Olli-Pekka Hilmola (ed.)

Fourth International Railway Logistics Seminar: Co-operation among Transportation Modes in Northern Europe

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Fourth International Railway Logistics Seminar: Co-operation among Transportation Modes in Northern Europe

Olli-Pekka Hilmola (Editor)

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Foreword

Growth of transportation in global economy has been impressive – based on different statistics of United Nations, our transportation is growing more than ever as compared to global GDP growth. Latest World Bank railway statistics on the other hand show that enlarged European Union is still seriously lacking behind in railway transports, indicating that only 5 % of railway freight traffic in the whole world context is transported in this area. This finding gives further support for the fact that European economy is increasingly dependent on road transports, its higher CO_2 emissions, and oil imports. However, in the longer-term perspective this can not be the applied model, and therefore increasingly more collaboration is required within and between different transportation modes. In this research meeting we are discussing from different perspectives how collaboration between transportation modes, actors and institutions could be enhanced. Overall from the research publications included in this volume, we could say that logistics is a branch of increasing volumes, resource addition, and new technology development (management and hardware).

This is our third time to arrange international research seminar at Kouvola, Finland (one occasion we had it in Moscow, Russia) – amount of participants has increased during the years, and we are delighted to have participation from surrounding countries within the Baltic Sea Region. During this year our seminar gets significant financial support from research project called Lognet (Development of Logistics for Supplier Net Models), which is European Union Tacis program funded two-year research effort among Lappeenranta Univ. of Tech. / Kouvola Unit, Innorail Development, St. Petersburg State Transport University as well as non-profit organizations of Ilot and Protey (both located in St. Petersburg). We would like to give our sincere thanks for EU giving us an opportunity to work on intermodal transportation issues in the border-region, and among area of industrial supplier networks.

Finally I would like express our gratitude for the city of Kouvola of arranging this research seminar among larger Innorail meeting – this two day event facilitates the exchange of knowledge and ideas as well as gives us good opportunity to develop future intermodal transportation systems further. I would also like to express sincere thanks for Tarja Mustonen-Udd and Ville-Veikko Savolainen from assistance in arrangements of this event.

In Kouvola, Finland May 2008,

Olli-Pekka Hilmola

Prof. (act.), Docent, PhD

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Differentiated Supply Chain Strategy – Building Knowledge through Case Studies

Per Hilletofth

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Abstract
Supply chains satisfy customers by striving for delivering the right products to the right place at the right time, at the right quality and at the right quantity within an increasingly faster pace and lower cost. One implication that can be made from this is that the nature of markets is the point of departure in both supply chain design and operations. Given that organizations usually offer a wide range of products and services with different supply and demand characteristics, one could argue that organizations conduct business in various types of non-coherent business environments. There has been a recognition that 'one-size-fits-all' supply chain strategies only satisfies a limited number of business environments, and that it is increasingly necessary to develop a differentiated supply chain strategy – including several differing supply chain solutions – to satisfy all major product/market segments in a better way. This paper employs a descriptive multiple case study approach to illustrate how two case companies has – or plan to – develop a differentiated supply chain strategy. Case study findings reveal that one efficient way to develop a differentiated supply chain strategy is to combine different manufacturing and delivery strategies into various supply chain solutions. By combining relatively few supply and delivery methods it is possible to develop several differentiated supply chain solutions.

Keywords: Supply chain management, strategy, differentiation, postponement

1. Introduction

One of the more interesting debates in recent years concerning supply chain strategy has centered on the ability of the supply chain to be either "lean" (Womack and Jones, 1996) or "agile" (Goldman et al., 1995). The idea of lean manufacturing has been described by Womack et al. (1990). Later this idea was expanded into the wider concept of "lean thinking" by Womack and Jones (1996). The focus of lean thinking has essentially been on the reduction or elimination of waste, also known as *muda* (Christopher and Towill, 2001). The origins of the lean approach can be traced to the Toyota Production System (TPS) with its focus on the efficient use of resources through level scheduling (Ohno, 1988). Lean thinking, or leanness, from a supply chain perspective means "developing a value stream to eliminate all waste, including time, and to enable a level schedule" (Naylor et al., 1999). This could for instance involve reduction of inventories, reduction of lot-size, reduction of the supplier base, evaluating suppliers based on quality and delivery performance, establishing long-term contracts with suppliers, and elimination of paperwork (de Treville, 2004). It has been suggested that lean principles are applicable in markets where demand is relatively stable and therefore predictable and where variety is low (Christopher, 2000).

On the contrary, in those markets where demand is volatile and customer requirement for variety is high, a much higher level of agility is required (Christopher, 2000). Agility is concerned primarily with responsiveness. It is about the ability to match supply and demand in volatile and unpredictable markets. Essentially, it is about being demand-driven rather than forecast-driven. Gunasekaran (1998) has defined agility as the ability to respond to market changes in a cost-efficient and profitable manner whilst Christopher (2000) has been defined agility as “a business-wide capability that embraces organizational structures, information systems, logistics processes and in particular, mindsets”. Thus, it could be argued that agility concerns the utilization of market knowledge and a responsive organization to exploit profitable opportunities in a volatile market (Naylor et al., 1999). A key characteristic of an agile organization is flexibility (Christopher, 2000). Certainly, the origins of agility as a business concept lie partly in Flexible Manufacturing Systems (FMS), which through automation (i.e. reduced set-up times) tries to enable rapid changeovers and as a result create responsiveness to changes in product mix and volume (Christopher and Towill, 2001). Later, this idea of manufacturing flexibility was extended into the wider business context by Nagel and Dove (1991), and the concept of agility as a supply chain paradigm was born. The focus of improvement efforts in the agile approach is on integrating the information flow across the supply chain with the objective of creating a market-responsive supply chain that responds quickly to unpredictable demands to minimize lost sales, forced markdowns and obsolescent inventory (Mason-Jones and Towill, 1999; van Hoek, 2000). A market-responsive supply chain emphasizes market mediation to a greater degree than the role of ensuring efficient physical supply of the product (de Treville, 2004). This requires reduction of process and information lead times throughout the supply chain (Mason-Jones and Towill, 1999). It includes coordinated planning, improved communication, and increasing access to demand information throughout the entire supply chain (de Treville, 2004).

Although lean and agile approaches are often discussed as opposing paradigms, they share a common objective: meeting customer demands at the least total cost (Goldsby et al, 2006). It is in terms of the characteristics of this demand and the basis of meeting customer demand that the two approaches differ (Goldsby and Garcia-Dastuage, 2003). In recent tears, numerous researchers have suggested that the lean and agile approach can be integrated into a variety of ways to create so-called "leagile" strategies (e.g. Naylor et al., 1999; Childerhouse and Towill, 2000; Mason-Jones et al., 2000a; Mason-Jones et al., 2000b; van Hoek, 2000; Christopher and Towill, 2001; Stratton and Warburton, 2003; Mistry, 2005). Thus, it is not really a question of lean or agile rather it is the thoughtful selection and integration of suitable aspects of these paradigms appropriate to the specific supply chain strategy (Christopher et al., 2006).

Naylor et al. (1999) created the term "leagile" to refer to hybrids of the lean and agile approaches. Based on this merged strategy Christopher and Towill (2001) visualized three distinct lean-agile hybrids. The first lean-agile hybrid is founded on the Pareto Rule, recognizing that 80% of a firm's revenue is generated from 20% of products. It is suggested that the dominant 20% of the product assortment can be managed in a lean MTS manner – given that demand is relatively stable for these items and that efficient replenishment is the appropriate objective – while the remaining 80% can be managed in an agile manner (Goldsby et al, 2006). The second lean-agile hybrid is founded on the principle of base and surplus demand, recognizing that most companies experience a base level of demand over the course of the year. It is suggested that the base demand can be managed in a lean manner while demand peaks over the course of peak seasons or heavy promotion periods can be managed in an agile manner (Goldsby et al, 2006). The third lean-agile hybrid is founded on the principle of postponement (Goldsby et al, 2006). Postponement means that certain supply chain activities (e.g. logistics and manufacturing activities) in the supply chain are postponed until customer orders are received (Pagh and Cooper, 1998). In other words, one decides which activities should be perform after orders are received and focus on responsiveness (i.e. agile, order-driven and customized) and which activities should be perform before orders are received and focus on efficiency (i.e. lean, planned and standardized).

In recent years there has been a recognition that the traditional 'one-size-fits-all' supply chain strategies (i.e. either a lean, agile or a hybrid strategy) only satisfies a limited number of customers or business environments since firms usually offer a wide range of products and services with differing supply and demand characteristics (Shewchuck, 1998). Consequently it is of growing importance to develop a differentiated supply chain strategy.

This research employs descriptive multiple case study approach to illustrate how case companies has, or plan to, develop a differentiated supply chain strategy. The research objective is to provide an increased understanding of how different manufacturing stratgies such as Make-To-Stock (MTS), Assemble-To-Order (ATO), Make-To-Order (MTO), and Engineering-To-Order (ETO) are used in contemporary manufacturing related supply chains. However, this paper will also investigate how these manufacturing strategies are combined with different delivery strategies such as factory direct, self collect and home delivery to truly differentiate the supply chain strategy. The overall purpose of this paper is to contribute to the understanding of supply chain design. The main emphasis has been on producing descriptive results of the studied phenomenon. The primary research approach consists of two case studies, which was considered an appropriate approach in order to tap in-depth data. The first case company (Alpha) is a Swedish manufacturer operating on international basis in the enterprise telecommunications industry. This case was strengthened with another case study (Beta), concerning a Swedish manufacturer operating on international basis in the appliance industry.

The remaining of this paper is structured as follows. In Section 2, different supply chain strategies based on the concept of postponement is presented and discussed. Thereafter, Section 3 presents and discusses research approach and data collection. Section 4 presents case study findings which reveal that one efficient way to develop a differentiated supply chain strategy is to combine different manufacturing and delivery strategies into various supply chain solutions. In the Section 5 research is discussed. Finally research is concluded and further research avenues are proposed.

2. Literature Review: Different Supply Chain Strategies Based on Postponement

The concept of postponement was first introduced by Alderson in 1950 (Alderson, 1950), who noted that postponement can change the differentiation of products (form, identity and inventory location) to as late a time as possible, and thus improve the efficiency of a distribution system. Later, these ideas were expanded by Bucklin (e.g. Bucklin, 1965; Bucklin, 1966). The foundation of postponement is that risk and uncertainty costs are linked to the differentiation of products that occurs during the activities in the supply chain (Bucklin, 1965), and that these costs can be reduced, or fully eliminated, be postpone certain activities (e.g. logistics and manufacturing activities) in the supply chain until customer orders are received (Pagh and Cooper, 1998). In other words, one decides which activities should be performed after orders are received and focus on responsiveness (i.e. order-driven and customized) and which activities should be performed before orders are received and focus on efficiency (i.e. planned and standardized). This implies that companies can finalize/customize the product in accordance with specific customer preferences (van Hoek, 2001; Yang et al., 2004) and at the same time achieve cost-efficiency, thus postponement can help firms achieve mass customization (Feitzinger and Lee, 1997; van Hoek et al., 1998; van Hoek et al., 1999).

Postponement increase the firm's ability to fine tune products to specific customer wishes (Hoek et al., 1998). Furthermore, it significantly reduces inventory carrying, warehousing and obsolescence costs (van Hoek et al., 1998). However, it should be noted that postponement may lead to smaller sized shipments over longer distances (van Hoek, 2001). Consequently postponement is often more relevant when products are more sensitive to inventory than transportation costs (e.g. higher value added products with large product variety). Moreover, lead-time constraints in the supply chain could limit the possibility to perform postponed activities while still assuring delivery according to customer required lead-time (Bucklin, 1965; van Hoek, 1997; van Hoek, 2001).

Postponement strategies can be applied to form, time and place (Hoek et al., 1998). Form postponement (or manufacturing postponement) means that companies delay production, assembly, or even design until after customer orders have been received (Bowersox and Closs 1996). Time and place (or logistics postponement) means that the forward movement of products is delayed as long as possible in the chain of operations and that products are kept in storage at central locations in the distribution chain (Bowersox and Closs 1996).

During recent years the use of postponement principles in the industry has increased. Numerous European industrial companies are currently implementing postponed supply chain systems (Hoek et al., 1998). These systems combine the three types of postponement: customization of products is delayed until products are ordered (form postponement), and the distribution of products is delayed as long as possible (time postponement), and products are stored at central locations (place postponement). Below logistics and manufacturing postponement are described in more detail.

Logistics postponement

Traditionally products are stored close to customers and distributed through a decentralized distribution system, including international, national, and local inventories. The purpose of logistics postponement is to maintain a full-line of anticipatory inventory at once or a few strategic locations (Bowersox and Closs 1996). This means to postpone inventory location downstream in the supply chain to the latest possible point (Bucklin, 1965). This means that the forward movement of products is delayed as long as possible in the chain of operations and that products are kept in storage at central locations in the distribution chain (Figure 1). In other words, the Customer Order Point (COP) is moved upstream the supply chain. The COP is the point in the supply chain where the customer order penetrates and that distinguishes forecast and order-driven activities, i.e. where real demand penetrates upstream the supply chain or where the strategic inventory is stored (Ericsson, 2003).

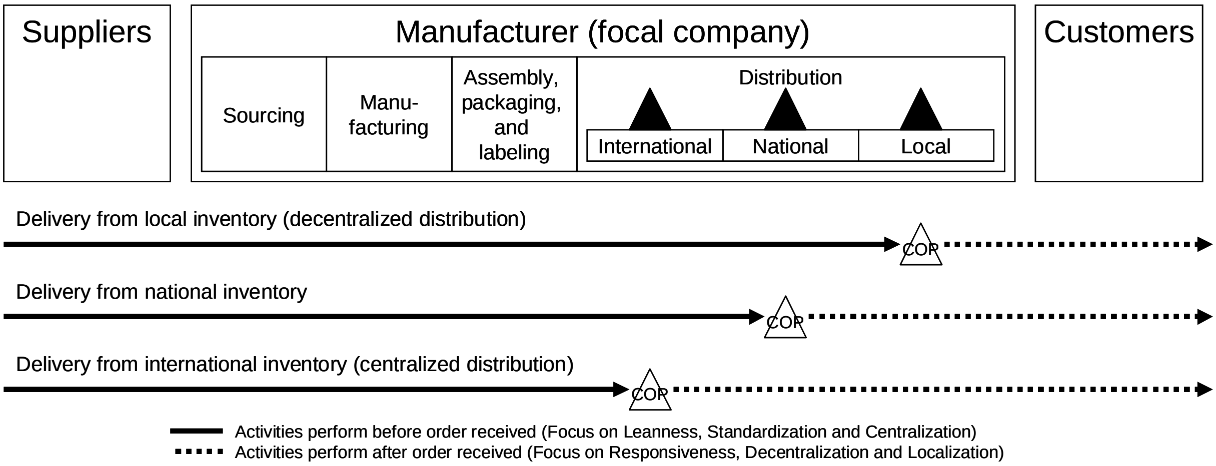


Figure 1. Different logistics strategies based on postponement of the customer order point (cop) upstream the supply chain.

The major reason to postpone logistics operation upstream the supply chain is cost-reduction (Yang et al., 2004). Logistics postponement allows a company to delay the decision where inventory should be finally located, thus significantly reducing the risk of wrong time and place utility of products (Bowersox et al., 1993). Further benefits of logistics postponement are reduced inventory levels in the supply chain as well as improved customer responsiveness (Yang et al., 2004).

Manufacturing postponement

Traditionally companies, based on forecasts and speculations, perform all manufacturing activities – including design, sourcing, manufacturing, assembly, packaging and labeling – before they have received any customer order (Zinn and Bowersox, 1988). Depending on whether the company employs logistics postponement these are either stored at local warehouses or at central warehouses.

The purpose of manufacturing postponement is to retain the product in a neutral and non-committed status as long as possible in the manufacturing process (Bowersox and Closs 1996). This means to postpone differentiation of form to latest possible point (Bucklin, 1965). This means that companies delay sourcing, production, assembly, or even design until after customer orders have been received (Figure 2). This allows firms to separate the customization of products from the primary manufacturing of standard products or generic modules (van Hoek et al., 1998). This separation frees primary manufacturing to focus more on large economical runs (i.e. leanness), while secondary or final manufacturing can be focused on responding to customer needs (i.e. responsiveness). Consequently, this postponed manufacturing system simultaneously enhances customer service and efficiency (van Hoek et al., 1998).

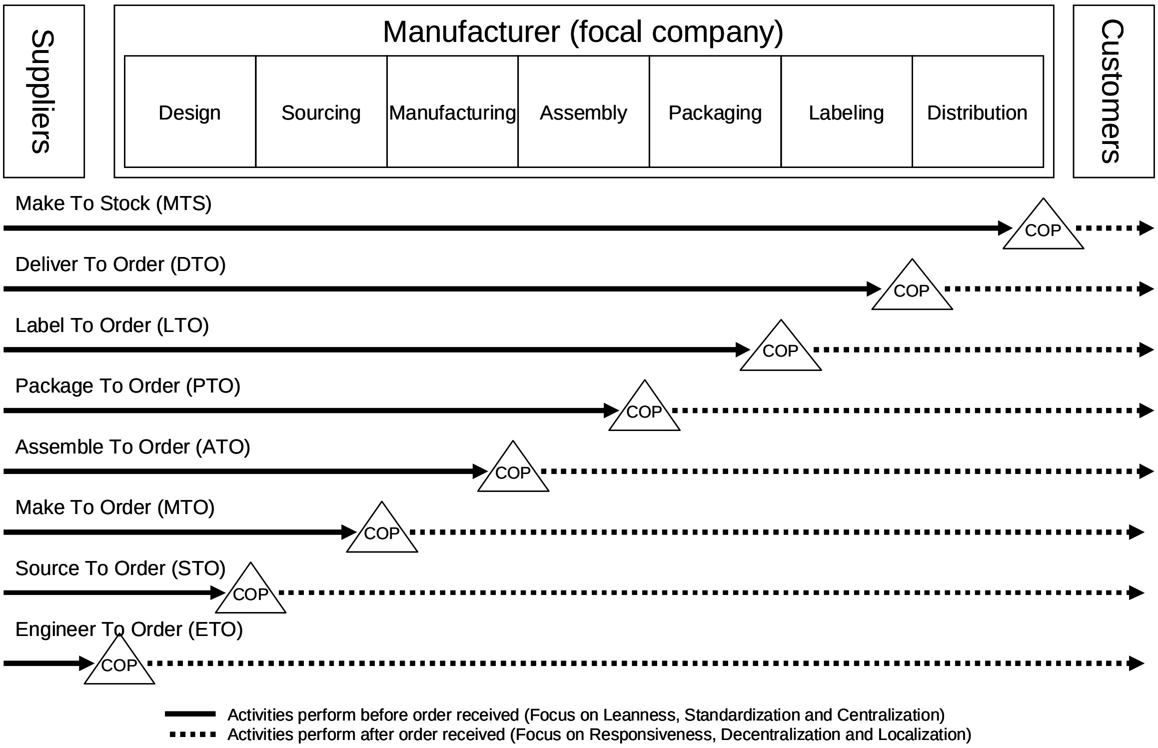


Figure 2. Different manufacturing strategies based on postponement of the customer order point (cop) upstream the supply chain.

There are several advantages of postponed manufacturing (van Hoek, 1998). Firstly, inventory can be held at a generic level resulting in fewer stock-keeping variants and hence less inventory in total. Secondly, because the inventory is generic, its flexibility is greater, given that the same components, modules or platforms can be embodied in a variety of end products. Thirdly, forecasting is easier at the generic level than at the level of the finished item. Finally, the ability to customize products locally means that a higher level of variety may be offered at a lower total cost, enabling strategies of “mass-customization” to be pursued.

In order to succeed with manufacturing postponement a reliable supplier network that can supply parts and services is necessary (Feitzinger and Lee, 1997). Furthermore, it is important to consider product families and explore the commonality/modularity of products and processes to find generic modules or platforms that can be embodied in a variety of end products (Zinn, 1990). However, it is important to note that too much standardization can reduce product differentiation, leading to a cannibalization effect (Swaminathan, 2001).

As could be noted, the application of postponement in manufacturing is a logical extension of implementing logistics postponement while postponement in sourcing and design are logical extension of implementing manufacturing postponement (Battezzati and Magnani, 2000). This means that the scope of postponement has expanded from logistics through manufacturing to the entire supply chain (Yang et al., 2004). Postponement can occur along the entire supply chain, from design to final distribution. It can be applied to a minor or a major share of the activities in the supply chain. Companies should first consider every postponement opportunity along the supply chain and then balance the trade-offs not from an individualistic perspective but from a supply chain perspective (Yang et al, 2004).

3. Research Approach and Data Collection

In this study it was considered that due to the fact that the paper investigated described logistics systems used by companies in a qualitative manner to enhance current knowledge of a differentiated supply chain strategy, inductive approach would be an appropriate research strategy (Eriksson and Wiedersheim, 1999). Moreover, due to the context-bound nature of the studied phenomenon, case studies would be an appropriate method (Bonoma, 1995). Thus, this paper employed a descriptive embedded multiple case study (Yin, 1994). The first case company (Alpha) is a Swedish manufacturer operating on international basis in the enterprise telecommunications industry. This case was strengthened with another case study (Beta), concerning a Swedish manufacturer operating on international basis in the appliance industry.

One advantage with case studies is the possibility to combine several data collection techniques (Yin, 1994). In this paper empirical data was collected from various sources to enhance understanding by examining the research object from several perspectives. Data collection techniques incorporated in this study was interviews, documents and workshops. Both the case studies are based mainly on data gained from in-depth interviews with key persons representing middle management in the case companies. In addition a number of internal (i.e. annual reports and technical reports) and external documents (i.e. industry reports) were included to get information on both the industries and the case companies' backgrounds. Moreover, a number of workshops including both major customers and the case company were used as data collection techniques in the first case study. The collected data has been analyzed by primarily using the principles of pattern-matching and explanation-building (Yin, 1994).

4. Case Studies

Case: Manufacturer Alpha

Manufacture Alpha is a Swedish manufacturer operating on international basis in the enterprise telecommunications industry. Their supply chain is displayed in Figure 3. The customer box in the figure can be separated in to sales partners, resellers and end-users. Alpha conduct business with sales partners and some resellers wile sales partners conduct business with resellers and end-users. Likewise the supplier box can be separated into several tiers of suppliers. As could be noted Alpha has chosen to outsource the manufacturing, assembly, warehousing and distribution operations in the supply chain.

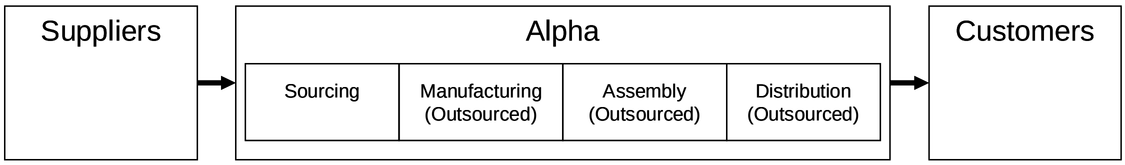


Figure 3. Alpha’s supply chain

Alpha aims to be the easiest supplier for sales partners to work with. Their goal is to deliver complete orders reliably directly to end-users anywhere in the world, in competitive fixed lead-times at competitive costs. Alpha regard customer service and effective management of the supply chain operations (i.e. supply chain management, SCM) as the two most important issues to achieve this.

