in relation to transit flow from Finland to Russia are related to crossing the border: customs procedures and documents needed for custom clearance. The size of the three building warehouse complex in Kouvola is 175000 m2 out of which 20 % specifically for items to hold under zero degree. Still it has to be mentioned that the available places on shelves are continuously on their way to rise. There are approximately 60 employees working at this site. The services offered are mostly for transition good flow management, but in addition warehousing services for domestic transport are also offered.

During the last few years some significant shift in the transport flows can be noticed: The share of transit traffic has reduced into a great extent and so the inbound traffic from Russia. As customers decide how to carry out the transport services they purchase, nowadays the Trans-Siberian railway is not used anymore at all and all traffic are handled through road with trucks (see Figure 5 below).

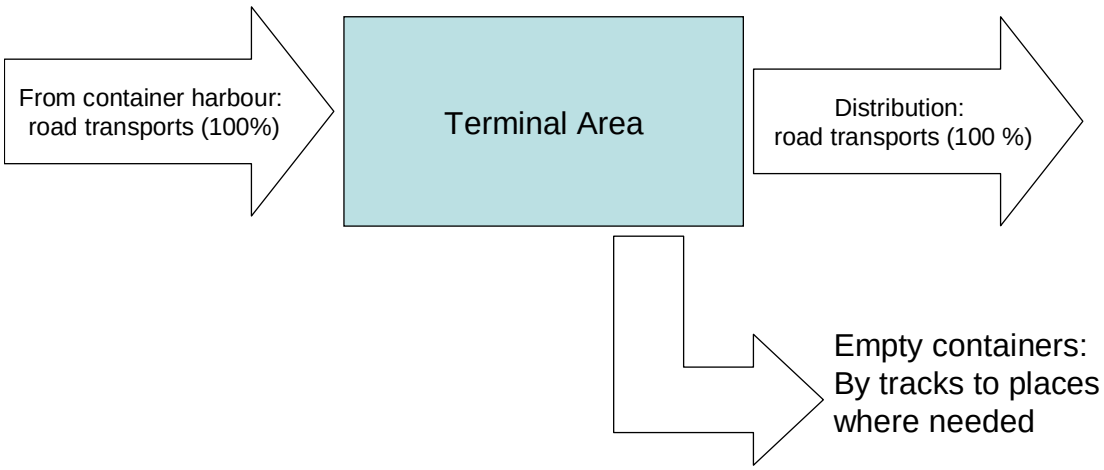

Figure 5. Incoming and outgoing transportation flows in Kouvola terminal of the company.

It has to be noticed that there is still a chance to take railway transport into use as there is rail-line into two buildings out of three in Kouvola. Still the volume of transit traffic in aggregate terms has not changed much only the selected routes have been switched to other due to customer requirements for lowering the costs with more value added services included. In the near future it can be claimed that lean principles will be more visible towards the

markets: block train and inter-modal solutions will increase their share out of the total amount of service platforms. In-house developed IT-services are already in a key position in implementing new service concepts for customers, but these IT-innovations are not sold outside as services to other partners. Employees are seen as competitive advantage. The objective is to offer them long term contract and enhance their level of expertise in areas needed.

Global Logistics Operator in the City of Hamina

This building complex of this global logistics service provider in the city of Hamina is of 69000 m^2 consisting of four different warehouses and there is 100 m^2 space with temperature below 0 Celsius for medicines. There are approximately 50 employees. The warehouse complex is made up of four different buildings so that the opening time is five days per week and the workers are assigned to two shifts per day. All the material flows are managed with trucks that carry most of the goods from and to the harbors of Hamina and Kotka (see Figure 6 below). The operations are coordinated from Helsinki. The busiest day of unloading cargos from trucks is Tuesday, while the busiest day for loading is Thursday. The largest categories of product groups are hand tools, printers, air conditioners and medicines. Seasonal changes are dependent on the category groups of products to be handled: for printers the time duration spent in warehouse is approximately 1.5 months, while handtools might spend 2.5 months in storage. Printers are more processed during winter whether the volumes of hand tools are higher during summer months.

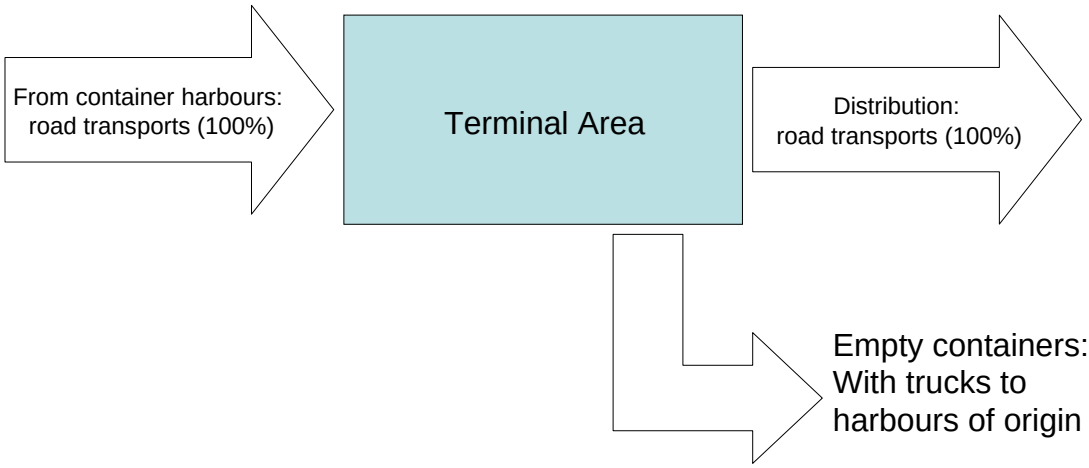

Figure 6. Transportation flows to and from the terminal of this global logistics service provider.

Major trends in good flows are the growth of volumes of transit flows and the decrease in need to storage of bulk products in Hamina as a result of direct shipments to Russia. Partly the procedures and practices related to storing products are dependent on the category and the amount of products under custom clearance. The firm provides transportation services. However, customers usually pick up their packages or they assign the tasks to a third party. The container traffic makes up 80-90 percent out of the total volume to be handled. Out of the total transport flows well over 90 percent is related with Russia, but westbound flow from Russia is only of marginal size. At the same time it can be said that the four largest customers make up 85-90 percent out of the volumes of transport.

The company uses an IT-solution for warehouse management that is developed in-house (named as Prologs) This IT-system is utilized as follows: Customers and other suppliers can access a central database and retrieve from there localized customized reports they need with the help of EDI-standard. In addition it is possible to track down the delivery process of every shipment for customers.

The major problems in current practices are related to uncertainty in customer clearance at the border between Finland and Russia and to changes in laws and the business environment in general: In so lean objectives must be spotted by small scale development projects that are all the time evolving: Central targets are safety/reliability and cost efficiency with the emphasis of value added services. Due to these reasons it cannot be seen whether in the future electronic documenting processes will bring more productivity in relation to warehousing processes.

In the future it is probable that the volumes of transit flows via Finland will decrease in relative terms as the result of increasing capacity of Russian ports to store goods in harbors. In Russia the transportation systems around ports are undeveloped and there are not that good value-added services available. It can be stated that it will take a long time before railways will be able to increase their share as a component of intermodal transport chain as it takes almost always longer to load and unload goods to and from rail cars than to and from lorries for example in case of targeting Moscow. In addition in many cases there are no specific wagons available on the market or if there are, one has to pay a very high price for purchasing them. Further with trucks one can reach almost every target site of the customers whereas with rail cars usually one cannot access the final destinations and extra handling is inevitable for transferring the good to trucks.

Finnish Logistics Service Provider

This company based in Helsinki, is involved in the Finnish – Russian transit transport via its terminals in the harbor cities of Helsinki, Kotka and Hamina and land terminals at border crossing stations. Despite the fact that transit is not the main segment of business, the company has a well established view on transit transport scenarios since it offers complete customer specific customizable package transport services where significant amount of transit transport takes place. These days approximately 65 percent out of the turnover of this firm is coming from Russia and from the other former Soviet Union countries. Currently the terminal capacity is of 130000m^2 in total out of which 75000m^2 is temperature controlled. A new terminal opened in Vuosaari in Helsinki at the end of November 2008 gives an increase of 50000m^2 to the total capacity of terminal storage areas within the near future. The harbor in Vuosaari is estimated to take a share of 20 percent out of the total transit volumes, but it is considered that it will stay mainly as a node for goods being imported to Finnish domestic markets.

The terminal in Kotka has a space of 35000m2 and it is the most significant warehouse dealing with transit flows of this enterprise. In the near future the majority out of transit transport will be centralized to go through Kotka and Vuosaari. Currently most volumes are handled with trucks, but in the future railways are assumed to capture a larger share from the road.

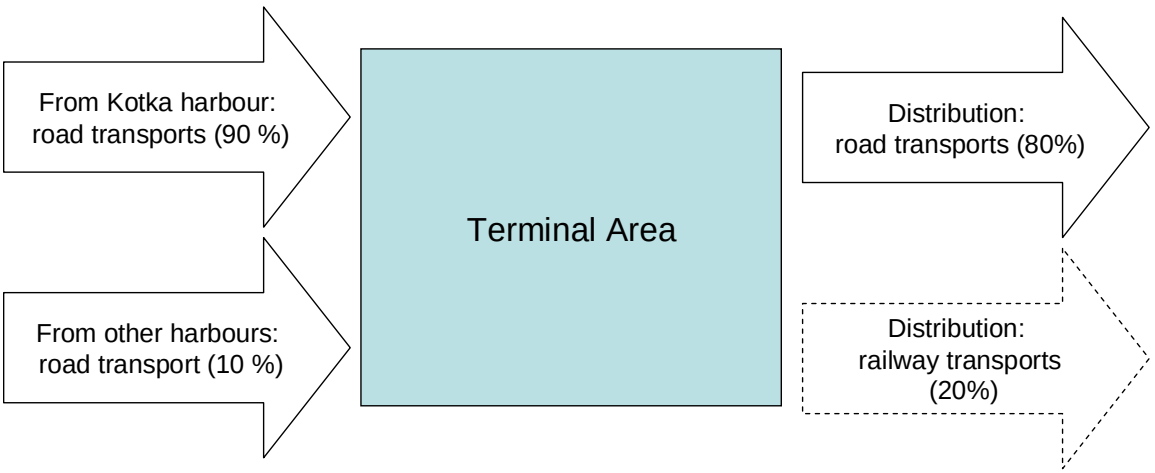

Figure 7. Flows of transport of terminal in Kotka of this service provider

Incoming flows of goods are mainly delivered to the terminal from Kotka harbor though some proportion of products is arriving also from the ports of Helsinki and Turku (see Figure 7). Both incoming and outgoing goods flows are of mainly containerized cargo. Empty containers are handled by partner shipping companies. There is a wide range of products to be handled as transit items: The most important ones are consumer electronics, raw materials, cars and semi-finished products for manufacturing purposes. Most products in the Kotka terminal are stored 60 to 90 days, but expensive consumer electronics items spend only around 10 to 20 days in the facilities.

In the future it is assumed that transit flows in Finland as total will decrease to some extent as the result of the increasing competition from other transit transport corridors evolving in Baltic States and Poland and the transfer of production to Russia. Nevertheless in some product groups such as semi-finished goods and components for the car industry the volumes will probably increase since Russian ports will not have the needed facilities and value added services and multinational manufacturing companies are on their way to set up more production factories in there. On the other hand an increase in the westbound transit flow will emerge.

The company seeks growth in the former Soviet countries, and plans setting up 3 to 4 new terminals in Russia, Ukraine and Kazakhstan. Possible areas of concerns include the depth and length of the financial crisis worldwide with related effects on the real economies and political relations between EU and Russia. Expansion to new markets and increasing market share overall is still possible as the firm has widespread base of key clients that are financially doing well and are reliable during periods of economic recessions. Approximately 60 percent of the turnover of the company comes from railway freight business. Currently the company owns approximately 1000 railway cars, and is planning to expand the fleet. One additional factor supporting the growth in a changing environment is innovativeness and the competitive advantage of the firm in having an extensive knowledge in documentation and IT-processes for custom clearance in relation to Finnish – Russian trade**.**

5. Discussion

Common themes for the cases analyzed are the facts that road transport is the dominant mode of transport, custom clearance procedures are conceived as troublesome and there are many

storage places available especially in the region of Russia. At the same time most terminal service provider are optimistic about the chances of railway to bring lean thinking into practice: block trains are seen as a solution in many places connecting areas around the borders between Finland and North-Western Russia. Nevertheless for example the currently expanding financial market crisis makes companies to consider more carefully their investment targets and this might result in reducing willingness to put extensive capital into the operational level of warehousing and transportation. Companies want to attempt on less but more targeted secured investments. Information available on m^2 in warehouses in Russia is vague and firms cannot differentiate in many cases between data on currently available and projected planned space in the warehouses (Nyby 2008).

At the same time the region of Moscow develops much more dynamically and as nowadays most of the economic activity is centered in there, the development attract even more potential warehouse users to go there. This fact can be supported with evidences about practices of custom clearance documentation procedures that are centered as well in Moscow. One of the consequences might be that many client enterprises of warehouse operators set up their headquarters of Russia in Moscow and not in St Petersburg so that they could handle the administrative issues related to warehousing and transportation. In addition a further reason benefiting Moscow is the current costs related to rents and prices of buildings: In the region of St. Petersburg currently the level of costs in these regards are clearly higher compared to the areas of the Russian capital reaching 140-180 $ per m^2 per year (Nyby 2008).

In overall it can be argued that in case current development trends will prevail in the near future in the region of St. Petersburg and Moscow, in the long run Moscow will in the end capture more customers away from St. Petersburg and the preconditions for lean transportation will worsen between Finland and Russia. Most of the forthcoming investment projects could be directed to seaport terminals and related connections located in the proximity of St Petersburg (see Tsuji 2008). This way congestion on the borders could be decreased and railways activate its advantage over road in terms of speed on shorter distances. The cases indicate that further integration in the context of collaborative schemes or mergers between railway operators and multimodal transport service providers would be fruitful, as these latter service companies are currently at the focus of global trade system and they have expert knowledge and needed equipments for providing quality services (Langley and Hoemmken 2008; Arvis et al. 2007). In the case of Russia this means also increasing role in development and co-ordination for governmental agencies.

Furthermore the case studies showed however that in the case of Russian – Finnish cooperative landscape in the greater regions of South East Finland and St Petersburg, the problems of container terminals are not that much concerned with physical space availability, but the interplay between companies and governmental bodies at customs on borders as well as the low state of utilization of intermodal door-to-door transport models. There are warehouses with a great amount of free storage places and usage of railway as a freight carrier is abandoned completely.

One additional factor increasing uncertainty for companies is related to the risks of economic downturn. Currently the worldwide financial market crisis is eating the willingness of companies to invest further capital into enlargement project. The negative effects are already seeable in the paper and pulp industry: There are fears that as a result of further drop of price of oil and unoptimised tariffs for wood would hurt trade between Finland and Russia (Helsingin Sanomat 2008; Lindström 2008). The cases showed that terminal operators in Finland see delivery process to Russian markets as an unpredictable and fluctuating one – this was also indicated with rather long inventory holding times (even months, instead of days or weeks). Clients of these business actors continuously integrating their supply chains in order to be able to reduce uncertainty by increasing the visibility into distribution processes. It can be envisaged that this development might lead to have reduced number of larger sized distribution centers in the near future: In this regard Moscow is a better place for warehousing as the business environment is more transparent there with brighter future outlook for strengthening demand (Nyby 2008).

It can be suggested that the only way St. Petersburg can compete with Moscow is to focus on port development and supplementary rail network construction. Leaness could be achieved with utilizing, existing, empty factory buildings that are already accessible with rail lines from the city and exploiting cheap open source warehousing software solutions in generating visibility and predictability into the distribution information flows needed by foreign manufacturing companies.

6. Conclusions

The literature analysis revealed that lack of space and warehouses at distribution centers of sea ports will put pressure to locate some set of activities handled by these hubs to hinterland terminals. In turn this move will put rail transport connections service into the forefront of

attention. It can be envisaged that the growing demand for customized specifically tailored transportation service packages in general at seaports will force to take into practice network oriented tools to measure productivity and performance at the network nodes (Kersten et al. 2007).

The case studies indicate that in St Petersburg area the general conditions for international transportation are way weaker than in Moscow, and coordinated investment projects into sea ports are inevitable. These nodes will have to turn into intermodal logistics service centers. Rail as a transport mode will otherwise loose further share to road and truck queues on the borders of Finland and Russia will grow even more from now.

With regard to future research pathways, additional case studies could be carried out with large industrial companies and terminal operators to reveal how network oriented productivity measures could be employed to accelerate efficiency and profitability in this region of Europe. It would also be interesting to investigate with qualitative approach how custom clearance procedures could be simplified along the Northern EU – Russian border line. One good target for further benchmarking could be the brand new "Kerava Cargo Center" in the Helsinki region that is scheduled to start its operation during spring 2009 (See LIMOWA 2008: KERCA). In addition it could be beneficial to produce a report shedding light on China – Japan axis and see how container terminals there develop their operations in relation to cross-border trade.

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Research Note: Warehousing in St. Petersburg, Russia

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Many container terminals are located and built new at the present time at the industrial area Shushary, in the southern outskirts of Saint Petersburg. As for existent ones railway terminal of October affiliate of Russian railways should be mentioned first of all. It was built about 30 years ago and disposed near railway marshaling yard Shushary. So it is very well located in relation to railway cars movement to and from the container terminal. Later it experienced some modernization. Area of the terminal is about 20 hectares and includes 2 container yards and warehouse with dimensions 60 by 230 meters. Two railway tracks go inside the warehouse and 4 ones were laid along the container yards. Total capacity of container yards amounts for 30 000 TEU annually and warehouse of unit loads – about 100 000 t. In the warehouse cargo is stored without any racking – just in stacks and handling with counterbalanced forklift trucks Container yards are equipped with RMG (Rail Mounted Gantry) and several Reach Trucks. A project is fulfilled now for extension the terminal on 10 hectares more to the South.

Another terminal facility, operating for the long time at the Shushary industrial area, is customs terminal Juzshney that receive and dispatch cargo only by road transport. It has customs Office and Warehouse of Temporary Storage of space about 4000 m^2.

First Container Terminal (FCT) located at marine port Saint Petersburg has capacity 500 000 TEU (Twenty-Feet-Equivalent-Unit) annual and needs to extent its handling capacity because the volume of container transportation over the port boosts near 15-20% every year. FCT is located in the 3rd freight region of the port and can store about 7000 TEU. This stock is not enough however for processing ever increasing container flow. Therefore FCT acquired a lot of land of 70 hectares in the Shushary industrial area and this project of inland container terminal in 13 km from the port is fulfilled at the present time.

Moscow wholesale company Avalon builds freight terminal of unit cargoes on a lot of 40 hectares in the Shushary industrial area – not far from the terminal of October railway. It

includes big warehouse of 120 000 m^2 area 13 m high that owner intends to give for rent to some retail firms as divided in sections of area 5000-7000 m^2.

One of the biggest Russian forwarding company Eurosib has built container terminal in the Northern part of Shushary industrial area in 2007 on lot of 18 hectares. There are container yard there of 40000m^2 space with stock capacity 2000 TEU and annual throughput 50 000 TEU. Warehouses of 30000m^2 space have handling capacity 400 000 tones per year. The terminal has 3 railway tracks 2500 m total length and owns shunting locomotive. Many of these facilities would have Customs Offices. The main works, fulfilled at majority of these terminals are as follows:

- Unloading containers from railway and road transport and temporary storage them on container yards in expectation of departure;
- Transshipment of unit cargo out of containers of foreign shipping companies into railway wagons and trucks for delivery to regions around Russia and vice-versa;
- Loading, unloading and temporary storage of empty containers (foreign and Russian);
- Loading and unloading of unit cargoes from railway and road transport and temporary storage them in warehouses in expectation of departure;
- Completion of fast container trains (shuttle or block-trains) and direction them from Petersburg to other regions of Russia.
- Customs clearance of import and export cargoes etc.

Research Note: A Simulation Model for the Train Movement between Passenger Terminal and Technical Station

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The simulation models are used for the solution of the various problems in the organization of the railway transport work. It helps to explore by the work of the separate elements of transport system in the different regimes of its exploitation. There is a possibility to make the common or local models. The local model helps to study of the work of separate elements only. The concrete proposals, which allow choosing the more effective schemes of the train movements and measures for the reconstruction (development) of the railway stations and junctions, are received on the base of the results by the using of the simulation model.

The program, is made in Petersburg State Transport University, is a example of using of the simulation model for the solution of the local problem: the determination of the times for the movements of the long distance passenger trains between the passenger terminal (PS) and the passenger service station (PTS).

On the PS: there are the arrivals and the dispatches of the passenger trains according to the time schedule, the boarding and unboarding of the passengers. On the PTS: there are the preparation works with the long distance passenger trains (the washing, the cleaning and maintenance by the cars) before the passage.

The creation of this program was stipulated by the necessity of the analysis for the influence of the system of the train movement on the location and number of PTS in the railway junction, having the some passenger terminals. This problem is characteristic for the every large railway junction, such as St. Petersburg.

Today, there is a tendency of the increasing of volume of the passenger traffic. Accordingly, it is need to develop by the technical equipment, using for the preparing of the passenger trains to traffic. But, it was appeared such problem: the existing PTS, where the technical operations are realized, are situated in the central part of the city. Practically, there does not exist possibilities for these further developments (the increasing of number of PTS station tracks, the building of new constructions).

Besides, it needs the supplementary land territories, but the prices of these lots are highest. In result, the common expenses for the development of the PTS will be more. Because, it is need to examine the variants of new PTS locations moving off from the PS. But that, the duration and the time of these passenger trains movements will increase.

This situation has an influence for the some economical factors: the expenses for the passenger trains movement; the expenses for the increasing of the station layout and the others. Besides, it influence for the times of the being by passenger trains at PTS, for the keeping of the train schedule, for the optimal number of the passenger trains.

This simulation model gives a possibility to determinate these time expenses for the movement between PS and PTS with regards for the mutual locations PS and PTS. The logical and mathematic bases of this model are described in this article.

PTS are immanent constituents of a large railway junction. They are intended to move passenger trains from and to passenger terminals and prepare the trains for further use in between arrival and departure moments. We will call a train traveling to PTS or back to the passenger terminal as intermediate train.

In this work we present a simulation model aimed to establish the optimal conditions for transferring intermediate train from passenger terminal to PTS and back and describe the main features of our model. We assume two-way traffic. The tracks are thought of to be divided into segments by stations. No outdistancing of trains is possible within a segment (*i.e.*, between adjacent stations). On the contrary, trains can by-pass each other at the stations. In what follows, the segments are denoted as kl with k and l indicating the beginning and end stations bounding the given segment. Besides we make the following assumptions. Firstly, the traffic priority of passenger trains with respect to the intermediate train is supposed. Secondly, the clearance between trains moving in the same direction may not be less than a given number (ρ) provided both trains are inside the same segment.

The data concerning the traffic of both passenger and short-distance trains are stored in the arrays d_i^{kl} and a_i^{kl} which are the departure and arrival times of train i moving within segment kl. Let us denote the average speed of a passenger or short-distance train for segment kl as v_i^{kl}. Then the following obvious relation holds

$$a_i^{kl} = d_i^{kl} + \frac{r^{kl}}{v_i^{kl}}, \qquad (1)$$

where r^{kl} stands for the extent of segment kl.

If a train moving through two adjacent segments kl and lm has a stop at station l then we have

$$d_i^{lm} = a_i^{kl} + \Delta t_i^l \ , \tag{2}$$

Δt_i^l being the stopping time.

Now consider characteristics related to the intermediate train. Let K denote the ordered set of the segments which build the route of the intermediate train from passenger terminal to PTS or the route in opposite direction. The run schedule for the intermediate train is described by the variables D^{kl} and A^{kl}, $\left(kl \in K\right)$ which are departure and arrival times, respectively.

To take into account the traffic priority of passenger and short-distance trains, it is useful to introduce the quantity $X_i^{kl}(t)$. This variable has the following meaning. If train i is inside segment kl, this quantity gives the distance measured from the beginning station k of the segment that the train has passed by the moment t. If the train is beyond the segment, the quantity takes on an infinite (or, in actual calculations, large enough) value. As we will see later on, such definition proves to be convenient for mathematical reasons.

Formally one has

$$X_i^{kl}(t) = \begin{cases} v_i^{kl}(t - d_i^{kl}),\ t \in \left[d_i^{kl}, a_i^{kl}\right] \\ +\infty,\ t \notin \left[d_i^{kl}, a_i^{kl}\right] \end{cases}. \tag{3}$$

A similar quantity is introduced for the intermediate train too:

$$X^{kl}(t) = \begin{cases} v^{kl}(t - D^{kl}),\ t \in \left[D^{kl}, A^{kl}\right] \\ -\infty,\ t \notin \left[D^{kl}, A^{kl}\right] \end{cases}. \tag{4}$$

Note that $\left|X_i^{kl}(t) - X^{kl}(t)\right|$ is equal to the distance between the scheduled train i and the intermediate train at moment t suppose both trains are within the same segment kl. Infinite absolute values of the functions (3) and (4) with opposite signs ensure that the quantity $\left|X_i^{kl}(t) - X^{kl}(t)\right|$ becomes infinite if at least one of the two trains is beyond the segment. It is mathematical imitation of the fact that there is no traffic conflict between trains moving on different segments.