There are several factors driving Alphas focus on customer service and effective management of supply chain operations. Firstly, their change in channel strategy from direct channels (own market units) to indirect and independent channels (sales partners) requires a change in the way customer are serviced and the supply chain managed. Secondly, their move towards e-business applies new pressures to the supply chain through new methods of order handling and increased customer service levels, such as shorter order confirmation and lead-times and improved delivery service. Thirdly, Alpha’s product strategy is to sell a wide range of own labeled and OEM products to customers, implying that the supply chain needs to be designed to handle a wide and diverse range of products. Fourthly, Alpha’s vision is to capture a significant share of the high growth mobile enterprise market by building and selling a portfolio of mobile enterprise products. Alpha’s supply chain plays a crucial part to facilitate the achievement of this vision. Finally, costs must be reduced for Alpha to protect its margins and profitability in light of an ever-more-competitive enterprise communications markets.

Alpha has identified six major issues to deliver competitive customer service. Firstly, the most important aspect of supply is to be reliable, implying that the focus of supply is on building and maintaining the trust of customers. Secondly, customers prefer a single contact point that handles all their needs including product advice, ordering and queries. Thus, Alpha needs to have the same point of contact for all products and errands. Thirdly, there must be immediate answers/acknowledgements to question and strong customer communication and responsiveness. Fourthly, customers need to know the status of their orders throughout the order process, i.e. good visibility of order and delivery processes. Fifthly, customers need a simple service offering that is competitive, easily understood and can be communicated to end-users quickly. Alpha has created “fast track functions” or standard product configurations that can be more easily and quickly ordered and delivered to customers. Finally, the most frequent and significant feedback that Alpha receives from customers is the need to shorten lead-times. In addition, there is a need to harmonies lead-times across Alpha’s product range in order that customer orders with multiple products can be delivered in full, within short lead-times.

Alpha has identified four major issues to effectively mange the supply chain operations. Firstly, customer requirement are uncertain and can never be forecasted accurately. Therefore, the supply chain needs to be designed in a flexible way to meet changing demand patters and customer requirements. Secondly, inventory is a necessary part of achieving flexibility in the supply chain. However, inventory needs to be managed actively to ensure that inventory levels and content are optimal to achieve a balance between excellent customer service and at the same time high inventory turns. Thirdly, price competition is increasing as new lower margin products are introduced and the existing product range faces increased competition.

Consequently, the costs of all supply chain operations needs to be competitive. Finally, supplier management is a key activity since Alpha not performs any physical operations in-house.

Alpha's supply chain strategy is to "mange what matters", i.e. focus on managing those areas of the supply chain where they can add value. Consequently Alpha has chosen to outsource manufacturing, assembly, warehousing and distribution in order to reduce costs and maximize performance. Alpha regards robust supplier management – to monitor and manage supplier performance – as an important issue to maximize the advantages from outsourcing. In addition, it is very important to continuously examine opportunities for increased collaboration with key suppliers, i.e. suppliers that can help Alpha improve its supply chain costs, supply chain processes and customer service.

As shown in Figure 4, Alpha utilizes two types of supply chain strategies. For standard products with short customer required lead-time Alpha employ a Deliver-To-Order (DTO) strategy. This implies that Alpha, based on forecasts and speculations, perform all supply chain operations – including design, sourcing, manufacturing, assembly, packaging and labeling – before they have received any customer order and focus on efficiency (i.e. planned and standardized). On the contrary, for customized and more complex products and applications Alpha employ an Assemble-To-Order (ATO) strategy. This implies that the production processes are decoupled from the assembly/distribution processes, or in other words assembly and distribution activities are postponed until customer order are received (i.e. postponement). This separation allows customer order to be managed with rapid lead-times assuming that the appropriate sub-units are held in stock. The customer order point (COP) is the point at which the supply chain processes are decoupled. Activities perform after order are received (downstream the COP) are focused on responsiveness (i.e. order-driven and customized) whilst activities perform before order are received (upstream the COP) are focused on efficiency (i.e. planned and standardized).

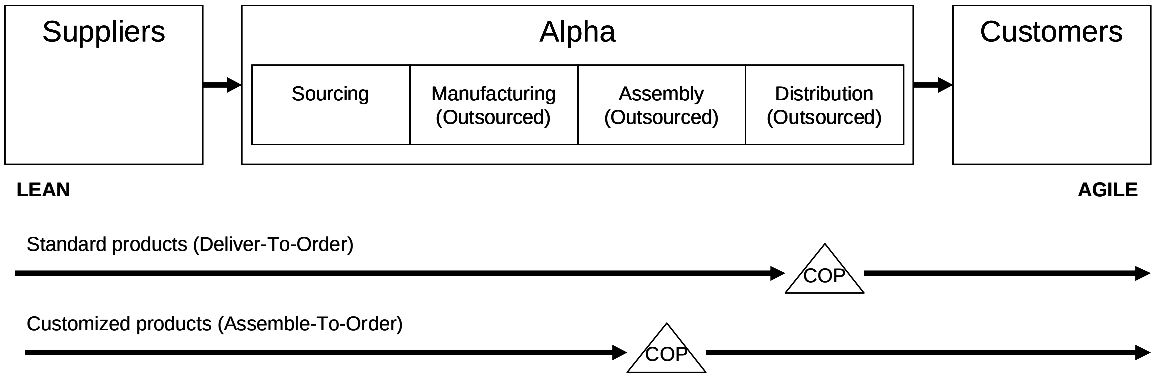


Figure 4. Alpha's current supply chain strategies

Recently, Alpha has sensed that there exists a need to differentiate the supply chain strategy since they feel that customer preferences regarding customer service differ significantly across markets and customers. In order to satisfy all major customer with differing preferences require several supply chain solutions, i.e. a differentiated supply chain strategy. Thus, Alpha recently has initiated a pilot project, in cooperation with the author, to identify the possible to develop a differentiated supply chain strategy by utilizing and combining different manufacturing and delivery strategies concurrently. So far Alpha has developed a segmentation model based on geographical location, type of customer and type of customer. In additional, Alpha has identified several supply chain solutions they could offer to the differing customers/products segments (Figure 5). Basically three main manufacturing strategies could be applied: deliver-to-order, assemble-to-order and source-to-order. These could be combined with several delivery strategies such as inventory direct, factory direct, drop shipment or cross docking. This implies that that one efficient way to develop a differentiated supply chain strategy could be to combine different supply and delivery methods into various supply chain solutions. By combining relatively few supply and delivery strategies it is possible to develop several differentiated supply chain solutions.

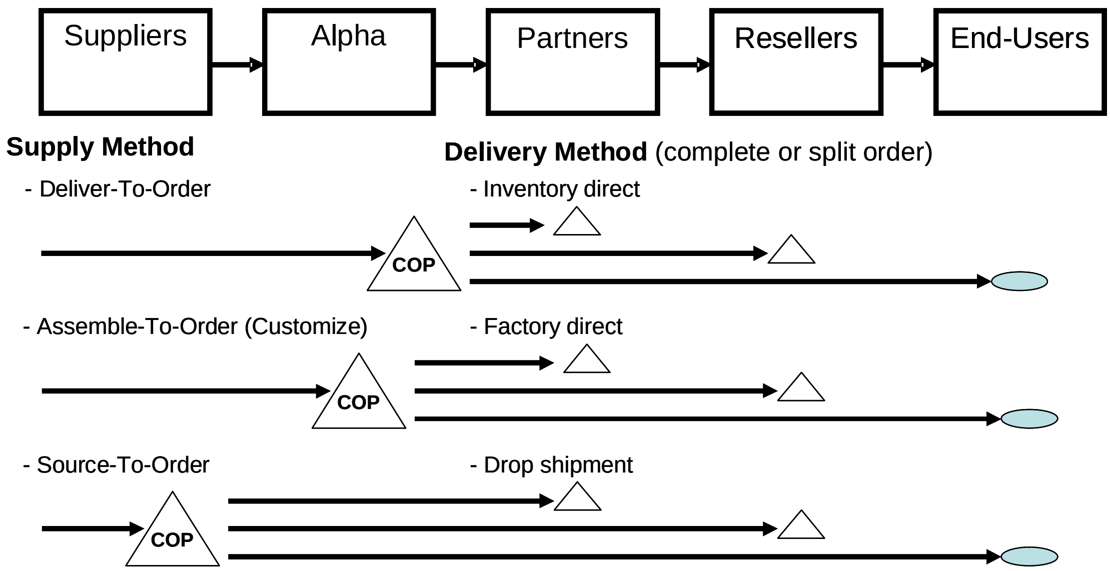


Figure 5. Potential supply chain solutions

Moreover, Alpha has discussed this topic with three of their major customers and identified that their customer indeed would appreciate differentiated supply chain solutions (Figure 6). Furthermore several supply chain issues have been identified. For example customers tend to stock-keeping same articles that Alpha are stock-keeping leading to unnecessary inventory in the supply chain and increased demand variability (often standard products ordered in high volumes periodically). Highlighted issues in order to realize a differentiated supply chain strategy are increased supply chain collaboration and demand and inventory visibility. Moreover, different supply chain solutions have different cost-to-serve. Thus, Alpha has to implement differentiated service prices. It is not clear how to realize this in practice.

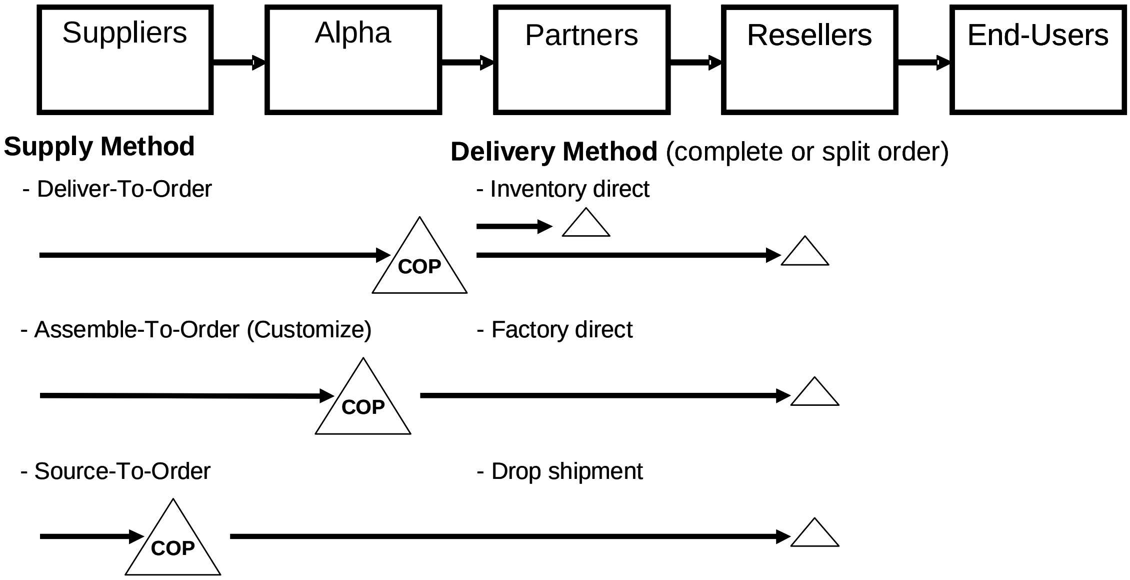


Figure 6. Customer desired supply chain solutions

Because this study has shown interesting results it presumably will be enlarged to include all major customers.

Case: Manufacturer Beta

Manufacture *Beta* is a Swedish manufacturer operating on international basis in the appliance industry. Their supply chain is displayed in Figure 7. The customer box in the figure can be separated in to retailers and end-users. Beta conduct business with retailers wile retailers conduct business with end-users. Likewise the supplier box can be separated into several tiers of suppliers. Beta has chosen to perform all manufacturing, assembly, warehousing and distribution operations in-house.

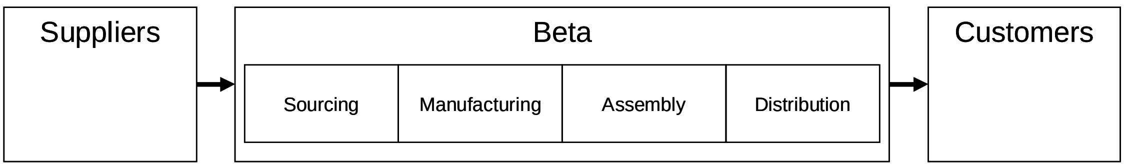


Figure 7. Beta's supply chain

Manufacturer Beta is working in an increasingly competitive industry characterized by intense competition, increased global product standardization, and shorter product life cycles. To survive in this new environment firms' needs to create a truly consumer-driven organization by focusing on consumer-oriented product development (to create an efficient and effective product flow), branding (to develop a strong global brand) and supply materials and products on demand (to create an efficient and effective demand flow, SCM).

The single most important factor to supply materials and products on demand is keeping the end-user and retailer needs in focus, it is therefore vital that the total supply chain, both production and distribution, is managed in a competitive way. To a large extent, success depends on whether the case company and their supply chain are as good as or better than the competitors. This requires supply chain collaboration, first internally then with the retailers and suppliers.

Manufacturer Beta's SCM has three major aims. Firstly, it aims to make sure that they deliver on time, as the first priority, however, it is also important to reduce unnecessary time which leads to Deliver On Time - In Less Time. Secondly, it is supposed to contribute significantly towards improving value creation. For example it aims to increase sales by making products available on time and to decrease costs and waste in the supply chain. Finally, innovation is critical to the success of new products, without new features based on consumer needs they will not be in a position to succeed in the market. However, innovation should not only be restricted to the products, it should also be applied to customer service since the case company offer retailers products and service. Their SCM can be separated into two sub-processes, i.e. supply chain design and supply chain operation, and focuses on meeting end-users needs while minimizing both the capital tied up in operations and the cost required to fulfill customer demand. In other words, their SCM concerns development and management of supply chains. Below the supply chain design part of SCM will be described in more detail.

The supply chain design step is planning activity consisting of three steps, firstly the case company identify how their end-users via retailers would like to acquire their products (i.e. understand the market they serve). This is achieved through consumer insight where major information that can affect their service to the retailers is collected. Retailers have a number of characteristics that need to be considered before deciding how to serve them, such as:

§ *Product Range*: which products does the retailer purchase?

§ *Lead-Times*: which lead-times does the retailer require for the demanded products?

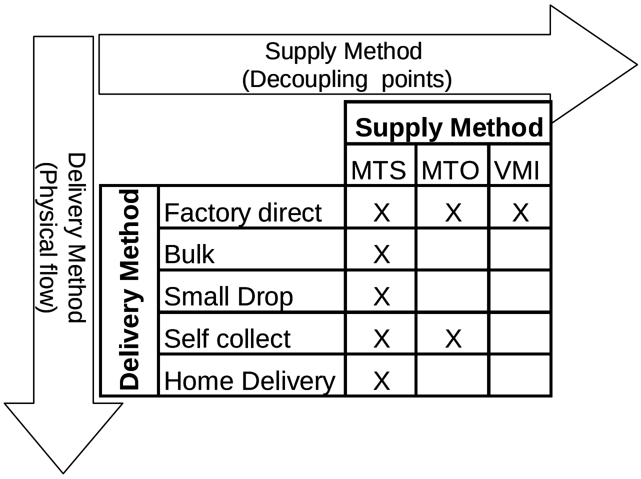
§ *Sales Channel*: can the retailer be grouped together with other retailers into a sales channel that describe their approach to business to business and in turn affect demand patters?

- *Delivery Location*: where does the retailer want us to deliver the demanded products?
- *Volumes*: how much of the demanded product does the retailer purchase?
- *Shared Data and Collaboration*: is the retailer willing and able to share data and collaborate?

Secondly, they have to understand their capabilities to serve the retailers (i.e. the market) regarding their production and delivery system capabilities to produce according to demand. This includes the capability of the suppliers to supply the production system, it is also important to appreciate the capability of the distribution system to deliver the output from the factories (i.e. production system).

Finally, when those steps have been completed the case company can design various approaches to serve the end-users via the retailers, commonly referred to as supply chain solutions. They may even have more than one solution for each retailer, for example in the case of supplying both their own labeled products and the retailers branded products (also known as OEM products or ‘private labels’).

A supply chain solution is a combination of a supply method (manufacturing strategy) reflecting the production system capabilities, and a delivery method (delivery strategy) reflecting the delivery system capabilities. Combining a supply method and a delivery method into a specific supply chain solution creates freedom of choice while at the same time maintaining the efficiency of operations in the production and delivery system, Figure 8 illustrates some possible combinations.



Delivery Method	Supply Method: MTS	MTO	VMI
Factory direct	X	X	X
Bulk	X		
Small Drop	X		
Self collect	X	X	
Home Delivery	X		

Figure 8. Supply chain solutions

One applied supply chain solution within the case company combines the supply method MTS with the delivery method self collect. This implies that the case company produces in advance according to a demand plan and stock-keeping until the retailer collects the goods themselves from one of their factories or Regional Distribution Centers (RDC). Self-collection needs to be implemented carefully to maintain loading efficiency in the RDCs. Another employed supply chain solution combines the supply method MTO with the delivery method factory direct. This solution is used when retailers order a number of weeks in advance, which enables the case company to produce and deliver to a specified date and time. Orders are normally in the form of full truckloads dispatched direct from the factory to a retailer (i.e. deliver method factory direct). Another utilized supply chain solution combines the supply method MTS with the delivery method home delivery. This solution implies that the case company on the retailers request physical bypass of their distribution network and deliver direct to the consumer's home. This delivery method is normally combined with other services such as installation and removal of old products. One more applied supply chain solution combines the supply method VMI with the delivery method of factory delivery. This implies that the case company is responsible for the inventory of their products within the retailer's warehouses i.e. responsible for calculation of delivery dates and quantities. Deliveries are normally in the form of full truckloads dispatched direct from the factory to a retailer (i.e. deliver method factory direct). It is an advanced supply chain solution that involves a great deal of close partnering and collaboration, including total sharing of data and regular communication.

Each supply chain solution has different cost implications for the case company and the retailer. One solution might be more expensive for them, but cheaper for the retailer and vice versa. It is also important to appreciate the cost to serve for a particular retailer when judging its profitability.

5. Discussion

There has been a recognition that the traditional 'one-size-fits-all' supply chain strategy (i.e. to use either a lean, agile or a hybrid strategy) not support a wide range of products with different demand characteristics sold in a diversity of markets.

Instead it is of growing importance to utilize different manufacturing and delivery strategies concurrently (i.e. develop a differentiated supply chain strategy). This research has shown that different manufacturing and delivery strategies need to be used concurrently in international manufacturing related supply chains to be successful in the market. Case company Alpha seems to decide either to select MTS or ATO approach whilst case company Beta seems to decide either to select MTS or MTO approach. Moreover this research has shown that one way to develop a differentiated supply chain strategy is to utilize different manufacturing and delivery strategies concurrently by combining different manufacturing and delivery strategies (supply and delivery methods) into various supply chain solutions. By combining relatively few supply and delivery methods one could develop several differentiated solutions.

This research shows t hat this basically can be achieved through the following four steps: (1) Developing a segmentation model, (2) Understanding the market we serve, (3) Understanding the capabilities to serve the market, and (4) Developing necessary supply chain solutions to satisfy all major customers. In the first step the firm needs to find out what kind of segmentation factors that affect the selection of the most efficient and effective supply chain strategy and then developing a segmentation model. First a preliminary segmentation model has to be developed based on company knowledge. Later on this may need to be altered according to customer requirements. Example of possible segmentation factors are geographical location, type of customer and type of product. For example, the firm could develop a market/customer segmentation model by first distinguish the major geographical location where they conduct their business. After that the firm could cluster similar customer and/or products into customer/product segments within each of the geographical locations. Similar customer/products imply comparable demand and supply characteristics.

In the second step the firm needs to find out what kind of supply chain solutions their customers prefer? In other words, identify how their customers would like to acquire products from them within the identified customer/product segments. The customers perhaps prefer "one-size fit all" supply chain strategy that handle all products in a similar way, or different solutions depending on segmentation category. For example, standards products supplied and delivered according to one whilst customized products are supplied and delivered according to another. In this step collaboration with marketing is crucial since them posses the knowledge on how customer needs are identified and customer value is created.

In the third step the firm needs to find out what kind of supply chain solutions they can provide, both existing and possible. In other words, identify their capabilities to serve the customers, i.e. the market, which implies definition of their production system and delivery system capabilities.

In the final step the firm needs to find out what kind of supply chain solutions they should provide to satisfy all major customer/product segments, and to what price. To satisfy all customers it could be necessary to develop a number of solutions in each customer/product segment. However, each solution could be used in several segmentation categories. The development of differentiated supply chains solutions is one way to make sure that highly varying needs of local and differing markets are meet at the same time as the achievement of economies of scale through centralization and standardization.

Furthermore, this research has highlighted several requirements for utilization of different manufacturing and delivery strategies concurrently in international supply chains. Firstly, the requirement of supply chain collaboration is in this case even higher then normally since a differentiated supply chain strategy will involve more supply chain partners. Both the case studies have highlighted supply chain collaboration as a major issue in developing a differentiated supply chain strategy. Secondly, there is a need to developed differentiated service prices based on the solutions differing cost-to-serve. As highlighted in this paper this is not an easy task and has to be researched further. Finally, more integrated information systems are needed along with decision support tools.

Moreover, this research has also highlighted opportunities of a differentiated supply chain strategy. What seems to be missing in current theories concerning selection of appropriate supply chain strategies are the possibly to competing through logistics in a more comprehensive way. Following the tradition, marketing sets the strategy (what to sell, where to sell, how to sell) and SCM execute this strategy. In other words, SCM build up appropriate supply chain capabilities and advantage according to the marketing strategy. However, as end-users wish for more customized products likewise they could prefer more customized supply chain solutions and perhaps be willing to pay more for this. In addition, there is a trend towards commoditization in many industries, resulting in customers perceive little difference between products. This implies that brand loyalty dwindles and competing through logistics (i.e. customer service) becomes a major determinant of success. This implies that companies in order to stay competitive must enhance customer value by making the product worth more in the eyes of the consumer by adding value to the core product trough inclusion of customer desired customer service. When developing differentiated supply chain solutions companies not only looks for efficiencies, i.e. how can we achieve a lower cost per item, but also on effectiveness, i.e. are we distributing products at a profit-maxing price. Revenue generation, not cost, is the key driver and the main goal is to develop customer-oriented supply chains. This requires closer integration with marketing since them posses the knowledge on how customer needs are identified and customer value is created. Logisticians need to be involved in the product development process and when future products are developed supply chain design should be address in parallel since this in an equally important topic.

6. Conclusions

This paper has shown that one efficient way to develop a differentiated supply chain strategy is to utilize different manufacturing and delivery strategies concurrently by combining different manufacturing and delivery strategies (supply and delivery methods) into various supply chain solutions. By combining relatively few manufacturing and delivery strategies one could develop several differentiated supply chain solutions. Furthermore, this paper highlights requirements to realize a differentiated supply chain strategy such as extended supply chain collaboration, differentiated service prices based on differing cost-to-serve, and integrated information systems and decision support tools.

An interesting aspect for further research would be to study the delivery performance and customer satisfaction before and after implementing a differentiated supply chain strategy. Furthermore this research has shown there are several requirements of a differentiated supply chain strategy and these have to be further investigated. Firstly, a differentiated supply chain strategy require more and improved supply chain collaboration due to the fact that a differentiated supply chain strategy will involve more supply chain partners. The realizing of improved and increased supply chain collaboration in differentiated supply chains has to be studied further. Moreover the requirement of for more integrated information systems and advanced decision support tools has to be studied further.

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Contemporary Directions of City Logistics

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Abstract
This paper develops general directions of modern city logistics. There are several reasons why cities use logistical approach to solve the problems with congestion. This paper shows the basic dependences between quality of life and city development possibilities. Having these dependences identified the Author shows the main directions of city logistics solutions, which are examined in modern cities.

Keywords: Urban logistics, transportation

1. Introduction

Over the last 50 years, the world has witnessed a dramatic growth of its urban population. The speed and the scale of this growth, especially concentrated in the less developed regions, continue to pose formidable challenges to individual countries as well as to the world community. During 2000-2030, the world's urban population is projected to grow at an average annual rate of 1.8 per cent, nearly double the rate expected for the total population of the world (almost 1 per cent per year). At this rate of growth, the world's urban population will double in 38 years. The process of urbanization is already advanced in the more developed regions, where 74 per cent of the population lived in 2003. The proportion of the population living in urban areas is expected to increase to 82 per cent by 2030. The share of the population that is urban is lower in the less developed regions: 42 per cent in urban areas in 2003, and expected to rise to 57 per cent by 2030 (UN 2004). The high concentration of people in cities is not only a huge challenge[1] but as well a big chance for serious problems in everyday cities life – ex. with safety, health, environment, lack of workplaces, places of living etc. Some of mentioned problems are purely logistical. For example this level of growth in city population will result in a corresponding increase in travel, putting an even greater strain on a transport infrastructure that is already at capacity in many areas and suffering from a deficit of investment. It will probably cause also problems with an efficient system of goods deliveries, and fright movement. These problems affect quality of life perception, which is crucial for city development perspectives.

[1] Scientists believe that a high concentration of people enables creating new concepts and inventions as a result of human interactions which is very possible because of breaking a critical mass of intelligence and imagination of citizens

2. What Is Citizen's Quality of Life and Why It Is Important for Citizens and the City Itself?

People invented the idea of cities for different purposes. Explaining urbanization to my students I often say that lazy people invented cities centuries ago in order to be freed from exhausting agriculture activities. Even if it is a simplification we may say, that cities offer better life to their citizens[2]. Why do people move to the cities? Throughout history, and across cultures, people have depended on the city for their safety, seeking protection within the ramparts and behind the walls. People were able to work in a variety of crafts that could thrive because there was a critical mass to sustain markets and foster economic diversification. Cities were places of freedom and liberty, where the escaping serf could challenge the rights of the feudal lord or the church. For centuries cities have been attracting people because they make interaction of all kinds easier, whether the individual is looking for economic, artistic, literary, religious, sexual, or some other kind of interaction[3]. Urbanization as an all-encompassing global phenomenon. On a global scale, cities have become the dominant form of human settlement, socially, economically, environmentally and politically. Being a form of human existence cities offer to their citizens a certain level of quality of life. The idea of what is quality of life can be simply described as a degree to which a person enjoys the important possibilities of his or her life. What makes one person's quality of life better or worse (how people feel about life) cannot be quantified in an objective index. But judging by the material conditions in which they live we may find some objective facts, called often as quality of living. This is why quality of life is subjective as well as objective. Interestingly, however, these two kinds of measurement are normally poorly related. Mercer's study[4] is based on detailed assessments and evaluations of 39 key quality of living determinants, grouped in the following categories:

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[2] We know that there were different reasons why cities were established – not only because of trade and manufacturing, but also because of religious reasons. The best example of the second reason is Jerusalem, established for worshipping the Noah Arch.

[3] The European Charter for the Safeguarding of Human Rights in the City adopting the stance of the European Charter of Local Autonomy, established Rights of citizens in European cities. In Paragraph 1 we find: Right to the City: 1. The city is a collective space which belongs to all those who live in it, who have the right to find there the conditions for their political, social and ecological fulfillment, at the same time assuming duties of solidarity. 2. The municipal authorities encourage, by all available means, respect for the dignity of all and quality of life of the inhabitants.

[4] Mercer Human Resource Consulting is the global leader for trusted HR and related financial advice, products and services. They provided surveys on quality of life in 2007 (http://www.finfacts.ie/qualityoflife.htm).

- Political and social environment (political stability, crime, law enforcement, etc)
- Economic environment (currency exchange regulations, banking services, etc)
- Socio-cultural environment (censorship, limitations on personal freedom, etc)
- Health and sanitation (medical supplies and services, infectious diseases, sewage, waste disposal, air pollution, etc)
- Schools and education (standard and availability of international schools, etc)
- Public services and transportation (electricity, water, public transport, traffic congestion, etc)
- Recreation (restaurants, theatres, cinemas, sports and leisure, etc)
- Consumer goods (availability of food/daily consumption items, cars, etc)
- Housing (housing, household appliances, furniture, maintenance services, etc)
- Natural environment (climate, record of natural disasters)

The top ten cities in the world due to Mercers Quality of Living Index are presented in table 1. We believe that all these cities are more attractive for living and making businesses than New York (which Quality of living index is equal 100) and all the others cities which index is below 100. This makes their competitive advantage in searching new development possibilities.

Table 1. The top ten cities in the world by the quality of living (base city: New York = 100). Source: Mercer 2007.

Rank 2007	Rank 2006	City	Country	Index 2007	Index 2006
1	1	ZURICH	Switzerland	108.1	108.2
2	2	GENEVA	Switzerland	108	108.1
3	3	VANCOUVER	Canada	107.7	107.7
3	4	VIENNA	Austria	107.7	107.5
5	5	AUCKLAND	New Zealand	107.3	107.3
5	6	DUSSELDORF	Germany	107.3	107.2
7	7	FRANKFURT	Germany	107.1	107
8	8	MUNICH	Germany	106.9	106.8
9	9	BERN	Switzerland	106.5	106.5
9	9	SYDNEY	Australia	106.5	106.5

Nowadays it is hard to imagine any of people activities which are not connected with transportation on any stage. Majority of above mentioned determinants of Quality of living index depend on transportation activities and efficiency of logistics solutions that are used in cities. What if the quality of living is decreasing as a result of city activities (or lack of proper activities)? What do citizens do when the quality of life (as their perception) is getting lower? Depending on the geographical region, culture (including traditions) and financial possibilities people express their dissatisfaction in different way. But when the quality of living is noticeably decreasing they often decide to leave the city for searching new life possibilities in different cities. This is the start a city collapse. Scientists believe that the situation when city becomes less attractive for new kind of businesses or as a place for living is connected with de-urbanization[5]. Here my understanding of "de-urbanization" is merely as the "reversal of urbanization" which can be understood as a city death, although I believe that a thing such as de-urbanization cannot occur due to the fact that de-urbanization is the direct reversal of urbanization and urbanization is not a process that will reverse. This does not change the idea that decreasing quality of living causes serious problems for modern cities.

3. Transportation Implications of Fulfilling Customer Service Level for City and Citizens

Mobility is a challenging concept for many of us. Mobility is not instantly comfortable. Mobility has to be slowly cultivated. After the initial attraction of mobility, how can we deepen its meaning for each mobile individual specifically? Modern societies depend heavily on mobility. Mobility is the quality or state of moving or being moved from place to place. It also means that motion is a subject of all transportation activities. It refers to goods and people. What we need as consumers in our lives is good customer service. Level of mobility is easily transferred to quality of life. Everyone is a consumer[6]. Customer service level which satisfies contemporary consumers can be understood as a function of several different

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[5] In order to define and distinguish movements and divisions of populations within a given territory, there are four popular concepts that have been identified - 'urbanization', 'suburbanization', 'de-urbanization' and 're-urbanization'. Typologically speaking, during initial phase of 'urbanization', there occurs an import of rural traditions into the city centers, whereas during 'de-urbanization', the typology of settlement at the 'urban' periphery sits in complete contrast to the rural traditions. For further reading, refer: Malfroy, Sylvain (1995) "Urban Tissue and the idea of Urban Morphogenesis". Cambridge, MIT: Conference Paper, Typological Process and Design Theory.

[6] Typically when business people and economists talk of consumers they are talking about person as consumer, an aggregated commodity item with little individuality other than that expressed in the buy/not-buy decision. However there is a trend in marketing to individualize the concept. Instead of generating broad demographic profile and psychographic profiles of market segments, marketers are engaging in personalized marketing, permission marketing, and mass customization. For more see: Cross, Robert G. (1997). Revenue management: hard-core tactics for market domination. Broadway Books, 66-71. ISBN 0-553-06734-6.

performance indices in a supply chain. The first one is the order fill rate, which is the fraction of customer demands that are met from stock. Another measure is the backorder level, which is the number of orders waiting to be filled and the probability of on-time delivery, which is the fraction of customer orders that are fulfilled on-time, i.e. within the agreed-upon due date. This is an example of sets of tasks connected with urban freight transport. Citizens mobility from city point of view is freedom of traveling for all citizens – these who are willing to change their place for any reason. It includes pedestrians and bicycle, scooter or vehicle users. It includes all seasons and any time. Finally it includes freedom of choice. All these movements – peoples and goods – result congestion of road networks and urban areas[7]. In the European Union congestion costs amount to 50 billion EUR per year or 0.5 % of Community GDP, and by 2010 this figure could go up to 1% of EU GDP. The number of cars per thousand persons has increased from 232 in 1975 to 460 in 2002. The overall distance travelled by road vehicles has tripled in the last 30 years and, in the last decade, the volume of road freight grew by 35% contributing to 7 500 km or 10 % of the network being affected daily by traffic jams (DG TREN 2008). We know that capacity of urban road network is quite limited. The capacity is the maximum number of pedestrians and vehicles accommodated in a limited road space during a certain period. Road traffic facilities are stable and limited during a given period, but the traffic flow is stochastic and dynamic, which will use the space and time of road network. Transport entails severe harmful effects on the environment and public health, waste of energy and, above all, accidents which cause fatalities, injuries and material damage. All the mentioned dependences are presented on Figure 1.

As we can see there is a connection between quality of life, congestion and city development chances. Logistics boosts the capabilities of the city and provides new business opportunities. It is inevitable for a city and a country to engage in the expanding transport networks. The development creates new jobs too. For citizens mobility is also a human right which has to be guaranteed by city. Logistics can be involved in finding solutions to problems with congestion. This is one of the reasons why city logistics was established 15 years ago.

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[7] Traffic congestion results when too many vehicles try to use the same roadway at the same time. Vehicles impede each other and slow down the movement of traffic over the roadway. If enough of those who would otherwise drive could be induced to switch to public transit, the number of vehicles trying to use the roadway would be decreased. This could reduce traffic congestion if the number of diverted automobile trips is larger than any negative consequence caused by public transit vehicles' larger size and slower speeds.

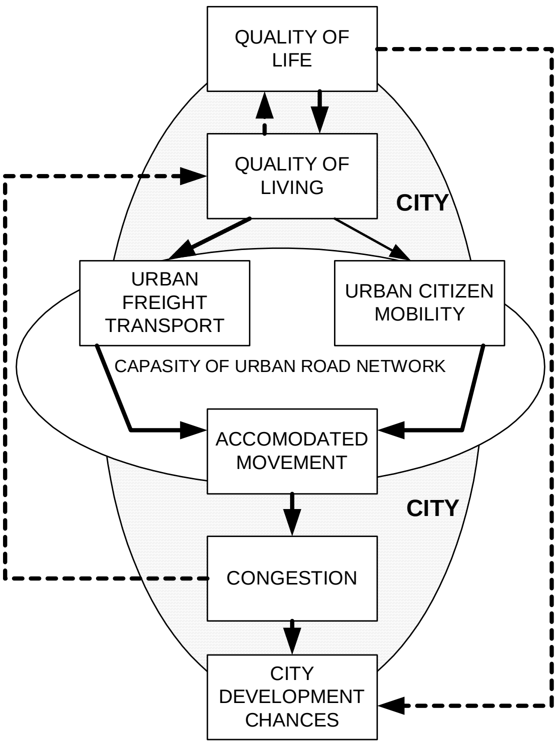

Figure 1. Transportation implications on quality of life and city future

4. What Does City Logistics Offer to City and Citizens Nowadays?

There are two main groups of problems which are under special attention of city logisticians. One of them is connected with goods deliveries in cities, another one with personal mobility. The detailed tasks and decisions depend on probable scenario of future. Such scenarios can be described as presented in tab.2. But the main directions are the following.

Firstly freight transport needs a strong management change. There are many cities that shifted from preliminary studies to system application in the new fields of city logistics. They have put a special attention on the flows of freight that get into the city centers, especially those linked to the providing of freight distribution to the medium and small-sized commercial activities. These schemes base on city logistics centers which connect two or more transportation modes. Such schemes lower number of tracks which deliver goods to the city receivers. As part of integrated advanced logistics and supply chain management, intermodal logistics is defined in terms of seamless door-to-door fright transport operations using at least two different modes of transport. In general, the initial/terminal positions are short and by road, and the main long haulage of containers, swap bodies, trailers or trucks by rail, waterway, sea or air. Intermodal logistics is also characterized by the absence of or minimal handling of goods during transfer. Cities are well known elements of intermodal logistics as they are on the way of material flows on each stage. There are actions on "transit points" that tries to concentrate the incoming freight reserving the activities developed in the city centre to few specialized subjects that have the right instruments for transportation, management and its informative backup. The other option accepts the entrance of a wider number of transport operators that are asked to adopt low impact vehicles and to accept well defined management rules for the goods unloading in fixed hours and places, and the reservation of load/unload stops. These represent also intermodality. Lately there are some doubts in effectiveness of such solutions. There are new concepts of night-time deliveries using specially prepared trucks and equipment.

Table 2. Possible scenarios of city development

	1: Base case	**2: Energy revolution**	**3: The dawn of a dark age**
Technology	**Incremental improvements**	**Clean, affordable energy**	New technologies not able to replace oil before crisis
Resources	Oil supplies last for next 50 years without price increase, Phase in renewable resources	Development of new energy sources alleviates scarcity of resources	**Oil Crisis**
Environment	Environmental pressures force changes in transportation technology	Less air pollution	More pollution due to low tech energy sources
Political	No major changes Government promotion of environmentally friendly modes	No major changes – government supports sustainable energy	De-Globalization & political instability Mandate research for alternative energy sources
Population	Population increase and continued pressure on cities	Population increase and continued pressure on cities	Population increase and continued pressure on cities
Economic structure	No major changes	No major changes	Greater polarization – rich not as affected, poor get poorer
Transportation costs	Moderate change Car affordable	Costs decrease Car affordable	Rise significantly
Social	More intercity travel “Image car”	Leisure travel increases More energy use	Living costs rise Travel decreases

Secondly citizens mobility is more difficult because people are independent on their choices. It is also very difficult to examine all citizens movements and the ways of their accomplishment. In order to fight congestion, make the traffic more fluid and promote a modal change it is necessary to act on two levels: the promotion of the sustainable alternatives to the use of cars (foot or bicycle travel, collective transport, new urban logistic) and limitations to the private motor vehicles with the use of dissuasive measures (limited access to historical centers, parking regulations).

Cities need to support a great effort to promote alternative and sustainable forms rather than the private motor vehicle. For the bicycle and pedestrian mobility it can a choice between a variety of options: infrastructural measures such as bicycle lanes, pedestrian zones, inter-exchange areas for park&ride, street and road works that help travel by feet or bicycle (underpasses, one way streets, crossings and pedestrian ways), special services such as bike sharing, a different organization of urban spaces that can include the creation of pedestrian ways from home to school for young people or urban trekking routes; financial rules such as tax refunding to help buy electric bicycles. For the collective transport cities need a rationalization and over all an improvement of the service offer, that are fundamental for the best use of infrastructures and to overcome the actual imbalance toward individual transport. At the same time cities need to start with a wide program of creation of new systems suitable for infrastructures and rolling stock[8].

All presented directions base on intermodal concept – both in freight (using logistics centers) and people (combining private and public means of transport in park&ride, kiss&ride or bike&ride systems, or promoting the ideas of car pooling and car sharing).

Third aspect is the problem widely discussed in framework of city logistics is "access rules" in the city centers. Almost every small, medium and big city have been adopted access and travel limitations and rules for the private vehicles such as the "limited traffic zone" and the parking regulations. In Poland we are on stage of protecting city centers of historical cities from any of movement – including supply and taxis. On this ground there are many interesting experiences going on in Cracow, using both financial and educational tools. It's especially important and positive the evaluation about the extension of electronic control systems to the city centre access, that is getting good results in the reduction of entrances and can be multipurpose (control of alternate plate numbers access and circulation, motorbike and scooter access control, support to flexible toll systems). It's important also to incentive, with prizes and recognitions, the more effective among the different options.

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[8] Based on a dialogue with the President of the Transport Commission of the Permanent Conference of the Regional Governors, with representatives of ASSTRA, the association that holds together the majority of the public transport enterprises of the nation, and with representatives of the Trade Unions also occurred.

In order to get important changes in the mobility habits of the citizens it's fundamental to strengthen the collective transport systems. Consequently city needs to renew the quality and the organization of services and create an intense program of building of new systems that can fit on as infrastructures and rolling stocks.

Fourthly, all before mentioned ways are strictly connected with shaping transportation behaviors, which was a subject of my presentation last year. Society is not far from consensus on the point that the more benign means of locomotion such as walking and cycling should be encouraged. At times it is recognized that the more destructive modes of transport should be discouraged. The task at hand now is to encourage society to envision how public space can be reallocated to support social interaction and a richer, livelier urban fabric. It is this transformation that most requires our dedication and creative energy.

The last but not the least aspect is how to implement all these actions. I use term of city saying than something has to be done. What, or rather who is the "city". We have to find the way of managing city logistics. The system of management has to cover in one action all movements in the city – freight and people. This has to be a mobility center which could be an organizer and advisor for all institutions and citizens wanted their freight to be moved or people wanted to travel.

5. Conclusions

City logistics is a very important factor for regulating and optimizing all movements in city in order to decrease congestion. Congestion level can influence on city users perception of their quality of living which can decide of success or failure of the city. This is why city logistics is a subject of interest and experiment in many cities in the world. This gives us opportunity to discuss the main directions of city logistics development in modern cities.

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Business Logistics: New Specific Approach to Concept

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Abstract
New approach to concept of logistic is proposed on the foundation of 40-year experience from projects concerning logistics systems, industrial transport, containerization and package transportation, automatic warehouses and freight terminals etc. Logistics is analyzed as complex system of 12 principles (methodical regulations), technical means and activities for efficient material flow organization. Important role of warehouses in logistic chains is highlighted, as special objects for material flow transforming in points of different transport and industrial systems interaction.

Keywords: Logistics, supply chain, transportation, warehousing, cargo

1. Introduction

In 1970-1980 , while working at the Project Institute of Industrial Transport, we fulfilled a lot (over 100) projects of industrial transport, storage facilities, mechanical handling technologies and equipment, cargo shipment and material flows, containerization and package transportation of cargo, warehouses and freight terminals and so on for companies of near 30 various industries. Thus, we projected the facilities and objects, which then were called in our country "loading-unloading, moving and storage works" (LUMS-works) and later started to be called "logistics".

It is this rather strong project and commitment background in the field of logistics that has provided the opportunity not only to continue project activity in the directions above mentioned in new economic conditions in Russia, but to teach post-graduate specialists and develop some theory aspects.

2. Determination of Logistics

There are a lot of determinations of the term "logistics". Some of these are rather short, others strive to include as much as possible problems, concerning transportation, storage, loading-unloading, shipping, commissioning cargoes and others and so these determinations happened to be quite long.

Besides, these determinations very often are too personal and reflect mostly particular experience of the authors in some limited field of knowledge (for example, economy, material supplying etc).

Further, to call great number of different works, transportation and transactions of cargo with just one word – "logistics" – is not very productive in relation of reception of efficient material flow, which is the main objective of logistics. So, we usually use the following definition of logistics:

Business Logistics is a complex system of methodical regulations, technical means and actions, directed to planning, organization and controlling of efficient material flows and their performance in accordance with strategy of the company and needs of markets of the special (aim) segment of economy.

Why we call logistics a system? We could say just group or combination of methodical regulations, technical means and actions. However, in order to receive the best results and in a short time, while projecting some supply chain; for example, we should use the methods of the General Cybernetic Theory of Systems – so as to produce the most efficient logistic system, providing the biggest profits for the commodity distributors.

The main features of the General Theory of Systems while analyzing or creating logistics as a system are following:

- objective of the system (receiving the greatest profit);
- elements, which consists the system of (i.e. physical and information operations);
- structure of the system, as various connections and relations between the elements (technological, dispositional, consequential relations etc);
- activity of the system (behavior – in the terms of the General Theory of Systems) – delivery cargo to the place of destination;
- interaction of the system with the environment (transferring of material and informational flows);
- results of the system activity, which are to be compared with the set objective (changes in elements, structure, activity or interaction with the environment – and sometimes even in the objective – are produced if necessary after comparison of

the activity results with the objective originally set).

What are the methodical regulations in the logistics determination? These are 12 main principles of logistics, which may be represented as follows:

- Performance Logistics as a system on a foundation of the General Theory of Systems – as was described right now;
- creating the logistic system taking into account mostly the consumer needs of the target market;
- priority distribution over manufacturing of commodity (no production of commodities, which do not have customers);
- optimal level of the customer service (not too high, that can be very expensive and not too low, because in this case the customer may be lost);
- seven features of commodity, being important for customer: necessary commodity, of necessary quality, in necessary quantity, at necessary place, in necessary time (e.g. just-in-time), in necessary condition and on affordable competitive price;
- consideration of the whole logistic chain, while working at enhancement of only one its link;
- analyzing of the logistic chain should be fulfilled, starting from its end (i.e. where the material flow is finished) – to its beginning in the direction opposite to material flow direction);
- all the competitive options of the logistic chain should be estimated with their economical characteristics;
- cost of every logistic operation should be calculated and used in analyzing of the logistic system options;
- gathering and using the most complete information about participants of the logistic process, material flows, modes of transport, freight terminals etc.

Technical means of logistic system are transport infrastructure, rolling stock, freight terminals, mechanical handling equipment, containers and pallets, IT systems etc.

The third part of the logistic system – its activity, fulfilled for delivery of cargo, - is technology and conditions of cargo transportation and its processing at freight terminals, while transferring cargoes from one mode of transport to another one in the systems of multi-modal transportation.

Performance and functioning of the logistic system are directed to organizing efficient material flow. But what does “efficient” material flow mean? What material flow we can call “efficient”? Certainly – that one, which provide the greatest profit. But how can we reach this? Firstly, we must choose the best parameters of the material flow and, secondly, while choosing these parameters, we have to save 6 resources, which usually are to be saved in every engineering or economical problem. These resources, which help us to receive the highest profit, are following:

- *space* – for example, area, occupied by warehouses; distances of cargo transportation etc.;
- *time* (of cargo storage, delivery, loading, unloading, demurrage of railway cars, trucks etc.);
- *materials*, which was used for manufacturing of various technical means of logistics and influence to their cost;
- *energy*, that was to be saved for operation of the logistic system components;
- *labor*, which was to be saved during operation of the logistic system (i.e. man power, using for various logistic operations – loading, unloading, palletizing, sorting, moving etc.) and at last –
- *money* – cost of separate logistic operations (physical and informational) and total for the whole logistic chain.

These are all types of resources that operate in this our world, where we live and work. Perhaps in some other world there are some other resources or there are some additional resources, which would be discovered later and also have to be taking into consideration. But at present time there are only these six.

For the first sight only the last of these resources – money – should be considered, because it covers all other resources and so there is no necessity to compute additionally other ones. Although it is acknowledged by many experts that none of other resources can be expressed adequately only in money representation.