Thus segment kl can be occupied by the intermediate train, if the following condition is fulfilled for any scheduled train i

$$\left|X^{kl}(t) - X_i^{kl}(t)\right| > \rho, \;\; t \in [t_1, t_2], \tag{5}$$

where t_1 and t_2 are the time bounds of interval as both trains are inside the same segment. These quantities can determined as follows

$$t_1 = \inf\left\{[D^{kl}, A^{kl}] \cap [d_i^{kl}, a_i^{kl}]\right\};\; t_2 = \sup\left\{[D^{kl}, A^{kl}] \cap [d_i^{kl}, a_i^{kl}]\right\}.$$

If the set entering equation (6) is not empty, t_1 and t_2 are given by formulae

$$t_1 = \max(d_i^{kl}, D^{kl});\;\; t_2 = \min(a_i^{kl}, A^{kl}). \tag{6}$$

If the intervals of equation (6) do not intersect, one gets $t_1 > t_2$. In that case no intolerably close location of trains on the segment is possible. That is why condition (5) should only be verified for those scheduled trains and the intermediate train as $t_1 < t_2$ for a given segment. In the present model we assume that all trains move with constant speed within each segment (though generally with different speeds on different segments). The fact that motion is piecewise uniform enables one to reformulate condition (5) as simultaneous realization of two requirements. First, trains should be separated by large enough distances at the bound times t_1 and t_2:

$$\begin{aligned} &\left|X^{kl}(t_1) - X_i^{kl}(t_1)\right| > \rho \\ &\left|X^{kl}(t_2) - X_i^{kl}(t_2)\right| > \rho \end{aligned}. \tag{7}$$

Second, there is no outdistance within the segment:

$$\left(X^{kl}(t_1) - X_i^{kl}(t_1)\right) \cdot \left(X^{kl}(t_2) - X_i^{kl}(t_2)\right) > 0. \tag{8}$$

We define as optimal such a schedule for the intermediate train which guarantees the minimum duration of its travel from passenger terminal to PTS or in the opposite direction. We can formulate this problem in the mathematical framework as follows. Let numbers $m = 0, \ldots, M$ enumerate the stations that the intermediate train successively passes on its route to PTS. Then the criterion given above is equivalent to solving the minimization problem $\min A^{M-1M}$ with subsidiary conditions (7) and (8). Besides, two more restrictions should be imposed

$$D^{01} \geq T_0 \tag{9}$$

and

$$D^{mm+1} \geq A^{m-1m}. \tag{10}$$

T_0 is the moment by which the intermediate train is ready to depart. The first restriction implies that the intermediate train cannot depart before it is ready to leave passenger terminal for PTS or, vice versa, leave PTS for passenger terminal. For example, the intermediate train should stay at passenger terminal unless the passengers left the train. The second restriction merely means that departure from a station follows arrival at it. We consider the departure moments at each segment D^{mm+1} to be independent variables. The arrival moments are obtained from the relations similar to relations (1):

$$A^{mm+1} = D^{mm+1} + \frac{r^{mm+1}}{v^{mm+1}}, \tag{11}$$

where v^{mm+1} stands for the mean speed of the intermediate train on segment $m, m+1$.

The restricted minimization problem just outlined above can be replaced by an unrestricted one by means of penalty functions. Let $\Phi(x)$ be a function that is equal zero for $x \geq 0$ and takes on a large enough value A if $x < 0$:

$$\Phi(x) = \begin{cases} 0, & x \geq 0 \\ A, & x < 0 \end{cases}. \tag{12}$$

Then utilizing $\Phi(x)$ as a penalty function one arrives at the following minimization problem:

$$\begin{aligned} &\min\Big\{ A^{M-1\,M} + \\ &+ \sum_{i,m} \Big[\Big(\Phi\Big(\Big|X^{m-1m}(t_1) - X_i^{m-1m}(t_1)\Big| - \rho\Big) + \Phi\Big(\Big|X^{m-1m}(t_2) - X_i^{m-1m}(t_2)\Big| - \rho\Big) + \\ &+ \Phi\Big((X^{m-1m}(t_1) - X_i^{m-1m}(t_1)) \cdot (X^{m-1m}(t_2) - X_i^{m-1m}(t_2))\Big)\Big] + \\ &+ \sum_{m} \Phi(D^{mm+1} - A^{m-1m}) + \Phi(D^{01} - T_0) \Big\} \end{aligned} \tag{13}$$

In this problem, D^{m-1m} are regarded as independent variables, all other quantities are functions of them. In particular, t_1 and t_2 are found from formulae (6) and thus they depend

on m and i. Summation on i is performed over those passenger and short-distance trains for which inequality $t_1 < t_2$ holds.

The present model enables one to estimate the time that an intermediate train needs to proceed to PTS and from it for different locations of PTS. This quantity is of great importance in finding the optimal position for PTS and thus reducing the corresponding costs.

We present the plot of the total delay of the intermediate train as an illustration of results which the model discussed can yield in Figure 1. The diagram relates to the St. Petersburg railway junction. PTS is assumed to be located at the Voibokalo station. Obukhovo is considered the only station where train by-pass is possible.

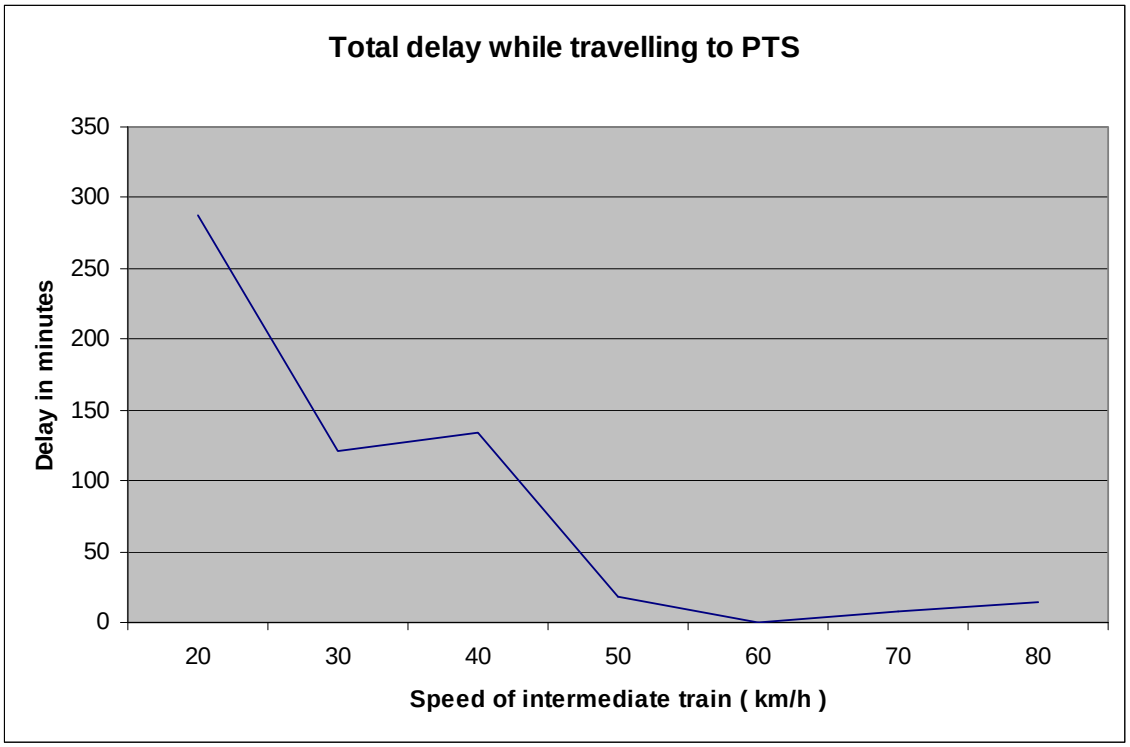

Figure 1. Total delay while travelling to PTS

As is seen from the diagram and as one could easily expect, the delay turns out to be zero at a speed value 60 km/h, which best matches the mean speed of scheduled trains.

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Role of Software Applications in Logistics Decision Making: Case of Warehouse Management Systems

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Abstract
The ability of software applications to help solving logistics related problems has become of critical importance in general and bringing about productivity improvements in particular. This research is to scrutinize the role of IT solutions in this regard with warehouse systems in focus. According to the findings, software applications will contain increasing functionalities for training and guiding in finding and implementing novel logistics operational models with the goal of increasing return on investment with fewer resources. Intelligent automatically itself-adjusting service level agreement platforms might well be in the centre of focus of attention in the near future. The case study reveals that by synchronizing warehousing processes with advanced functionalities of a wms it becomes feasible to integrate strategic tactical considerations into operational matters in logistics decisions. In this manner it will be possible to enhance capacity utilization rates in executing processes despite large scale fluctuations in demand so as to increase responsiveness towards customers. In turn these factors will bring further simplicity and transparency into the contractual relations between the parties of a supply chain.

Keywords: Supply chain management, logistics decision making, software applications, lean principles, warehouse management system

1. Introduction

Globalization and the increasing uncertainty of business environment expose logistics managers and other decision makers to more difficult trade-off situations than before. Customers of commercially oriented manufacturing organizations demand higher quality but cheaper with quicker realization. At the same time governmental agencies are on their way to reduce their involvement in strategic business segments - such as transport is - around the world (Boeri et al. 2006). As a result there is an increasing need for responsiveness and agility in firms' ability to secure their future (Holweg 2008; Bonfill et al. 2008; KetiKidis et al. 2008; Helo 2006). This research is to reveal the emerging role of software applications in enhancing the value added dimensions offered by logistics services. In particular functionalities of software applications to ease logistics decision making will be highlighted. The research question can be formulated as follows: In what ways software applications can support logistics decision making taking into consideration of constantly changing turbulent business environment and what are the scenarios for the future.

The case for the study is covered by examining the functionalities and processes involved in the business warehouse management system of Microsoft Dynamics. The perspective is taken from the user i.e. how to set up and use this system in order to solve the problems related to storing products and managing the relevant processes. The aim is at illustrating the options available to control the costs incurred during warehousing via showing how process parameters can set up in configuring a warehouse structure to increase the value for a user company. To the same token it has to be emphasized that the text cannot be seen as manual as how to use the software: the specific detailed paths to activate functions are left out from the descriptions. Nevertheless screen shots are employed to visualize the platform of possibilities for implementing operational models. In addition each core concept is explained to support the understanding the scale of opportunities included into the system.

The structure of the scrutiny is as follows: In Section 2 the underlying concepts of logistics and supply chain management will be focused on after which the next section covers the nature of logistics decision making and the role of information technology in it with the help of a literature review. Based on this background Section 4 is to reveal the starting points for classifying software for logistics decision making. Methodology section reveals the arguments for classifying this study as a qualitative research. The case study section discusses the relevant views for understanding the functionalities of Microsoft Dynamics in controlling warehouse management operations. There after the trends and arguments for developments taking place on the markets will be discussed with concluding remarks. Some research areas are suggested too to proceed on with.

2. Definitions of Relevant Concepts

In line with the changing nature of business environment over the last thirty years the world ”logistics” become of a broad term to complement newer dominant aspects of modern philosophies. Nowadays logistics is seen as more of a complex process involving many services and product(s) within a value creation oriented network of organizations – a supply chain (Council of Supply Chain Management Professionals 2008):

“Logistics is that part of supply chain management that plans, creates and monitors the efficient, cost-effective flow and storage of goods, semi-finished items and manufactured products as well as related information between the point of origin and the point of consumption in order to meet customers' requirements.”

Due to the role of logistics as an interface platform between supply chain members, it is also a critical part in product development and manufacturing processes: The terms “Procurement Logistics”, “Production Logistics”, “Distribution Logistics”, “Spare-parts Logistics” and “Reverse Logistics” are indications of strategic importance of this research field (DHL Logbook 2008). According to this same reference, in turn supply chain management is a set of processes forming a system. The sets of processes can be categorized as follows: customer relationship management, customer service management, demand management, order fulfillment, manufacturing flow management, supplier relationship management, product development and marketing, and returns management. Logistics is becoming increasingly a lean thinking oriented concept too. A novel definition of logistics performance confirms this argument (Ngwainbi 2008):

“Logistics performance is described in terms of superior customer value at less cost, and this customers value is derived from tailored services, reliability, and responsiveness whereas a cost advantage comes through capacity utilization, asset turn and synchronous supply.”

3. Facets of Logistical Decision Making and the Role of Information Technology

As the above definition illustrates to achieve an advanced level of logistics performance (see Ngwainbi 2008), different functions and processes within a company must be in a smooth interplay through, which more value can be produced with less costs. Logistics decisions are the tools to mitigate trade-off between demand product and operational considerations: Synchronizing warehousing with production and controlling supply & demand conditions to ensure high customer satisfaction is a task with full of conflicting objectives. The problems are usually of cross functional in nature, involving a great amount of parameters with numerous decision makers within a context of increasing uncertainty about future circumstances (Meepetchdee & Nilay 2007; Ratliff & Nulty 1996; Davidson & Kowalczyk 1994). A recent research study revealed that in the case of inter-organizational setting the platform for logistics decision making is even weaker: the concepts themselves are in many cases not clear to the parties involved to the decisions and it is difficult to integrate external parameters coming in from customers and suppliers with internal decision making procedures (Williams and Tokar 2008; Kicin, Hemilä and Gringmuth 2008).

As a consequence the impacts of the decisions are not easy to evaluate and the need for quantitative analysis is a fundamental one. Most often optimization models are built within the context of concepts of linear programming, heuristics, but simulation techniques and data envelopment analysis have been showing rising popularity as well. With regard to integration of warehousing models with transportation choices, information technology (IT) has been utilized in many different ways in relation to route and mode selection questions. In the context of this setting important decision making related variables are price, service level, delivery time, safety and stability (See Ivanova 2007). The ultimate objective of logistics managers is to set out a control mechanism with specifying a set of parameters that are to optimize the interplay of warehousing, inventory and transportation processes in relation to product flows: to be able to make efficient decisions on production logic (that is to choose between make to stock, make to order, assembly to order or engineering to order), to choose between pull/push strategies for inventory and decide whether centralized, decentralized or hybrid model to apply for inventory (Wanke and Zinn 2004). Nowadays costs considerations seems to become even more important while “delivery time” is bound to be the most influential service level performance measurement tool for warehousing and inventory decisions (Butner and Huppertz 2008; Williams and Tokar 2008; Päivinen, 2008; Wanke and Zinn 2004). In general software solutions can be seen as uncertainty reducing tools in their capability of bringing deeper visibility into the links between warehousing, inventory and transportation processes (Mathy 2008; Rodrigues et al. 2008). Below Table 1 presents the perspectives on the implications of evolving IT solutions on logistics and supply chain decision making.

Table 1. Article analysis on the role of IT in logistics decision making.

Author & Title	Major arguments	Additional information
E.W.T.Nagi et al. (2008) Logistics information systems: The Hong Kong experience	It is argued that perceived benefits of an LIS do not have an effect on itself the decision to purchase a system. Lack of financial resources, employee knowledge and appropriate support may lead to rejection of implementation.	Capacities and accuracy of logistics processes can be improved significantly by adopting a LIS to compress total lead time and inventory. Computerization of logistical activities is widely accepted in the literature and practice.
P.H. KetiKidis et al. (2008) The use of information systems for logistics and supply chain management in South East Europe: Current status and future direction	Due to infrastructural, problems, strategic planning and collaboration weaknesses companies in the region do not seem to have an ability to play a demanding in role in global supply chains.	In Albania, Bulgaria, Greece, Former Yugoslav Republic of Macedonia, Romania, and Serbia and Montenegro, companies do have similar challenges in using IT systems for logistics.
Holweg, Mattias and Pil, K. First (2008) Theoretical perspectives on the coordination of supply chains	The contribution of IT systems in achieving better logistics decisions are to provide a tool for sharing of information without delay. Uncertainty and lead time compressions are possible.	The implications of change of SCM at a firm level is better to model with integrating theoretical approaches of resource-based view, complex adaptive systems and adaptive stucturation theory.
Bonfill, A. et al. (2008) Decision support framework for coordinated production and transport scheduling in SCM	The meaningful coordination of production and distribution systems is still an uninvestigated field of research. Common uncertainty factors are product demand and processing time variability.	The presence of uncertainty in these models is most often ignored. At the same time the majority of work available considers only strategic and tactical level factors.
Katerina, Pramatari (2007) Collaborative supply chain practices and evolving technological approaches	A tool of centralized web-platform – portal is not suitable to support logistics decisions making in solving process deficiencies when information intensity is high among participants of a supply chain.	A decentralized solution with a back office system supported by RFID technology might be a better solution for companies to collaborate in case of high level of information exchange and complex processes.
Kärkkäinen, Mikko et al. (2007) Roles of interfirm information systems in supply chain management	Firms in Finland use supply chain software solutions mainly for transaction processes, planning and collaboration and order tracking & distribution coordination.	As a result of lack of personal communication profiles and practices for sharing information, IT systems cannot effectively support inter-organizational decision making.

Based on the outcomes of the arguments of the articles analyzed above, it is evident that the use of IT-solutions for logistics decision making is firmly recommended everywhere and the claimed strategical and operational benefits are confirmed too. Nevertheless the actual implementation is often limited due to human factors. These observations imply that towards

the future software applications that are cheap with flexible, easy to use interface design will be the ones to capture more market share. As a consequence, it can be argued that increasing complexity of turbulent business environment will force further mergers and integration between giant software and logistics service providers to be able to provide simple and responsive solution for customer requirements. In line with these developments it will be more important in the future to include into software applications multiple research methods with a possibility to integrate these together. In the end one could say that in the future with software better outcomes have to be achieved in shorter time and with fewer resources. In so, lean paradigm in software aided logistics decision making will prevail and become even stronger.

4. Methodology and Limitations

This scrutiny was written by employing a qualitative research approach to understand the nature of software applications in the context of logistical decision making. To be able to find trustable starting point earlier academic journals articles on this topic was scanned through and complemented with updated reliable Internet resources. This work can be claimed to be a case study as it focuses on the role of warehouse management systems in leveraging lean strategy into operational models of warehousing. At the same token it can be argued that this research is a cumulative case study as it draws on the conclusions on previous literature with an emphasis on warehouse management. A significant limitation is the fact that the concepts targeted in this scrutiny are of changing nature in the facets of emerging views of relevant theories and practices. In addition there were no interviews accomplished with managers and consultants of the fields in concern and therefore the findings might not be exhaustive.

5. Classification Platforms for Software Applications: Perspectives of Logistics and Supply Chain Management

There are basically three different aspects through which it is convenient to divide the range of software application for logistics and supply chain management. The first approach is the

organizational view: One can observe intra-firm and inter-firm tasks oriented software. The second classification criteria is based on data-management considerations:

There are transactional and analytical products; the former is targeted for capturing, processing and storing raw data whereas the latter is for utilizing decision models for supply chain development. The third aspect for grouping is stemming from process management strategies: The first group is a set of software applications for planning and the second is for executing. The former group is concerned with defining the best processes for order fulfillment whereas the latter group is engaged with implementation and control activities with tracking physical status of goods and materials and related final information (Helo and Szekely 2005). In the following the classes are presented with list of software providers for each group. In the Appendix there is a short booklet about warehouse management module of Microsoft Dynamics (NAV) so as to reflect the theoretical concepts in practical use.

5.1 Warehouse and Transport Management Systems (WMS/TMS)

Warehouse management systems can be depicted as systems for control of storage and movement for products and goods within a warehouse so as to easy the information control of associated transactions, such as shipping, receiving, put away and picking. Below in Table 2 there are the missions and the benefits of these kinds of systems for logistics decision makers.

Table 2. Objectives and obtainable benefits from WMS (adapted from Helo and Szekely 2005).

Mission	Benefits for logistics decision makers
A software package that brings about competitive advantage in a form of advanced visibility into inventory activities within a company. This is achieved through cycle time reductions, process improvements and optimized space calculations.	It is possible to produce higher valued reports and analysis in an integrated manner on process control parameters related to warehouses, cost indicators of keeping inventory and planning & scheduling of operations. As a consequence it is possible to target better processes for investment portfolio configuration.

Among the most common functionalities included into a WMS are receiving, put-away, inventory management, cycle counting, task interleaving, wave planning, order allocation, order picking, replenishment, and facilitating packing & shipping processes. In the new wave of development labor optimization, parcel manifesting and voice picking are about to become the novel components of WMS. Vendors increasingly offer their solutions as service bundles encompassing process compositions (Woods 2008). Major players of this market are Manhattan Associates, RedPrairie and HighJump Software, Sterling Commerce while niche oriented actors are Oracle Corporation, Infor, Swisslog, Aldata, Kewill Systems, and Consafe Logistics. Transport management systems can be seen as systems for synchronizing processes of planning and decisions related to finding the best models for route selection under given circumstances, produce follow-up data to monitor the movements of products and goods with relevant key performance indicators assigned. Below in Table 3 the mission and associated benefits are given for decision making with regard to logistics.

Table 3. Objectives and obtainable benefits from TMS (adapted from Helo and Szekely 2005).

Mission	Benefits for logistics decision makers
A software package for bringing competitive advantage in a form of optimized use of vehicles, loads and drivers, enhanced selection methods for carriers and transport mode, improved synchronization with production and lower administrative costs.	It is possible to produce higher valued reports and analysis in an integrated manner on process control parameters related to the use of transportation fleet, cost indicators of deliveries to and from suppliers, distribution centers and customers in line with constraints and seasonal fluctuations. As a consequence it is possible to target better processes for investment portfolio configuration.

The most common functionalities of TMS solutions cover planning and optimization tasks such as load consolidation, routing, mode selection, carrier selection, and these are often complemented with execution oriented processes such as tendering loads to carriers, shipment tracking and trace, freight audit and payment. These days attention is paid increasingly on new dimensions for enhancing global visibility and controlling performance: Processes of event management, business activity monitoring (BAM), track and trace, and analytics are serving strategic sourcing and planning platforms (Klappich 2008; Connaughton 2008). The leaders in this segment are Oracle Corporation and I2 Technologies, but JDA Software, SAP

AG, Infor and Manhattan Associates follow right behind. Nice players are Sterling Commerce, Logility, RedPrairie, HighJump Software, Transplace and Lean Logistics.

5.2 Enterprise Resource Planning Systems (ERP)

ERP can be defined as integrated business management systems for all possible facets of functions existing in companies providing visibility links to customers, suppliers and for other organizations in a supply chain. Below in Table 4 there are the missions of these applications and the benefits they offer for decision making in logistics.

Table 4. Objectives and obtainable benefits from ERP (adapted from Helo and Szekely 2005).

Mission	Benefits for logistics decision makers
A software package that standardizes and streamlines business processes of a company by integrating the data sources of all the functionalities of human resource management, material and production management, and financial resource management.	It is possible to produce higher valued reports and analysis in an integrated manner on the process performance level of customer service provision, product development & launch and efficiency of human resources. As a consequence it is possible to target better processes for investment portfolio configuration.

There are wide varieties of functionalities in these kinds of ERP applications including tasks of controlling financial, material and information flow from a supplier to the customer and allocating these tasks to workforce available. For example in the context of the process "order-to-cash", there is a broad section of work to be done: Receiving and order, confirming this order, communicating the details needed for production and finance and finally closing the order with assuring that the price is claimed and the revenue is received. Toward the future the emphasis of development is on functionalities needed in specific industries and data structures facilitating vertical integration within a market so that ERP software could function as a backbone transactional system (Hamerman 2008). The long time leaders in this market are SAP AG and Oracle Corporation, but nice companies such as Agresso, Epicor Software, Infor, Lawson Software, Microsoft, and The Sage Group are notable actors too.

5.3 Supply Chain Management Systems (SCM)

SCM solutions can be described as systems for advanced planning and scheduling (APS) for inter-organizational process control. The final goal is to find the optimal balance between raw materials and production capacity in order to meet actual demand in a long run. Below in Table 5 the mission and related benefits out of these systems for decision makers in logistics are presented.

Table 5. Objectives and obtainable benefits from APS (adapted from Helo and Szekely 2005)

Mission	Benefits for logistics decision makers
A software package that is to help to design an optimized sized supply chain network so as to minimize costs and maximize value for all the parties involved. This is achieved through simulation, mathematical & linear programming models, or heuristics.	It is possible to produce higher valued reports and analysis in an integrated manner on supply chain network cycle times, service level indicators part of inter-organizational process parameters. As a consequence it is possible to target better processes for investment portfolio configuration.

The there core classes of tasks of APS software packages are network planning and optimization, supply chain simulation and inventory optimization. The first group is of strategic nature involving the tasks for solving the trade offs between network and service options cost wise. The second group is dedicated to resource allocation in that they are to provide a set of scenarios on possible events to mitigate risk involved in implementing the strategic options. These techniques are often based on Monte-Carlo analysis, a statistical method for forecasting patterns of occurrences. Inventory optimization functionalities are to determine the right level of inventory and policies for a company at each level of a supply chain. This group of decisions can support postponement and pull/push strategies for achieving the optimal customer service. (Supply Chain Digest 2008).

The most significant actors in these segments are mainly the same as in the ERP sector: SAP AG and Oracle Corporation dominate the sceneries, and there are huge amount of smaller companies such as Manhattan Associates, RedPrairie, Aldata, CDC Software, I2 Technologies, IBS, Infor, ILOG, QAD, Epicor, IFS.