As for the strategy, having been mentioned in the logistics determination, every company must have the strategy, discovering its plans and policy for the nearest one-two years and future 5-10 years, including its relations to the commodity production, markets, competitors, promotion, prices policy, business partners, internal and external (corporate) ethics.

As for necessities of markets, also mentioned in the above mentioned determination of logistics, that is one of the fundamental principles of the business logistics: to work for the needs of consumers, as was already shown before.

Every commodity and service should be directed not just to some big market, but namely to the narrow aim segment of the market, where there are some customers, which are waiting for this commodity or services or just ready to consider their acquiring.

Concept of material flow

We are saying that logistics is a system for organizing efficient flows. But what is material flow and what have we to do with it – so that it was "efficient"? Apparently we have to choose or change some parameters of the material flow – so as the results of its appearance on the market were positive and conveyed desirable profit.

To reach this purpose we have to know parameters which characterize the material flow. These parameters are as follows:

- Total quantity of cargo which has to be moved from one point to the other for some specific period of time (per year, month, day or hour). The quantity of cargo can be measured in tones, units, cubic meters, pallets. That value is of initial data and can not be changed during optimization;
- Volume of transport batch;
- Time intervals between arrival of transport batches and their regularity;
- Quantity of cargo names in transport batches;
- Type and features of cargo packages, units, tare and wrapping;
- Times of arrival and shipping of transport batches.

Material flows can be classified by their kind of cargo, capacity, regularity, types of routes, locations of operation, volume of batches etc.

It is selection the best combination of the material flow parameters that should be considered as main purpose, while projecting efficient material flow on the foundation of the logistic principles.

3. The Structure of a Logistic System

A logistic system may be represented as consisted of two subsystems: physical (or material) and informational (or virtual) – see Figure 1 for details.

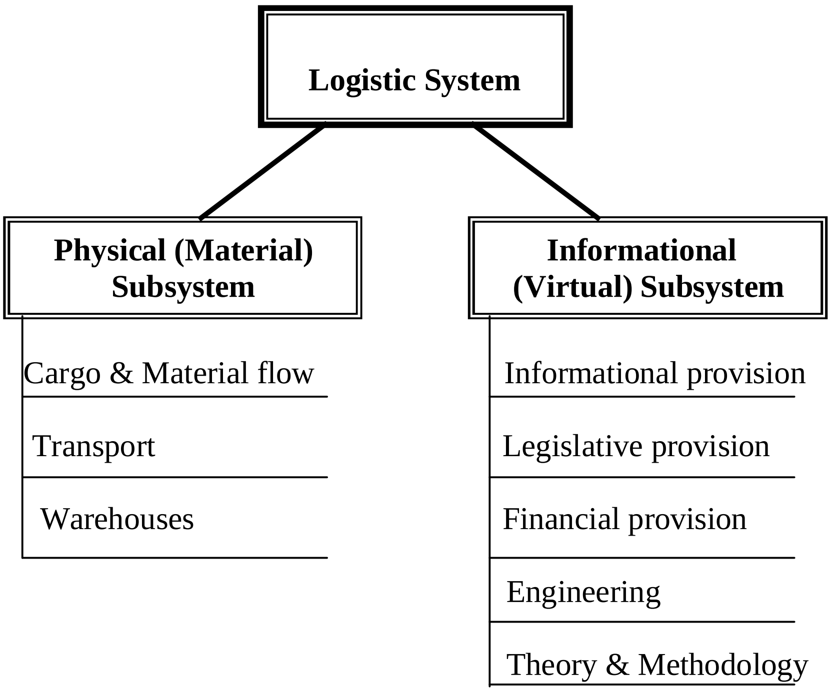

Figure 1. The structure of a logistic system

The physical subsystem includes the following components, which exist as physical objects:

- Cargoes and material flows (as considered above);
- Transport (infrastructure, rolling stock, traction, devices for automation, signals,

control, communication, security, repair and maintenance facilities);

- Warehouses and freight terminals (buildings and other erections, handling and storage equipment, devices for automation, control, internal and external communication systems).

The virtual subsystem includes the following components, which can not be visible or touched as physically existed objects:

- Informational provision of logistic system (databases, Information Technologies, computer assisted methods of decisions making, automatic control of cargo transportation, processing and accounting);
- Legislative provision of the logistic system (Federal and Local Legislation, State Codes and Regulations, instructions and orders of Government and local Administration, contracts and agreements for cargo transportation, storage etc.);
- Financial provision of the logistic system (all kinds of bank and cash payments for the cargo and all logistics operations: physical – transport tariffs, loading, unloading, storage, sorting, commissioning, packing and informational – customs clearance, messages of the cargo moving etc.);
- Engineering provision (all kinds of technical and economical calculations, planning, justifications and projecting , concerning logistic operations – transport route selection, equipment productivity and capacity, warehouses capacity and parameters, loads setting and fastening in railway cars and containers and so on);
- Scientific provision – theory of logistics, carrying out methods of calculations, projecting and justifications, application of mathematical statistics, probability theory, operation research methods, theory of storage systems (TSS), decision making in the indeterminable conditions, simulation of technical systems on computers etc.

Logistical process

In dynamic representation the logistic process may be considered as a system, consisting of 2 levels (physical and virtual) and 3 stages:

1. Stage of planning, preparation and organization (SPO);
2. Stage of physical (or material) flow (SMF);
3. Stage of checking and analysis (SCA).

Logistics classification:

There are many methods of logistic systems classification. With different types of entrepreneurship the following kinds of logistics may be identified:

- Industrial Logistics – organization of efficient material flows at an enterprise, that manufactures some products;
- Commercial Logistics - organization of efficient material flows at a trade enterprise;
- Transport Logistics - organization of efficient material flows by a transport enterprise;
- Building Logistics - organization of efficient material flows, while constructing buildings;
- Agricultural Logistics - organization of efficient material flows for operation of agricultural enterprises and in food industry.

4. Logistic System of an Industrial Enterprise

Logistic system of an industrial enterprise (i.e. Industrial Logistics) includes the following 4 subsystems:

- *Supply Logistics* – which finds the more convenient vendors of raw materials, spare parts and semi-finished items, organizes contracts concluding for their delivery to the factory, receives these cargoes to its warehouses and supplies the manufacturing processes with necessary materials, in necessary amount, in necessary time, of necessary quality, in necessary condition, in necessary place due to technology need. The Supplying Logistics in its work interacts with some external enterprises and organizations (vendors, various modes of transport, wholesale, customs, regional logistic Centers, other partners) and internal departments, shops, industrial transport of the factory.

- *Manufacturing Logistics* – provides all moving of materials, semi-finished items and end-items in according to existed technological proceeding, using industrial transport, internal industrial tare and technological warehouses in shops of the factory.
- *Distribution Logistics* – researches markets, competitors, prices, works out promotion, pricing and distribution strategy, organizes distribution chains and networks with distribution centers, warehouses, shops, super- and hyper-markets. The Distribution Logistics in its work (so as the Supplying Logistics) interacts with some external enterprises and organizations (customers, various modes of transport, wholesale, customs, regional logistic Centers, freight terminals, other partners) and internal departments, shops, industrial transport, warehouse of finished products of the factory.
- *Waste Logistics* – gathers various waste of manufacturing, transforms it for further proceeding, transportation or using. The Waste Logistics in its work (so as in the previous cases) interacts with internal departments, shops, industrial transport, sometimes – with warehouse of finished products of the factory and with some external enterprises and organizations (customers, various modes of transport, wholesalers, logistic Centers and freight terminals, other partners – depending on completeness of the producing cycle).

5. Logistic Chains and Operations

There are two determinations of a logistic chain:

- The logistic chain is a consequent group or composition of enterprises (partners), taking part in logistic process of cargo delivery from the consignor to the end customer.
- The logistic chain is a consequent group or composition of logistic operations in the process of cargo delivery from the consignor to the end customer.

Although it would seem odd, however, both these determinations may be acknowledged as correct and competent. Just first of these is recommended to be applied in the beginning of the logistic system projecting, and the second – on the concluding stage of this procedure (while specifying details).

Now, considering logistic chain as a consequence of some enterprises we can see, that it consists of 2 types of links: transport and enterprises. Every well organized transportation should be started and finished on warehouses, suitably performed and equipped for efficient loading, unloading, storage, commissioning, palletizing cargoes etc. These special facilities for cargo handling are modern mechanized and automatic warehouses. So, it is possible to declare that any logistics chain (supply chain or distribution chain) consists only of 2 objects: warehouses and transport (Figure 2).

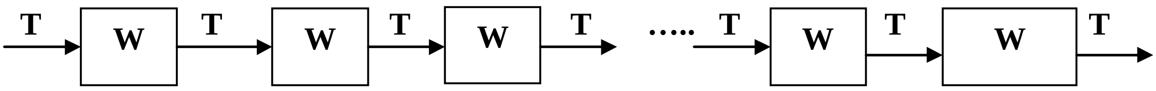

Figure 2. Logistic chain, consisting of transport and warehouses

Disposed in different points of a logistic chain, warehouses can be parts of various enterprises, composing the logistic chain. For example, logistic chain can go firstly through long-distance railway transport, over its freight terminals, then come to some industrial enterprise and go through its technological warehouses and come to warehouse of finished products. In this warehouse new logistic chain may be started (or it may be considered just as continuation of the whole big previous logistic chain) and finished commodities would go from the warehouse of this factory along its distribution chain to warehouse of wholesale enterprise etc.

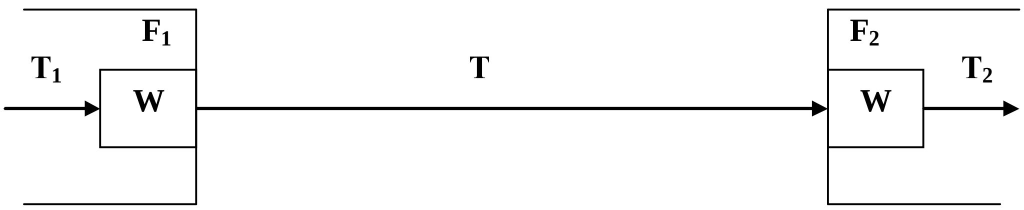

Figure 3. A link of a logistic chain

Any local transportation process, as a link of a logistic chain, should be considered as completed of 3 elements: warehouse of dispatching, transport and warehouse of arrival (Figure 3).

6. Purpose and Designation of Warehouses in Logistic Systems:

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.

Analysis of logistic systems shows, that any well organized logistic chain consist of consequently following transportation and warehouses and every transportation process starts and terminates at some warehouses.

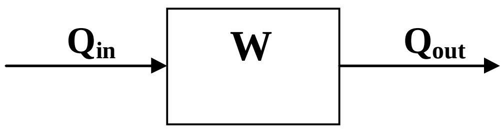

Figure 4. Material flow transformation by warehouse

A warehouse always interacts with two type of transport – first, that delivers cargoes to the warehouse and second, that delivers cargoes from warehouse to customers (they can be the same or different modes of transport) – shown in Figure 4. Certainly the whole amount of in-bound materials flow for rather long period (for example for a year) should be equal to the whole amount of out-bound materials flow.

However, as was shown earlier, material flow is characterized not only this single parameter – the whole amount of cargoes, delivered to or dispatched from warehouse for a year, although this one is very important. Other main features of a material flow that change while processing at warehouse are as follows:

- amount of transport batches (which 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 dispatching of transport batches and their regularity.

Comparison of these characteristics of in-bound and out-bound goods flows at a warehouse displays, that they may be different from each other. So, although the whole amount of arrived goods to warehouse for some long period (for year) would be equal to the whole amount of dispatched goods from the warehouse for the same period, other in-bound flow parameters could not be equal to the appropriate elements of out-bound flow parameters.

So, the warehouse changes or transforms some of the flow parameters, mentioned above. For example, volume of the transport batches can be changed from big to the small ones – if goods come to a warehouse with big batches in heavy-duty long distance trucks and deliver to customers with small batches in small local ones through retail chain. At the same time number of goods denominations in transport batches could lessen dramatically. Moreover, if the warehouse under consideration is of a type of logistic center, 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 completed and prepared for delivering to customers.

Time characteristics of transport batches dispatched from warehouse also are different from these of arriving batches. This time difference creates term of cargo storage in the warehouse, 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 operation, but only one of about 40 possible technological operations fulfilled with goods at 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 lot 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 receive specific characteristics of these systems.

So the flow of finished products comes to factory products warehouse by means of internal factory transport with some multitude of parameters. These parameters are suitable for products manufacturing and industrial transport, but do not match railway or outer road transport, that have to deliver these goods to logistic center or directly to a shop or super-market. And this multitude of the goods parameters can be not suitable also for these shops or super markets (for example, in relation of amount of goods in the transport batches, their contents and goods denominations, dimensions of separate packages and parcels, type of transport tare and packages, time of dispatching, other conditions of goods delivery 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 cargoes.

In the same manner freight terminal at railway station or in sea 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 with 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 using of the materials and unfinished components, arrived to the factory.

Thus warehouses of various types and designations are created in the points of interaction of different transport and industrial systems with an objective of material flow transformation for the best further transportation and/or using goods. Temporary storage and handling cargoes at the warehouses are just some of its proceeding operations, fulfilled for changing 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 modern automated warehouse, which is known to experts in this field of knowledge.

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Modelling Stochastic Elements in Transportation System Simulation – Evidence from Four Projects

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Abstract
Discrete event system simulation is often seen as a genuine tool to investigate the performance of transportation systems. The complexity of real-world systems often prevents us from accurately describing these by a mathematical model that can be evaluated analytically, thus, simulation is often the only realistic alternative. Another advantage of the simulation is the ability to include statistical analysis for different simulation scenarios.

In this paper we discuss the main problems concerning the modelling of transportation systems. Well-known approaches of incorporating uncertainty into models include trace driven simulations and sampling directly from gathered data (this latter could also be presented by a fitting statistical distribution). Another aspect to be taken into account is the economics of simulation modelling; a more detailed model requires additional building time, and proper treatment of stochastic models requires statistical analysis, which again usually implies several simulation runs. From this outset the following question arises: Should stochastic behaviour be included in transportation simulation models in the first place at all?

We present real case examples including evaluation of a railway transportation concept, capacity analysis of an automatic guided vehicle system, CBA of a railway network investment and evaluation of different multipurpose railway wagons, where stochastic behaviour is dealt with in different ways. Based on the cases we make an initial attempt to formulate framework for deciding how to include stochastic behaviour in the simulation model. We stress that the metrics used to evaluate system performance should be included in the framework. For further research topics we suggest formulating explicit guidelines to deal with stochastics to increase the efficiency of model building.

Keywords: Transportation systems, simulation, stochastic variables

1. Introduction

When studying the functionality of a system, experiments should primarily be conducted using the actual system to avoid questions about the relevance of the results (Law 2006). Very often this is not a viable option as the system cannot be disturbed or it may not even exist (Banks et al. 2006), the second alternative is to experiment with a model of the system. Mathematical models represent the system using logical or quantitative relationships which can be altered to see how the system reacts under different conditions (Law 2006). If an analytical solution to the mathematical model is available and it is computationally efficient, it is usually preferred to simulation because it is optimal (Guedes 1995; Law 1998).

However, simulation is often the only analysis technique which allows a probabilistic behaviour and desired accuracy of the model (Law 2006; Banks et al 2006). Unfortunately, a more detailed analysis usually involves more time and cost, thus, only if the level of accuracy attained is not acceptable is additional complexity justified (Law 1998).

The objective of this paper is to make an initial attempt to formulate a framework for deciding how to include stochastic behaviour in the simulation model when modelling transportation systems. The framework is based on three real case simulation studies and aims at increasing the efficiency of simulation model building. Our research problem could be described with the following questions: (1) ‘How should transportation system simulation be modelled?’, and (2) ‘To what extent do we need stochastic variables in these models?’

This paper is structured as follows: In Section 2 we will introduce discrete event simulation and discuss its possible advantages and drawbacks as compared to other problem solving tools. In Sections 3 to 6 we present four simulation cases, where stochastic behaviour is included in the models in different ways – three of these cases concern railways (new wagons with new logistics configuration, evaluating different multipurpose wagons, and railway network investment evaluation), while the fourth one is completed in engine part manufacturing, where Automated Guided Vehicles (AGV) are used in handling of internal logistics. In Section 7 we present the sources of stochastic behaviour of the simulation models in a tentative framework. Based on our findings we argue that there rarely exists a need for including endogenous stochastic behaviour in the simulation models of transportation systems. In the final Section 8 we will conclude our paper and also propose avenues for further research.

2. Literature Review: Transportation Systems Simulation

There are several advantages which support the use of simulation as a problem solving tool (Law 2006). Such include the complexity of real-world systems, which can not accurately be described by a mathematical model and be evaluated analytically. Thus, simulation is often the only alternative, which could be applied; it allows the estimation of the performance of an existing system under different conditions (‘what if’ scenarios). Alternative system designs can be compared to see, which best meets the requirements. In simulation the control over experimental conditions is better than when experimenting with the system itself. Simulation also allows the study of a system with a long time frame.

However, simulation does not come without drawbacks. Because a stochastic model produces estimates of the true characteristics of the system, several observations for each set of input parameter values is needed. In order to be able to construct confidence intervals based on these observations, the observations have to be obtained from different runs. Simulation is therefore better suited to comparing a limited number of alternatives than optimizing a system (Law 2006). Simulation models are often expensive and time-consuming to develop. Usage of these requires special training, and when constructed by independently by several competent individuals, the models will hardly be the same (Banks et al 2006). Furthermore, simulation might be impressive even if the model itself might not be a valid representation of the real system (Law 1998).

Simulation has been widely used in transport system analysis. Applications range from elevator planning (Tervonen et al. 2008) to Canadian coal transport route evaluation (Ash et al. 1991). Simulation has also been used in testing schedule performance and reliability for train stations (Carey 2000) as well as airport baggage handling system design (Rijsenbrij et al. 2007). In the UK a simulation analysis has been conducted to evaluate the arrest cost and resource deployment impact of a law change regarding 'late drinking' (Greasley 2000).

Although simulation is often seen as an alternative to other analysis tools, it can also be used in combination with them. Neural network meta-modelling has been used in connection with simulation to find approximate optimum solution for a kanban system (Hurrion 1997). The Canadian Pacific Railway has used an optimal block-sequencing algorithm, a heuristic algorithm for block design, simulation, and time-space network algorithms for planning locomotive use and distributing empty cars when changing their service concept (Ireland et al. 2004).

3. Simulation Case-Study: Evaluating New Timber Railway Transportation Concept

System under study

The simulation study aims at evaluating a new business concept for timber rail transportation. Current practice of the Finnish railway operator is based on a large network of hubs where railcars are stored and combined. From these hubs the cars are transported and left at a loading station by a diesel-powered engine. Cars are loaded by the harvester within a given time frame and another engine is scheduled to fetch the loaded cars afterwards. These loaded cars are typically combined at a hub, from which a scheduled train will transport the cargo to the mill. The combined routes are equipped with electricity and the engines use it as their power source since it is more cost efficient.

The new concept to be evaluated is a so called ‘unit train’, where the locomotive is always present, i.e. the cars are not dispatched at any time. The locomotive to be used can be connected to the electrical system of the track, being the preferred mode as it is powerful and cost efficient. On routes where electricity is not available the engine runs on diesel power. Furthermore the train is equipped with a timber loader. Cargo is assumed to be available for loading on arrival. Because of the relatively fast loading speed, there is no need for detaching the engine during loading for other tasks; and thus the personnel of the train are free to operate the loader.

Simulation model

The simulation model was built using Quest, simulation software offered by Delmia Corp. The model of the rail network includes stations and connecting rails with length, intermediate speed and electrification. Stations are modeled as buffers; conveyors are used for connecting rails. The physical network structure has been built in the model, but the attributes of the nodes and links are also read from a matrix. The station logic manages the traffic in the model. As a train runs in the model it makes reservations on the track ahead. As the traffic does not run based on a predefined schedule, if a train pass is not possible on the other end of the reserved track further reservations are made to avoid collision.

In the beginning of each planning cycle, new timber loads to be picked up arrive at the loading stations. As the result of the route planning process we get planned routes from the loading stations to the mills. The algorithm only combines loads with the same destination. The route planning algorithm used aims at maximizing fully loaded travel. Pick up stations with full train capacity loads are routed first. Secondly, when no further full train loads can be found, the routes for the most far away stations are searched, when combining loads to form full trains. The search begins with the most distant stations to ensure their service level. Furthermore, once a load is routed, the planned routes are not rerouted, even if they would be open in the beginning of the next planning cycle.

The trains are initially located at a mill. In the beginning of the simulation, as well as when the train has completed its previous route at one of the mills, the train selects its next transport route from the available planned routes. The route having the highest loaded travel ratio is selected. The route planning and task selection process logic of the model are shown in Figure 1.

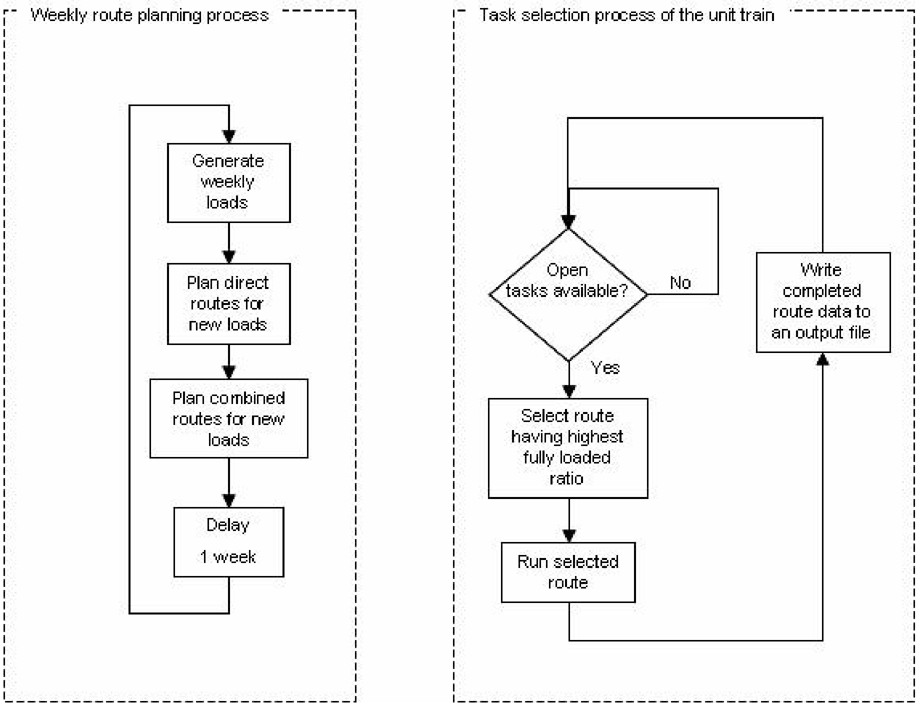

Figure 1. Overall model logic.

Energy cost in the model depends on the energy source and load carried. The labor model takes into account working hour regulations and the operator is changed accordingly. Wages are calculated including extra charges for night time and weekends. The cost of the locomotive as well as other equipment includes interest cost and maintenance.

In the case model, rail transport of timber to two mills located in Southern Finland is being analyzed. The mills have a direct connection to the railway network and close access to harbors. The supply of timber comes from 28 loading stations located in central Finland, a typical timber source area. The average distance of the loading stations to the mills is 290 kilometers. Routes for new loads arriving at pick up station are planned on a weekly basis resembling the current planning cycle of the Finnish forest industry. As the harvesting process is under the control of the industry, the loads to be picked up are assumed to be reasonably sized. In the simulation each load equals the capacity of half a train. The only stochastic element of the study is the determination of the destination of each load; this is drawn independently. However, it is ensured that equal amounts are transported to the two destination mills.