5.4 Enterprise Application Integration (EAI)

EAI can be set out as systems combining processes, software, standards, and hardware for facilitating integration of enterprise applications so as these could function together as one. Below on Table 6 there are the mission and benefits provided by these systems for logistics decision making.

Table 6. Objectives and obtainable benefits from EAI (adapted from Helo and Szekely 2005).

Mission	Benefits for logistics decision makers
A software package that is to advance the state of quality of interface between enterprise systems in different companies so as to enhance customer and supplier relationships, shortening time to markets for products and services, helping to increase responsiveness of technology platforms in use.	It is possible to produce higher valued reports and analysis in an integrated manner on the quality indicators of relationships between companies from the viewpoint of logistics and state of utilization of IT solutions for supply chain management. As a consequence it is possible to target better processes for investment portfolio configuration.

The main functionalities of an EAI package is in connection with tasks for translating data from an IT – system to another so as these could understand each other. There is a wide variety of layers within IT system through which the goal is to be achieved: middleware, application servers, adapters and workflow oriented processes. In the end one of the core objectives of EAI software is to automate transaction processing so that analytics components could understand the contents of data flows straight away. Electronic Data Interchange was the first wave of EAI generation while nowadays Web Services with emerging standards of Simple Object Access Protocol (SOAP), Universal Description, Discovery and Integration (UDDI) and Web Service Description Languages (WSDL) are the representatives of new generation's products. The leading vendors in this segment are Webmethods, Tibco and IBM while large ERP providers are on their way to become relevant players in the industry too: SAP AG, Oracle Corporation offer increasingly viable options for customers.

Currently there is a trend that each of these software market segments are on their way to converge as the final objective in every case is to tighten cooperation in a supply chain so as to become more competitive (Buxmann et al 2008; Wang and Salunga 2008; Sharon et al.

2007) In accordance with this fact, one can notice that the leading players for example of the warehouse management sector are increasingly represented in the advance planning and scheduling market too. Still there are some exceptions: For example in the EAI market there are enterprises that are absent from other segments of enterprise application software. One can refer to IBM, Tibco Software, Pervasive Software, MOND Technologies, iBOLT, StoneBond Technologies, webMethods, etc. The following list below in Table 7 is an illustration of the most influential market players of the above mentioned software markets.

Table 7. The largest suppliers of Enterprise Applications worldwide. (Trebilcock 2008)

Vendor	WMS	TMS	ERP	APS	EAI
SAP AG	X	X	X	X	X
Oracle Corporation	X	X	X	X	X
Manhattan Associates	X	X		X	
JDA Software		X		X	
RedPairie	X	X		X	
I2 Technologies		X		X	
Infor	X	X	X	X	

These selected vendors showed in Table 7 are all well known companies though there is a strong concentration of market power: SAP AG and Oracle Corporation are well ahead of their competitors in terms of sales and net income and the gap is only widening. During the period of 2004 and 2007 only Oracle Corporation has managed to almost double its net income from 2886 to 5521 million USD, whereas the overall net income of JDA Software, Manhattan Associates and I2 Technologies have risen by 3.5 folds from 21 to 73 millions

USD (see Thomson One Banker 2008 data in Appendices). Still niche players are emerging all the time: The Helsinki based Xtract Ltd. is one example out of these newcomers. This company provides for example an analytics tool (Xtract Autoscore) for companies to transform sets of raw data into business parameters about customers to recognize the best way of interacting with them (Xtract Ltd. 2008).

6. The Case of Microsoft Dynamics NAV

The core objective of an ERP-system is to integrate all necessary business processes – such as order processing, product planning and development, inventory control, customer service and human resource optimization – into a single system to make the tasks related to implementing and managing these processes easier and more efficient, that is, lean (Liao et al, 2007; Yang et al., 2007). Microsoft Dynamics NAV is a fully integrated ERP-system that delivers functionality for all aspects of operational and financial activities of a business. It incorporates several modules each addressing different business activities and functions in the organization. Table 8 displays the major modules incorporated in Microsoft Dynamics NAV along with their functions and utilities.

Table 8. Modules, Functions and Utilities Included in Microsoft Dynamics NAV. (Hilletofth 2008)

Module	**Functions & Utilities**	
Financial Management	General Ledger	Budgeting and Reporting
	Receivables & Payables	Consolidation
	Cash Manager	Project Management
	Fixed Assets	Multiple Dimensions
	Human Resources	Multi Currency
Distribution	Warehouse Management	Pricing for Sales & Purchasing
	Order Processing	Inventory Costing
	Returns Management	Shipment & Delivery
	ADCS	
Manufacturing	Production Orders	
	Bill of Materials	
	Supply Planning	
	Capacity Requirements Planning	
	Manufacturing Costing	
Customer Relationship Management	Contact Search & Management	Document Management
	Contact Classification	Interaction Log
	Campaign Classification	E-Mail Logging
	Opportunity Management	Outlook Client Integration
	Task Management	
Service Management	Service Item Management	Service Contract Management
	Service Price Management	Planning and Dispatching
	Service Order Management	Job Scheduling
E-Business Solutions	Commerce Portal	Commerce Gateway

This ERP system of Microsoft is especially suited for small and medium sized companies and as a result of heavily investing into this business, Microsoft has managed to catch up the market leader in this segment (Deininger 2006). Today the system has over 30 thousand installations and over 300 thousand users in over 50 countries (NAV, 2008b).

One advantage of this ERP system is its similarity to ordinary Microsoft products. For example, the utilized graphical user interface is very similar to popular Microsoft products such as Word and Excel. Additionally, several functions are performed in the same manner and through the same shortcuts. Figure 1 displays the main application window – including a work window and the navigation pane. The navigating pane is on the left side of the application window and shows all the incorporated functionalities such as financial management, sales and marketing, purchase, warehouse and manufacturing. As can be noted the upper part of the navigation pane includes more detailed information concerning incorporated utilities and activities. The upper part of the navigation pane is used to select tasks while the lower part is used to select module/area. All the tasks are performed through different types of work windows. Depending on the type of task selected, the work window looks different.

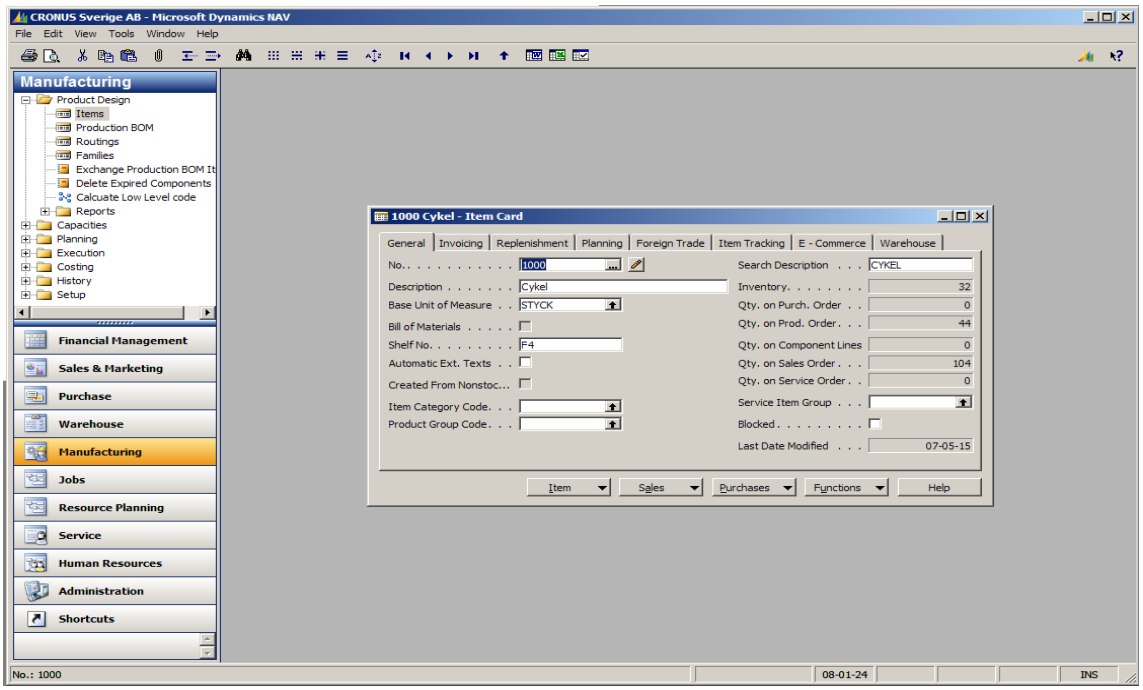

Figure 1. Main application window - showing the navigation pane and a work window

Another advantage of this ERP package is that it is designed to work smoothly with other Microsoft products (Hilletofth, 2008). For example, documents written with Microsoft Word can take data from the Microsoft Dynamics NAV database and incorporate that information into a customer letter. Moreover, users can utilize Microsoft Excel to create reports with up-to-date figures imported from Microsoft Dynamics NAV. A final advantage of this ERP system, connected to the first one, is that it is quite easy to use because of the simply and also well know graphical user interface. The graphical user interface allows the user to enter and maintain all business activities in one place, work in several windows concurrently and locate, choose and execute various activities.

As highlighted above Microsoft Dynamics NAV incorporates several modules, including varies subsystems or applications, and below one of these applications, namely the WMS, is described in more detail. This application is grouped under the distribution module and also tightly linked to other sub-processes in the distribution module such as order processing, return management, pricing for sales, inventory costing as well as shipment and delivery. Consequently, it is easier to perform activities aiming at coordination between processes such as to monitor inventory levels, to project item availability, to pick and ship products or to handle cross-docked goods (Hilletofth 2008).

The objective of a WMS is to minimize the inventory levels hold by a company (Baker 2007), by managing all the associated tasks, i.e., the warehouse workflow. As can be noted in Figure 2, this involves receiving and put-away goods, picking and shipping goods, movements and replenishment of goods and cross-docking, as well as management of the physical inventory.

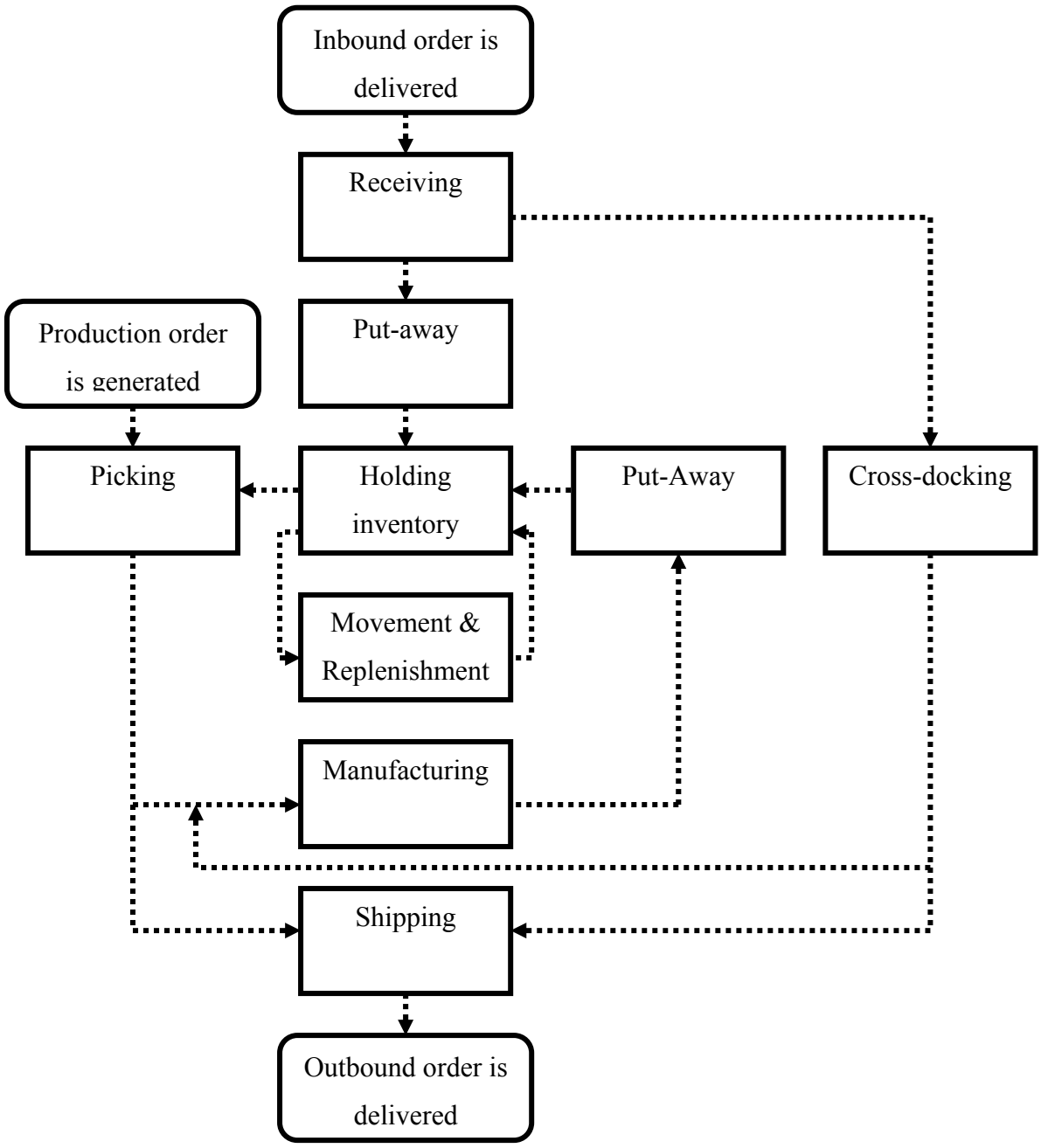

Figure 2. Warehouse management in Microsoft Dynamics NAV

A typical scenario for items going through the whole warehousing workflow could be depicted in the following manner: A set of items or an item arrive(s) to a warehouse where a person working there confirms the quantities and qualities of the items with the help of the delivery documents and records the available data for the warehouse information system. Based on the incoming inbound order document the items are placed in the warehouse in bins at shelves and are given a bin code (see Appendix B for definitions of core concepts). In case it is feasible the items are cross-docked directly toward shipment. In between it is still possible to add value to the process by having manufacturing functions included. After items are registered for inventory they might be compounded with additional components from manufacturing and then they are picked up at a certain moment. Still during the process of storage, adjustments and movements related to these items take place to notify the possibly realized gains or losses. To facilitate smooth deliver to the next customer, based on the available outbound orders and the location code, the warehouse manager creates a shipment document specifying who picks the items and by which sorting method. Warehousing might end by picking the items needed for production order purposes. In case of an outbound order transportation is to be carried out, it is based on the conditions specified to in the contract of relevance. The warehouse system registers changes all the way down the process and notifies the users in case of discrepancies between input and output requirements related to item(s) processing. At the end of certain determined period a physical inventory is carried out to verify that the set of data in the system (both in bins and in the warehouse as a whole) on items is in line with the reality.

Because the different sub-processes in the distribution module are tightly integrated, the data moving along the warehouse workflow can be modified to reflect the conditions according to the incoming data from other related sub-processes. In these types of systems the data is always available through a centralized database. This implies that all the distribution processes utilize the same data enabling the company to optimize the distribution activities as a whole. Consequently, this application help companies to compromise trade-off problems stemming from geographical dispersion and demand patterns for products and services that make it difficult for supply chain partners to formulate common decision making practices (see Kicin, Hemilä and Gringmuth, 2008).

In the following the function and utilities included in the WMS of Microsoft Dynamics NAV for managing the warehouse workflow – i.e. receiving and put-away goods, picking and shipping goods, movements and replenishment of goods, as well as management of the

physical inventory – is described in more detail. Additionally, the setup of the WMS is discussed, as well as some advantages associated with this application.

6.1 Setup of Warehouse Management System

The WMS in Microsoft Dynamics NAV is quite easy to setup. As can be noted in Figure 3, the setup consists of three parts: Inventory, Warehouse and Location.

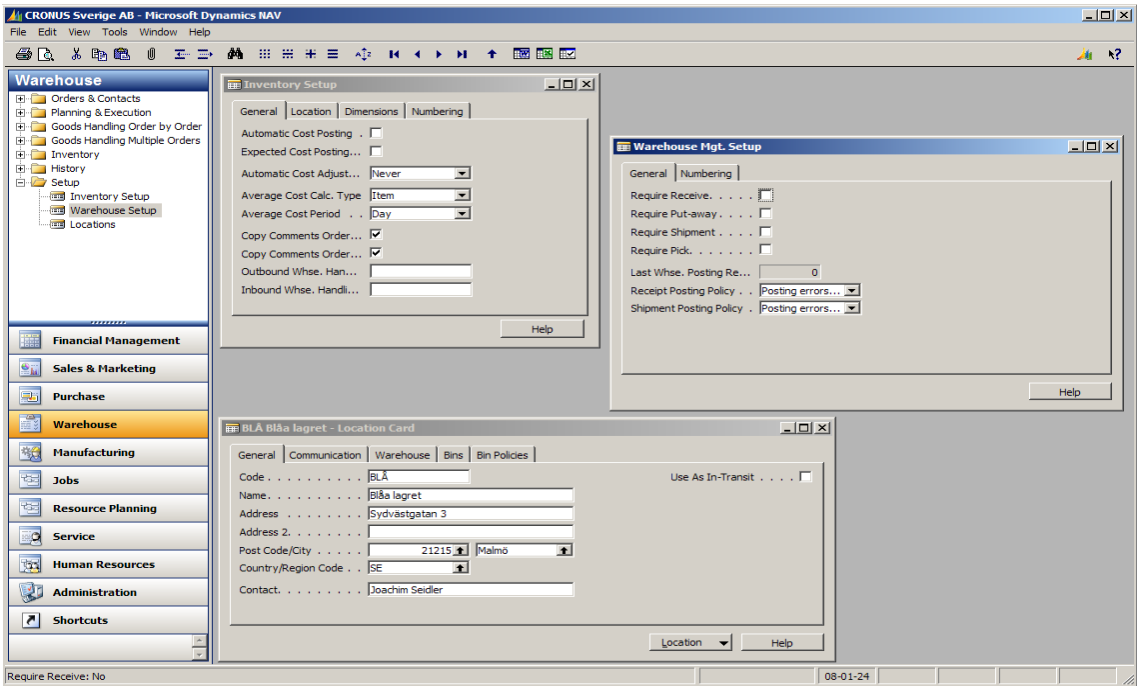

Figure 3. Warehouse Management System Setup in Microsoft Dynamics NAV

During warehouse setup the activities that constitute the warehouse handling processes are specified (i.e. require receive, put away, shipment and/or pick). For example, it is possible to set out whether the stored product will be picked up by the customer or the focal company must itself deliver the item forward. Warehouse setup activities contain the number series that will be used for various warehouse documents (e.g., receipts, picks and put-aways), the posting error policies for receipts and shipments, and the activity requirements for warehousing functionality.

In the inventory setup the company specifies certain aspects of their inventories. For example, which costs should be automatically posted to G/L and should information on

comments field be copied to transfer orders. In addition the software can set up to calculate average cost for holding inventory for a product in a bin so that the period of calculation can be specified. Moreover, the company can setup default location codes and number series.

In the location setup all warehouse locations (e.g., inventories and distribution centers) are specified. This setup includes numerous options. On the first page the location card contains basic information about the warehouse, e.g., the address, contact person for the warehouse. It is possible to make all the transaction movements visible by assigning a "bin code" to each unit of storage. Additionally, it is possible to define the amount of documents for recording the data for each warehouse. One document can be determined for example to show a specific set of data from each warehousing process. In case the workload and the organizational setting of the warehouse requires, it is possible to change the existing reporting structure so as each process data is reported on a separate document. Furthermore, it is possible to specify pick and put always policies by assigning different bin selection methods. For example, should the system suggest the same bin for an item to pick and put away or should the system suggest the last used bin as the default.

6.2 Receiving and Put-Away Goods

Microsoft Dynamics NAV includes four ways of carrying out receiving and putting away processes to maximize the efficiency in receiving items at the warehouse receiving dock and put these away to the inventory: (1) Post receipt and put-away from the order line, (2) Post receipt and put-away from an inventory put-away document, (3) Post receipt and put-away from a warehouse receipt document, and (4) Post receipt from a warehouse receipt document and post put-away from a warehouse put-away document.

These above mentioned options exist in the system so as to facilitate for a company to choose the appropriate model for implementing receipt and put-away processes in line with its accepted practices and level of organizational complexity. In a case of a straightforward business model with small amount of personnel, the best option could be to opt for is the first one, i.e. to transfer the needed data for warehouse monitoring from the order lines. In any case the process of receiving and putting away starts with the incoming information displayed by an inbound order document that can be a purchase order, a sales return order or an inbound transfer order. These incoming documents communicate to the dedicated personnel the quantities and types of products to be put away in the warehouse. The personnel can evaluate

on the basis of the information available on the “Purchase Order” the circumstances whether the warehouse have the capability of receiving and putting away the certain amount of product that is to arrive at the warehouse at a time requested by the customer (Figure 4). From this point of view the most relevant information in this window are the following: Vendor Invoice No., Purchaser Code in the upper part of the screen, while the lower section reveals such parameters as the Item No., Description, Location and Quantity needed.

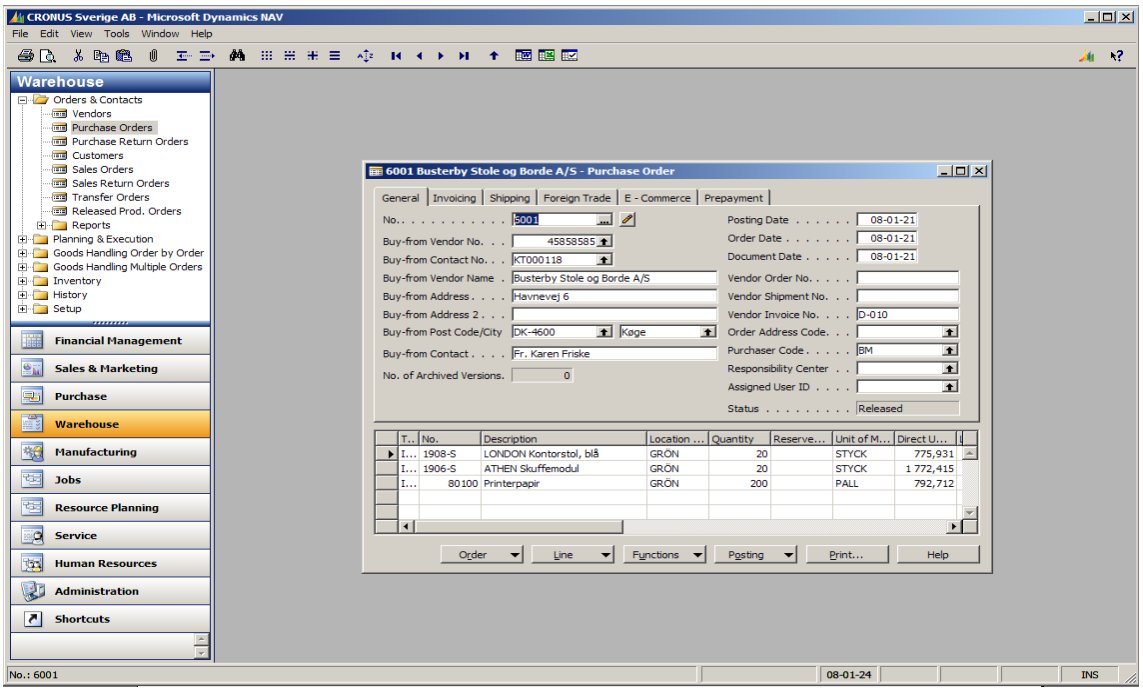

Figure 4. A “Receiving and Putting Away” - document is based on the information available in an inbound order: in this case it is a “Purchase Order”.

On the other hand a firm with a more sophisticated warehousing structure, where the crew is educated to handle cumbersome put-away processes it might become necessary to separate warehousing documentation from the one related to order management: options two or three. The third choice gives a company a chance to organize the processes so as to be able to manage multiple orders: a warehouse receipt document is a source of information with accurate data on the forecasted workload to be managed at the warehouse receiving docks. The forth method gives a company a detailed picture on put-away procedures with a separate document on each transaction. If there is no requirement for separate put-away documentation, the receipt document is the one, where the employee must record the up-to-date data about transactions (NAV 2008a).

6.3 Picking and Shipping Goods

In the same manner to maximize the activities of picking items from the shelves and shipping these out of the warehouse, it is possible to select out of four different options in line with the complexity of warehouse structure and processes in place: (1) Post pick and shipment from the sales order line. (2) Post pick and shipment from an inventory pick document, (3) Post pick and shipment from a warehouse shipment document, and (4) Post pick from a warehouse pick document and post shipment from a warehouse shipment document.

Just as in the case of receiving and putting away processes the set of options available here is to help companies to adjust their practices with the ones available in the system. A company with a simple structure, where an order can be satisfied most of the time from one bin, it is appropriate to choose option to process data straight from the inbound order document. For example, when the process starts with a sales order, the system registers the relevant information for the relevant warehousing purposes (Figure 5). From this document the most important sets of data with regard to further processing of products are as follows: “Sell to Customer No.”, “Status”, and “Responsibility Center” in the upper part of the screen of this window. In the lower part of the window the item of target for the sales order is shown in detail: Item No., Description, Location, and Quantity ordered. As can be noted these set of data contains for example the “Requested Delivery Date”, so that it could be evaluated whether the delivery can be met within the set timeframe.