Results

As the model describes a currently non-existent system, it could not be validated against real data. To enhance model validity, an assumptions document for the model was prepared with the aid of expert people responsible for timber transportation. In the verification process, components of the simulation model were tested using data sets, for which calculations were made also manually.

The length of the simulation run was two weeks with total commissions of 28,000 cubic meters of timber. The system with two unit trains was able to complete the commissions with a service ratio of 100%, i.e. each route was completed during the same period it was planned. The utilization of the trains was 80 %. The calculated cost for each route is shown in Figure 2. The MSE estimate fitted to the data is also shown in the figure. The marginal cost of transporting a cubic meter of timber an extra kilometer is 0.83 snt. The fixed cost of transporting one cubic meter of timber is 1.78 euros. This cost component is due to time spent loading and unloading the cargo.

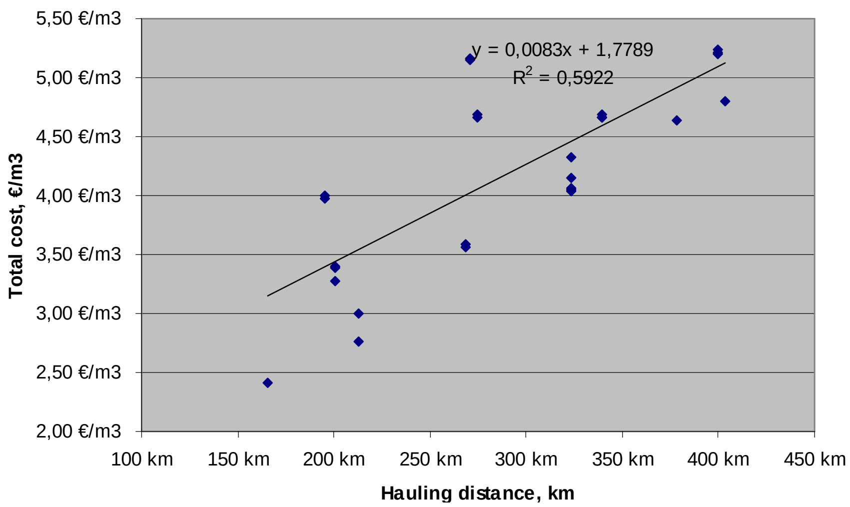

Figure 2. Total transportation cost as a function of hauling distance.

The time usage is divided almost evenly between driving empty, loading, driving loaded and unloading. Although, these numbers might indicate that transportation system is inefficient, the simulation research of Automated Guided Vehicles (AGV) inside of factories have shown even lower utilization levels, in other words driving as loaded (Ujvari & Hilmola 2006). In alternative scenarios, where the number of available commissions was reduced achieving 70% and 60% usage ratios, the transportation cost rose by 6 and 11 percent respectively.

4. Simulation Case-Study: Evaluation of Railway Network Investments

System under study

The simulation study aims at valuating the annual freight transport cost on a given part of railroad network. Possible reductions in freight transport cost are assumed to increase operator surplus, which results in higher values for the CBA cost-benefit ratio. Scenarios are constructed for different investment alternatives.

The track under study is mainly single track and 334 kilometres long. It runs between Seinäjoki and Oulu serving as the Western key route between Northern and Southern Finland, Furthermore, it provides access to the Kokkola Port, which has the highest volume in Russian transit cargo (measured in tons) of Finnish ports (Tapaninen et al. 2007). The track is used daily by 30 freight trains and 32 person traffic trains. In year 2005 the track was used by 0.9 - 1.2 million passengers annually, which equals 12 percent of long distance train passengers. Altogether 26 percent of national passenger kilometres are travelled using this part of the track.

General planning of the track was started in 2004. Based on this planning process five investment alternatives to be evaluated, were formed. The total investment cost of each investment alternative is presented in Table 1.

Table 1. Investment cost in each investment alternative.

Investment alternative	**0+**	**A**	**B**	**C1**	**C2**
	Base	*Ideal*	*Plan*	*Compromise*	*Passenger*
Total investment (M€)	193	700	580	400	400

In the base scenario, to which the rest of the alternatives are compared, the track is kept on its current level. The maximum speed of passenger trains is 140 kilometres per hour and axel weight is limited to 22.5 ton. Alternative A presents the track in its ideal layout. Passenger trains run at a speed of 200 kilometres. For freight trains an axle weight of 25 ton is allowed at 100 km per hour. All 105 level crossings are removed. Three shortcuts are being built, double rails are laid at two sections of the track, five new stations are built and three are moved. In the more realistic alternative B, passenger trains run at a speed of 200 km/h. An axle weight of 25 ton is allowed at 80 km/h. All 105 level crossings are removed. Double rails are laid at two sections of the track and five new stations are built. Alternative C1 includes a subset of track improvements heading towards the ideal layout. This compromise alternative aims at improvements both in passenger and freight traffic. Passenger trains run at a speed of 200 km/h. An axle weight of 25 ton is allowed at 80 km/h. 49 level crossings are removed. Double rails are laid at one section of the track and five new stations are built. Alternative C2 includes a subset of track improvements heading towards the ideal layout. Alternative C2 aims exclusively at improvements in passenger traffic; passenger trains run at a speed of 200 km/h. Current axle weight is restricted to 22.5 ton. All 105 level crossings are removed. Double rails are laid at one section of the track and five new stations are built.

Simulation model

The simulation model was built using Quest, a simulation software offered by Delmia Corp. The model of the rail network includes stations and connecting rails with length, intermediate speed and electrification. Passenger trains run on a predefined schedule in the model. Freight trains enter the track as scheduled. Their travel speed is defined by the characteristics of the locomotive as well as freight carried and track type. Passenger trains also affect the movement of freight trains on the track as they are prioritized when reserving track capacity.

The cost model for freight transportation includes several cost components. Energy cost in the model depends on the energy source and load carried. Wages are calculated including extra charges for night time and weekends. The cost of the locomotive as well as other equipment includes interest cost and maintenance.

Future freight traffic time tables were constructed by modifying the weekly timetable of year 2004. The freight volume was assumed to equal the national rail freight forecast for the year 2025, as the evaluation period of Finnish railway investments is 30 years. Because the track had different layout in each investment alternative, time tables were constructed for each scenario individually. Additional 23 trains per week were scheduled, while maintaining current train size of 1488 tonnes. In scenarios with increased axle weight the number of wagons per train was reduced on routes allowing the new axle weight also outside the track part analyzed. Each weekly schedule was run and the total freight cost of each alternative was calculated based on the output of the simulation model and unit price of each cost component.

Results

To enhance model validity, an assumptions document of the model was prepared with officials of the Finnish Rail Administration. In the verification process, components of the simulation model were tested separately. Prioritization of trains was tested based on visual observation of the model. Travel speed and performance data output were verified by manual calculations.

The operating cost in the basic scenario was 53.5 million Euros per annum. The annual operating cost of all investment alternatives is presented in Table 2. The cost decrease in alternative C2, which concentrates on benefits in passenger traffic, is smaller than experienced in other investment alternatives.

Table 2. Annual operating cost in each investment alternative.

Investment alternative	0+	A	B	C1	C2
	Base	*Ideal*	*Plan*	*Compromise*	*Passenger*
Annual cost (M€)	53.5	42.8	43	43.4	50.9
Relative change		-20%	-20%	-19%	-5%

The results of the freight transport analysis were included in the overall cost benefit analysis of the track investment. Reductions in freight transport cost are assumed to increase operator surplus, which results in higher values for the CBA cost-benefit ratio. The overall CBA of the track investment can be found in Rinta-Piirto and Pesonen (2006). Here we only state that each investment alternative is positively affected by the inclusion of freight transport in the analysis. Furthermore, the ranks of the alternatives are affected by the inclusions.

5. Case-Study: Volvo's Car Engine Plant in Skövde, Sweden

System under study

The case study involved the Volvo Car Company's J-division in Skövde (Sweden), which is a car engine crankshaft plant. The degree of automation is very high and the complete Volvo Eastern Engine plant is recognized as a leader in an effective production of car engines.

The plant produces four, five, and six-cylinder engines of a large variety of models with options such as turbo and exhaust configuration etc. At the time of this research there were eight types of crankshafts that were produced at the J-division. The production is divided into 32 workcells, which perform operations on the raw-material forming it to finished crankshafts. The layouts of the work cells are three large ovals where firstly rough-cut machining, secondly fine-machining, and finally grinding is performed. At the end of the line is an intermediate high-store buffer, where the products are stored before entering the internal engine assembly line.

The materials handling is carried out by an AGV system, which transports the crankshafts on special pallets that can carry 20 crankshafts each. One AGV can carry one pallet either loaded or unloaded. Between all the work cells the pallets are moved by AGVs, which result in a considerable number of transportation tasks. This is carried out by 29 AGVs. The AGV system is a moderately old system using inductive wire-guidance for navigation. The guide-path layout is unidirectional with zone-blocking for traffic control. The dispatching rule chooses the closest free vehicle first for a delivery task. There is no planning ahead capability implemented to improve performance.

The basic principle of control is pull-demand, in other words JIT. This is combined with manual control of the work-in-process level of the system and the part mix. The production flow is line-based and the crankshafts travel from one cell to another on pallets. Some cells have multiple functions or machines to balance the total cycle-time of the cell. Each work cell place material requests to fill its local buffers, which have a capacity of one pallet (Figure 3).

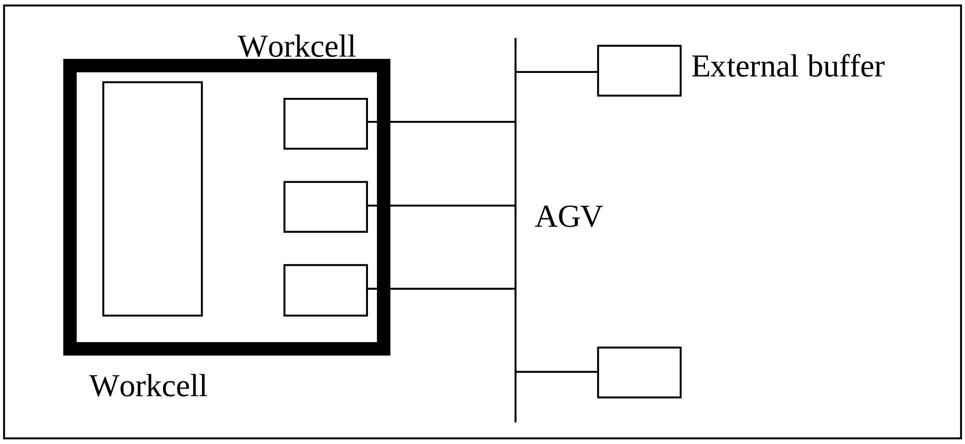

Figure 3. Workcell layout, which includes one machine (or more), three work cell buffers, and two external buffers. Parts in the workcell are handled by an overhead-gantry which defines the boundary of the cell.

Most work cells have three buffers from which parts are picked, machined, and put back in position. Once the operations are made to the parts on a pallet it is requested to be removed from the work cell. If there is space in a downstream work cell, which can perform the next operation, a transport request is issued and the move is made. As second priority a check is made for space in the external buffers of each cell. If no space is available there either the work cell becomes blocked.

At the beginning of the production line parts enter the system. This work cell is manually operated and the total work-in-process is controlled not to become too high and cause congestion in the system. A logistics manager decides the actual part mix of crankshafts to be produced to keep the safety stock up-to-date.

Simulation model

The simulation model was built using Quest. The model is based on two major subsystems, the set of production machines, and the overall transportation system. There exist 32 separate machines for production, i.e. lathes, drilling machines, balancing machines, rough and finegrinding, finishing etc. The failures of these machines are based on *stochastic parameters* in relation to the number of parts produced or time in production so that mean-down-time, mean-time-to-repair, and mean-time-between-down will vary for the machines.

The transportation system is based on a central AGV-controller, a varying number of AGVs and several miles of wire-guided tracks. The transportation demand of the production machines is feed to the central AGV-controller, which dispatches the transport orders to individual AGVs in a manner similar to a taxi-control-center, e.g. closest empty AGV gets the order. The transportation system itself does not include *stochastic variables*, but is influenced by the production systems failures.

Results

Before starting to analyze the effect of speed and number of AGVs on the production system performance, a validation on the simulation model was made using real production data. Based on the average production performance of Volvo’s J-Division, the simulation model showed a difference of only a couple of percents. Therefore, we are confident to argue that the used model represents reality in a valid manner.

The speed of the AGV system was in the first place varied, but this seemed to produce insignificant effects on the production output, since guided paths restrict higher speeds. For example, the speed of a vehicle was constrained by the following factors: (1) safety regulations (as humans are working in the system, max. speed is 1 m/s), (2) system curves (which required lower speeds), (3) system congestion, and (4) single vehicles inability to accelerate fast enough. As the simulation results reveal, production output increases nearly linearly just by adding more AGVs in the system. Therefore, we might assume that this service type of operation represents a constraint in the engine production process. So, it seems to be the case that the management of this company is recommended to invest more on adding AGVs in the floor, if production output and flexibility is the aim in the future. Also the simulation made it possible to test up to 35 AGVs since only 29 were available in the real system.

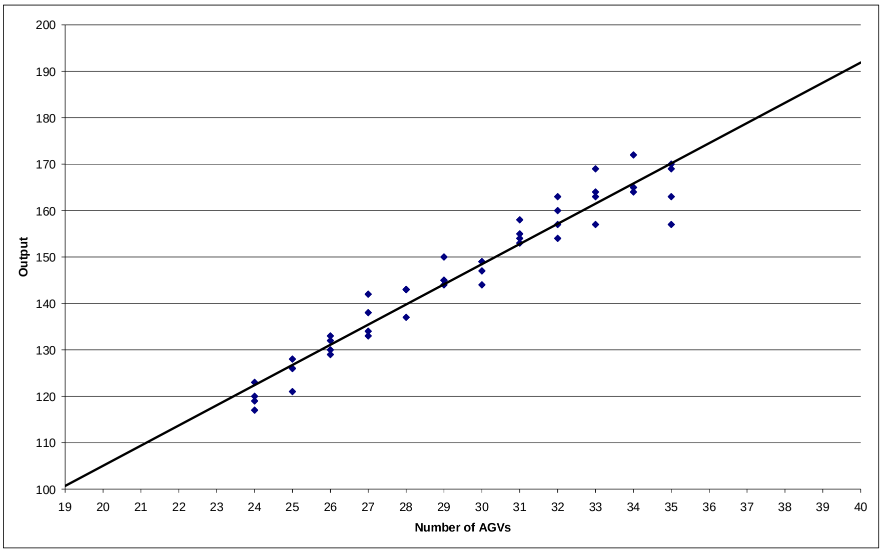

Figure 4. Production system output and number of AGVs used (different observation points correspond to varying speeds from 1.0 to 1.3 m/s).

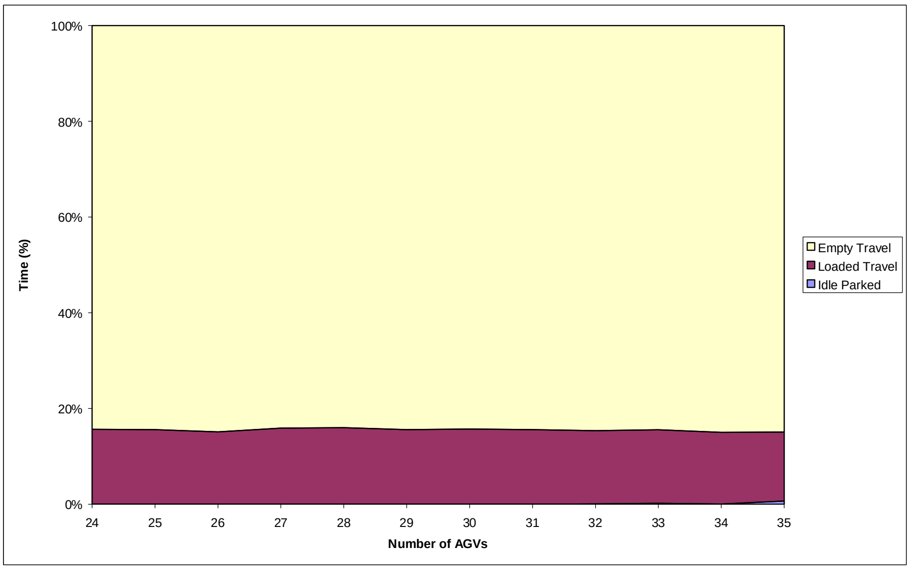

Figure 5. Time spent in different states for the AGVs with speed of 1.0 m/s.

Further simulation analysis shows that AGVs spend increasing amount of time in the empty travel mode, as the number of vehicles is increased in the system. With 35 vehicles AGVs also spend a small amount of time as “idle parked” (see Figure 5) (Time spent for loading and unloading pallets are not included since they are constant for every load-transfer.). Difference between these two “unproductive” modes is worthwhile to deal with further. In the former mode, “empty travel”, the AGV has completed its transportation task, and is heading back to a parking area, but in all other simulation scenarios, except 35 AGVs in a system, vehicles will receive new assignments to be completed before arrival to the parking area. It should be noted that empty traveling also occurs, when an AGV is having an order, but it is heading towards the place to pick-up items. The used level of artificial intelligence also affects on the amount of empty travel; e.g. in this case the AGV system is rather old, and uses “no plan ahead policy”. In a number of cases this will result in a situation where a free vehicle from the other end of the system is assigned for a transportation work instead of an AGV located near-by but still in use for the next 20 seconds. However, these all together demonstrate idleness and utilization issues well in a service type of machine case (as it can not build any inventory buffers); a manufacturing unit just needs to accept “empty traveling” as a competitive weapon to assure production system productivity and flexibility.

AGV simulation in real-life is a more complex issue as is given in the above; presence of numerous production buffers, and dynamic properties of the manufacturing system are difficult to predict. Also the number of AGV blockings increase as more vehicles are being added to system. For example, in Figure 4 production output was somewhat lower in 35 AGV case than in the former one.

6. Simulation Case-Study: Evaluation of Railway Wagon Alternatives

System under study

Finland is one of the most important pulp producing countries in Europe (CEPI 2006). During year 2005 the total amount of wood imported to Finland was 21.5 million m^3. Russia holds as a source for 79 percent of imported wood to Finland (Finnish Forest Research Institute 2006).

59 percent of Russian wood is transported on rails. As a consequence rail transports have idle capacity in the eastbound direction on the Finnish – Russian border. The cost advantage of Russian timber in comparison to Finnish raw material is likely to decrease in the future as Russia has announced a schedule to increase tariffs for timber exports – these are already effective, and based on the tariff increase program are only going to get higher in the future. To correspond this new demanding environment the exporters need to examine and fine tune their cost structure of procurement.

On the other hand the ever increasing demand for imports in Russia has lead to insufficient capacity of the Russian ports to handle the volumes required. This has resulted in a transit flow through Finnish ports. The transit volume was 276 364 TEUs in 2005 (Finnish Port Association 2008). From the ports goods are transported to Russia by road. The share of Finland in Russian transit transports is likely to decrease, but the absolute volume is expected to grow (Ruutikainen et al. 2007).

The simulation study aims at examining the transportation cost of forest industry raw material using two different types of railway wagons in a given network, with the possibility to use the equipment to serve the eastbound transit container flow.

Simulation model

In the case model, rail transport of timber to two mills located in Eastern Finland is being analyzed. The supply of timber comes from 4 terminals located in Russia. The average distance of the terminal to the mills is 458 km. For the simulations Quest was used. The simulation model of the rail network includes stations and connecting rails with length and intermediate speed. Each connection between two locations in the network is modeled separately, i.e. the model does resemble the actual rail network structure in physical terms.

In the beginning of the simulation run all wagons are located at the terminals. There is a train leaving from each terminal to both mills each day. The amount to be transported has an annual pattern, where the quantity of each month is different. The daily amount carried by each train is drawn from a uniform distribution with a variability of 10 percent (i.i.d). After customs clearance the trains travel to the destination mill where they are unloaded. Empty wagons are returned to the terminal where it was originally located. The typical wagon turn of the base scenario is 12 days.

The alternative scenario combines container traffic with wood transportation. In this scenario wagons are, after unloading at the mill, directed to a container terminal located in Kouvola, Finland. At Kouvola wagons are loaded with containers, which are transported to St. Petersburg. From here, empty wagons are returned to the terminal where they were originally located, as in the first scenario. This container traffic would substitute road transports. A screenshot of the model is presented in Figure 6. The points in the left side of Figure 6 represent container docking point of Kouvola, the two upper points in the middle are pulp/paper mills located in Imatra and Eno. Wood collection terminals on the Russian side are located all in the right side, while the St. Petersburg container dropping point is located in the middle. The typical lead time of the alternative transportation loop is 19 days.

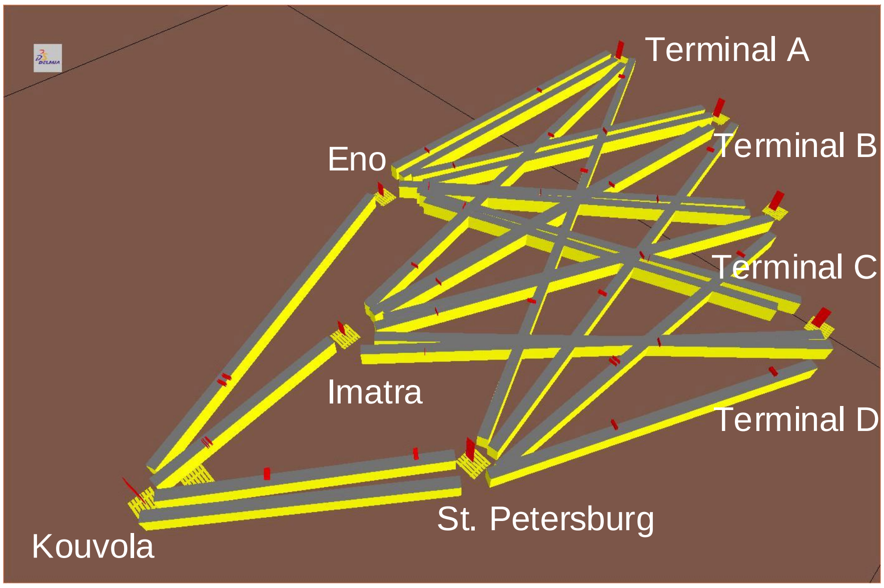

Figure 6. Screenshot of the simulation model running.

The transportation cost in the model consists of two components, cost of the wagons and traction cost. The cost of the wagons includes interest cost and maintenance, 5 %, while the traction cost, 2.0 eurocent per ton kilometer, charged by the operator is assumed to depend on the gross ton kilometers to be transported.

Although mills basically run and produce at a fairly constant rate, wood harvesting and transportation experience a heavy annual pattern. For the seasonal pattern of the transports Finnish commercial round wood removals by month are used. The pattern is shown in Figure

7 (Finnish Forest Research Institute 2006). The total volume of the peak month is 71 300 ton.