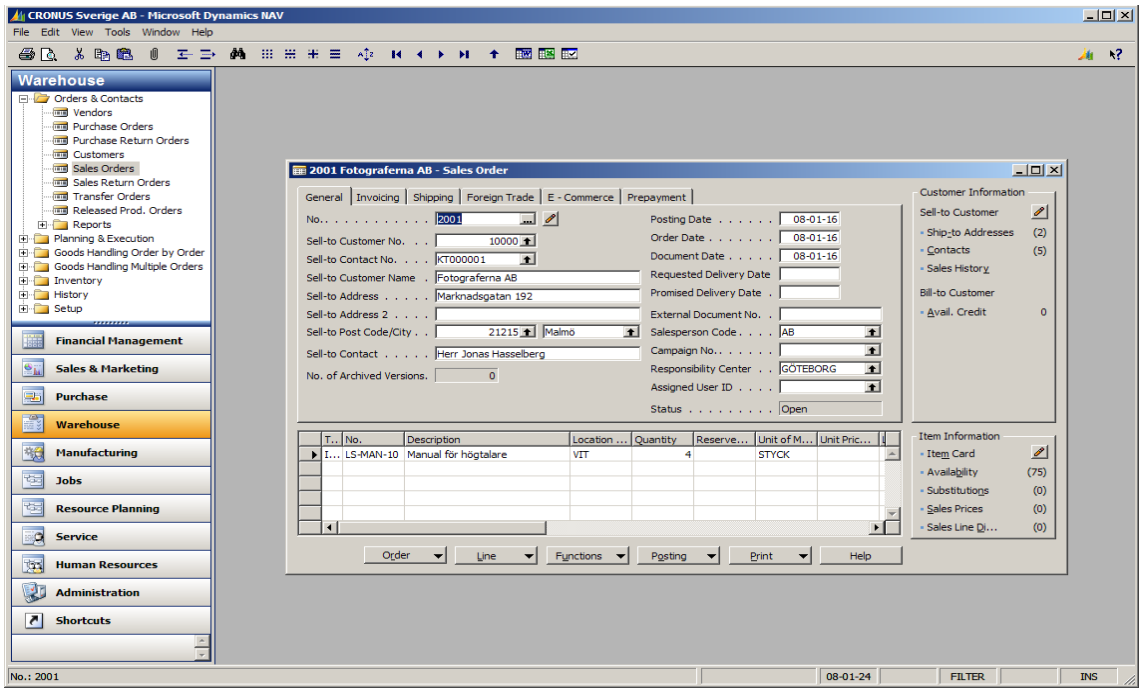

Figure 5. An "Inventory Pick and Shipment" - document is based on the information available in a released outbound order: In this case it is a "Sales Order".

Where the circumstances require with dedicated warehouse staff it is more viable to opt for a more sophisticated model. In case a firm must manage multiple orders the best is to separate pick documentation from the one shipment: With this option the system registers the pick transaction first and posts the shipment later based on an updated outbound document. As in the case of receiving and putting away, the basic source of information for starting the process of pick and shipment is an inbound order document that can be a purchase return order, a sales order or an outbound transfer order (NAV 2008a).

6.4 Movements and Replenishment of Goods

The movements, adjustments of items in a warehouse are the implementation of picking and shipping considerations. Through these procedures replenishment and cross-docking opportunities are realized. On the other hand these are the processes that facilitate the correction of revealed mistakes: e.g. in a case during physical inventory it turns out that in the warehouse in one bin there are more items than what is showed by the entries (records) of the system, an adjustment of quantities of that item in that bin is necessary. To realize the

correction items have to be moved between bins. This can be done with the help of "Item Reclassification Journal" (Figure 6): With this window a user can search for the item located in a bin and determine for it a new bin, where to transfer a certain amount of items. The system registers all this transaction, so that inventory could be updated. On the other hand, when needed quantities of items within a bin can be adjusted to a new situation by the "Item Journal" (Figure 7): A user can select an item and choose a function to reduce or increase the number of items in a bin. The icons available can be seen in the lower part of the screen in Figure 7.

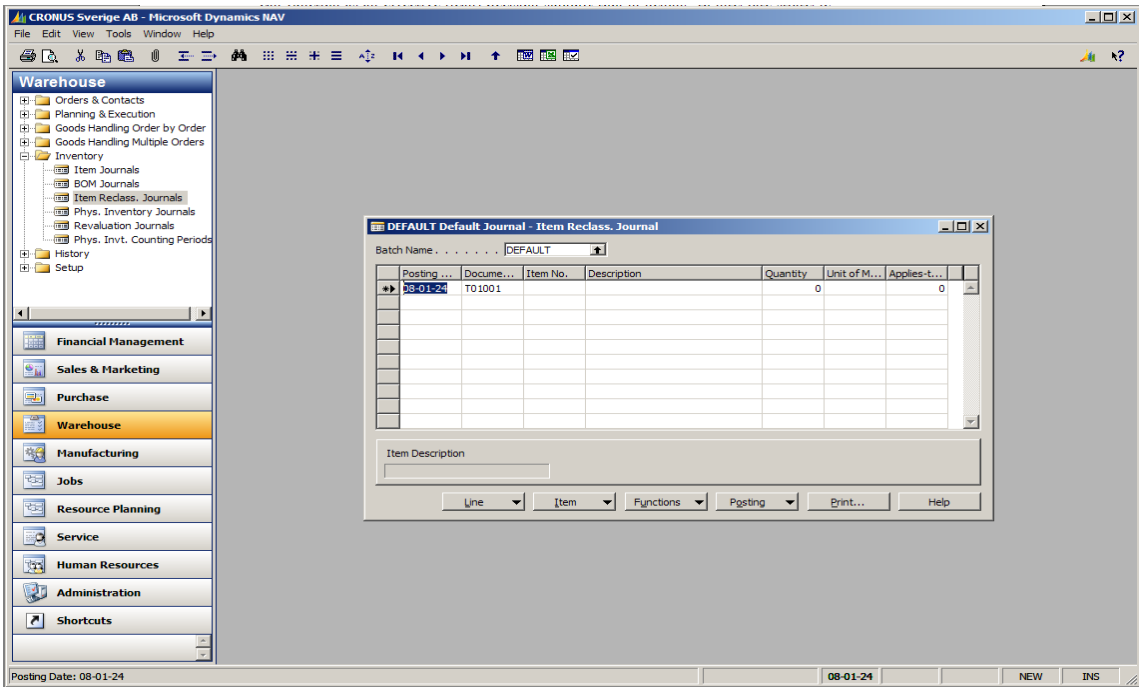

Figure 6. To move an item from a bin to another, the starting place is the "Item Reclassification Journal"

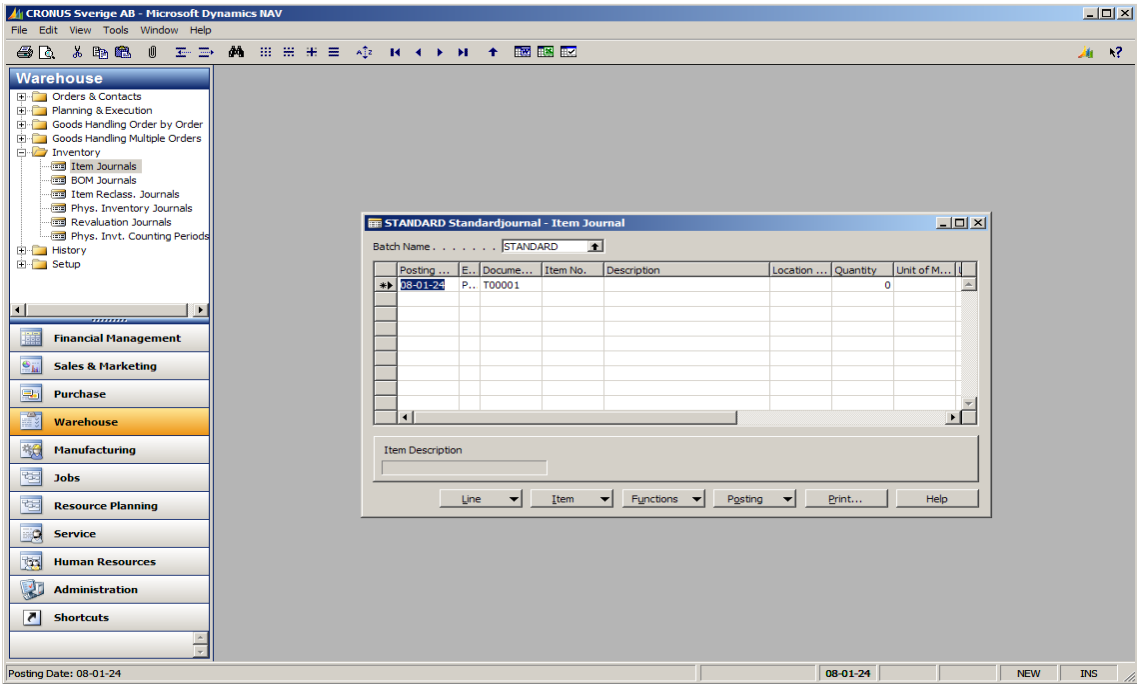

Figure 7. To adjust the quantity of an item in a bin, the starting place is the "Item Journal"

The difference to note between the two operations is that using reclassification function might mean also the change of location from a warehouse to another. In this case the system creates an item ledger entry to notify the change in the quantity of that item in the inventory records of those warehouses involved in the transaction. Still if an item is marked to be stored in a bin as mandatory in a warehouse, the system registers the transaction to the item ledger too (NAV 2008a).

6.5 Management of the Physical Inventory

By ensuring that the items stored in warehouses are under real-time and visible control all modes of waste can be minimized in the distribution process: Unnecessary inspection procedures can be eliminated and physical inventory is easier to carry out e.g. at the end of the year. The counting of the amount of items in bins versus the whole warehouse is otherwise similar except that in the case of bins the actual difference between bin records and reality is not carried on in each case from a bin to another and summarized in the end. Still the discrepancies if exist are recorded within each bin and later it is possible to post these data to the "physical inventory journal" (Figure 8).

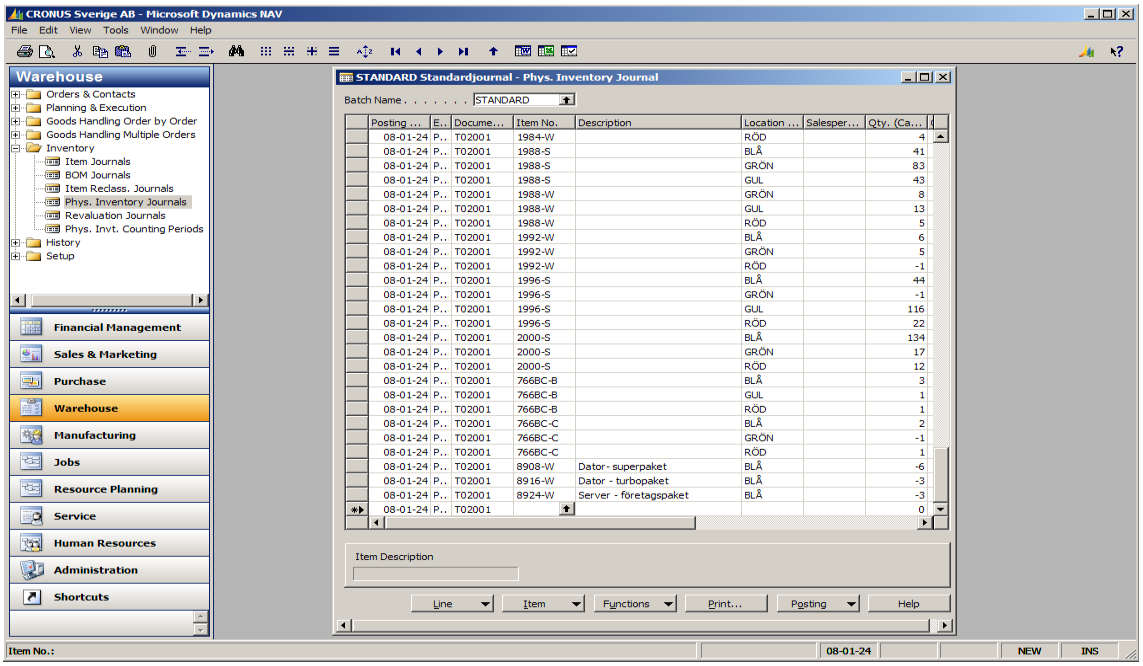

Figure 8. A printed report of the changes in the contents of the bins is based on the "Physical Inventory Journal"

One way to accomplish physical inventory is to assign a warehouse employee to a specific area in the warehouse so that this employee could quickly count the number of items in each bin. After all bins in the warehouse have been examined, the manager of the warehouse can easily sum up the results and compare them to the record entries available in the system. In the system there is a function "Calculate Inventory", where one can choose a specific warehouse building with all the bins in there and by running this calculation, it is easy to retrieve all the information needed from the database for the "physical inventory journal". At the same time a manager can prepare a report with the function of "physical inventory list": This list is to be transferred to the physical inventory journal so that an employee could sign to the system the actual amount of items he/she notifies as existing in the warehouse. After the workers marked their observations to the report, the manager have to compare the two documents created by "Calculate Inventory" and the one filled out by the warehouse staff. All these procedures can be speed up through the Automated Data Collection System Support so that managers only need to print out the report viewing the possible discrepancies.

6.6 Advantages of Microsoft Dynamics NAV Warehouse Management Application

In general many positive effects are gained once the application is utilized. Cumulative benefits can be achieved as a result of integrating strategic, tactical and operational managerial considerations to improve responsiveness and reliability in the eye of customers (Kicin, Hemilä and Gringmuth, 2008). Employees can affect the outcome of services and they will feel better recognized as their ideas might be used for further improvements of processes. In the end the development might even lead to new warehouse business models, where fewer resources are utilized to produce higher valued outputs: In so WMS software can function as a decision support tool for leveraging lean thinking into practices and demonstrate the personnel of a company visible savings in efforts to handle complex tasks while accomplishing daily duties. Employees will use their working time more efficiently committing fewer errors and they will have wider opportunity to use their creativity. Further for managers this application brings detailed information on cycle frequency per items and this functionality is beneficial together with item tracking so to be able to determine the appropriate strategy for integrating the right pick prioritization method to the automated pick, movement and put-away decisions.

The quality of the warehouse operations increases as with up-to-date pivot tables the cost-structure of the products in the warehouse can be opened up. In addition, not only it becomes possible to calculate the costs of pick and put-away of a single product (product families), but also to identify product that are on shelf during a specific time in a season. In so the documentation of product life-cycle is easier that in turn make it feasible to reallocate resources in case needed. With sophisticated functionalities built in the granules of the system further synenergy can be achieved by automated data collection, possibility for directed put-away and pick processes and utilizing available system capability of RFID technology for data retrieving and saving (NAV 2004). In so it is easier to choose the most efficient set up structure for optimizing space in a warehouse and ranking bins as for replenishing items: Bins can be determined for only certain products while some goods might be stored in a wide range of bins of choice - floating bins (NAV 2004). In overall one can state that the organization of product in a warehouse becomes more systematic and logical helping the whole company to adjust to the business environment in a more agile way.

7. Discussion and Conclusions

Based on the available literature it can be suggested that nowadays logistics as a concept is increasingly referred to be the same as supply chain management, where a specific set of processes evolve to form a system. It seems that as the result of global trends of current business environment covering the drivers for shortening life-cycles of products, and integrating the aspect of research & development with operational considerations, it is possible to view logistics as a set of supply chain management processes focusing on material handling and information management. The holistic approach to see these two entities as one can be supported by the growing role of research of operation management techniques (ElMaraghy and Majety 2008; Ballou 2007).

All these views are well reflected into the development of classification platforms for software applications related to logistics and supply chain management. One can observe that the borders between internal and external classes on software functionalities for managing logistics operations are about to become obsolete and the functionalities to manage systems are on their way to capture more attention. At the same token, transactional data input abilities of software applications are increasingly seen as a basic ability to support analytical tasks to reveal new ways of reaching higher profitability in a company. In this way it can be argued that the analytical functionalities are the ones that will catch the larger share of capital investment schemes of commercial organizations in the near future. The emphasis is more and more on the interface points of these two classes of software applications: The ability to turn the benefits stemming from analytics to transactional phase of operations. In one sense one can point out that in the future there will be no meaning of the above mentioned classification approach, as software solutions will contain both functionalities of transactional and analytical nature as a matter of fact. It might be that soon there will be grouping based on "supply network utilization" and "supply network synchronization" approaches. Planning and execution tasks will also become more integrated in terms of their nature as the result of increasing speed requirements set by shortening life-cycle theme of products. Instead of these division platforms, classification may become more oriented towards functionalities on parameters for sophisticated configuration of products and services in a specific business environment.

Market development trends of logistics related software applications reflect well the arguments presented above. Out of the category of ERP for example there were certain segments outpacing the average growth rates of the markets. As reported by Trebilcock

(2008) in 2007 ERP solutions with capability of service part planning platforms, supply chain network design schemes and inventory optimization functionalities showed high rate of growth: Service oriented ERP increased by 42 percent, inventory optimization oriented ERP climbed up by 32 percent while ERP including strong functionalities for supply network design have managed to rise by 29 percent when comparing to the year of 2006. There are also some other news from the market that indicate further integration of ERP, WMS, TMS and APS system is on its way as requirements for agility and responsiveness speed up (McCrea 2008; Incisive Media Limited 2008; Mathy 2008).

As a conclusion it can be argued that the nature of logistics decision making will become even leaner than before. Escalating negative effect of globalization of international production network will force companies to integrate tighter their supply chain and this will take place in continuously geographically enlarging markets. This development will lead to the growing importance of warehouse management system and cross-docking functionalities as companies will continue to cut down the amount of distribution centers they interact with while these service centers will themselves become larger. At the same time manufacturing companies will have to scan through their customer base even better to find the optimal sized customer portfolio so that clients are able to pay their duties even in a constantly changing operating environment. This will render the role of social "soft" skills such as negotiation capabilities a key resource and for keeping key customers happy the contractual platforms in a supply chain will have to become flexible being able to optimize the trade-offs for the whole network of actors (Setia et al. 2008; Jayn and Benyoucef 2008; O' Leary 2008; Ballou 2007). In so analytical capabilities of supply chain network optimizing tools will be of key importance and many firms will be forced to replace their existing IT-systems (Richardson et al. 2008; Maoz 2008; Langley and Hoemmken 2008; Gilmore 2008). The enabling role of these software solutions in logistics decision making procedures will in the end turn onto a role of coaching and guiding to find and implement new business models for capturing more return on investments.

Further target for research could be to study how lean objectives could be achieved in warehouse management with open source software applications for companies operating in regions where countries represent different states of economic development. There is also demand for case studies on logistics decision models that could be applied to handle together sea, air, rail and road cargo utilizing lean warehousing principles. In relation to these matters it could be studied how "RailTrace" type of service portals launched by Finnish Railways

might be expanded to include parameters of road, sea and air freight transportation so as to minimize warehousing costs and increasing value for the carriers and manufacturers.

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Appendix A: Financial performance indicators of some leading firms of markets for Enterprise Applications in millions USD (Source: Thomson One Banker 2008)

SAP AG

Indicator/Year	**2007**	**2006**	**2005**	**2004**
Sales	14130	11905	10538	9389
Net Income	2647	2370	1853	1637
Total Assets	14920	12446	10587	10144
Total Liabilities	5425	4339	3743	3880

Oracle Corporation

Indicator/Year	**2007**	**2006**	**2005**	**2004**
Sales	22430	17996	14380	11799
Net Income	5521	4274	3381	2886
Total Assets	46908	34525	29013	20655
Total Liabilities	23883	17606	14001	9818

JDA Software

Indicator/Year	**2007**	**2006**	**2005**	**2004**
Sales	374	277	215	217
Net Income	27	-11	7	2
Total Assets	560	571	314	321
Total Liabilities	174	230	32	45

Manhattan Associates

Indicator/Year	**2007**	**2006**	**2005**	**2004**
Sales	337	289	246	215
Net Income	31	20	19	22
Total Assets	262	314	261	287
Total Liabilities	76	77	56	42

I2 Technologies

Indicator/Year	**2007**	**2006**	**2005**	**2004**
Sales	260	280	337	379
Net Income	15	21	40	-3
Total Assets	194	182	196	385
Total Liabilities	34	42	72	558

About the author

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ERP Training through Traditional and Intensive Course Formats

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Abstract

Nowadays Enterprise Resource Planning (ERP) systems have a important role in the performance improvement and control of a company and its entire supply chain. Therefore, this system is a vital part of a company's competitiveness and new approaches for learning are needed to be developed in order to provide knowledge and skills in faster and more efficient manner for employees. Our aim in this manuscript is it to show, how ERP systems could be incorporated in the logistics courses of a university. This environment provides good platform to test new course formats, since most of the university students do not have any previous experience with these systems.

In this research the structure and contents regarding ERP system usage in certain courses in the logistics curriculum at a Swedish University are being presented. Essentially, a traditional approach, where computer sessions are incorporated in ordinary courses are compared to a new intensive and flexible course format entirely dedicated to ERP systems. Additionally, the two utilized approaches are analyzed through student evaluations based on courses arranged during year 2008.

Research shows that both of the approaches offer good opportunities; the students appreciated the traditional approach, since it allowed them to receive both theoretical and practical knowledge and skills, while they felt the intensive to be beneficial in developing practical side further. Consequently, the best alternative could be to utilize both of these formats. Still, this research shows that skilled responsible lecturer, among intensive course setting, is quite possibly one route for faster learning and higher productivity of lecturing.

Keywords: ERP, traditional and intensive course format, logistics, training

1. Introduction

Supply Chain Management (SCM) can be defined as a set of approaches utilized to efficiently integrate and coordinate the materials, information and financial flows across the Supply Chain (SC), so that merchandise is supplied, produced and distributed at the right quantities,

to the right locations, and at the right time, in the most cost-efficient way, while satisfying customer requirements (Gibson et al., 2005). This has become increasingly difficult due to several developments in the market, such as increased competition, increased demand variability, increased product variety, increased amounts of customer-specific products, and shortening product life cycles (Christopher et al., 2004). These developments, due in part to globalization and outsourcing, provide additional management challenges and new practices in which SCs are designed and managed (Hilletofth, 2009), and can eventually make the difference between companies staying competitive or not (Christopher and Towill, 2002).

In order to stay competitive in this volatile and globalized economy companies need to reduce total costs, lead-times and inventories in the entire SC, as well as expand product assortment, improve customer service, provide more reliable deliveries, and efficiently coordinate world-wide demand, supply and production (Li et al., 2006; Umble et al., 2003). To accomplish these objectives, Information and Communication Technology (ICT) is required (Liao et al., 2007; Sun et al., 2005). For example, this supports sharing of information and SC integration, which can considerably reduce demand uncertainty and inventory levels. Thus, it can be argued that the advances in and possibly the existence of SCM are based on the rapid development in ICT.

ICT is supposed to increase the efficiency of individual SC processes, i.e., efficient utilization of resources, such as transportation, warehousing, inventory control, order processing, and logistics administration (Mentzer and Konrad, 1991). It should also facilitate intra-organizational and inter-organizational integration across the SC, i.e., the integration between different information systems across the SC, as well as enable collaboration between SC members (Kumar and Diesel, 1996). ICT is crucial to the development of efficient and effective SCs, and the utilization has numerous advantages. At a strategic level, Alkadi et al. (2003), highlight that the utilization of ICT can increase the efficiency of SCs. Moreover, Williams et al., (1997), underline that the exploitation of ICT can increase the alignment between SC strategy and business strategy. Additionally, Kotha et al. (2000) and Byrd and Davidson (2003) emphasize that the employment of ICT in SCs can increase overall growth and profitability. On a more operational level, Kincade et al. (2001) have linked the utilization to an increase in product offerings and customer service levels, while Brandbyberry et al. (1999) have linked the exploitation of ICT to an increase in quality and timeliness of production information.

There exist numerous types of information technology tools to support different functions and processes inside the company as well as across the SC. One of the most commonly used

information systems within companies is the Enterprise Resource Planning (ERP) system. The core objective of this type of system is to integrate all necessary business processes – such as order processing, product planning, purchasing, inventory control, sales, financial and human resources – into a single system with a shared database in order to make the tasks related to implementing and managing these processes easier and more efficient (Liao et al, 2007; Yang et al., 2007). This system is the central piece in any attempt to create an information system for the whole SC.

Several benefits of a successfully implemented ERP system have been reported in the literature (e.g. Yusuf et al. 2004). Still, selection of an appropriate system and its implementation are not simple tasks, the literature includes numerous of examples where companies suffer greatly from ERP system implementation problems, which are mostly arising from improper training for the usage of the system. The major issues are that training is generally regarded as a cost burden in many companies and thus restricted as well as ignored, or limited to a couple of months quite late in the implementation project, since the employees often are too busy conducting ordinary business activities. Recent research work shows that adaptation into new systems takes years rather than months (Häkkinen and Hilmola 2008), and failures in implementation could end in court trials between suppliers and the customer organization (Xue et al. 2005). This implies that this system is a vital part of a company's competitiveness and fast and efficient training is important to successfully implement this type of systems in an organization. Consequently, new approaches for learning need to be developed in order to provide intense knowledge and skills faster and more efficient.