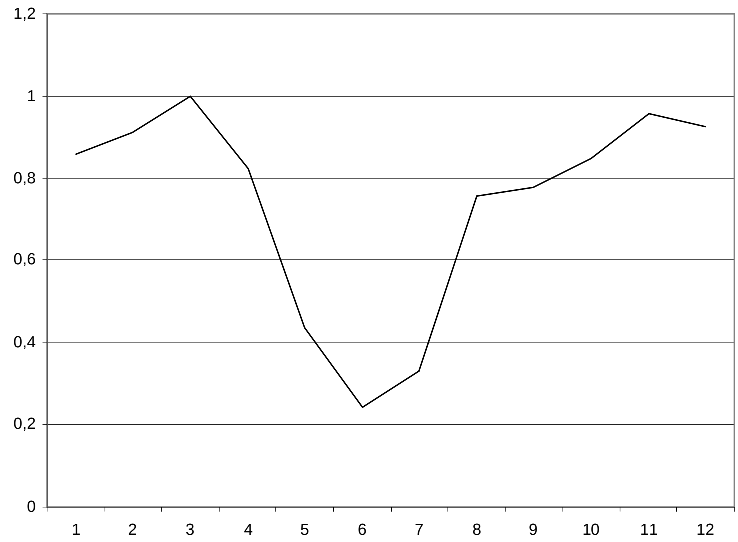

Figure 7. Commercial round wood removals by month.

Technical and economic parameters of the two wagon types evaluated are presented in Table 3. Technically a 13-926-01 type wagon could carry 66 tons of cargo. However, the maximum axle weight allowed on the rail network is 22.5 ton, which restricts the cargo to 62.2 tons

Table 3. Wagon parameters used in simulation model.

Wagon type	13-401-20	13-926-01
Length	14620 mm	19620 mm
Body Weight	23.8 tons	27.8 tons
Load Weight	66 tons	66 tons
Load Volume	130 cubic meters	158 cubic meters
Price	45 000 €	50 000 €
Lifetime	32 years	32 years
Resale price	2 000 €	2 000 €

Results

The length of each simulation run was 14 months with a warm-up period of 2 months. As the cargo carried by the 14 meter wagon is greater than that of the 19 meter wagon, 66 and 62.2 tons respectively, fewer the smaller 14m wagons are needed for transporting the same amount of wood. With equal lifetime the 14 meter wagon induces less capital cost per ton kilometer. Furthermore, as it has a better cargo-dead weight ratio, the traction cost is lower. So in the base scenario the 14 meter wagon is the more efficient and economic choice of the two wagons.

When container traffic is combined with wood transportation, extra wagons are needed, which increases the capital cost. Additional freight is carried and distance is traveled which increases the traction cost. This extra cost can be divided by the systems annual capacity to transfer 20-ft containers, or TEUs. A 14 meter wagon can carry 2 TEUs, while the capacity of the 19 meter wagon is 3 TEU. Given the wagon type the break-even price for TEU is 177 € and 150 € for 14 meter and 19 meter systems respectively. Because of the larger TEU capacity of the system based on the 19 meter wagons, the 19 meter combined scenario becomes more attractive as the price of transporting a TEU increases. The 19 meter combined system is the global optimum if 225 € or more can be charged for the transportation of a TEU.

According to the sensitivity analyses conducted, the traction charge, accounting for 86 - 89 percent of the transportation cost, is the most important factor when determining viability of the alternative systems. Figure 8 shows the Break-even prices of the combined systems as a function of traction charge. If the market price for transporting a TEU is below the lower break-even level in Figure 8, the cost efficient alternative is to use 14 meter wagons solely for timber transportation. If the market price lays between the two lines found in Figure 8, the combined system using 14 meter wagons is optimal. If the market price of TEU transport is above both lines, the combined system based on 19 meter wagons should implemented.

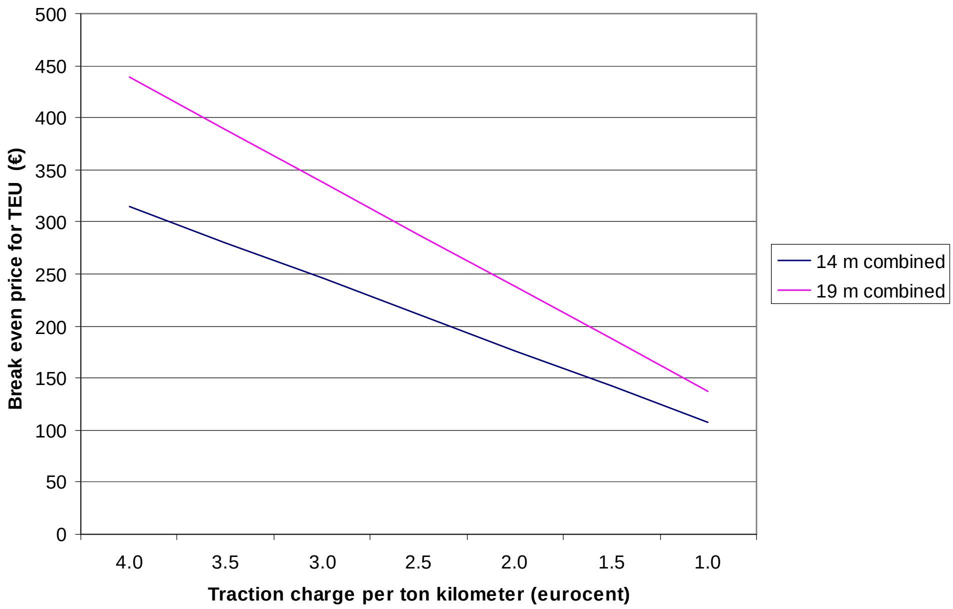

Figure 8. TEU break-even prices of the combined systems a function of traction charge.

Another way to use the wagons for container traffic arises from seasonality. During the idle period extra wagons could be transferred to and used solely on the Kouvola – St. Petersburg route. Given the wagon type the break-even price for TEU is 197 € and 167 € for 14 meter and 19 meter systems respectively, still on a reasonable level. The total annual TEU capacity for the combined systems utilizing idle wagons for container traffic is for the 14 and 19 meter wagons 35850 and 57420 respectively. Given that the annual volume of wood carried by system is approximately 10 percent of the total volume imported and that the same border crossing points are used practically for all rail transports of wood from Russia to Finland (Tapaninen et al. 2007), the combination of wood transports and container traffic could be applied even more widely. A rough container capacity estimate for a system based on 14 meter timber transport wagons would be 350 000 TEU per annum, the theoretical capacity of the 19 meter system is even higher. Although a considerable amount of the transit container traffic is going to e.g. Moscow instead of St. Petersburg, combined use of timber wagons offers an economic way to transport containers on rails.

7. Discussion – Towards Transportation System Simulation Framework

In all of the four reported simulation cases, which have been developed in larger research projects, have showed us that stochastic features of transportation system simulation models are divided into two parts. The most suitable dividing point is whether stochastic variables are located inside the transportation system (endogenous), or is it arising from the served system (exogenous; see Figure 9). Frequently, as e.g. is the case in three cases out of four, the most important stochastic variable is demand of production system/network. In Volvo's case two other exogenous stochastic variables, namely related to failure rates in machines/equipment as well as in their setups and cycle-times were needed to be taken into account. Surprisingly, in the second research project case the project's final customer was extremely happy for the transportation system simulation model, which did not include stochastic elements at all. The transportation system simulation model for evaluating railway network investments just contained operating structure of a transportation network, and it was able to gather costs as well as benefits by using pre-determined timetables of train movement. In a railway context it is relatively easy to understand such a modeling requirement since booking of railway network even under free competition, and in united Europe takes easily 6-12 months time. Timetable building in railway networks are built in an extremely cautious fashion, where each track phase has its own safety time-buffer, should the train does not proceed with the planned speed. Other two cases completed within railway sector, also indicate that the general scope of the problems requires only minor amount of stochastic elements in the simulation models.

Endogenous Stochastics	Case I	Case II	Case III	Case IV
1. Transportation lead-times				
2. Loading and un-loading times				
3. Failure rates				
4. Possible sequencing / quality control				
5. Availability of transportation resources (equipment/labour)				

Exogenous Stochastics	Case I	Case II	Case III	Case IV
1. Demand	●		●	●
2. Failure rates in machines/equipment			●	
3. Cycle-time and setups in particular machine			●	
4. Transfer lot sizes between phases				
5. Availability of resources (equipment/labour)				

Figure 9. Endogenous and exogenous stochastic variables in transportation systems simulation models.

Based on these four case-studies as well as earlier research works in the transportation system simulation area, we do not identify any significant need to use endogenous stochastic variables to a larger extent in the future. Same applies for unused exogenous variables. As the only potential variable to be included in the future models is the availability of resources – transportation systems, e.g. increasingly road transports as well as airlines, operate through hub-and-spoke system, which enables high utilization of resources and star operating structure use. However, downside of hub-and-spoke is its vulnerability for resource availability, e.g. maintenance problems with one airplane could cause transportation system malfunctioning all over the continent. Thus, it should be noted that resource availability has not traditionally been a problem in transportation systems – in a case of e.g. road transportation resource utilization with general equipment is relatively low, and in rare cases represents production system constraint. However, as case III showed, low resource utilization does not necessarily mean that the transportation system itself would is not the production system constraint. In customized and built-to-order products transfer lots have decreased considerably and production systems have been centralized only in a handful of locations. So, in this environment transfers between system components increase significantly, although the transportation work measured with traditional measures, like in tonne-kms, itself is not increasing that much. Thus, transportation amounts are increasingly significantly (kilometers).

Future usage of stochastic variables in the end depends on used evaluation criteria of the served production system. In all of three cases we followed such issues as costs and system throughput. However, if the criteria are directed more to the customer perspective, e.g. trying to evaluate lead-times for production or service in the system, the realistic transportation system model would need to take into account even endogenous stochastic variables.

8. Conclusions

In the past three decades time simulation has become a frequently used approach in modeling logistical systems, understanding their behavior, and improving performance. However, analytical models are still a good option for expensive simulation projects. Currently simulation is being used mostly in production related situations, but we argue that in logistics field in the near future transportation systems are the main source of further productivity improvements. Notable is the fact that simulation research has not discussed widely, how transportation systems should be modeled, and how different stochastic parameters should be incorporated into models. Based on our research, we argue that most important modeled aspect in transportation systems is the endogenous served system and its stochastic variables to external world – the transportation system structure is of course a vital part of simulation success, but stochastic variables could be neglected, and still the whole model would perform realistically, and provide needed answers for decision makers.

For further research in this area, we would be interested to complete cases in transportation systems, where there exist multiple customers and products to be transported between locations, or entire network. It would be worth of analyzing, how collaboration between different customer groups, product groups and locations affects transportation system performance, transportation equipment requirements, and eventually how these more complex transportation networks should be modeled with regard of structure and stochastic variables.

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Bullwhip and Step Increase in End Demand

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Abstract
The amplification of demand, or bullwhip effect, in supply chains has grounded a lot of research during the last 50 years. The topic is important because fluctuation of orders reduces efficiency of a supply chain.

Transparency and the use of different forecasting methods have been suggested as effective ways to reduced amplification of demand. Our research, however, shows that faced with a stepwise one time increase in end demand the bullwhip is actually amplified if Exponentially Weighted Moving Average forecasting method is applied.

Keywords: SCM, bullwhip effect, EWMA, system dynamics, simulation

1. Introduction

The history of system dynamics states back to the article ‘Industrial Dynamics--A Major Breakthrough for Decision Makers’ by Jay W. Forrester, which was published in Harvard Business Review year 1958. The book titled Industrial Dynamics, also by Forrester, was published in 1961.

Today the amplification of demand fluctuation in a supply chain is known as Forrester effect or bullwhip effect. The bullwhip reduces the efficiency of the supply chain (Boyaux et al. 2007). Efficiency is lost especially in terms of low resource capacity utilization, high inventory level fluctuation and large safety inventories (Nienhaus et al. 2006). According to Hwargn and Xie (2008) feedback loops, interactions and delays in a supply chain can result even in a chaotic behavior.

In principle elimination of the bullwhip is fairly simple – it can be achieved simply by applying lot-for-for replenishment at each stage of the supply chain. In reality companies need to manage their inventory, lot-sizing, and market, supply, or operation uncertainties. (Moyaux et al, 2007). In addition to demand uncertainty, uncertainty exists in respect of delivery lead times, manufacturing yields, transportation times, machining times and operator performances, which all have a significant impact on chain performance. (Bayraktar et al. 2007).

According to Nienhaus at al. (2006) the main reason behind bullwhip are delays related to material supply and information sharing. The later information on demand changes is received and the longer it takes to react to changes the more forcefully one needs to react.

Other factors contributing to bullwhip include the use of the demand of the next layer to forecast end demand, forecasts based on historical data, lot sizing, price fluctuation and rationing and shortage anticipation. (Chen et al. 2000; Nienhaus et al. 2006; Moyaux et al. 2007) Furthermore, misperception of feedback and local optimization may increase bullwhip (Moyaux et al. 2007)

Information sharing (Chen et al 2000; Moyaux et al. 2007; Nienhaus et al. 2006) and different forecasting methods (Bayraktar et al. 2007; Chen et al 2000) have been seen as an effective way to reduce the bullwhip effect.

The bullwhip effect has been illustrated and experimented widely by using the beer game, a four stage supply chain management simulation constructed in MIT in the 1960’s. (e.g. Nienhaus et al. 2006; Hwarng & Xie 2006)

In this paper we investigate the performance of a four stage beer game type supply chain facing a one time step like increase in end demand. Our results indicate that in this case transparency in supply chain reduces variation, but using Exponentially Weighted Moving Average method for forecasting increases variation.

2. Model

In this paper we investigate the performance of a beer game type supply chain consisting of a retailer, distributor, wholesaler and production facility when different forecast methods are applied. The lead time in each stage of the supply chain is 4 time periods. The production and inventory capacities are assumed infinite. Customer demand is 99 units per period in the 99 first periods and 8 thereafter.

The different alternative scenarios include:

- Base scenario: demand forecast = latest demand
- Exponentially Weighted Moving Average (EWMA)

- Transparency to the next inventory
- EWMA + transparency

The simulation models presented in the article are made using Vensim, a typical system dynamics software package.

3. Base Scenario

The model of the base scenario is shown in Figure 1.

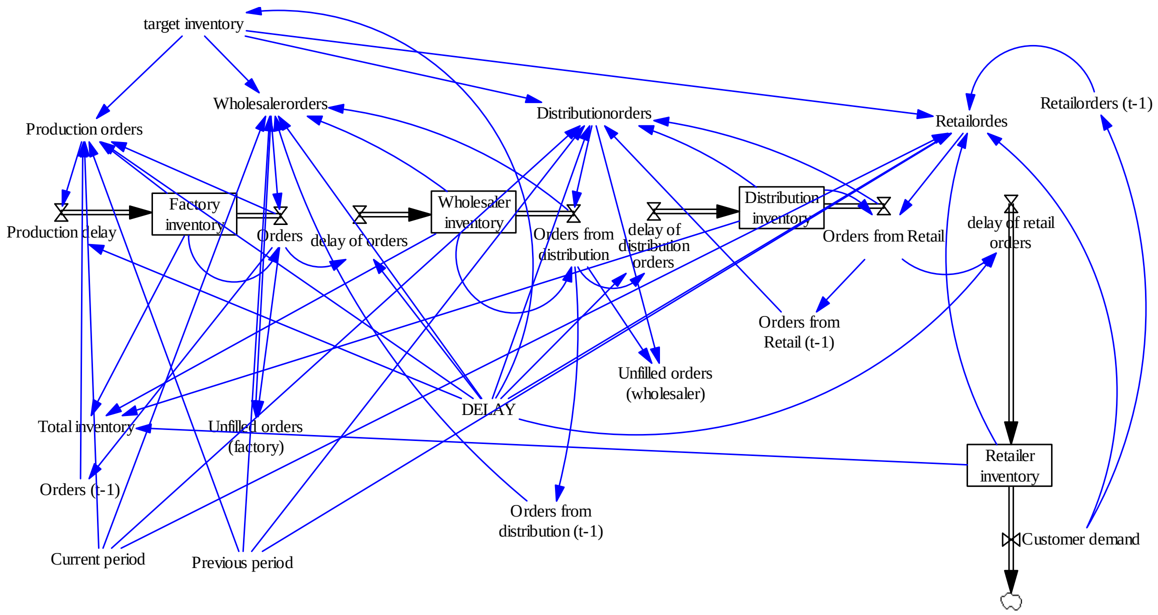

Figure 1. Base scenario model

The parameterization of the model shown allows the use of a two period Moving Average forecast. The constants Current period and Previous period found in the lower left corner of the figure are used for this. The base scenario is constructed from these by using the respective values of 1 and 0, which equals the situation were latest actual demand is used as the demand forecast. The parameterization has been removed from the equations presented, but not from the model because it comes handy when constructing the EWMA model later on.

In this, as well as in other scenarios later on, the target inventory level is given by

20*lead_time=80 units, which is also used for initial level of each inventory. All inventories use similar fill up strategy. For example the retail inventory fill up strategy is given by:

IF THEN ELSE((Orders from Retail+((target inventory-Distribution inventory)/DELAY))<0, 0, Orders from Retail+((target inventory-Distribution inventory)/DELAY))

So, if the inventory level is forecasted to fall below the target level during the lead time, a replenishment order equalling the shortage per period is released. By ordering per period the need to keep track of open orders can be avoided

4. Exponentially Weighted Moving Average (EWMA)

EWMA forecast can be constructed from previous observation by:

$$\hat{d}_{T+1} = \alpha d_T + \alpha(1-\alpha)d_{T-1} + \alpha(1-\alpha)^2 d_{T-2}......$$

,where 0< α <=1. (Source: Pindyck, Robert S.& Rubinfeld Daniel L. (1998). Econometric models and economic forecasts. Irwin)

This can be written also as

$$\hat{d}_{T+1} = \alpha d_T + (1-\alpha)(\alpha d_{T-1} + \alpha(1-\alpha)d_{T-2} + \alpha(1-\alpha)^2 d_{T-3}...)$$

Because

$$\hat{d}_T = \alpha d_{T-1} + \alpha(1-\alpha)d_{T-2} + \alpha(1-\alpha)^2 d_{T-3}......$$

By substituting we get

$$\hat{d}_{T+1} = \alpha d_T + (1-\alpha)\hat{d}_T$$

This format can be used in simulation.

Figure 2 presents the weight of previous observations for different values for alpha. The greater the value of alpha, the more heavily does the forecast react to changes in latest observations. When α =1, only the latest observation is taken into account when constructing the forecast.

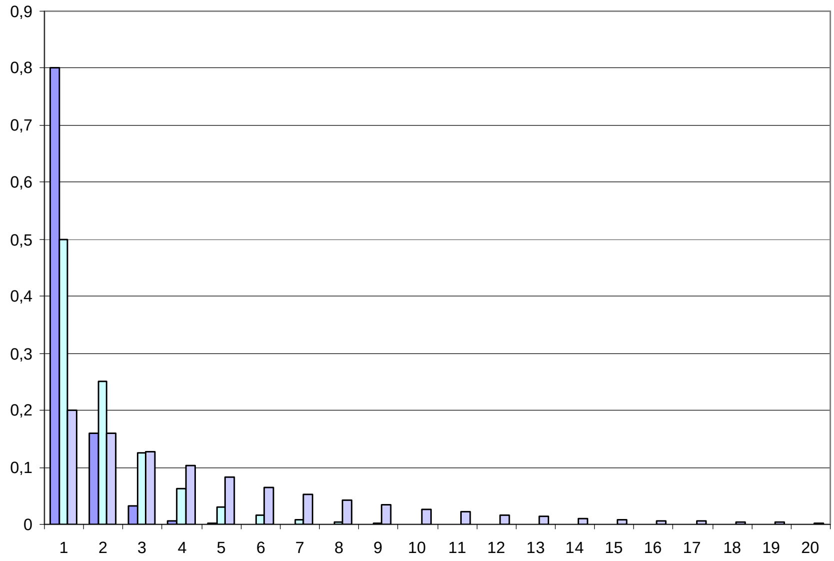

Figure 2. Observation weights in the EWMA forecast with alpha values of 0,8 , 0,5 and 0,2

The EWMA model is presented in Figure 3.

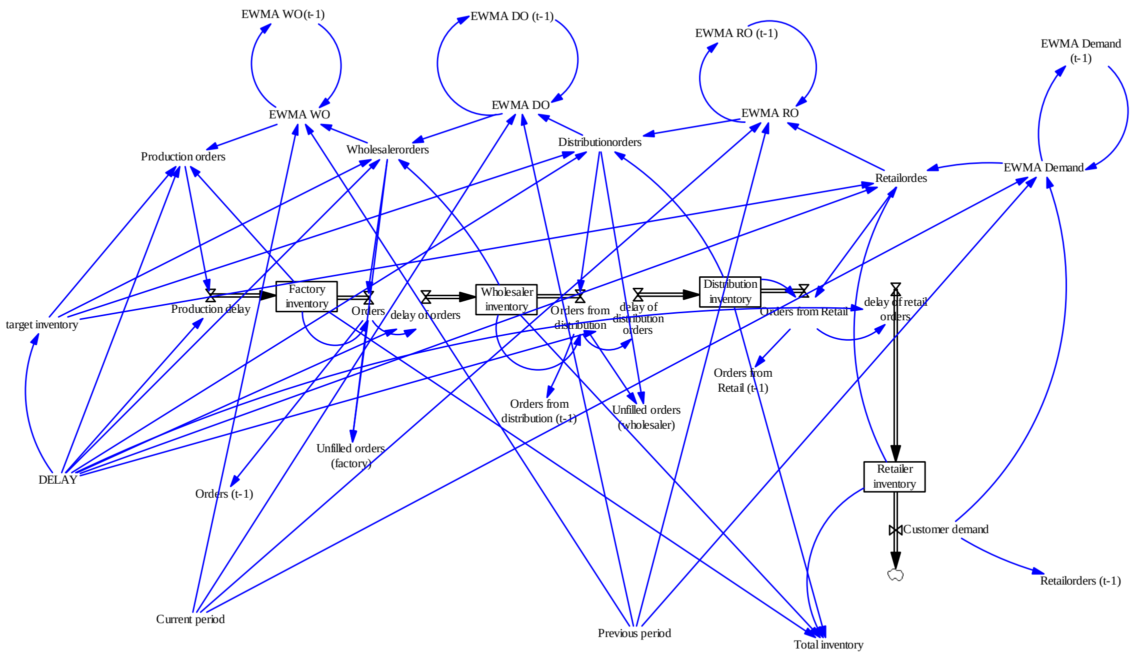

Figure 3. EWMA model

The model differs from the base case in that sense that at each stage of the supply chain a EWMA forecast is constructed. The respective loops are visible in the top of the figure. For example, the EWMA forecast of the distribution warehouse, EWMA RO, is constructed as:

EWMA RO=Current period*Retailordes+Previous period*EWMA RO(t-1)

EWMA RO (t-1) =DELAY FIXED(EWMA RO, 1, 0)

, where Current period = α and Previous period = 1-α.

In the retailers replenishment policy, demand is substituted by the forecast constructed, i.e.

IF THEN ELSE((EWMA RO+((target inventory-Distribution inventory)/DELAY))<0, 0, EWMA RO+((target inventory-Distribution inventory)/DELAY)).

In the verification process, the behavior of the customer demand forecast after t = 100 was observed. Furthermore, the behavior of the base model and EWMA model with α = 1 was compared, as they should be identical.

5. Customer Inventory Transparency

The model used for exploring the effect of customer inventory transparency is shown in Figure 4.