The purpose of this research is to investigate how ERP systems could be incorporated in logistics courses to provide an opportunity to obtain intense knowledge and skills faster as well as to highlight how productivity of lecturing could be enhanced. In this paper the structure and contents regarding ERP system usage in certain courses in the logistics curriculum, at one Swedish University, is being presented. Essentially, a traditional approach where computer sessions are incorporated in ordinary courses is compared to a new intensive and flexible course format entirely dedicated to this type of systems. Additionally, the different approaches are analyzed through student evaluations based on courses arranged during 2008, in which 23 students participated in the traditional course and 20 students in the new intensive and flexible course. Participants of the courses were quite a typical group of students; most of them did not have any earlier experience with ERP systems, and only a handful of them had used these systems in their previous place of work.

The remaining of this paper is structured as follows: In Section 2, a literature review of ERP systems and the previous research in the field is presented. In particular the structure of and functions included in this type of system is described in more detail. Moreover, motivations concerning, why companies should use this type of system are discussed among implementation success factors. Thereafter, in Section 3, different approaches to incorporate ERP systems in logistics courses are presented through description of its usage in certain courses in the logistics curriculum. In Section 4 the different approaches to incorporate ERP systems are analyzed through student evaluations. Finally, in Section 5 we discuss research findings, and conclude our research work. Additionally, we propose further avenues for research in this topic area.

2. Literature Review: Enterprise Resource Planning Systems

ERP system has been developed from the previous Materials Requirement Planning (MRP) systems and Manufacturing Resource Planning (MRPII) systems logic (Yang et al., 2007). It is an enterprise-wide information system that integrates all necessary business functions, such as product planning, purchasing, inventory control, sales, financial and human resources, into a single system with a shared relational database (Liao et al, 2007; Yang et al., 2007). The key idea of this system is using information technology to achieve the capability to plan and integrate enterprise-wide resources (Kumar et al, 2003). Examples of major objectives with this type of systems are “once typed data” as well as ability to support business processes and traceability. Figure 1 provides an overview of the system’s relationships with functions within a company, and its relationships with the suppliers’ and customers’ organizations. Currently, it is increasingly popular to utilize ERP systems to integrate functions inside of company and towards suppliers and customers (e.g. Leonard and Cronan 2005; Rantala and Hilmola 2005). This new approach creates operational logistical benefits, such as lower inventory holdings and shorter response times, but also enables companies to increase their overall cost efficiency and create value enhancement for customers.

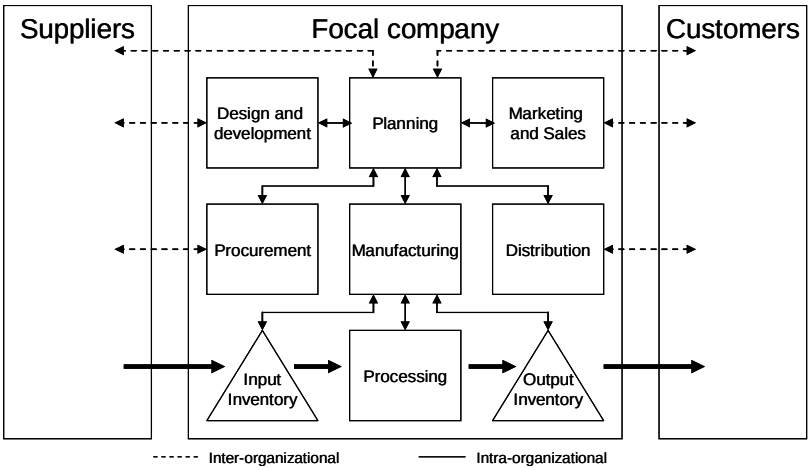

Figure 1. Overview of the ERP system's relationships with functions inside a company, and its relationships with the suppliers' and customers' organizations.

ERP systems are nowadays important to reduce total costs, lead-times and inventories, as well as to improve customer service and efficiently coordinate world-wide demand, supply and production. This implies that this system is a vital part of a company's competitiveness. It is increasingly important in modern business, because of its ability to integrate all necessary business functions into a single integrated system, or in other words because of its ability to integrate the flows of material, finance, and information to support organizational strategies (Yusuf et al., 2004). However, today it is seldom the case that companies only utilize one integrated system. Integration requirement and amount of information processed each day in modern global corporations is huge, and nowadays small and medium sized enterprises (SMEs) are typically having better opportunity to implement and utilize one integrated system. In larger corporations it is still the case that several types of systems often are used concurrently within the organization. For example, Koh et al. (2006) reported that even SMEs in Greece utilize between one and three systems. Additionally, Yusuf et al. (2004) reported ERP implementation process at Rolls-Royce corporation, where in total 1500 internally developed systems were used in different business divisions before deciding to integrate all operations under one ERP (plus additional system used in maintenance management, which was decided to be kept in operation).

A successfully implemented ERP system can offer companies several benefits. Examples of benefits reported in the literature are automated business processes, timely access to management information, and improved SC performance through, e.g., the use of e-commerce (Yusuf et al. 2004). Basically productivity and speed are improving within organizational

context, providing important strategic asset for a company (Shang and Seddon, 2000; Murphy and Simon, 2002; Al-Mashari et al. 2003).

The selection of an appropriate system and its implementation are not simple tasks – Ziaee et al. (2006) propose a two staged process, starting from larger strategic picture, information gathering from potential vendors and establishing project team, and in the second stage leading into the selection of vendor. Ifinedo (2007) reported survey research findings from Finland and Estonia, and found that vendor selection is critical for successfulness of ERP use. There are numerous examples in which companies were not successful in obtaining the potential benefits that motivated their investing in an ERP system (e.g. Chen, 2001; Davenport, 1998; Davenport; 2000; Nah et al., 2001). Thus, the question of how to successfully select (e.g. Liao et al., 2007; Wei et al., 2005; Yang et al., 2007; Ziaee et al., 2006) and implement (e.g. Kumar et al., 2002; Kumar et al., 2003; Li et al., 2006; Nah et al., 2001; Sun et al., 2005; Umble et al, 2003) ERP system remains an essential research topic, and vital for larger corporations as well. It is well-known that several failed implementations have caused severe losses on operations overall, causing significant drops on sales, and profitability, but also lost customer satisfaction. Gargeya and Brady (2005) and Xue et al. (2005) have both reported cases of ERP implementation failure; Gargeya et al. (2005) argue inadequate internal readiness and training among inappropriate planning and budgeting to be primary reasons for failure, while Xue et al. (2005) emphasize the importance of culture (especially the language used) as well as appropriateness of reporting tools.

Training is vital to retain the value of an ERP system investment – typically it is estimated that purchasing of system and its needed new ICT infrastructure takes roughly one third from overall investment. Latter part of the implementation project is related to implementation support work, e.g., using key users, and call centers for user help (Häkkinen and Hilmola 2008) among training. It is not in common that companies who are implementing new system are using two systems at the same time, since the new system could not be trusted due to its low information accuracy, its slow usage (e.g. due to new database used) and/or since data transfer from old system has not been accurately completed. Training is one of the most focal points in ERP system implementation; aiding users to understand system functionality, improving productivity of office work, and lowering the barrier of using new system. However, training is typically regarded as a cost burden in many companies and thus restricted as well as ignored, or limited to a couple of months quite late in the implementation project, since the employees often are too busy conducting ordinary business activities. Still, cost savings in training do produce harm for these companies during long and malfunctioning

implementation processes. In essence, training is important to retain the value of all major improvement works or ICT investment (Marri et al., 2007) and the training can either be conduced by skilled employees, in-house training facility or our by external education provider. It is important that the training are process-oriented rather than task-oriented in order to be successful, since the latter one creates a situation where the students tend to focus only on and understand a limited area within the system (Boykin and Martz, 2004); and this is not enough in order to realty understand the system. Still, the offered training courses at different institutions often continue to be task-oriented (Boykin et al., 1999).

3. Enterprise Resource Planning Training at University of Skövde

ERP systems have been utilized in logistics courses at University of Skövde (Sweden) since 1995. In the beginning, ERP system called Scala was used in an industrial manufacturing course to illustrate how production planning can be supported by this system. Basically the idea was to include a couple of practical computer sessions in a theoretical course in order to provide the students with both practical and theoretical knowledge and skills.

This is still the case; however, nowadays, the ERP system Microsoft Dynamics NAV is used and it is incorporated in an increasing number of courses such as *"Fundamentals of Logistics"* and *"Logistics for Industrial Manufacturing"*. As stated above the idea of this traditional approach is to include a couple of practical computer sessions, often between 6-10 hours in total, in a theoretical course, which often has a scope of 7.5 higher education credits (approximately 200 hours of study), to provide the students with both practical and theoretical knowledge and skills. This implies that the practical ERP section of the course is quite limited and the students only have time to handle a few functions in each course.

As highlighted in the literature review, information systems are increasingly important to efficiently integrate and coordinate the materials, information and financial flows across the SC. Moreover, it is argued that training is vital to retain the value of a large investment, and that this issue often is ignored by many companies due to cost and time restrictions. Consequently, students and companies could benefit from courses providing an opportunity to obtain intense knowledge and skills in ERP systems faster and more efficient. Therefore, a new intensive and flexible course entitled *"Introduction to the ERP System Navision"* recently has been developed; its scope is 7.5 higher education credits (approximately 200

hours of study). The idea of this intensive and flexible course is to provide the students with an opportunity to obtain practical knowledge and skills in ERP systems. There are three major differences between this intensive and flexible course and the traditional courses. Firstly, it is entirely dedicated to ERP systems and not only through a couple of computer sessions. Secondly, it does not provide the students with any theoretical background of the different task performed and studied in the ERP system. Finally, it requires that the students work intensively by themselves through e-learning materials since it would be impossible to provide this opportunity only through lectures and computer sessions due to the system's details. Currently, this course is promoted as an additional course for our logistics students and towards the industry.

The different functions performed and studied in the "*Logistics for Industrial Manufacturing*" course (traditional approach) as well as in the "*Introduction to the ERP System Navision*" course (intensive and flexible approach) are discussed in more detail below.

3.1 Logistics for Industrial Manufacturing

During the computer sessions in the *"Logistics for Industrial Manufacturing"* course, the students learn more about manufacturing management in a modern ERP system. Manufacturing management, also referred to as Manufacturing and Resource Planning (MRPII), is one of the classical purposes of an ERP system. Manufacturing management is a key element for competitiveness in a manufacturing organization, and concerns how the company plans for and then executes the plan to produce or acquire products and resources. Manufacturing itself is a complex process, involving stochastic behavior in cycle times, dependency in production steps and uncertainty regarding to supplies and customer orders; an ERP system can help organize, plan and manage all of these issues. Table 1 displays the major area incorporated in the course and the specific objectives within that area.

Table 1. Specific objectives in the "Logistics for Industrial Manufacturing" course

Area	Objectives
Manufacturing Management	Create new production items (item cards) and learn the purpose of all fields and functions on the item card Create, copy, and change Bill of Materials (BOM) Create, copy and change routings (i.e. Bill of operations - BOO) Understand the structure and make-up of a production order Understand the purpose of a production order Create and change production orders View the routing and components of a production order

As can be noted the students are supposed to learn how to create production item cards in the system as well as learn the purpose of all the fields and functions on the item card. Moreover, the students are supposed to learn how to create, copy and change Bill of Materials (BOM) as well as production routings, also referred to as Bill of Operations (BOO); BOM is a list of all the parts, purchased and produced, that are required to make an item and a production routing is an instruction of how to manufacture a production item. Additionally, the students are supposed to learn how to create and change production orders as well as understand the structure and make-up of a production order and the purpose of a production order. In this course the students also get an idea of how to manage varying customer demand through inventory levels and production orders. Finally, the students are supposed to learn how to view the routing and components of a production order.

3.2 Introduction to the ERP System Navision

In a traditional course the students performs a few functions within a specific area within an ERP system through a couple of computer sessions. This type of course is not dedicated to these systems, but use them to provide the students with both theoretical and practical knowledge and skills. Still, the practical ERP section of the course is quite limited.

The purpose of the *"Introduction to the ERP System Navision"* course is to provide the students with an opportunity to obtain intense knowledge and skills concerning a specific area in an ERP system. This course is entirely dedicated to ERP systems and the students can choose one of the following areas: order management, inventory management, warehouse management, manufacturing management and financial management. The first time this course was offered we had students working in all of the incorporated areas. Table 2 displays the major areas incorporated in the course and the specific objectives within each area.

Table 2. Major areas incorporated in the "Introduction to the ERP system Navision" course and the specific objectives within each area

Area	Objectives
Inventory Management	Monitor inventory levels and projected item availability
	Reserve items and use order tracking functionality to track orders
	Set up and use multiple locations within a company
	Set up and use transfers to move quantities between locations
	Perform basic warehousing operations including receiving, putting away, picking, and shipping
	Set up and use item tracking features such as serial number tracking, lot number tracking, warranties, and
Order Management	Manage sales transactions (sales order management)
	Create and use sales prices and discounts
	Process sales of items with substitutions and cross references
	Process sales of nonstock items
	Manage purchase transactions (purchase order management)
	Create and process purchase requisitions
	Set up and use item charges
	Use the order promising functionality
	Process returns from customers and to vendors
	Create analysis reports
	Perform analysis by dimensions
	Create sales and purchase budgets
Warehouse Management	Set up a company for use with Warehouse Management Systems
	Receive and put away items
	Set up and use cross docking to direct items directly to the ship zone
	Perform internal warehousing operations including movements, internal picks, and internal put-aways
	Use warehouse journals to adjust or reclassify an item
	Set up and use counting of physical inventory
	Pick and ship items
	Ship cross-docked items
	Use Break-bulk functionality to break items stored in larger units of measure into smaller ones
	Set up and use item tracking when receiving, moving, and shipping items
Manufacturing Management	Create, copy, and edit Bill of Materials (BOM)
	Create, copy and edit routing (Bill of operations - BOO)
	Use production BOM Reports
	Use Capacity Journals and reports
	Set up Capacities
	Understand the structure and make-up of a production order
	Understand the purpose of a production order
	Define the five statuses of a production order
	Create and change production orders (i.e due date, quantity reqired, coponets reqired)
	View the routing and components of a production order
	Reserve components for a production order
	View actual against expected costs, and capacity of a production order
	Use item substitution for components
	Make changes to the production order routing
	Understand the reports printed directly from a production order
	Access the Production Schedule from a production order
	Understand the standard reports available for production order reporting
	Understand the purpose of the Replan Production Order batch job
	Understand how the Replan Production Order batch job operates
	Understand the effects of scheduling a production order with a phantom BOM
	Calculate a manufacturing batch unit of measure
	Understand the two methods of changing the status of a production order
	Issue components using the Consumption Journal
	Pick and Put Away items used in manufacturing in Warehouse
	Record production order output using the Output Journal
	Register consumption and output from a Production Journal
Financial Management	General Ledger
	Receivables & Payables
	Cash Manager
	Fixed Assets
	Human Resources
	Budgeting and Reporting
	Consolidation
	Project Management
	Multiple Dimensions
	Multi Currency

In order to obtain intense knowledge and skills concerning a specific area in an ERP system requires that the students work intensively by themselves through e-learning materials, since it would be impossible to provide lectures and computer sessions dealing with all the

function and. Still, it is necessary to incorporate some traditional lectures, which introduce the students in ERP systems and some computer sessions in which the students can receive help from skilled lecturer.

Intensive course consists of two lectures (8 hours) and five lecturer supported computer lessons (20 hours). One of the lectures discusses ERP systems in general by focusing on their functions and possibilities, while the other lecture gives practical example of utilization concerning Microsoft Dynamics NAV. When the lectures have been conducted, the students basically meet once a week, during a 5 week period, to conduct lecturer supported computer sessions. Between each of the five computer lessons the students work at home through e-learning materials. The students may receive help during the computer sessions but can also contact the lecturer on phone and email between the weekly meetings.

4. Course Evaluation Analyses

In this section the two utilized approaches to incorporate ERP system are analyzed and compared. The analysis concerning the traditional approach is based on a course evaluation of the "*Logistics for Industrial Manufacturing*" course, while the analysis concerning the intensive appraoch is based on a course evaluation of the "*Introduction to the ERP System Navision*" course; both of these courses were conducted during 2008. Altogether 23 students carried out the traditional course and valid evaluations were received from 15 of them (65%), while 16 students carried out the intensive course and valid evaluations were received from all of them. The students rated different statements individually on a Likert scale from one to five. Questions included student background, lecturing quality, general arrangement of the course, and ERP system use items. The student's backgrounds were quite similar, since both of the courses mainly were occupied by B.Sc. students of our institution. However, three persons from industry took part in the intensive course. Moreover, the same ERP lecturer was involved in both of the courses. In the following each appraoch is first analyzed separately and later compared to one another.

4.1. Traditional Course Results – Logistics for Industrial Manufacturing

Participated students had very low ERP knowledge and skills in the beginning, but they believed to have significantly improved their knowledge and skills regarding this topic after conducting the ERP section of this course (see Figure 2). Students also believed that the course provided them with important knowledge and skills for future work. Still, it should be noted that the practical ERP section of the course was quite limited and the students only had time to handle a few relatively simple functions.

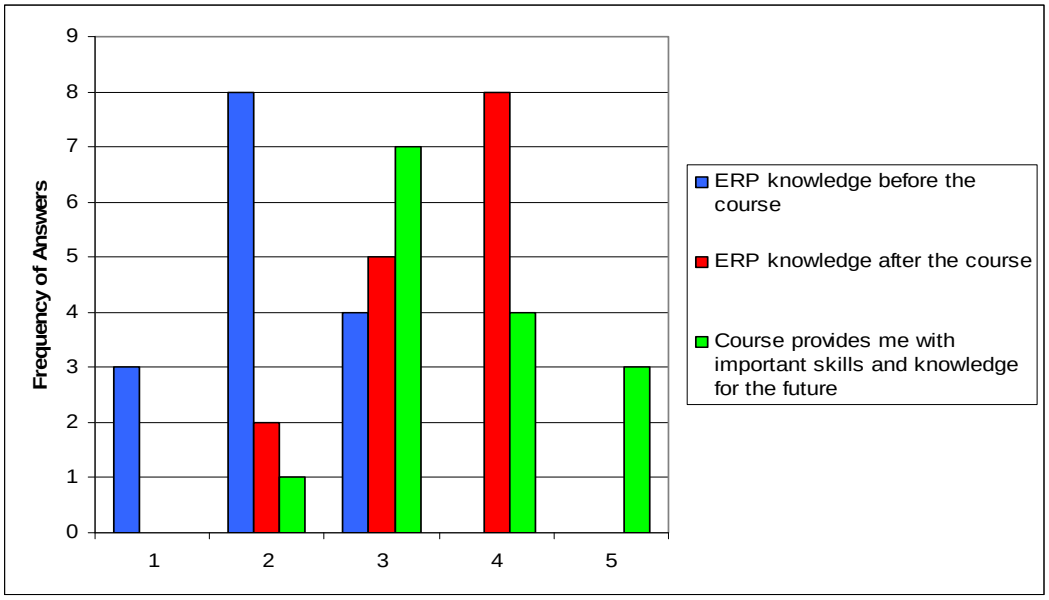

Figure 2. ERP knowledge before and after the course as well as consideration concerning the usefulness in the future (n = 15; aver in knowledge before 2.1 and after 3.4, aver. in providing important skills/knowledge 3.6)

Students also felt that the used ERP system was quite easy to use and to learn (Figure 3). Still, it is important to note that the students only studied a few relatively simple functions and this is also something that the students have emphasized in qualitative comments. Moreover, several students have commented that it is quite easy to get an overall picture, however, in order to really understand the system probably requires more hours than offered in this particular course. Additionally, several students have commented that the utilized course materials along with lecturer are important factors to learn the system. The lecturer needs to be quite skilled in the system to handle a variety of upcoming problems and the course material needs to be pedagogic and simple to follow. Both these aspects were regarded as excellent in this course.

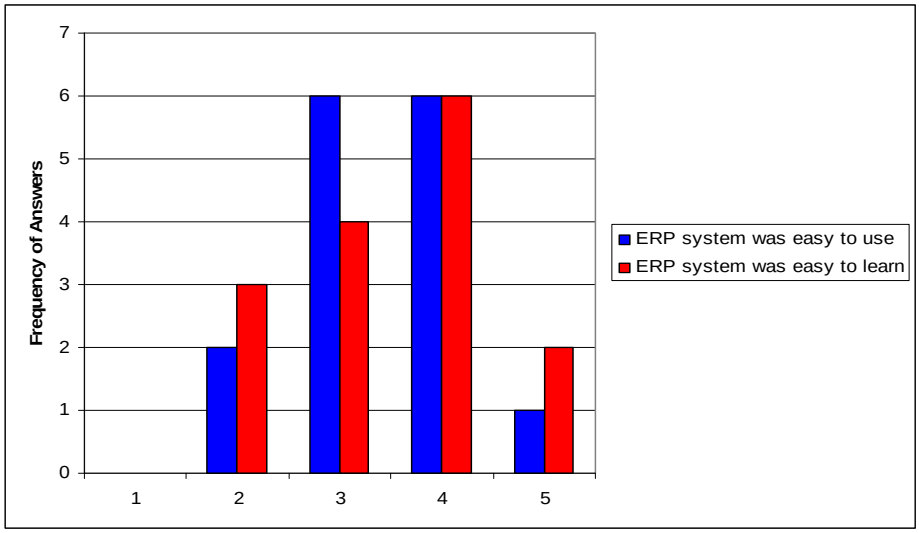

Figure 3. ERP system was easy to learn and use (n = 15; aver. in using 3.4 and in learning 3.5)

As highlighted in Figure 4, students regard traditional course setting as quite good. However, several students thought that there were too few computer session in order to really understand the system and some students also requested a separate course that dealt with these issued in more depth. Still, it important to note that this was not the opinion of all students, some really appreciated the combination of theoretical lectures and practical computer sessions.

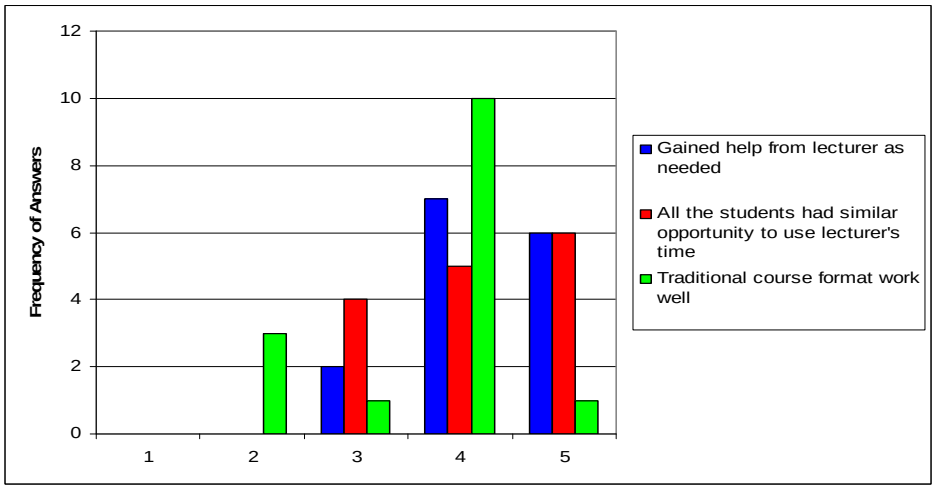

Figure 4. Lecturer's role and input in the course as well as evaluation from intensive type of course overall (n = 15; aver. gained help 4.3, opportunity to use lecturer's time 4.1, intensive/flexible course format 3.6)

Overall the students appreciated the computer sessions and thought that they provided them good knowledge and skills – also lecturers role was considered as good or even excellent (Figure 4). One indication from positive outcome is that the students also requested inclusion of this application in other courses.

4.2. Intensive Course Results – Introduction to the ERP System Navision

Similarly to traditional course arrangement, students of intensive course had very low ERP knowledge and skills in the beginning, but they believed to have significantly improved their knowledge and skills regarding this topic after taking part of this intensive course (shown in Figure 5). Students also believed that the course provided them with important knowledge and skills for future work. Still, it should be noted that students were mostly using their own time to learn how to use the system, and the time spent was quite significant. In ERP related topic it would be simply impossible to handle all of the system details through lectures – this is the main point of running ERP training in intensive format.