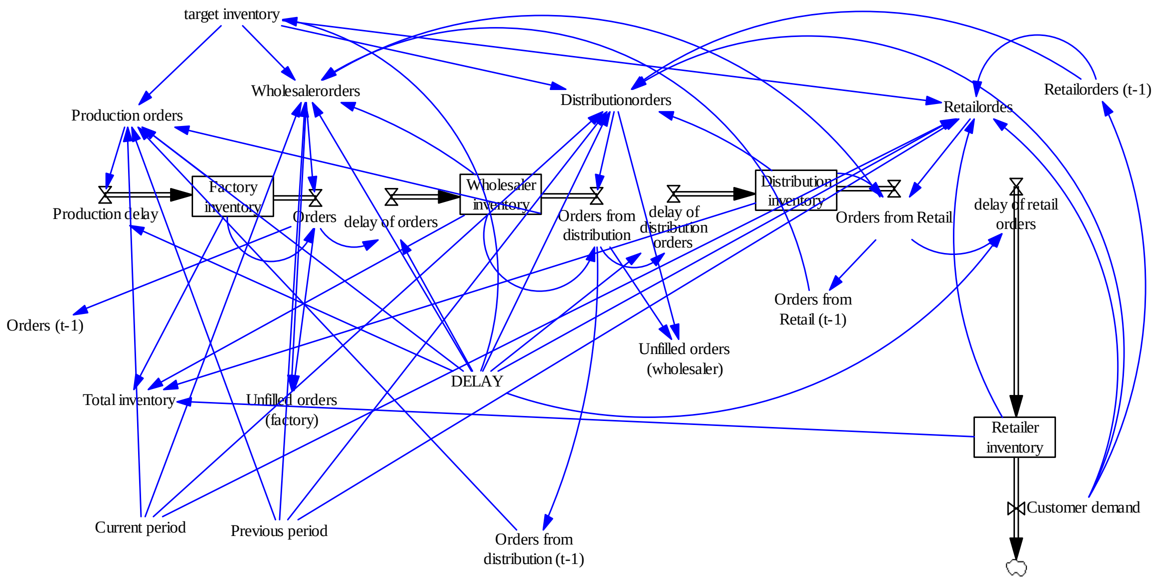

Figure 4. Customer inventory transparency

Here it is assumed that transparency equals information of customer inventory level and the demand facing the customer, i.e. orders placed by the customer's customer. The relevancy of the latter can be questioned. However, if we are the only supplier we can calculate demand facing our customer's inventory based the inventory level itself. However, replenishments are made based on actual orders, so we are not dealing with a Vendor Managed Inventory.

In the replenishment policy the demand to be taken into account are the orders placed by the customer's customer. Again, in case of the distribution inventory:

IF THEN ELSE((Customer demand+((target inventory-Distribution inventory)/DELAY))<0, 0, Customer demand+((target inventory-Distribution inventory)/DELAY))

Instead of making his orders based on retail orders the distributor orders based on retail sales.

6. EWMA and Transparency Combined

Combined model including both EWMA and transparency is shown in Figure 5.

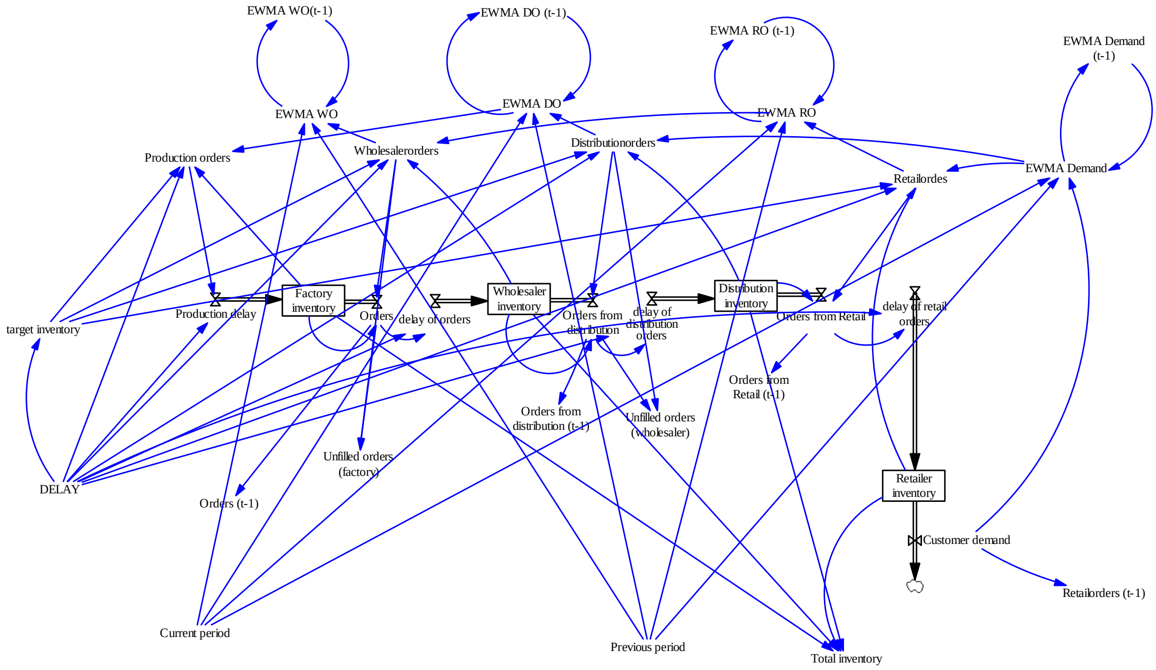

Figure 5. The combined EWMA and transparency model

In comparison to the transparency model the replenishment policy is not directly based on the orders placed by the customer's customer but on the EWMA forecast constructed based on these. In case of the distribution inventory:

> IF THEN ELSE((EWMA Demand+((target inventory-Distribution inventory)/DELAY))<0, 0, EWMA Demand+((target inventory-Distributioninventory)/DELAY))

7. Results

Figures 6 and 7 present the development of orders and inventory levels during a simulation of 300 time units in the base scenario respectively.

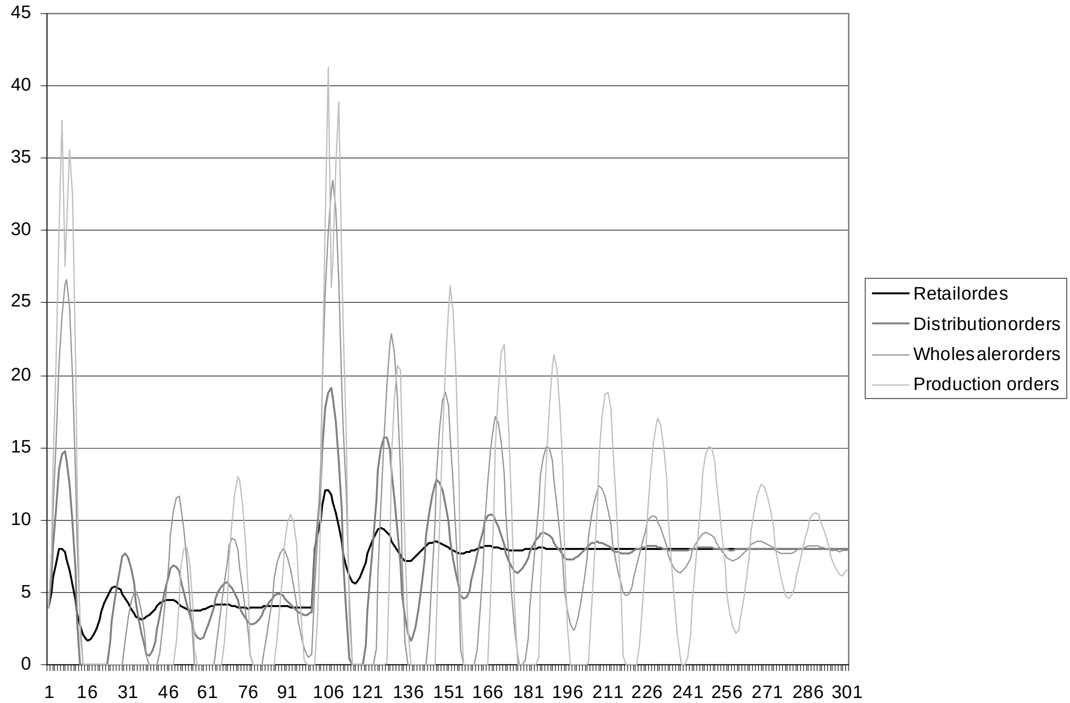

Figure 6. Demand fluctuation in the base scenario (x-axis =time units, y-axis = amount)

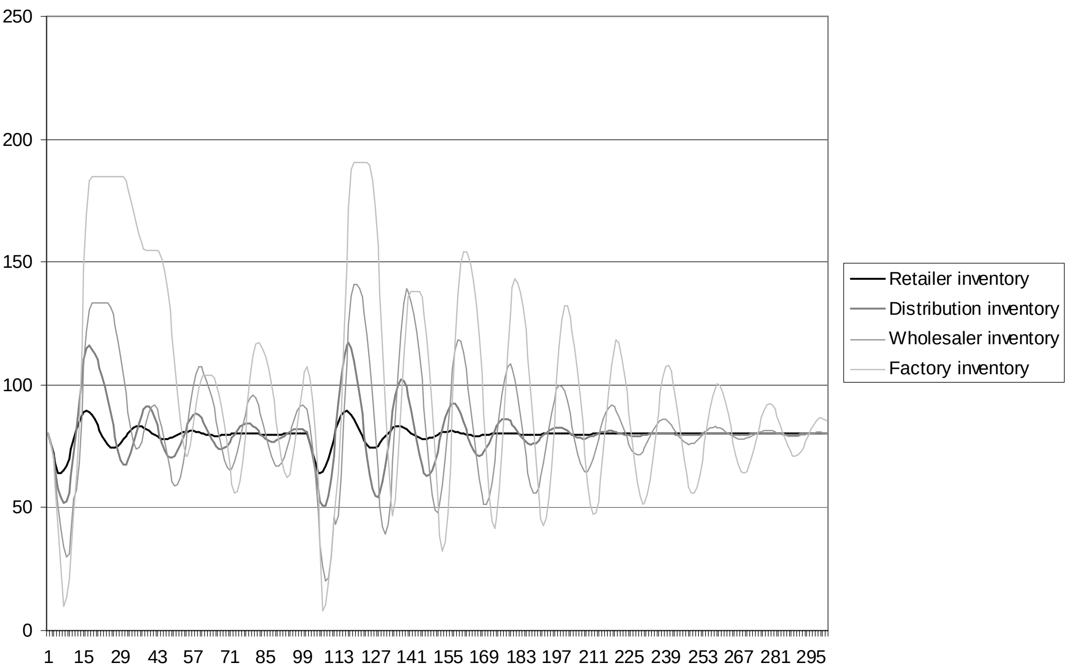

Figure 7. Inventory level fluctuation in the base scenario (x-axis =time units, y-axis = amount)

From Figures 6 and 7, it can be stated that the fluctuation of orders and inventory levels is amplified when moving upstream in the supply chain. The demand changes occurring at t=0 and t=100 are also visible in the figures. The disturbance in the beginning of the run is caused by the delivery lead time of 4 time units and that no orders are arriving during the first time periods. However, as the simulation is started at the target level of each inventory, replenishment orders are sent immediately. In order to avoid the effects of the warm up period, the statistics from different scenarios, shown in Tables 1 and 2, are calculated from t=100 onwards. The amplification presented in the tables is calculated as the ratio of the variation of the next stage of the supply chain, i.e. customer, to the variation of the current stage. For EWMA models presented in the tables the value 0.5 is used for alpha. Using the values 0.8 and 0.2 did not affect the results considerably.

Table 1. The variation of orders at different stages of the supply chain in different scenarios

Base scenario	Retailordes	Distributionorders	Wholesalerorders	Production orders
Max	12,0	19,1	33,4	41,3
Min	5,6	0,0	0,0	0,0
Variation	6,4	19,1	33,4	41,3
Amplification		3,0	1,7	1,2
EWMA	Retailordes	Distributionorders	Wholesalerorders	Production orders
Max	12,5	20,9	37,3	52,8
Min	5,3	0,0	0,0	0,0
Variation	7,2	20,9	37,3	52,8
Amplification		2,9	1,8	1,4
Transparency	Retailordes	Distributionorders	Wholesalerorders	Production orders
Max	12,0	15,8	19,7	25,3
Min	5,6	0,4	0,0	0,0
Variation	6,4	15,4	19,7	25,3
Amplification		2,4	1,3	1,3
EWMA+Transparency	Retailordes	Distributionorders	Wholesalerorders	Production orders
Max	12,5	16,7	21,2	27,7
Min	5,3	0,0	0,0	0,0
Variation	7,2	16,7	21,2	27,7
Amplification		2,3	1,3	1,3

Table 2. The variation of inventory levels at different stages of the supply chain in different scenarios

Base scenario	Retailer inventory	Distribution inventory	Wholesaler inventory	Factory inventory	Total inventory
Max	89,6	117,3	140,7	190,6	526,6
Min	63,9	50,6	20,4	8,1	148,7
Variation	25,6	66,7	120,3	182,4	377,9
Amplification		2,6	1,8	1,5	
EWMA	Retailer inventory	Distribution inventory	Wholesaler inventory	Factory inventory	Total inventory
Max	90,7	114,0	155,9	245,2	577,8
Min	61,9	44,8	10,6	0,0	121,6
Variation	28,8	69,2	145,4	245,2	456,2
Amplification		2,4	2,1	1,7	
Transparency	Retailer inventory	Distribution inventory	Wholesaler inventory	Factory inventory	Total inventory
Max	89,6	110,4	130,1	147,8	465,2
Min	63,9	48,7	31,6	20,4	207,1
Variation	25,6	61,7	98,5	127,4	258,1
Amplification		2,4	1,6	1,3	
EWMA+Transparenc	Retailer inventory	Distribution inventory	Wholesaler inventory	Factory inventory	Total inventory
Max	90,7	114,2	139,0	163,2	495,2
Min	61,9	45,1	29,2	20,3	191,6
Variation	28,8	69,1	109,8	142,8	303,6
Amplification		2,4	1,6	1,3	

In all scenarios the variation of orders and inventory levels is amplified when moving upstream in the supply chain, i.e. the Forrester effect is present

As intuition suggests, transparency decreases variation in comparison to the base scenario as well as in combination with EWMA forecast. Surprisingly, however, EWMA increases variation of both orders and inventory levels. The variation of total inventory was decreased by the introduction of transparency by more than 30 percent. 'Utilization' of the EWMA forecast increases variation by almost 20 in comparison to the alternative, in which the latest order is directly used as the forecast.

8. Conclusions

The results indicate that transparency reduces variation in a supply chain, but EWMA forecast would increase it. In the case of EWMA forecast the result is counterintuitive.

In the case presented customer demand changes only at one point of time shifting to a new, higher, level. The EWMA forecast does not immediately react to this change; the new level of demand is noticed after a certain period of time. Inventory levels are reduced during this period. As the new, higher, level of demand is realized when inventory levels are low, larger orders are made respectively, which in turn increases the variation of both orders and inventory levels.

This finding, however, does not imply that EWMA forecast would reduce the efficiency of the supply chain in general. If customer demand includes variation, EWMA would reduce the amplification of variation when moving upwards in the supply chain.

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Transit of High-Value Goods via Finland to Russia

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Abstract
The growth of Russian economy has increased trade and transit traffic between Finland, Russia and European Union. In this paper we assess the current condition and future development of high-value exports to Russia. We use official transit and trade statistics that are supported by company interviews and literature. Our study shows that the Finnish share of transit to and from Russia is, and will remain, high. The annual increase in absolute TEUs is too high to be handled by new and improved Russian ports or the competing routes from other parts of Europe. The Finnish route has several competitive advantages. It is regarded reliable and predictable with good warehousing and value-added services. The transit time is considered short by the interviewed companies. In the case of high-value items, the growth continues. However, operators consider that direct transports will increase and the need for warehousing decreases.

Keywords: Transit traffic, high-value goods, transportation, Finland, Russia

1. Introduction

Russian economy has been growing steadily since economic crisis in 1998. Growing middle class creates demand for import products. In 2006 the growth rate of imports to Russia exceeded the amount of exports. The growth of imports from 2006 to 2007 was 25%. Finland has become a key transit route to Russia. Accounting together values of Finnish exports to Russia, and transit from other nations, the amount equals approximately 38 billion euros in 2007. This is a quarter of all imports to Russia. The largest commodity groups are radio, television and computer products together with cars. Important nodes in Finland (from Europe and other parts of the world) are ports of Hamina, Hanko and Kotka. Transit traffic has a significant economic impact to these locations, particularly in the region of Kymenlaakso where Kotka and Hamina ports are located.

Our topic is high-value transit to Russia. We consider current state and future prospects. We use mainly statistics that are supported by earlier works on the topic and selected key-actor interviews from businesses. Our paper provides empirical[9] overview of high-value good transit between Finland and Russia. A relevant study on this topic is done by Pekkarinen (2005) who has analyzed the developments of Finnish-Russian logistics. His work focuses on

[9] The empirical parts of this study have been made in 2007 by the authors. It has been partly financed by European Union, South-Eastern Finland–Russia Neighborhood Programme.

Northwest Russian transport logistics cluster. In addition, the growth of transit has implications for cross-boarder co-operation and small and medium sized enterprises (SME). Käki (2008) has discussed about these potentials with references to co-operation models and functions. Logistics of St. Petersburg corridor has been one major development areas in search of innovative solutions for cross-border co-operation. We focus on “high-value” goods. These include cars and electronics underneath the main statistical classification of machinery, equipment and transportation.

Pekkarinen (2005) compares potentials of transport modes in Russia. He concludes as follows (Pekkarinen 2005:111): “Railroads are the traditional, largest and most reachable transportation mode in Russia. Moreover, the utilization of the Trans-Siberian Railroad will increase the overall competitiveness of railroads.” […] the other transportation modes, road, sea and inland, and air transportation as “potentially competitive”. All these suffer from aging due to low investment levels. Road transportation is going to increase its share because of its flexibility. Sea and inland water transportation will benefit from their cost structures if the infrastructure is renewed properly. Air traffic will increase in general and the possibility of using Russia’s airspace as a route for global flights connecting Europe and Asia will accelerate the volumes.” This interpretation is relevant for our study, because our approach includes intermodal aspect of high-value transit. Unfortunately use of Trans-Siberian Railway has been very low since raise of the tariffs in the beginning of 2006.

Sergeeva (2007) studied car manufacturing in Russia. She discusses the structural change and development trend of multinational car manufacturers locating their functions. Cars are rapidly growing itineraries of high-value transit. Sergeeva (2007: 43) points out the fact that the majority of new car transit goes through Finland to Russia. She considers that a potential challenge experienced by the Russian markets is that the warehousing capacity in Finland diminishes in near future due to extensive volume growth. In addition, an elemental issue of this theme is the extensive development taking place in Russian ports. Russian transport strategy states that these ports aim to increase the level of direct transportation of goods from and to Russia from 75% in 2003 to 90–95% by 2020.

2. Development of Russian Economy since 1996

Russian economy has developed fairly balanced after the economic recession of the 1998, when the Russian ruble was devaluated (Figure 1). The exchange rate in US$ changed from 6R to 20–25R per one dollar. Therefore, ruble lost some 70% of its value and the Russian GDP declined 5.3% in 1998. Industrial production declined over 5% and primary production over 12%. The devaluation was also reflected to average salaries: in 1997 the average salary in Russia was 164 US$ per month. It declined to 62US$ in 1999. During the same time the amount of exports declined over 50%. However, the devaluation of the ruble resulted to resurrection of Russians own industrial production. Import products also became more expensive and therefore local production and products became more competitive in Russian home markets.

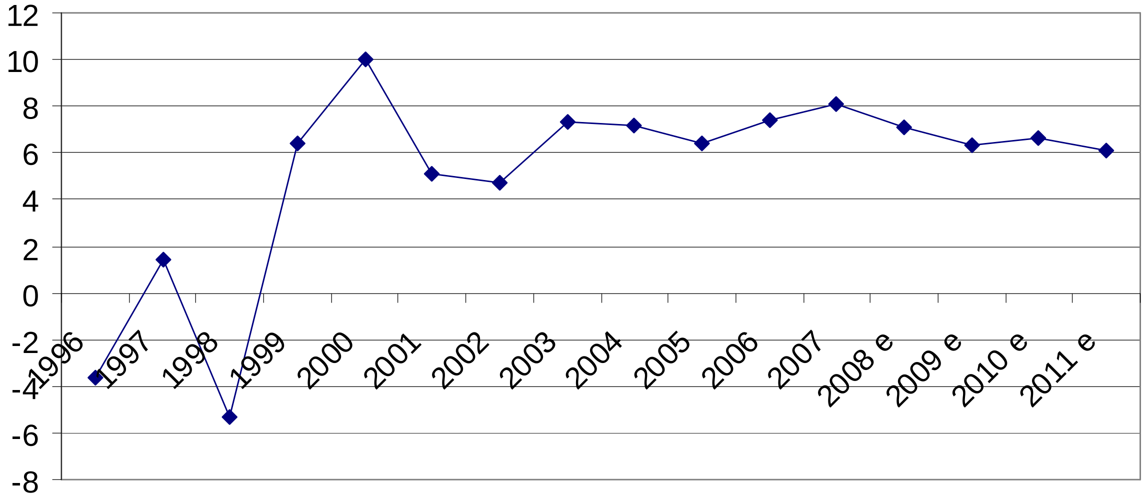

Figure 1. Annual development of Russian GDP 1996–2007 and forecast for 2008–2011, %-change. (Source: BOFIT Russia forecast 2/2006, Rosstat, BOFIT weekly 17/2008).

The economic revival took place quickly. In 1999 GDP started to grow and it has continued to do so until the latest data available (2007). The growth of Russian national economy has impacted the purchasing power and potential of Russian population. Also salary levels have increased. The increase in wealth in Russia has increased particularly the demand for high-value goods and their transit. Cars, electronics and household appliances are constantly transited through Finland to Russia in expanding amounts.

In the 2006 statistics of Russian foreign trade (www.gks.ru) the growth rate of imports has exceeded the level of exports (Figure 2). The total value of imports was 163.3 billion US$ equalling the annual growth of 30.8%. In comparison, the value of exports was 304.5 billion US$ (growth 25%). The most important itineraries include cars (20%), chemistry products (17%) and groceries (15%). The most important trade companion of Russia is EU that has a share of 53% of the total Russian trade. The trade to CIS-countries has decreased to 15%. The trade to China is some 6% of total trade. (BOFIT Russia Review, 15.11.2007). Trade between Finland and Russia was 19 billion US$ in 2006 equalling 4.2% of Russian foreign trade.