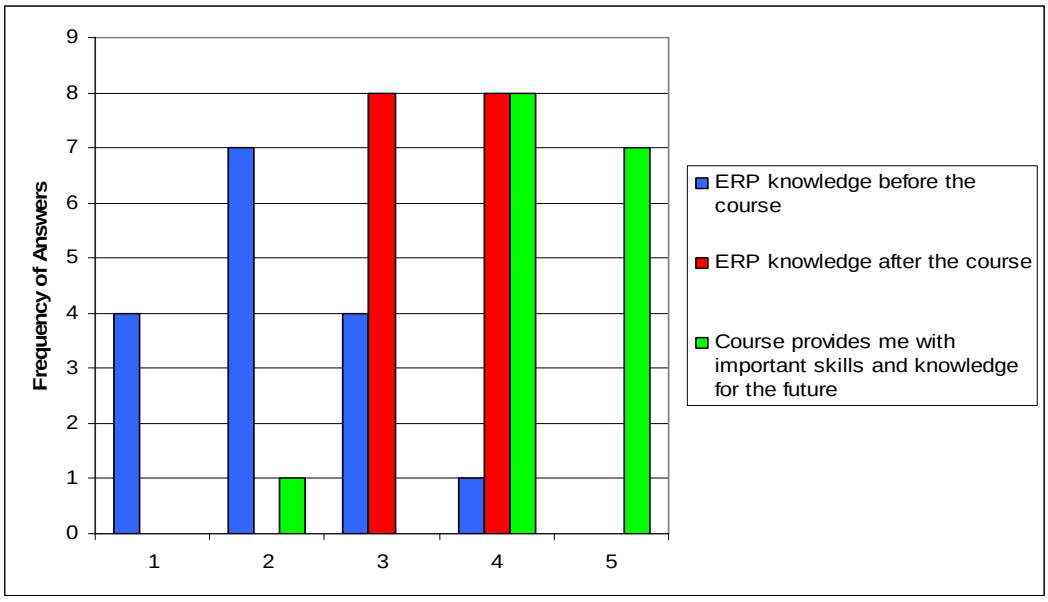

Figure 5. ERP knowledge before and after the course as well as consideration concerning the usefulness in the future (n = 16; aver in knowledge before 2.1 and after 3.5, aver. in providing important skills/knowledge 4.3)

As Figure 6 highlights our students felt that the used ERP system was quite easy to use, particularly considering that it is a fairly complex and large system. They especially liked the easy access menu, the user interface and the similarities with ordinary Microsoft products. Our students also regard Microsoft Dynamics NAV as a quite easy system to learn. However, in qualitative comments students emphasized that learning takes time; some students' comment that it is quite easy to get an overall picture, however, in order to really understand the system require many hours intensive work. Others commented that it is relatively hard to learn the system in the beginning, but it becomes easier after time.

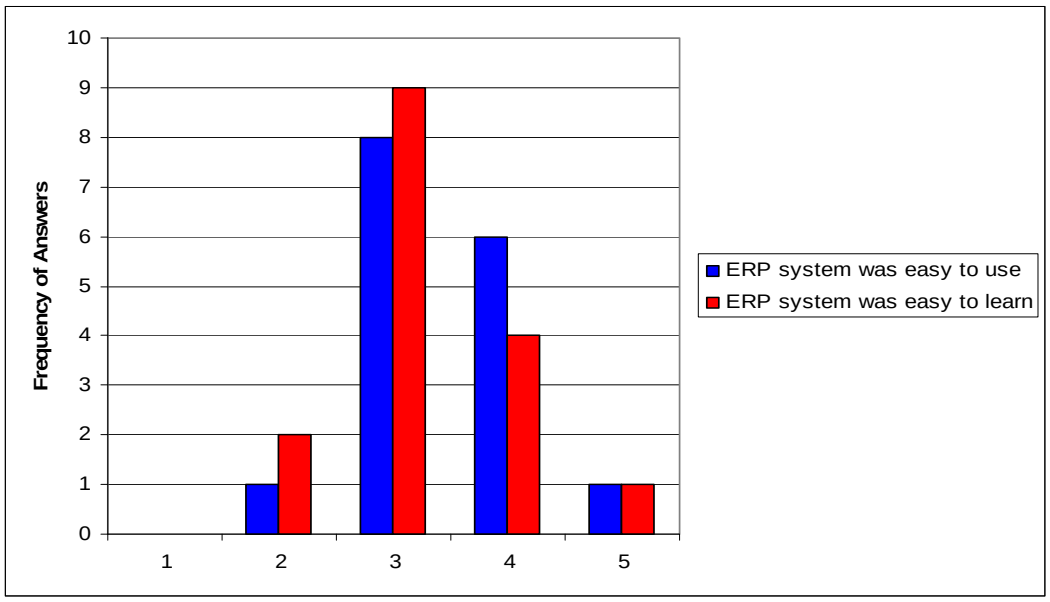

Figure 6. ERP system was easy to learn and use (n = 16; aver. in using 3.4 and in learning 3.3)

As could be seen from Figure 7, students regarded flexible course setting as an excellent one. They especially liked the possibility to choose direction based on their own interests and the freedom and responsibility, at a relatively large extension, determine the course schedule. One problem with the course setting compared to traditionally classroom courses, which the students addressed, was when a problem occurred that they could not solve on their own. Still, these problems fairly easy were solved through e-mail or phone.

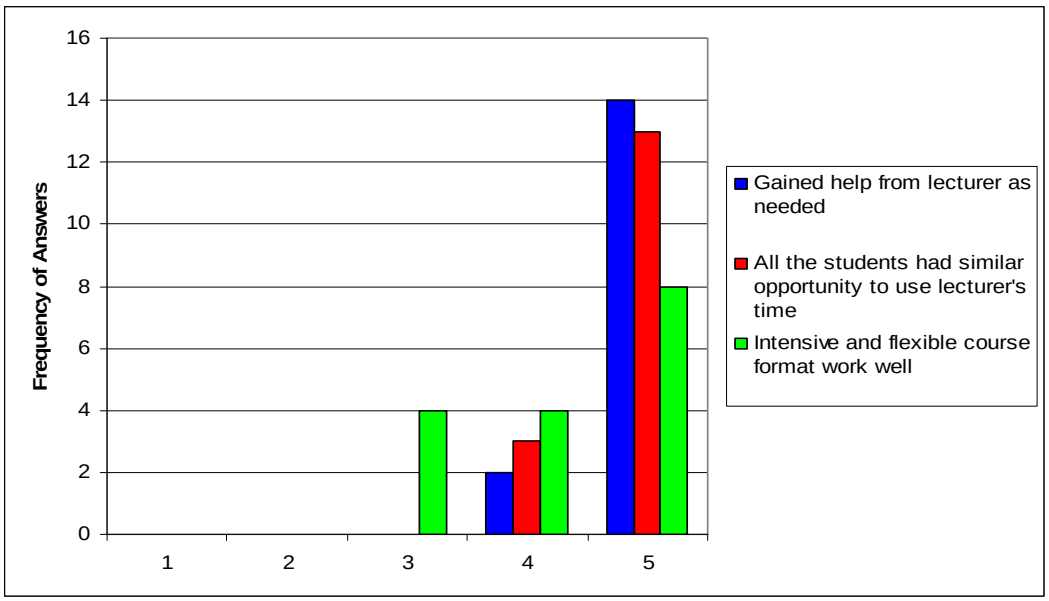

Figure 7. Lecturer's role and input in the course as well as evaluation from intensive type of course overall (n = 16; aver. gained help 4.9, opportunity to use lecturer's time 4.8, intensive/flexible course format 4.3)

Overall the students really appreciated the course and thought that it provided them good knowledge and skills – also lecturers role was considered as good or even excellent (Figure 7). One indication from positive outcome is that students also requested a continuing for this course, so that they could learn an additional module.

4.3. Comparison of Traditional and Intensive Course Evaluations

As course evaluation sub-items are evaluated thoroughly, we could identify in both of the cases that students felt to have received remarkable improvement in their skills taking either one of the earlier evaluated courses (Figure 8 see two first items). However, several students in the traditional course regarded their knowledge and skills as quite limited, since ERP section of the course was limited. Consequently, students in the intensive course believed that the course provided them with important knowledge and skills for future work in higher extension than students in the traditional course; an ANOVA single factor test also confirmed this difference to be significant. This difference is not surprising result, since students in the intensive course were mostly using their own time to learn how to use the system, and the

time being spent was quite significant. Still, it is important to note that both of the courses received quite high rank with this regard.

Moreover, the students, irrespective of approach, rated the utilized ERP system in a similar manner regarding how easy it is to use and learn. Based on this research it can be argued that the utilized ERP system is quite easy to use and learn. Still, it is important to note that it takes time to really understand the system. Students in the traditional course emphasized that it is quite easy to get an overall picture, however, in order to really understand the system requires more hours than offered in this particular course. This view is further confirm by students in the intensive course, who emphasized to really understand the system require many hours intensive work. Moreover, this research highlights that the utilized course materials along with the ERP lecturer are important factors to learn the system. The lecturer needs to be quite skilled in the system to handle a variety of upcoming problems and the course material needs to be pedagogic and simple to follow.

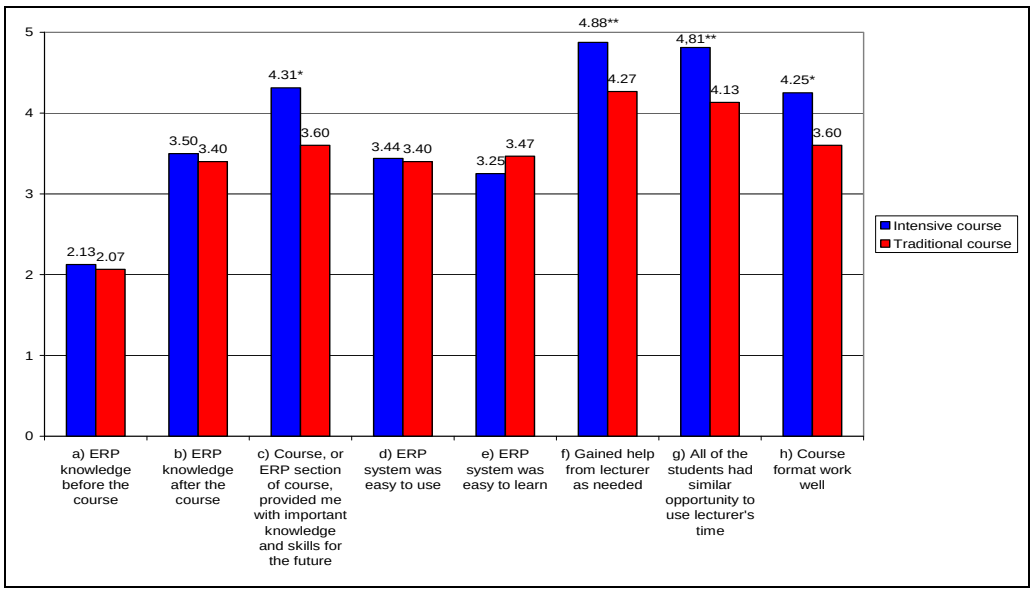

Figure 8. Comparison between the traditional and intensive approach. Notes: Denotation (Anova Single Factor): *< 0.05 probability for significance, **< 0.01 probability for significance, ***<0.001 probability for significance

As highlighted in Figure 8, students in the intensive course believed that the course format worked well in higher extension than students in the traditional course; an ANOVA single factor test also confirmed that this difference to be significant. It is also important to note that both the courses received quite high rank in this regard. Basically students in the traditional

course thought that there were too few computer session in order to really understand the system and some students also requested a separate course that dealt with these issued in more depth. Still, it important to note that this was not the opinion of all students, some really appreciated the combination of theoretical lectures and practical computer sessions. One problem with the intensive course setting compared to traditionally classroom courses, which the students addressed, was when a problem occurred that they could not solve on their own. However, students in the intensive course believed that they gained help from lecturer as needed as well as that all students had similar opportunity to use ERP lecturer's time in higher extension than students in the traditional course; an ANOVA single factor test also confirmed these difference to be significant. The reason for this is that students in the intensive course did not ask for help regarding every minor issue that arises. Instead, they in larger extension try to solve upcoming issues on their own and only requesting help when they really need it. Still, it is important to note that both the courses received very high rank in this regard.

5. Discussion and Conclusions

It has been argued that it is very important to incorporate ICT in general and ERP systems in particular, in any modern logistics education. This because this type of systems is required to stay competitive in today's globalized economy and since successful implementation and utilization requires skills and knowledge, which only can be received through comprehensive training. This research reports how this type of systems should be incorporated in logistics courses. In essence, a traditional approach, where computer sessions are incorporated in ordinary courses has been compared to a new intensive and flexible course format. It can be concluded that both of the approaches in some way offer good opportunities, the students appreciated the traditional approach, since it allowed them to receive both theoretical and practical knowledge and skills, while they appreciated the intensive approach, since it allowed them to receive significant practical knowledge and skills. Irrespective of approach, the students believed to have significantly improved their knowledge and skills in ERP systems and also in similar extension compared to prior knowledge. However, in the intensive course the students believed that the course provided them with important knowledge and skills in higher extension than students in the traditional course. Still, it is important to note that both the courses received quite high rank in this regard. Consequently, the best alternative could be

to utilize both of them; but it should be highlighted that this research indicates skilled responsible lecturer among intensive course setting to offer possibly one route for faster learning and higher productivity of lecturing. It is also important to emphasize that universities not solely should run intensive course but also incorporate ERP aspects into logistics courses. It is not enough to be skilled with either theoretical or practical knowledge; both theoretical and practical knowledge is required. In contrast, the intensive approach quite possibly can be used towards industry to provide faster, flexible and more efficient learning. Nevertheless, caution should be addressed in choosing right lecturer for the course – intensive lecturing means that presence in lecturing hall and exercises is lower, but more time is spent within responding emails and phone calls.

Another interesting question highlighted in this research is the importance of vendor selection to succeed with ERP system implementation. As reported in the literature survey, vendor selection is considered as one of the most important issues to succeed with ERP system implementation. This observation is further verified by our study; the findings shows that the students already were familiar with Microsoft products and the well-known user interface gave considerable help in the learning process of this system. One final interesting question highlighted in this research is the importance of culture, especially the language used in the information system; in our case students did have good mastering of English, but menus and reports produced from information system with own language made learning much easier.

An interesting aspect for further research would be to try this intensive type of ERP system course developed in our university in other countries, like rapidly developing economies such as BRIC (Brazil, Russia, India and China). We are confident that this type of course has demand in Scandinavia (due to small power distance and generally feminine culture; earlier studies emphasize the importance of cultural aspects in ERP system implementations, see Xue et al. 2005, and Krumbholz and Maiden 2001). However, currently rapidly developing BRIC countries have usually different cultural profile; masculinity and power distance is dominant feature in these, and therefore intensive courses should be modified for this environment. Therefore, we would be interested in the development process of such a curriculum. However, another interesting avenue to be further developed is additional courses to be given after the first intensive course in our home university.

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Passenger Transportation Organization on Railways between Russia and Finland

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Abstract
The railway communication history between Russia and Finland is under interest of this article. Features of the Russian-Finnish agreement on passenger transportation are considered in details.

Keywords: Passenger transportation, ticket, booking-cash register system, journey rules

1. Introduction

The passenger transportation is very important and is in the eye for the international cooperation. VR operates nearly 320 long-distance services every day of which six between Finland and Russia. On Helsinki-St. Petersburg and Helsinki-Moscow lines 50% of passengers are Russian and 30% Finnish passengers, the remaining 20% represent various nationalities. In addition to Europeans the largest groups are Americans and Asians. Leisure travelers account for 60% and business travelers 40% of all passengers. The program concept consists in the organization of national transport system with service of passengers under the integrated schedule. The railway communication history between Russia and Finland confirms communications during the various periods.

2. History of Passenger Transportations between Finland and Russia

On the 30th August 1870 Finnish railway started for regular transportation between Saint-Petersburg and Helsinki. To the train bounded from Saint-Petersburg for Vyborg was attached “Special non-stop train for passenger transport between Saint-Petersburg and Gelsingfors” (Vulfoe 2007). Construction started in 1868 after the decision of the Diet of Finland on allocation of finance for construction of onshore transport way via Saint-Petersburg. The sources of finance were “taxes for wine and smoking and drink sales», and also an internal Finnish loan.

Railway between Saint-Petersburg and Helsinki was constructed for the trade development between Finland and Russia, especially with Saint-Petersburg, which at that

time became the main principal place for sales between Finland and Russia agricultural and industrial products.

Construction has been completed on high technological level and very quickly. The passenger carriages were very comfortable, their design supposed through pass from head to a tail. The payment for travel for that time was not cheap, but quite accessible: the cost of the ticket on one versta (a Russian unit of length, 1 versta = 1.0668 kilometers) was in I class three, in II - two and in III - 3 kopecks. It is uneasy to count up that trip from Saint-Petersburg up to Vyborg at distance of 120 versts, required from 1 ruble 20 kopecks up to 3 rubles 60 kopecks.

Construction of the railway bridge over Neva and connecting ways between the Finland's and Nikolaev's railway stations in 1913 has provided through service with other railway network of Russia. Accepted at construction of tracks in Finland the width in 1524 mm has provided the cargo transportation by freight trains without transit and as consequence through-transportation of passengers on interim Russian - Finnish railway connection since 14th October 1913. The special office on the issues of the Russian - Finnish railway connection has been founded in Main Railways Management Office in 1st October 1915

After revolution passenger movement between the Soviet Russia and independent Finland in the small sizes became possible only in 1921, after signing of the Tartu peace treaty. However, actually Russian - Finnish direct railway communication began only in 1925, when the sleeping through-car with re-couple on Vyborg has been appointed between Helsinki and Leningrad. Then the sizes of movement have been increased due transit from Finland to Baltic and the Central Europe through Soviet Union. Passengers went not only to Leningrad, but also to Moscow, Riga and Tallinn. Luggage and cargo luggage could be forwarded to some other stations too.

After 1939 winter war within above railway communication framework the passenger transportations between Soviet Union and Finland were carried out as well during an armistice, since 1st October 1940. Since 1944, according to the Agreement on armistice Porkkala - UDD under name of Finnish territories occupied by Soviet military-naval base the passenger transportations in small volume were carried out. The military train № 19/20 Leningrad – Kirkkonummi passed through Helsinki once a day. Civil passengers among whom there were mainly officials and diplomats were transported in international car as well.

After the Second World War the new agreement on Soviet - Finnish direct railway communication (tariff manual № 16) has been made on 19th December 1947. In 1952 passengers have gone to Helsinki from the Finland railway station to Olympic Games, in

which the Soviet sportsmen took part for the first time. However, normal passenger transportations it was managed only from the beginning of 1953. In 1953 one sleeping car and one baggage car shuttled between Helsinki and Leningrad in a day. Since 1954 the direct railway communication with sleeper car was expanded to Moscow. In 1956 after returning to Finland, the territory of Porkkala military base the passenger movement has been amplified. From Moscow in Helsinki the daily train № 32/31 has been appointed to which the cars of RIC dimensions were coupled in Leningrad. The Soviet attendants from staff of October railway served the train. The train changed the movement direction in the Leningrad junction twice: 1) on departure from Leningrad from the Moscow railway station, 2) at angular arrival on the Volkovskaya station, where it got on connecting line and through the Gluhoozerskaya station and Dolgorukov's Dacha followed to Vyborg way.

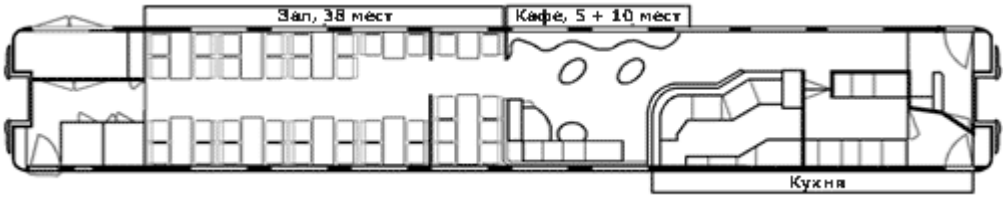
In 1958 between Helsinki and Leningrad the special trains made up from sleeper cars of Finland Railways have been tried specially for the days off. To 1984 on 5 kms of line Leningrad - Moscow way out has been stacked and the blockhouse has been equipped providing Moscow – Helsinki train admission through the Gluhoozerskaya station and further Dolgorukov's Dacha with stop on Ruchji Station. This technology of the international train acceleration was offered by the then Head of the October railway passenger department N.U.Dmitriev. The Moscow train has been named by L.N.Tolstoy, the genius of the world literature. The increasing passenger traffic has demanded the separate train from Leningrad that was included into the Finland railway station schedule under № 33/34. The Leningrad train became day time and has changed the composition to cars with places for sitting (6 passengers in the compartment) and one soft seated carriage with places for lying in the 2-seat compartments. The train has been named in honour of great artist I.E.Repin. Since 1992 in addition appeared Finnish formation train "Sibelius" with open and compartment cars with places for sitting. This train was named in honour of the well-known composer Sibelius. The plan of the place arrangement in passenger cars of this train is shown on Figure 1. Now daily between Russia and Finland three daily trains shuttle with the minimal stops. Boundary and customs formalities, the currency exchange and taxes-free check returning are made in the train during movement.

3. The Characteristic of Modern Volumes of Passenger Traffic

Nowadays Passenger traffic stream between two states is stable, symmetric, with steady dynamics of growth that outstrips the forecasts the both OSS «Russian railways» as well Finland railway. So as Chairman of Council of Directors of Finland railways Mr. Henri Kuitunen informed in April 2007 the number of actual passengers upon results of the year was 337 thousand people, while the forecasts for 2006 was 325 thousand person. According the data of the Head of the passenger communication department of OSS «Russian railways» G.V.Verhovih growth of passenger turnover for 2007 has made 27 % in relation to the previous year (Lebedev 2007).

a) compartment car of the 1-st class with negotiations lounge

b) open car of the 2-nd class with compartment for animals



c) restaurant car

Figure 1. Place arrangement in the cars of Sibelius train

According the consolidated opinion of Russian and Finnish railway specialists after the project realization on the organization of high-speed transportation between our countries the

quantity of the passengers who would prefer railway for travel will grow three times (Lebedev 2007). About 60 % of passengers are Russian and about 30 % citizens of Finland. Russian – Finland railway is used by the citizens of other countries of Europe, Asia and Northern America also. Almost half of passengers are in business trip, that's why the share of employers and businessmen among passengers is significant. The most of the passengers use the second class cars. Average for year between Russia and Finland each passenger makes 6 return trips by train and 4 return trips by other types of transport, the reasons being more convenient schedule, necessity of the personal automobile in the country of destination, the time deficiency at aviation travel, etc. Bus trips are motivated by lower fare associated with minimum convenience such as long expectation of the passport and customs control over border.

The customs and boundary control organization experience in the moving trains has been developed in the European countries. This technology decision provides significant reduction of the trip time. The technology of passing the border at the stationary crossing point will lead to necessity to arrive to railway station approximately 2 hours ahead of the train departure for the boundary and customs control. After arrival from abroad the exit to city will be possible only after such control also. In result the trip time for passengers in a high-speed train with boundary formalities will differ a little bit from travel in usual passenger train (Ministry of Railways of the Russian Federation 2002).

4. System of Passenger Transportations in Finland

Total length of the Finland railway network is about 5781 km with 196 stations open for passenger operations. Arriving from Russia to Finland by train, the passenger can make without problems a change for the trains following both to the western coast, and to Lapland. Bus service also is coordinated with the schedule of trains. For example, a train bounded for Kajaani is well connected a bus that comes to the slopes of Vuokatti where the mountain-skiing season proceeds from November till first of May holidays. The railway communication inside Finland is provided with trains of various types that differ a little on a spectrum of services.

Finland's railways (VR) in 1995 were reorganized from the state enterprise into joint stock company operating as any other commercial structure. The state of Finland doesn't

stipulate the tariffs for railway transport and the prices are being formed by the company on the basis of actual market situation. Thus VR concern has a possibility by it's own and flexibly propose to the passengers a wide scope of transport services. VR owns a rolling stock of 1024 passenger cars and also a number of enterprises rendering bus passenger services. It's interesting, that in spite of general believe that passenger transport in the world is unprofitable, VR's economical effect is always positive. VR's share in transport market of Finland is 25% that is 10% higher than corresponding indications of railway companies of other European Community countries (VR 2008).

5. The Russian-Finnish Passenger Tariff

For Russian-Finland direct connection the rules of Unified International Passenger Tariffs (UIPT) are in force. Children up to years old are transported free of charge in case they don't occupy the places. A fee for children from 6 to 16 years is 50% of one for adults. A ticket same as for adult is required since 17 years age. This rule is in force in Russia-Finland connection only. One place may be occupied by two persons in case one of them is younger than 10 years.

For having a separate place a price of a ticket and place booking fee should be paid. It's vital to stress, that this principle is in force for the trains of Finland's railway. For local or suburban trains, where the places are not booked, a ticket only is sufficient. This item of contradiction should be noted specially, since in Russia's railway purchase of a ticket and place booking are represented as being necessary for any train of Finland's railway. It's possible that such interpretation is connected with ongoing discussion on the transition to so called "global" tariffs, where a ticket and place booking are performed on a single form of a single transport document. Such "global" tariffs are in action, for instance, in the route Moscow-Venice.

In Russian-Finnish direct connection for group transport discount system is being applicable: the more people are in a group – the cheaper is a trip for a person. Thus, for a group of 6-24 persons – 40%, for 25-35 persons -50%, for a group of more than 36 persons – 60% ticket price discounts are being granted. It's important to note, that in contrast to the whole Europe in Russian – Finnish connection only the principle of "children addition" is being applied, meaning that two children with paid fare are considered as being one adult

person. For the persons of 60 years onwards 30% “senior” discount is being granted. Discount for place booking is never granted.

In all cases (but for children) a passenger may have one discount only, for instance, a person having already senior discount, is not to be granted season – ticket discount. There is of interest of application in Russian tariffs a practice of granting discount for mini-groups, comprising at least one adult person and one child of up to 16 years old, but not more than 5 adults with one child. Within mini-group 30% for adults, and 50% for children discounts are being granted. For instance, the train fare (summing up a ticket and place booking) from Helsinki to St.Petersburg is 54.80 Euros and within mini-group an adult has to pay 40.8 EUR. In a group of 6-24 persons train fare for an adult is 36.1 Euros and for a child 22.10 EUR correspondingly.

Season-tickets for 20 trips for 4 months period are being applied. The users enjoy 30% ticket price discount. However, in case a person fails to use complete number of trips within period of validity, the money for unused trips is not refundable. Season-tickets may be used by one or a number of passengers personally or in a group. By way of exception season, tickets are available without seat booking, but in any case prior to boarding of a train seat booking should be purchased as in a train they are not available.

In case a person wishes to trip in a separate compartment of the 1-st class sleeper car it may be done in case vacant places are available. In this case a person has to pay for one 1-st class ticket and for “single” seat booking. To occupy 2-nd class separate compartment a person should pay a fare due for the class and a fee for a seat booking of corresponding category as per quantity of all places in the compartment. Not occupied seats are to be paid as per tariff for adult persons.

The rules of transport in Finland differ from the ones in action in Europe, as well as in Russia. With the progress of tourist business development, of interest are transport cards Finnrailpass intended for the people permanently residing out of Finland. The above tourist cards are valid for the 1-st and 2-nd classes for 3.5 or 10 arbitrary days (not specifically in succession) within one month. Any person may take with him up free of charge to 4 children not above 6 years old. For children from 6 to 17 years old a child’s ticket should be purchased priced half of adult’s fee.

A passenger has to submit his baggage to a baggage car and get it back upon arrival. However, nowadays in Finland there are few trains with baggage cars, so a passenger has to transport his baggage with him at specially provided places or in the baggage racks located in car’s vestibule. There no baggage cars in the trains in the Russian-Finnish connection. A

person should store his own hand luggage close to his place. According to international rules a person may carry with him as a hand luggage an article with 3 dimensions totaling to 200 cm, but for adult's ticket 3 pieces of luggage are allowed only with total mass of 35 kg, two of them free of charge and the 3-d paid as per baggage tariff. On child's ticket only one peace of luggage is allowed free of charge, the second one for payment, while the total mass of two pieces should be not more than 15 kg. These rules are in contradiction with Russian ones where baggage transport requirements are the same for adult's or child's ticket; in addition the sum of 3 dimensions is 180 cm.

In Russian – Finnish railway connection only dogs and cats may be transported and not more than two animals. On Russian side this rule is contradictive: one pet is allowed and two in exclusive case only. No other animals (for instance monkey, polecat etc) may be carried. In the Finnish train "Sibelius" a person with a pet should trip in the car number 4 in the special compartment with seat numbers 69-72. The above seats for a trip with a pet may be booked when going from Finland. Booking is impossible from Russia due to technology specialty of "Express 3" booking system. That's way, when coming from Russia to Finland a passenger with a pet has to be booked at any seat, however, Finnish attendant will locate the person in the car number 4. For each pet child's 2-nd class ticket should be purchased. In Finnish 1-st class trains transport of pets is impossible. In Russian trains the animals may be transported only in separate compartments of the 1-st and 2-nd classes. The passenger and a person traveling with him should purchase the tickets and seats booking for the seats in the occupied compartment. The seats have to be paid completely as transport of a pet with occupation one seat only is prohibited. However, in case of one of duly paid seats is vacant, two pets may be carried on one seat without a ticket. Same principle is in action in Russian railway system as well, but in the trains of Russian make up only. In case a person with a pet travels along it's reasonable to purchase one 1-st class ticket and booking "single". The passenger will have a total compartment at his disposal, but for a pet child's 2-nd class ticket is obligatory. In open type cars with sittings and in business class cars transport of pets is prohibited.

Travel documents are being checked by Russian attendant when boarding a train and by Finnish attendant underway of a train. VR train attendant punches the transport documents. An attendant of "Sibelius" train has at his disposal vacant seat numbers 64-76 in the car numbers 2, 3, 5. As presented on the set up Figure seat numbers 35-42 are opposing each other. The above seats are being booked on special request, otherwise they are available for free sale. However Finnish booking-cash register system "Opera" provides the above seats for sale only after the other seats have been booked. Seat numbers 43-64 in the car number 3 are

assigned for the Vyborg station. The seats in the negotiations lounge of the 1-st class have to be booked requesting the definite seat.

6. The Organization of High-speed Movement

A start of St. Petersburg- Helsinki rapid train operations was planned for the end of 2008, but is being regularly postponed. According to presented explanations the reasons of delay are in production time, trials and certification of Pendolino trains with variable angle body inclination. On of Pendolino trains, owned by VR, completed trial operations on Moscow-St. Petersburg line. The trials are successful with some small claims connected with train operations in mist and heavy precipitation (Mihno 2007).

But for purchase of new rolling stock, the project of rapid St.Petersburg-Helsinki connection provides for investments into infrastructures of Finnish and Russian railways. For rapid connection in 2005-2006 a straight section of rail line Kerava - Lahti was constructed, that is Finnish- Russian trains are not now passing through Riihimaki station. In 2007-2011 reconstruction of the way between Lahti – Luumaki for passenger trains of 160-200 km/h to be completed. In Finnish part speed of a train to be 200-220 km/h, in Russian part- 160 km/h. As a result time of St.Petersburg-Helsinki trip will be shortened from 5,5 hours to 3,5 hours.

Every train includes one 1-st class car, 5 second class cars and restaurant car. There are the rooms for smoking passengers. In total in the train of 7 cars 350 passenger seats will be available. In one of the cars separate room for border guard and customs officers will be provided. An inquiry has been submitted for purchase of 4 trains.

Selection of staff for the trains in Finnish – Russian operations will be based on the idea of reduction of operational expenses. The attendants for these international trains will be recruited in Russia as well as in Finland. Due to the above, it’s clear, that cooperation with VR will not bring to Russia’s railway new technologies of production and maintenance of rapid trains. Some experience may be expected in servicing of the passengers in the international lines. International experience proves that success in sales of transport services is same dependent upon level of services as on speed of transport.

Helsinki-Vainikkala project provides for modernization of the existing line of 257 km between Helsinki and Vainikkala station at the Russian border. This line is the part of the speed network in northern three angles and is very important for development of passenger traffic in the direction of Turku-Helsinki-Vainikkala-St.Petersburg, as well as cargo transport

to Russia and backwards. For getting to Russia crossing the border a trip document will be required starting in Vainikkala at least.

As passenger traffic is explicitly irregular, before and after the holidays additional trains are usually put into operation with the tickets available for booking, for instance train number 69/70 Moscow – Helsinki. As per request of tourist bureaus charter routes are being devised with group booking only. The points destinations of these trains as a rule are Rovaniemi, Kajani, Kuopio etc.

7. Uniform Transport System of Finland

In Finland it is believed that trip's convenience depends not only on comfort of a train and schedule accuracy, but on coordinated functioning of the whole public transport. The program is being implemented here on the development of so called "passenger centers", where all suitable conditions are provided for passenger easy move from one transport to another. In the centers under one roof the tickets are available for any transport all over the country. The biggest centre is founded in the middle Finland in Jyvaskyla. There are plans of founding similar centers in 22 areas of Finland by 2012. The basic for the planning of passenger transport organization became unified state system of public transport (Finnish abbreviation – Vali), where at the central station the connection of all the trains is available with easy move of passengers from one train to another is provided. Pendolino trains do not come to the city stations. Regional stations are attended only by local trains and auto transport.

Efforts against ticketless trips are actual in Finland as well. A penalty for this violation is 80 EUR. It's important to stress that in Finland not only penalties are being in practice, but mainly the services are being developed for easy access and convenience of ticket acquisition. The experience of capital's region of Finland in ticket –cashing technology is of interest for major junctions of suburban traffic in Russia.

In Helsinki the tickets for any transport including suburban trains, may be purchased via mobile phone. For getting a ticket a person sends SMS message to the number 13 -121, a fare automatically writes off his account as well as service payment. Phone user gets return message that serves as a ticket. In 2003 VR started sales of the tickets via Internet. A ticket may be booked, paid and received in ticket machine. Development of electronic ticket system enables to a traveler to print a ticket at his own printer/PC (Vasiliv & Okno 2007).

Unified transport system of Helsinki enables application of unified tourist ticket for any public transport without any limit of trips. There are the tickets for 1, 3 or 5 days. Price of a single trip ticket in the machine is 2 Euros, a driver takes 2.20 EUR. A ticket for a day costs 6 EUR for 3 days-12 EUR, for 5 days-18 EUR. Purchased in advance ticket is an electronic card activated by validater when entering any transport. A ticket is registered and dated automatically (Kasnina 2008).

In Finland the program of rolling stock of passenger cars is being underway since 1999. The travelers got used already to white & red painted trains of French company Alstom. The trains are equipped with soft seats and air conditioners. On low traffic lines locomotives were replaced by rail buses with diesel drives. There are 63 seats and 60 persons may trip standing within the 1-st zone. Maximum speed is up to 120 km/h. Control cabins are provided on both ends of a bus car. There are 3 passenger lounges separated by vestibules. Rail bus may be made up with 3 cars maximum.

On the lines with stable and significant passenger traffic rapid transport is being developed. The first rapid Pendolino trains were introduced in 1995 on Helsinki – Turku line. In the schedule these trains are indicated by symbol S. In summer of 2008 more than 18 pcs of these trains of 6 cars were already in operation connecting principal cities Helsinki, Turku, Joensuu, Oulu, Kajaani making up to 220 km/h. With traffic growth, trains may be connected. Every train is equipped with restaurant car Presto, if trip time is 1.5 – 2 h. Catering services are also provided in the compartments from hand carts. Intercity (IC or IC2) trains are making up to 160 km/h. The above trains are made up of 1 or 2 storey cars Talgo. Special requirements of families with children, impaired mobility or sight, persons with allergies, with pets has been taken into account. The above trains are operating between major cities with principal destinations from Helsinki to Turku, Tampere, Oulu, Rovaniemi, Kuopio and Joensuu.

The night trains cross Finland in one night. Since 2008 booking for these trains is possible via native system “Express 3”. In composition of the trains there are the cars with seats and compartments with 1, 2 or 3 sleeping berths. For overnight family trips to Lapland 20 wagons of 2-storey sleep cars are used. There are 38 beds in 11 compartments on the lower and middle floors and in 8 compartments of the 2nd floor. All the compartments are double, but may be booked for one person as the 1-st class and purchased as single. Two adjacent compartments of lower floor may be connected through sliding door forming 4 berth compartments. At every berth electric plug is fitted for PC or charging unit. On the lower floor toilet and baby handling room are provided. There are toilet and shower on the middle

floor. On the upper floor WC and shower are in every compartment. Every night train has a restaurant car. Most of the night trains may carry motorcars. Booking for the trains is available on year in advance. The above trains are recognized by Russia's railway management as prospective for replacement of old fashioned reserved seat cars (RZD 2008).

Regular care of Finland's railway about quality of services, gratitude and respect to the passengers bring stable turnover growth. Attention to improvement of services, educated marketing enable VR not only to retain up to 30% of total passenger traffic, but also confidently compete with auto transport companies.

8. Conclusions

Study on the experience of passenger transport organization abroad enables to propose feasible versions of their application in the system of Russia's railway as regards to railway traffic improvement, as well as upgrading of services at the terminals and on the trains of various classes. There are also interests of the special issues of passenger traffic tariff regulation, social trend in passenger business brightly demonstrated in VR operations. This article was recommended for publication at the faculty session of science's week.

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Operator Companies in the Conditions of Financial Crisis

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Abstract
The modern society in the economic development has once again faced the phenomenon of financial crisis that inevitably affects absolutely all fields of activity of the person, whether it is connected with procurement, processing, warehousing, selling or transportation of resources. The article concerns studying of influence of this economic event on the private transport forwarding companies recently formed in railway transportation, or as they commonly referred to, operator companies. The review of the situation which has developed in modern market system and also in railway transportation in particular is made, basic problems which the operator companies have faced are revealed and the main ways of their solving are specified.

Keywords: Financial crisis, railway transportation, operator companies, tariff regulation, private rolling stock

1. Introduction

The world economy has now entered a very difficult economic period. In the centre of this global crisis there is American financial system. The reasons were innovations in the field of mortgage lending: low interest rates have made credits attractive to various strata of society. Large quantities of credits which have been given out by American banks were not supported by anything which resulted in building crisis: banks have ceased to finance building of houses and after an ambiguous situation in the building industry problems with unemployment have emerged. Now we can observe a similar situation in Europe which undergoes the same mortgage disaster. (Vremlja Nagosti 2008; The Wall Street Journal 2008). Russian mass-media have quickly reacted to the beginning of crisis in Russia:

"Yesterday Russian stock market has set up a new anti-record by falling on 9 %. We haven't seen such shattering decrease by results of one day for last years… the reason, according to unanimous opinion of experts is mass withdrawal of money from the Russian assets by large foreign players "(Rossaskaja Gazeta 2008).

In addition appreciable decrease in rates of growth of economy and manufacture in many developed countries including China and India which population makes third of globe is marked. This recession has affected oil cost. Demand for it has fallen as well as the price per barrel. Charts of oil price are shown below (source: Energy Information Administration). For recent years on the chart we see appreciable growth of oil price during the period from 2005 to 2008, which is presented in Figure 1.

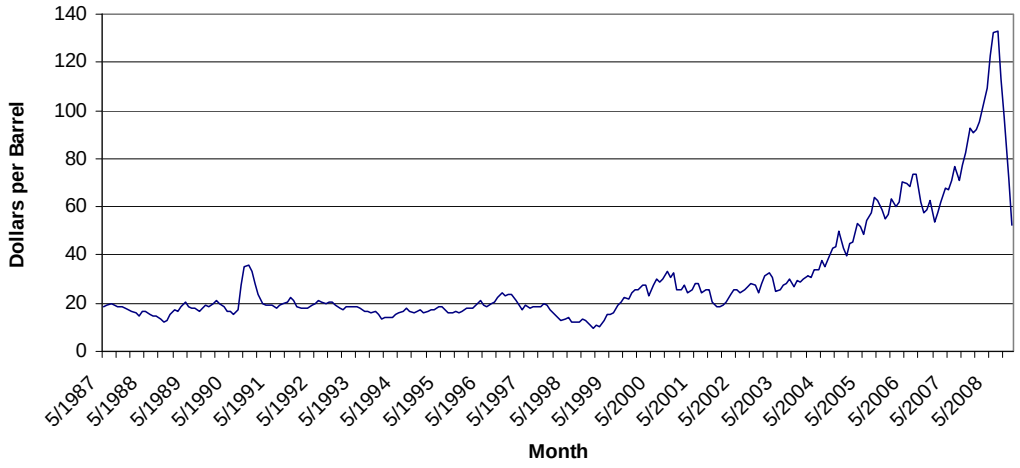

Figure 1. Dynamics of Europe Brent Spot Price FOB in 1987-2008.

From beginning of August 2008 to the end of the year, 2008, we will note a sharp depreciation of oil, which is presented in Figure 2 (source: Energy Information Administration).

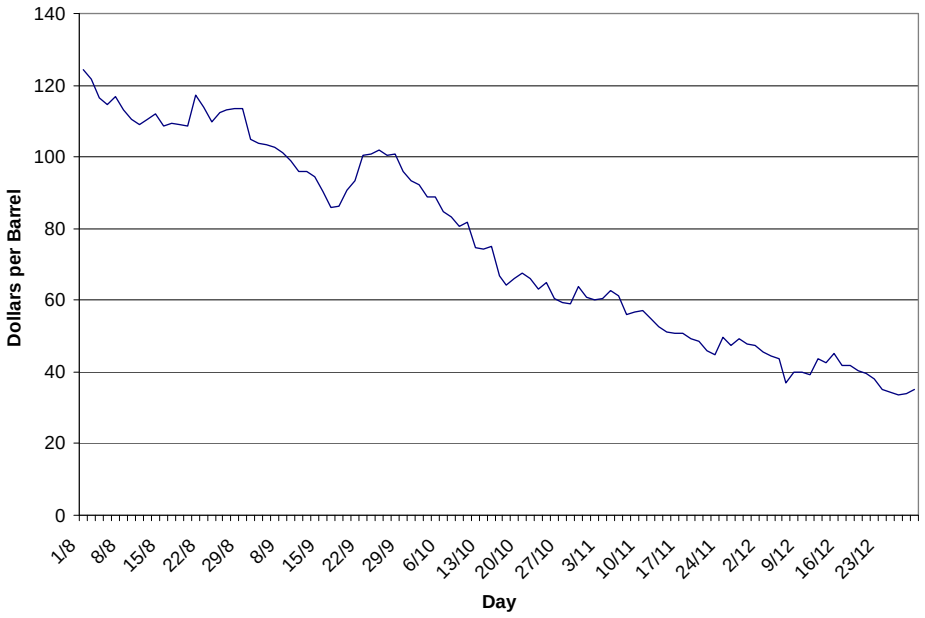

Figure 2. Dynamics of Europe Brent Spot Price FOB during August-December 2008

The crisis has caused growth of inflation by chain reaction. Now in the USA, Europe and China it has reached its superior limit. Naturally it should affect economy of Russia and other countries.

Since May, 2008 the Russian bank system undergoes liquidity crisis. More simply, banks practically don't have operation money resources which is caused low involvement of resources from abroad, cautious investment of recourses to Russia and large quantity of given credits. The South-Ossetian armed conflict with participation of Russia and Georgia has poured oil on flames. As a result domestic analysts already mark reduction of indicators in growth of gross national product, volumes of the involved investments and outputs. It also causes increase in interest rates on credits which will grow further till the stabilization on international scene.

These events, anyhow, make the impact on all fields of activity - manufacture, transport, finance, building, industry, thus, in this general interrelation it is important take competent and sufficiently operative decisions in order to stabilize the situation and to keep Russia's tendency to development and increase of its role not only inland but also over the sea.

How operator companies which have recently mastered transport business, proprietors and tenants of railway rolling stock which transport now more than 30 % of cargoes should act in current conditions, what they should undertake and how to keep the position in the market of transport services, to minimize risks and to remain competent transporters - these questions will be considered in the given article.

Despite the urgency, the given subject is poorly studied, that is why it is not presented in literary editions in details. The exception is S.M. Rezer's work (Rezer 2002). It is caused by absence of the detailed analysis and rather fast development of events in the world markets; for this reason the author has to rely mainly on publications in periodicals as well as interviews and opinions of the experts directly connected with railway transportation and transport business as a whole.

2. Occurrence of Operator Companies in the Conditions of Market Economy and Their Development within the Limits of Reforming of Structures of Russian Railway

The urge of private companies to create their own rolling stock has initially been caused by inability of the state to cope with necessary volumes of cargo transportation. In the Soviet times there was a heavy shortage of cars. After market reforms the situation has only aggravated, in 1990s Ministry of Railways has definitively lost possibilities for modernization of fleet of cars and locomotives. As a result by the moment of revival of the Russian economy fast-growing demand for transportations considerably surpassed capacity of railway branch.

Having faced the problem of rolling stock deficit, the large industrial business based on export oriented companies began to solve it with their own recourses. Leading oil, metallurgical and chemical corporations actively purchased cars. Naturally, in formation of their own fleet they were focused on specialized kinds of rolling stock: tanks, open box cars, pellet cars etc. Management rail transportation was often transferred to specially created affiliated transport companies, for example “Zheldorexpeditia” formed in the beginning of 90s. However, by getting cars industrial enterprises only protected themselves from the faults connected with spasmodic work of Ministry of Railways. There were no real methods to decrease transport costs or commercialize use of new assets then.

In 2001 (it should be noted that it was the 150 anniversary of Saint Petersburg - Moscow railway) the book «Occurrence and development of forwarding business on railways» edited by M.M.Uzdin was published, one of which chapters concerns formation of private forwarding in 1991 - 2000 - during generation of market economy in Russia. The special attention is paid to formation of the legal basis of forwarding activity which has established the basic aspects of organization of transportations, rights and duties of participants of transport process. So on January 17, 1998 “Transport charter of railways of the Russian Federation” was published by the end of 90s the System of Firm Transport Service has been practically finished.

The situation has cardinally changed in 2003 after in the tariff for rail transportation the payment for using a rolling stock (or so-called "car component") (Akhpolov 2006) has been especially distinguished. According to the new Tariff provision («Price-list 10-01»), (Price List 2003) proprietor of cars received the discount from the tariff for transportation of cargoes for size of "car component". It has created conditions for development of private business in the sphere of railway cargo transportation. Now the company possessing own fleet could offer

services to clients by tariffs lower than those established by Ministry of Railways. At the same time industrial enterprises having their cars have got new possibility for decrease costs of products transportation. It has resulted in sharp growth of demand for rolling stock from the private companies.

By the estimations of Russian Railways experts published by Rating Agency "Expert" (based on results of the research conducted by rating agency "Expert PA" in August-September, 2006) in formation of own fleet of cars by independent operators 80 billion rubles have been invested and the general number of cars under their management has made in the first half of the 2006 281 thousand units. The share of private traders in total amount of transportation of cargoes in 2005 has reached 30 % whereas in 2003 this indicator was only 21 %., as presented in Figure 3.

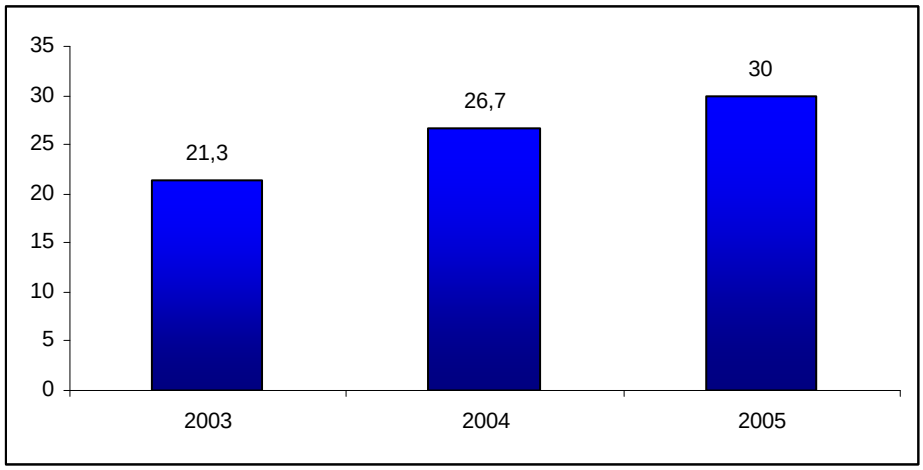

Figure 3. Rate of transportations in own rolling stock

According to the research conducted by RosBusinessConsulting (RBC) news agency (Rossiskaja Rinok 2007) now about 2500 operator companies work in Russia. “Last year the volume of transportations of cargoes in private rolling stock has reached the level of 527 million tons, thus the rate of transportations by private fleet has made 35.3 % in comparison with 32,2 % in 2006 (see Figure 4)”, - Salman Babayev, the vice-president of Open Society "Russian Railways" (Kommersant 2007a) noted. Commodity structure of the Russian market of cargo rail transportation (data received as a result of the above-mentioned RBC research are given):

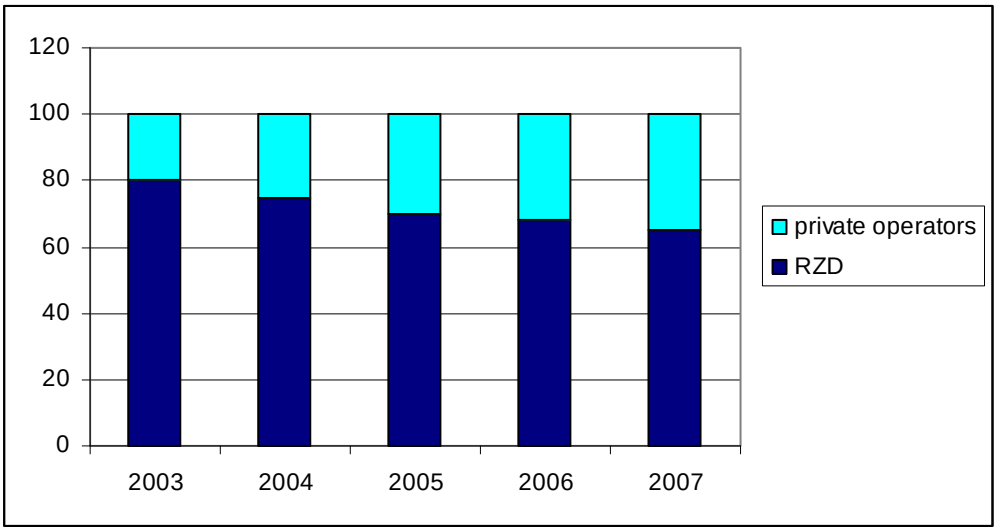

Figure 4. Rate of private operators in the Russian market of cargo rail transportation

The structure of the Russian market of cargo transportation for 2007, in tons, based on RBC analysis, is presented in Table 1.

Table 1. Structure of the Russian market of cargo rail transportation

Fleet type	Open Society Russian Railways Fleet	Private cars
Open box cars	791 886 590	241 840 082
Tanks	95 172 908	246 578 699
Covered	72 544 312	16 285 382
Platforms	41 052 279	22 931 650
Containers	1411 308	28 353 228
Dumping cars	2 613 953	13 572 149
Refrigerators	2467488	5 101 283
Apatite carriers		391 752
Chip carriers	79 725	236 860
Autorack cars	22 663	162 941
NA	87 250	17425
Transporters	48 529	
Non-cargo	746	1481
Container carriers	191	
Total	1 007 387 942	575472 932

Actually the structure of the transportations which are carried out by independent proprietors of a rolling stock was generated under the influence of the state tariff policy. The current system of railroad rates provides the three-level rate, (Price List 2003). The highest rate is applied by transportation of oil refining products (for example, polyethylene and rubber), ferrous and nonferrous metals, consumer goods. This segment is tapped by independent companies first of all. Here again they managed to press the railway monopoly considerably. So, private companies now carry out more than 60 % of transportations of oil and mineral oil, about 70 % transportations of different chemicals, as presented in Figure 5. Coal transportations are paid by the lowest, social rate. This niche is not interesting for independent transport companies - their rate here does not exceed 5 %-10 %. (according to rating agency "Expert" for 2006).

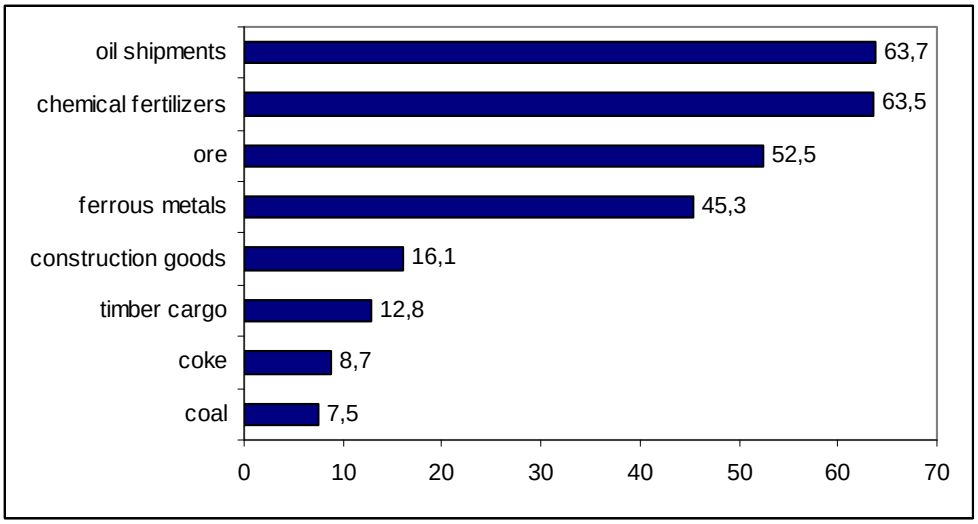

Figure 5. Rate of private companies in the country cargo turnover

Russian Railways were superseded to the least profitable sectors of the market by the pressure of private companies. More than half of cargo turnover of a railway company falls at cargoes of the first class on which transportation the lowest tariffs are set. And the rate of such transportations grew annually. If in 2004 their relative amount in the general structure of cargo turnover was 55.9 %, in 2005 - already 56.8 % (also according to rating agency "Expert" for 2006). The established tariffs for "social" kinds of cargoes by no means always compensate even expenses for transportation. Giving privileges for transportation of any cargoes, the state in facts makes Russian Railways finance them from their own profit. It suffice to say that expenses on transportation of coal, the most popular railway cargo, do not cover tariff incomes. "Social responsibility of the Russian Railways" is not limited to it.

The state has made the company responsible for performance of social passenger rail transportation by obviously decreased tariffs without offering any mechanism of compensation of losses. As a result the business structure which the Russian Railways are, has been actually compelled to play a role absolutely unusual for business - subsidize social obligations of the state from own incomes. The total amount of losses from passenger transportations in 2005 was 47.4 billion rubles. Creation of the Passenger Companies (for which, as a rule, payment for using infrastructure is reduced thanks to what on directions with the big volume of passenger traffic preconditions for profitable work are created) has been intended to improve the situation, but it has required to raise additional investments.

Current tariff regulation of activity of the largest railway company does not allow it to react to demand change adequately. Unlike operator companies which are able to have a

flexible approach to formation of tariffs for transportation of cargoes, Russian Railways is absolutely deprived of freedom of maneuver. The company is obliged to keep to the rate of tariffs set by Federal Tariff Service. As a result the railway monopolist often lost in a competition both to independent companies and other types of transport. For example, the part of railway directions of transportations passes along navigable rivers and channels. However even in navigation period the Open Society Russian Railways has no possibility to lower tariffs. As a result during this period many enterprises prefer to use water transport or services of private operators offering discounts to the tariff of Russian Railways.

Meanwhile, we can't forget that despite competition development, Russian Railways remains the unique national railway carrier managing all infrastructures. Besides the company still plays a key role in maintenance of requirement of subjects of economy in rail transportation. Russian Railways possess rolling stock, many times exceeding total quantity of cars and locomotives belonging to independent companies. But maintenance of objects of infrastructure, rolling and power stock demands multi-billion investments.

Now deterioration of the fixed capital of Russian Railways is 60.2 %. If to speak about condition of their active part here the situation is much more difficult. Depreciation ratio of freight cars in 2005 has reached 85.9 %, electric locomotives – 72.5 %, diesel locomotives – 84.2 %. Average age of locomotives is 20 years age of freight cars is 21 year. The general demand for investments only for purchase of new freight cars is estimated in 280 billion rubles the next 10 years. With the account of the capital investments necessary for maintenance and development of the infrastructure, liquidation of restrictions of capacity, organization of new routes by estimations of Open Society "Russian Railways" by 2016 it is necessary to invest not less than 2.6 billion rubles in the branch (Rossiskaja Rinok 2007). The Open Society "Russian Railways" has no own recourses for such large investments. In this connection the Open Societies Russian Railways had to involve considerable recourses for the long-term period, including recourses of foreign investors. The Open Society "Russian Railways" «has decided to involve private investors in completion of 16 projects of construction in progress. Among them there are access roads to Chiney iron-ore deposit and Elga coal deposits adjoining to Baikal-Amur Mainline and also unfinished vacation hotels on Black sea and water park in Moscow», (Vedemosti 2004). In the "News" (Vedemosti 2007) it is noted that the Open Society "Russian Railways" suggests private investors to invest in building of a bypass branch line round the sinkhole on the mine in Berezniki.

However, at the expense of available own and involved recourses it is possible to finance at the best only half of required investments, maybe for this reason the Open Society "Russian

Railways" for the first time has started talking about public offering of the shares, so-called IPO. (Kommersant 2007a)

Creation the new centre of profit and involvement of additional private investments according to management of Russian Railways would be possible by separating from the structure of Russian Railways the cargo company working in the market on the same conditions as private operators. So on July 26, 2007 the First Cargo Company was founded. Having no social obligations and tariff restrictions of the parent company, a new affiliated company of the Russian Railways undoubtedly has great competitive advantages which in time can be converted in market capitalization. Kommersant writes: “The First Cargo Company have plans to enter the IPO market which are confirmed by board of directors by its foundation - 49 % minus of 2 shares the First Cargo Company should sell in the open market in 2009-2010” (Kommersant 2008a).

Fears of private operators that foundation of the cargo company possessing huge fleet of rolling stock will allow it to take possession of the market were strongly exaggerated - it is impossible to learn to manage the huge fleet "inherited" from Russian Railways quickly and competently. Certainly, occurrence of the new powerful player in the market in the name of the First Cargo Company will inevitably lead to competition strengthening in the market of railway transport services.

In September 2008 the quantity of rolling stock directly managed by the Open Society “First cargo company” (see Appendix for definition) has exceeded 135 thousand units. Thus, as the company press-service informs, the Open Society " First cargo company " fleet at the moment is 13.5 % from the Russian fleet of freight cars (as a whole the fleet of freight cars of the Russian railways is 997.2 thousand unit, among them 450 thousand, or 45 % are inventory, 547.2 thousand unit, or 55 %, including cars of the First cargo company are private) (RZD-Partner 2008).

One of the principles which have been laid in the concept of creation of such cargo company was maintenance of equal competitive conditions for all participants of the market. In case of its violation the state apparently has all possibilities to suppress unfair competition and nothing prevents it to put them into practice.

Nevertheless, private operator companies for a long time accuse Russian Railways of restriction of access (discrimination) of the independent companies to objects of infrastructure. The majority of managers of transport companies notice that trains of Russian Railways and now the First Cargo Company as well first of all are moved for unloading, start from stations quicker and repair of private rolling stock in the depots belonging to Russian

Railways is carried out on the "special" overestimated accounting of expenses that results in unproductive idle times and additional expenses. And though representatives of railway monopoly always rejected these charges, they were hardly mere complaints. At least, the largest operators seriously considered possibility of building of own depots. Multimillion investments in their construction speak for such problem in themselves.

All that has gradually led to that the prices for services of private operator companies had to grow constantly to reduce arising costs and to remain profitable -apart from everything else, with inflation growth the prices for rolling stock grew as well. So, for example, during the period from 2006 to 2008 cost of rent of the covered car of model 11-270 manufactured in 1990 has increased from 800 rubles per day inclusive VAT to 1100 rubles per day. It is also caused by intermediary companies created in this period which earned only by subleasing of cars and had nothing to with the carriers.

3. Problems of Independent Operators in the Conditions of Crisis, Ways of Their Solving

So it was the way operator companies gradually tapped the market of transport services in difficult market conditions. When for last months the tendency caused by crisis to reduction of volumes of transportations and even a temporary work stop of some enterprises became obvious, it became clear, that it won't be easy to survive in new conditions.

According to Federal State Statistics Service (Kommersant 2008b) the price level on freight cars in 2006 has made 98.9 % from level of 2005, and in 2007 the average prices have grown on 19.8 %. Thus, total appreciation of freight cars in two years was 18 % that as a whole corresponds to rate of a rise in prices for metal rolling. However by the analysis of data of Federal State Statistics Service we should understand that in this case the question is dynamics of the prices of manufacturers. Actually cars are not always purchased directly from the manufacturer. In case there are intermediaries real dynamics of the prices for rolling stock depends on the trading margin and can essentially differ from statistical data. For today the tendency of growing prices remains.

So, the popular rolling stock - covered cars (to 70 % - cars of Armavir heavy engineering plant, to 60 % - cars of "Altaivagon"), open box cars and fitting platforms (to 40 % - "Ruzkhimmash" and "Altaivagon") has become the most expensive. Nevertheless, despite

appreciation of rolling stock gain of volume of deliveries of freight cars in 2007 in relation to 2006 has made 40 % (to 58,8 thousand units). The greatest rates of gain have been by open box cars (70 %) and autorack cars (gain almost in 3 times - to 1000 units).

Since 2005, carriers more often purchase cars by leasing schemes. And it concerns not only small private carriers not owning sufficient recourses for one-time purchase but also the largest player of the market - the Open Society "Russian Railways". Following the results of 2005, the initial stage of active development of leasing of rolling stock - the volume of the Russian market of leasing of railway transportation was estimated in $1.9 billion. Following the results of 2006, according to experts, this segment of the market has reached the amount of $4.2 billion, thus the gain by 2005 has made 121 % (the gain of all market of leasing - 42 %). It is estimated by participants of the market today approximately in $3 billion, (Kommersant 2007b).

According to the chief of department of leasing of the equipment of Open Company "Globus-leasing" Alexey Myatlik conducted researches of development of the market of leasing of railway transportation show high level of concentration: “For 20 % of the companies working in this market fall about 80 percent of all leasing transactions, - he says. - Main reasons for it are in large scale of transactions and high price competition” (Kommersant 2007b).

So we can see that demand for freight cars constantly increased with growth of requirement for transportations so the prices for all of them always grew that in its turn resulted in the final production cost and thereby stimulated inflation growth again. Now the number of owners of rolling stock already has reached almost 3 thousand; today in property of 2292 companies there are 533 thousand cars. Among them there are 13 companies, each of which owns fleet of more than 5000 units. 65 companies own from 1000 to 5000 cars, 61 companies has fleet from 500 to 1000 units. 245 companies have from 100 to 500 units. Other companies own less than 100 cars.

As a whole the rate of private rolling stock in the common fleet already exceeds 50 %. Dynamic growth of number of private freight cars (which turnover considerably lags behind from inventory ones owing to a longtime location on uncommon rails) and also more intensive operation of inventory park of the Russian Federation by other railway administrations by increase in requirement for transportations create deficit of loading resources in the market. Besides, inconsistency of actions of the operator and the sender, on the one hand, and the operator and the carrier, on the other hand, leads to the raised loading of common railway infrastructure.

Against the background of growing prices, appreciation of the daily rent rate and leasing payments all abovementioned factors have led to that now possibility of granting of reduced rates to clients, nearly the only competitive advantage of operator companies, has run its course. The size of discounts from the tariff of Russian Railways became ever less and balanced in the range from 1 % to 5 %. As the experience shows, recently independent transport companies transport cargoes at the rates by 10 %-15 % exceeding tariffs of Russian Railways, in view of increasing transport expenses and ever growing prices for rolling stock. And such margin seemed unjustified to consumers of their services. After all the state carrier is not always capable to offer senders the kind of cars necessary to them and to provide transportation of cargoes on a required route in the set terms. Besides, private companies are more loyal to their clients. In particular for idle time of cars the Open Society "Russian Railways" imposes penalties on the enterprises whereas independent operators concern such violations much more indulgently. Also it is impossible to forget about the process shady side: using rolling stock deficit, for priority granting of cars of the Russian Railways fleet officials often take additional payment from the enterprises, which finally is imposed on the buyer of products. Thus, with growing ambitions of separate structures and different "layers" making money from nothing the final product cost grew unreasonably. In meantime, the buyer of such production started to search for alternative - more comprehensible price; in this connection manufacturers had failures of sales, long-term contracts of delivery were terminated.

Such tendency can be observed on an example of several last months of work of the Kemerovo AZOT, the largest in the country supplier of mineral fertilizers. Even in the spring of 2008 volume of transportations of ammoniac saltpeter only at the station of North Caucasian railway was about 400 cars per month, the enterprise was in great need of rolling stock; even cars of the Russian Railways fleet were insufficient for satisfaction of requirements of the plant. Small companies which practically did not have their own fleet quickly reacted to the situation; using sharp shortage of the cars, they managed to conclude with AZOT contractual relations on too favorable conditions, thereby imposing directly to operators owning rolling stock their "rules of the game". This resulted in artificial saltpeter overpricing which has immediately led to response from buyers - practically all agricultural enterprises of the North Caucasian region rather quickly have found an alternative, factory of mineral fertilizers in Kirovo-Chepetsk. Naturally, such action has led to sharp decrease in sales of AZOT - the volume of transportations in region was cut at first by half, then and has fallen practically to zero. Today the enterprise had to almost completely reorient to deliveries

in its own region. It is clear, that such sudden redistribution of material flows has caused release of considerable transport resources - more simply, there was a surplus of cars in the region, many companies-carriers (tenants and proprietors of rolling stock) had considerable losses as they practically had to search loading for their fleet park.

Unfortunately, the wave of sharp decrease in volumes of the manufacture, connected with unfairly overestimated cost of transport services coincided with the current crisis of the world financial system. In the developed conditions change of basic principles of interaction of the Open Society "Russian Railways" as a carrier with other participants of the transport market of freight traffic is required.

There is a necessity of change of operating standard base, creation of a legal basis for development and introduction of new methods of the organization and regulation of loading resources for the purpose of meeting of demand of all cargo owners for transportations. Undoubtedly, constant growth of private fleet demands revision of traditional technologies of management by loading resources and solving of the big number of the arisen questions. In new conditions efficiency of the centralized regulation of car fleet has decreased considerably, it becomes impossible to provide cargo orders in due time. New forms of coordination and interaction of a carrier, operators and proprietors of rolling stock, introduction of new management methods by car fleet and systems of assessment of efficiency of transportation process are required. But it should be stressed that transport business should be built not only on financial benefit but also on meeting of transport requirements of the state, observance of the uniform technology of transportations, mutual obligations and responsibility.

Reforming of the tariff policy is also necessary and it is perhaps the most urgent problem of railwaymen. The Open Society Russian Railways is the only transport company in the country which provides socially-significant transportations at its own expense. Having inherited since the Soviet period the vicious scheme of cross financing of socially-significant kinds of activity at the expense of profitable transportations, the Russian Railways basically restrain both interests of the company, and national economy as a whole. It is a question not only of financing of the unprofitable passenger complex, but also of socially-significant freight traffic which also do not bring the company anything except losses.

How and when this problem knot will be cut - the financial condition of the Open Society Russian Railways will depend on it; apart from this, the company should also find recourses for investment projects: modernization of rolling stock and infrastructure. The possible solution of the problem of cross subsidies is in use of target subsidies to cargo owners strategically important for the state: to the coal industry, agriculture, power. Thus it is

important to establish that level of freight rates which will economically reasonable; yet growth of cargo rates considerably concedes both to the rate of inflation and dynamics of appreciation of industrial products.

It is necessary to pay special attention to companies emerging in the market of transport services calling themselves carriers but in fact they perform just mediatorial function, don't have their own fleet and offering to manufacturers their services thereby stimulating unjustified growth of prices. It is necessary to introduce strict criterion of responsibility of the operator companies to senders, the latter in their turn should be more careful in choosing of the operator, we should probably bring into practice carrying out of tenders for rendering of transport services with exactly specified and proved price limit.

Ideally there is such a scheme of work of the system "manufacturer-transportation-buyer" in which the enterprise itself is the proprietor of rolling stock. Then all objectively arising costs will be reflected in production cost which should prevent or, at least, curb growth of the price of the final product for consumer.

Certainly, it is connected with a number of problems: enterprises, as a rule, have no own logistical system, for competent management of transportation processes qualified experts are required, there is no adjusted interaction with receivers for implementation of the scheme of rolling stock return, there is no repair base and information support. All these problems should not exceed ability of the operator company, that is why there is an urgent question of choice of the most competent and reliable company which is able not only to solve these problems, but also to take active part in development of conceptually new individual customer-focused logistical schemes.

In this situation it seems to be the most profitable to the operator company in the conditions of surplus of private cars to set a goal to reduce the fleet to the threshold value established by market situation. The effective remedy for overcoming the crisis is long-term leasing of cars directly to enterprises. It is supposed that it should solve several problems at once: first, it will allow the operator company to release resources for search of partners most resistant to the crisis, to develop a constant, probably ringed scheme of work of own cars adjusted for an individual customer; secondly, to lower risk of the company merger - buying of its park for nothing by larger or state companies; thirdly, to provide the enterprise manufacturing products of the national value (coal, wood, grain, flour etc.) with rolling stock, guaranteeing stable and constant level of free transport; fourthly, with correct and quick reaction to sudden reduction of demand for rolling stock, in due time to occupy free market

niches preventing other companies from withdrawing their fleet, so to make them lower unfairly overestimated rent rates and prices for railway cars.

4. Development Prospects

All above suggested measures should not imply termination of activity and complete disposal of fleet, it is a question only of change of the quantitatively-focused direction of activity by qualitatively new approach to operator company work - providing of wider range of services: information support and forwarding, realization of a full cycle of transportation of products of one enterprise, development of projects for a specific transport problem. There is full scope for perfection of work of operator companies, search of essentially new innovative logistical solutions, improvement of quality of provided transport services, implementation of personnel potential of the companies.

Probably, the current crisis to a certain extent will be an incitement to transition to a new stage of development for many operator companies by leaving really strong players in the market of transport services and will serve as the next step of evolution of all market economy as a whole.

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Appendix

The structure of fleet of the Open Society ", First cargo company" is as follows:

- open box cars - 48,1 thousand, or 13,2 % from the Russian fleet of open box cars (total 362 thousand);
- tanks - 47,5 thousand, or 20 % from the Russian fleet of tanks (237 thousand);
- cement carriers - 16,0 thousand, or 46 % from the Russian fleet of cement carriers (35 thousand);
- platforms - 12,7 thousand, or 19,5 % from the Russian fleet of platforms (65 thousand);
- covered cars - 4,2 thousand, or 5 % from the Russian fleet of covered cars (82 thousand);
- mineral carriers - 3,6 thousand, or 8,8 % from the Russian fleet mineral carriers (41 thousand);
- grain carrier - 2,8 thousand, or 8 % from the Russian fleet of grain carriers (35 thousand)

Research Note: Company Colors Teks – Case Study

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1. About the Company

Company Colors Teks, being one of the biggest lacquer-color manufactures in Russia, is a member of Finnish Group of Companies Tikkurila. Tikkurila was founded in 1862. It develops, manufactures and markets colors and coverage for public as well as for construction and industry. Today Tikkurila has manufacturing facilities in seven European countries and trade companies in eight other countries and occupies a leading place in North and East Europe. The manufacturing and distribution network of Tikkurila in Russia and Europe is having appropriate presence. Tikkurila is a part of international chemical Concern Kemira.

Household and general construction colors of Tikkurila are produced under following brands: Tikkurila in Finland, Poland and Russia, Teks in Russia, Alcro and Beckers in Sweden and Vivacolor in Baltic States. Also rather well-known local brands are: Finncolor in Russia, Colorit in Ukrain, Polifarb Debica in Poland and Pigrol in Germany.

Table 1. Key characteristics of Tikkurila

	2007	2006	2005
	M €	M €	M €
net sales	625	563	458
costs	-534	-474	-387
depreciation	-18	-17	-15
trading profit	73	72	56
trading profit, %	12	13	12
net assets (average)	311	310	283
return on net assets	24	23	20
investments	49	47	18
personnel	3789	3494	2272

Tikkurila bought the Colors Teks in year 2006. Colors Teks manufactures 9 groups of lacquer-color materials: water-dispersed colors, alkyd enamel, special enamels, alkyd and water-soluble lacquers, fillings, clearcoles (pads), antiseptics, glues and oil colors. Company's maximum product volume is equal to 15000 ton of lacquer-color materials per month. Products manufactured by the concern, are characterized by: high quality, environmental safety, reliability and convenience in usage. Brand TEKS products are manufactured by up-to-day technological equipment of leading world companies: Netzsch (Germany) and Oliver Y Battle (Spain) with use of the best import and domestic raw materials.

Company quality management system is certified by the firm Det Norske Veritas according requirements of international standards ISO 9001:2000. Company quality management system homogenizes all company processes, beginning from R&D of new products and ending by storage of finished goods.

2. Manufacturing and Marketing Network

The company Colors Teks has plants in Saint-Petersburg and Stary Oskol (Belgorod Region). In the nearest future would be opened new plants at Ural and Siberia. The company has rather developed distributing net, which covers all regions of Russian Federation, and also Lithuania, Latvia, Kazakhstan, Kirgizia, Uzbekistan, Ukraine, Belorussia and Moldova. Headquarter office is located in Saint-Petersburg, there is also subsidiary office in Moscow. Sales representatives are working in more then 50 large cities in Russia. The company is a partner of the largest European constructing hypermarket nets: OBI, Marktkauf, Leroy Merlin. In total more than 6000 entities are permanent trade partners of the company. Developed distributing net conduced to a situation, when in Russia now every second constructing company is using lacquer-color materials produced by Teks.

Every company included in concern Tikkurila has its own departments responsible for logistics. At Colors Teks two divisions are responsible for logistics: transport division and logistics division. Transport division serves departments, which are responsible for raw materials and components supply at manufacturing. Task of the transport division is creation of supply chains: searching for and selection of logistic providers, evaluation of transportation manner (transport mode, type of conveyance), tracing and tracking etc. Logistics division serves merchandising departments and is responsible for creation of marketing logistics chains, supplying well-timed transportation of finished products to the regions.

Colors Teks is using following transport modes in its supply chains: motorway, maritime and railway. The most frequently used are motorway vehicles. This transport mode is used for carrying import materials and for transportation of finished goods in regions. Merits of its usage are: easiness of loading-unloading, customs operations are simpler, tracing and tracking is rather essential, easier to find vehicles. Maritime transport is used for finished goods transportation as well as raw materials transportation.

Today Colors Teks uses railway transport only for carrying chalk from the central part of Russia to its plants in Saint-Petersburg and Stary Oskol. For import and finished goods transportation usage of railway transport was canceled due to its insufficiency. Reasons of railway transport discommodities arise e.g. from difficulty to find free cars (vans) during peak seasons (spring-summer) and complicated van order procedure. Furthermore, the Saint-Petersburg plant does not possess railway lay-by, so additional loading-unloading incurring extra costs would be needed. Additional difficulties arise from frequent underloadings and low cargo safety on route, difficulty of tracing and tracking on route, long time of delivering, customs arrangement problems and problems with custom clearance. Obviously, partly the problems of railway transport usage are caused mainly by poor technical organization of railway transportation and peculiarity of customs arrangements.

The raw materials (pigments and other colour components) to Saint-Petersburg are received mainly from Belgium, India and Russia. From Finland it comes boxing and special packing. It is interesting to notice, that Colors Teks and Finnish departments of Tikkurila company have different suppliers of raw materials and components. It is explained by differs in purchasing strategy in Russia and in Finland. Finnish management looks to work with reliable and tested suppliers, mainly with Finnish ones. The most important criteria for them it is material's quality and delivery time. Russian department is forced to search cheaper materials for supporting competitive level of market prices. As a result, they receive no more then 15% of raw materials from Finland. Deliveries from Finland come from Vantaa, located in Southern Finland. Trucks and FIN-pallets are used for transportation. The cargo from Vantaa consists mainly from cans of different volume for packing of finished products. During peak season (April-August) 3-5 trucks with can's cargo arrive every week. During the rest of the year the transportation volume is reduced to 1-2 vehicles per month. The main problems of delivering from Finland are the delays of cargo at Russian Customs caused by low competence of custom's staff. As a result the company tries to avoid foreign suppliers and looks for deliveries from inside Russia.

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