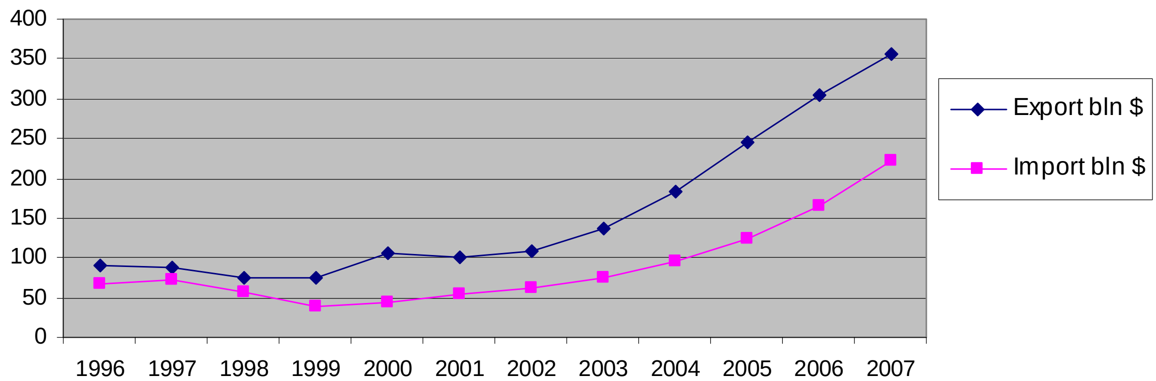

Figure 2. Russian foreign trade 1996–2007. (Rosstat, Central Bank of Russia, www.gks.ru)

The forecast created by the Russian ministry of economic development and trade for the years 2005–2007 (Table 1) has been rather accurate concerning the development of GDP. This can be seen by comparing predicted figures with the latest available statistics (Table 2). These forecasts are important for our study, because they have been taken into an account in the creation of current Russian transport strategy. However, the amount of imports and exports exceed the predicted figures and highlighting the challenge of growing transport. Russian transport strategy is also based on the “optimistic” scenario that is based on the assumption that global oil markets and oil prices stay within the limits of OPEC. Another assumption is that Russian investment growth stays on 2002–2003 level when GDP growth was rather high (see Figure 1).

Hernesniemi et al. (2005) concluded that optimistic scenario (annual GDP growth approximately 6%) predicts 10% growth in Finnish transit imports to Russia and 5% growth in exports. The growth concerns to a large extend cars and consumables that have growing demand in Russian markets.

Table 1. Economic forecasts for GDP, import and export to and from Russia 2004–2007. (Hernesniemi et al. 2005, Bofit, Russia Review 11/2006, www.gks.ru 2008)

	2002	**2003**	**2004**	**2005**	**2006**	**2007**
GDP	4.7%	7.3%	6.9%	6.3%	6.1%	6.5%
Export			9.5%	5.1%	5.3%	6.2%
Import			19.5%	10.1%	9.3%	9.7%

Table 2. Realized statistics for GDP, import and export to and from Russia 2004–2007. (Hernesniemi et al. 2005, Bofit, Russia Review 11/2006, www.gks.ru, 2008)

	2002	**2003**	**2004**	**2005**	**2006**	**2007**
GDP	4.7%	7.3%	7.2%	6.4%	7.4%	8.1%
Export	5.0%	26.6%	35.0%	33.0%	25.0%	24.7%
Import	13.3%	24.7%	26.0%	29.0%	31.0%	36.1%

We address three main points. First, the Russian economy is growing fast and it very likely is going to do so in the future. The country has extensive natural resources and a large population. Second, the general growth of salaries and wages of average population continues to keep the pressure up for growing export figures for high-value goods such as cars and electronics. Third, Finland is and continues to be a major transit route between EU and Russia. The transit is forecasted to grow according to the levels of GDP growth and this means that the current infrastructure capacities are going to face serious challenge from continuously growing trade and transit.

3. Transit Traffic of High Value Goods via Finland to Russia

General trends

Russian transit through Finland has a long history. It began in 1970s with containers from Western Europe through Soviet Union to Japan and vice versa. In 1976 Finnish national railroad company VR and Soviet railway company Sojuzvneshtransport made a transit agreement to which V/O Sojuztransit joined in 1980. This arrangement managed forwarding of international goods trough Soviet Union. There are several factors underlying the development of Finnish transit capabilities and reputation. These include geographical location, equal rail gauge with Russia, developed port operations and a long term experience of transit traffic. These were stated as the main factors in 1985 by Panu Haapala who was the CEO of VR that time (Salanne & Saarto 1998).

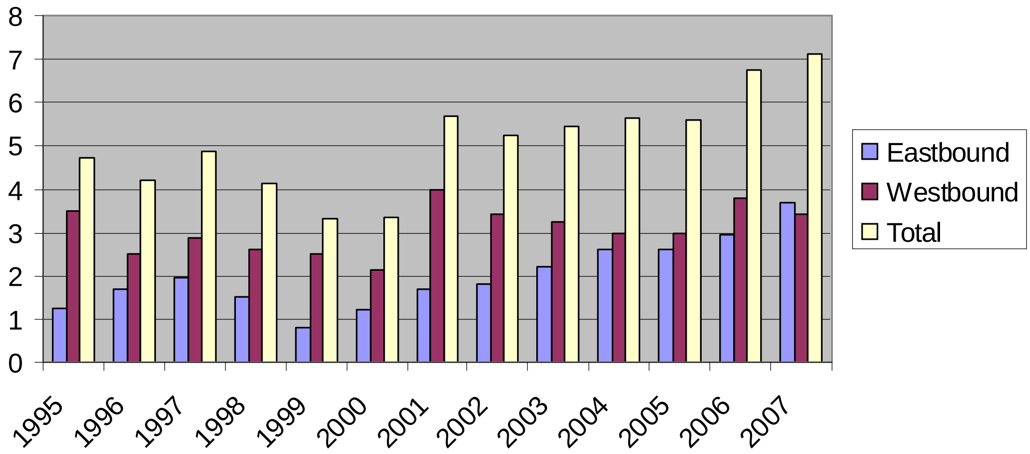

Figure 3. Volumes of transit between Finland and Russia 1995–2007, bln tn. (Finnish Board of Customs 2006, 2007 and Finnish Maritime authorities 2007)

The amount of transit has grown steadily. The annual level of two million tons was exceeded in 1980. The corresponding level has increased in 2007 over 7 billion tons. The westbound traffic has a share of 3.5 and eastbound 3.69 million tons. Annual total growth has been rather stagnant 2001–2007. A common feature has been the increase in eastbound traffic and decline in westbound traffic. In 2006, however, also the westbound transit increased and together with the eastern growth the total transit level increased over 1.15 million tons (Figure 3). The ton amounts still tell little about the economic impacts of transit.

The structure of Russian imports is presented in Table 3 showing that machinery, equipment and transportation equal 47.7% of all imports in 2006. This segment includes our main high-value products (electronics and cars). Data from Russian Statistics indicates that the value of machinery, equipment and transportation (US$) has experienced a growth of almost 500% 2000–2006 from 10.6 (share 31.4% of all imports) to 65.6 (47.7%) billion US$ (www.gks.ru, 2007).

Table 3. Structure of Russian imports 2006. (www.gks.ru 2008).

Import total	1000 USD	Percentages
	137 703	100
Groceries	21 614	15,7
Raw materials	3 302	2,4
Leather and fur	435	0,3
Chemistry, raw materials	21 783	15,8
Tree, paper and pulp	3 962	2,9
Textiles, shoes	5 489	4,0
Metallics, jewelry	10 633	7,7
Machinery, equipment and transportation	65 623	47,7
Other	4863	3,5

The reasons to use Finland as a transit route relies to a large extent to same grounds as it did in 1985. The stakeholder interviews show that in additions to earlier grounds also the availability of empty containers from transit together with sophisticated value-added services in ports, and in logistical chain in general, are important competition advantages of Finland (Ruutikainen et al. 2006). If we consider the contents of transit, the main transit flows from and to Finland can be divided into three main categories:

1) Westbound transit consisting fluids and dry bulk from Russia
2) High-value electronics to Russia from the Far-East.
3) Vehicles (mainly cars) to Russia from the Far-East and western industrialized countries.

The westbound fluid and dry bulk arrive to Finland mainly by trains and are then transported to ports of Kotka and Hamina where they are loaded to ships. The port of Kokkola, on the other hand, has become an important export node for dry bulk, particularly iron pellets, during the last ten years. The high-value goods arrive to Finland either by rail or sea. Most often the transit goods are loaded to trucks and thus continue their way by road to Russia. Due to changes in Russian railroad tariff policy in 2006 majority of high-value good transit has moved to sea.

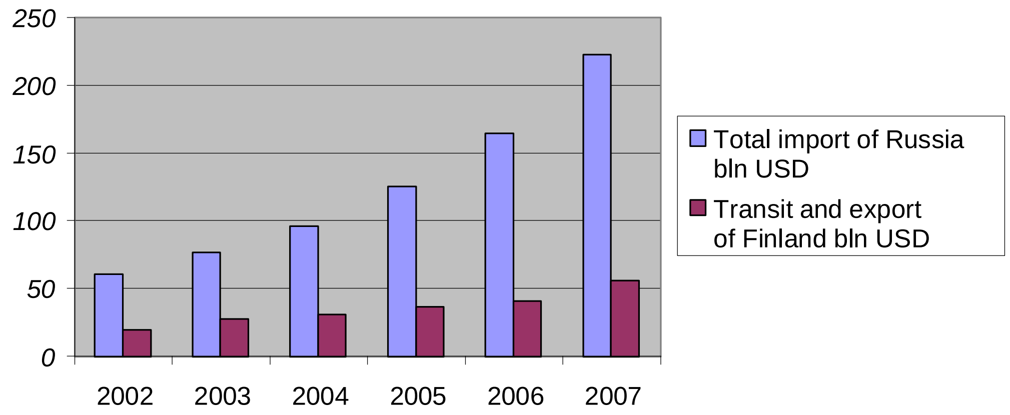

Figure 4. The development of Russian imports and Finnish transit together with Finnish exports to Russia 2002–2007. (Board of Customs, 2008; www.gks.ru 2008).

Figure 4 shows National Board of Customs statistics concerning the value of transit goods to Russia. In 2007 the value of the transit was over 30 billion EUR. Since 2002 the value has doubled. Together with the Finnish exports to Russia the value is approximately one third of the overall Russian imports. This highlights the importance of Finland transit to Russian overall foreign trade. A further detailed picture of the transit can be obtained with industrial branches. Figure 5 clearly shows that cars are the most important product group in terms of value. In addition, the importance of car transit has increased considerably between 2005 and 2006. The second item group includes radio, television and computer products. However, the value difference is more than double between cars and electronics in 2007.

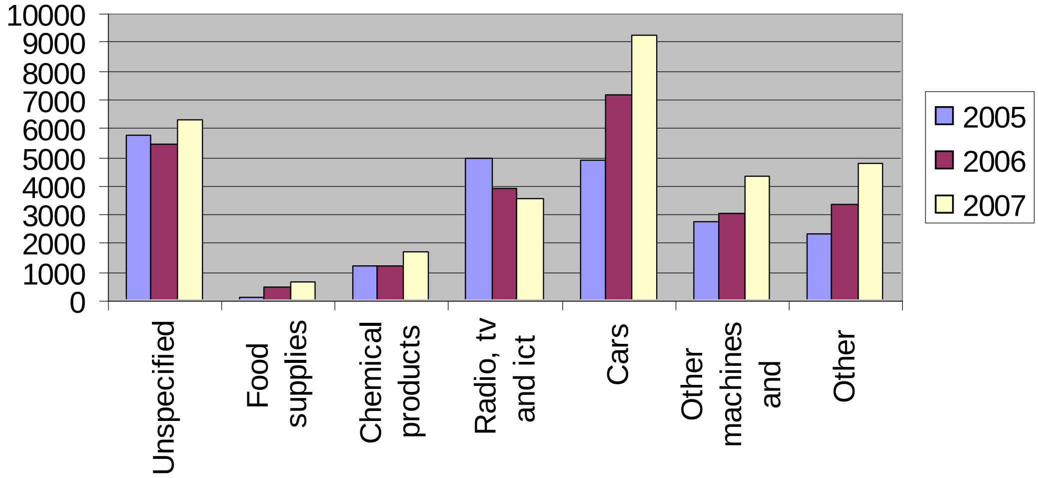

Figure 5. Value of eastbound transit by product groups 2005–2007, mln EUR. (Board of customs 2008).

High-value transit

The Russian national economy has grown significantly and it is reflected to imports of high-value goods such as electronics. According to Russian Statistics, the overall value of machinery, equipment and transportation imports has quadrupled during 1995–2006. Figure 6 shows the joint correlation between overall imports and high-value imports to Russia. The trend lines are very similar with each other. The total share of high-value imports is 47.7% of all imports.

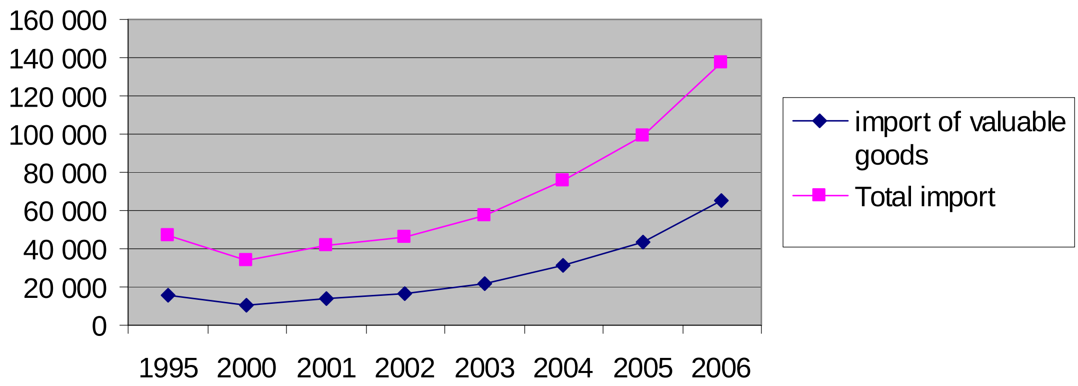

Figure 6. Russian total and high-value imports 1995–2006, mln USD. (www.gks.ru 2008)

Figure 7 shows development of car and electronics transit that are two most important product groups. Figures indicate that in 2006 the total value of Finnish transit was 24.7 billion EUR and the corresponding annual increase approximately 8%. The value of car transit is 7.2 billion and the annual increase 2005–2006 was 47% higher than 2004–2005. The share of electronics decreased over 20%.

The transit of electronics has been rather steady 2002–2007, but the current value decrease is interesting (also Figure 5), because the overall figures including car transit continued strong growth. In our interview study[10] stakeholders consider that this due to changes in Russian customs management that has caused uncertainty operators. This is reflected quickly to high-value transit. An interviewed person stated: “Uncertainty in Moscow regarding transit shifts led to a situation in which our wholesalers did not import anything. This period lasted surprisingly long in May and because of the beginning of holiday season the electronic

[10] For the study 13 persons representing authorities and companies operating in the logistical branch of the eastbound transit were interviewed.

suppliers were in trouble. There is always a hiccup in May, but now it was combined with the changes in Russian custom administration and therefore the slow down was longer than normal lasting two months."

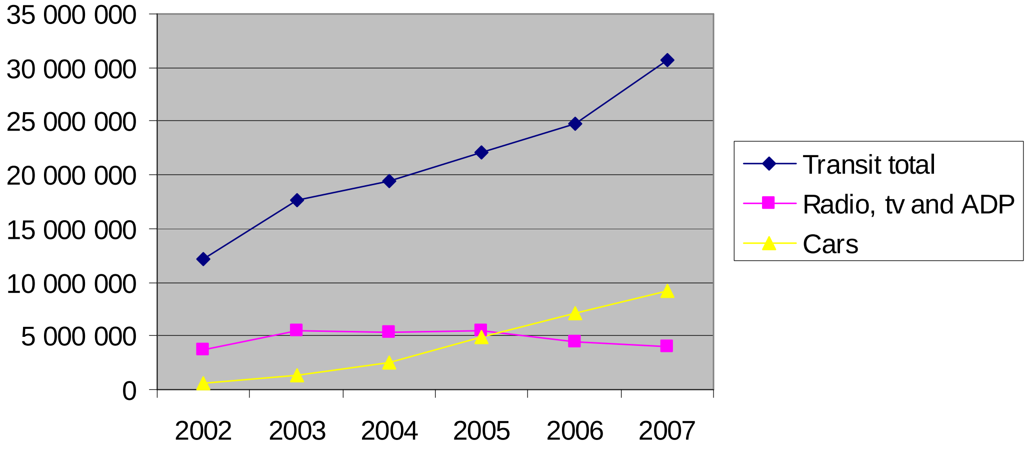

Figure 7. High-value transit to Russia in total together with values of cars and electronics 2002–2007, bln EUR. (Board of Customs 2008)

Russian economy is forecasted to continue its strong growth and thus also wealth of Russian households is expected to grow. This leads further increase in demand of high-value goods. Considering Finnish transit, cars and electronics continue to be the main products. The development of Russia's own ports will not lead to decrease of transit volumes in Finland due to this growth. A hinder for changing high-value good transit directly to Russia is caused by Russian custom legislation, bureaucracy and lack of high quality warehousing (Ruutikainen & Tapaninen 2007). In addition, it is expected that other transit routes (e.g. via Baltic) will increase their shares. Probable result is that the relative transit share via Finland decreases, but the absolute value and tons increase. The stakeholders evaluate Finnish transit route as reliable and safe. In addition, the close physical proximity to St. Petersburg and Moscow is an advantage. Service standards and quality are considered high and infrastructure is well developed.

Transit has caused contradictory feelings among stakeholders, mainly for two reasons. First, the transit is managed and conducted to a large extent by Russian transport operators. Finnish companies have a share of only 5% of total transit. Second, Finnish eastern border areas experience long truck queues waiting to cross the border at Vaalimaa and Nuijamaa crossing points. The truck queues have also environmental impacts and they decrease road safety.

Economic impacts of transit were first analyzed in a study of Ministry of Transport and Communications in 1995 (Saarto et al. 1995). In 1995 the economic impact of transit was 224 million EUR. In addition, the calculated positive employment effect was 2 610 jobs. These results were contrasted in a new TRAMA (computer model for economic impacts of transit) model (2007). In TRAMA research the corresponding economic impact of transit in Finland was 334.8 million EUR (2005). The employment impact of transport was 2 710 jobs. In the year 2006 the model predicted a small decrease in value to 324.3 million EUR and employment to 2 540 jobs. The decrease is due to shifts in transported goods. Eastbound truck transit increased in numbers but the amount container transports decreased in comparison to car transports (Figure 7). In addition, the slow down of Trans-Siberian railway transports (due to Russian tariff increase) had a negative economic impact to obtained figures. In comparison, researchers of ETLA used port authorities of Kotka, Hamina, Hanko and Turku to assess the employment impacts of transit. They estimated that Russian logistics employ 3 040 persons in 2003 (Hernesniemi et al. 2005). Ollus and Simola (2006) have also analyzed interrelations between employment and transit. Their calculations estimate that employment effect was 3 500 in 2003. Figures are slightly more optimistic than results of TRAMA project.

4. Discussion and Future Trends

Ministry of Transport and Communication has published a report analyzing competition factors of the Finnish transit route against competitors (LVM 2005). The report concludes to state that the main factors supporting Finnish transit are reliability and functionality. Ruutikainen et al. (2006) highlighted the importance of traditions in trade between Finland and Russia. The tradition also implies that Russian companies have knowledge of the available services and value-added logistics in Finland. Another factor is the price of sea freight. Finnish export industries have efficient means to use empty containers and therefore keep overall costs relatively competitive. On the other hand, OKT-Infra project (Hilmola et al. 2007) showed that some of the inevitable continuous investments required by increasing transit traffic, like warehousing and border crossing capacity have been neglected during the years of Russian transit growth, and the best capacity situation exist in the harbors (lifting).

Agenet Finland Oy (2005) produced a market study dealing with Russian export companies. The companies included retailers, logistics service providers and freight owners. These companies listed the following benefits of the Finnish route:

- Closeness to Russia
- Safety and functionality of warehousing
- High service quality
- Reliability of logistics chain
- Developed infrastructure.

In the case of Finnish ports, majority of the studied companies (89%) were very satisfied and they did not see an alternative to them. For example, Russian ports were considered to have low quality service, unreliability and loss of goods. The essential problems in Finnish-Russian transit concerned the functionality of Russian customs, inefficiency, bureaucracy, corruption and crime. The main problems related to Baltic routes were also related to slowness on border areas. However, they have more competitive (lower) prices than Finnish route.

TRAKET project compared transit routes between Finland, Germany-Poland, Baltic countries and ports of St. Petersburg. The data included stakeholder survey including responses of logistics managers of car manufacturers, electronics and cosmetics industries. The most important reasons to select Finnish route is due to warehousing quality, safety, value-added services, predictability of transport industry, transit time and tracking of product locations (Märkälä & Jumpponen 2007). The result supports our interview data and interpretations.

Our data includes interviews from representatives of Russian companies having activities in Finland and their logistics partners. They commonly state that warehousing is two to three times more expensive in Russia than in Finland. In addition, there is a shortage of high quality warehouses and warehousing of high-value transit products has certain risks. The current Russian customs legislation also forbids warehousing of goods if not declared after import.

The development of customs legislation may change this situation.

The main determinant underlying route selection for private companies include port services and passage time. Producers of electronics use those ports that are offered by the transportation companies. Second elemental is a long term co-operation. One interviewed person stated: “Collaboration is done in a long perspective in mind. It includes several invisibilities, such as security and continuity”. The importance of physical proximity should not be underestimated. Russian main markets locate in St. Petersburg and Moscow. Several products have a relatively short life span, the importance of time to reach markets is essential. The availability of the product to customer is important. The close proximity also makes additional supplies possible with a short notice. Logistical service providers have a relatively good trust to Finnish infrastructure and professionalism of logistics partners (quality of workforce and skill).

The decisions made in companies regarding transit routes of high-value products are commonly made in production facilities. Freight agreements are globally negotiated. The transportation selection is in most cases based on the earlier business agreements and experiences together with references. The decision making includes all sections in the logistical chain: ports, shipping companies, terminal operators and land transport. Global transportation is commonly a multimodal functions. In addition, transport agreements are jointly made with the importer. In practice, the chain depends also on the contract agreements of the importer. Importers are commonly large companies that have their own arrangements to distribute the high-value goods from ports to retailers. The trend of producers to keep the control of the distribution chain is visible in Russia. As soon as the infrastructure and other logistical services reach competitive standard the logistical decisions will be done in more restricted control of the producers. This will eventually lead to more direct transport to Russia without warehousing in neighbouring countries.

Russian challenges include the development of warehousing and custom operations. When these have more functionality portions of current transit volumes will be directly transported to Russia. Currently, direct transports to Russia have already increased. This means that a container arriving to Finland will be directly (and without downloading) transported to Russian importers. Large customers use this, because they have a capacity to distribute the goods directly to customers or retailers.

Transporters of high-value products constantly seek new routes and alternatives to minimize the total cost. Kalingrad has been tested as well as Baltic routes including Latvia (Riga) and Estonia. In addition, intermediate warehouses have been built in central Europe and Baltic. This, however, has not decreased the pressure to Finnish route. An interviewed stakeholder stated: “However, it often happens that eventually trucks will end up in Finland anyway.”

Trans-Siberian railway has been stated as one option, but the volatility in the Russian railroad administration lowers its potential to function as a substitute to shipping. The Russian railway administration lowered the tariffs in the beginning of 2007, but this has not lead to same shift back to railroads that was lost when the tariffs were increased. The main reason for this deficit is the lack of trust to continuity and long term sustainability of Russian decision making together with increases in price determinants. These include increases in wagon rents and port handling costs. The negative price effect of lowered tariffs was lost and the total cost remained rather same. At the same time, prices of shipping have decreased and become more competitive due to larger ships and increased volumes. In addition, Japanese electronics producers have traditionally used shipping and they probably continue to do so also in the future.

Currently, it seems probable that the share of car transit via Finland to Russia will decrease. Port of Ust Luga will take some of the volume beginning from 2008 onwards. In addition, truck transit via Poland (Gdansk) to Russia is a viable option as well as Russian ports at the Black Sea (Novorissisk and Iljitsevsk) or ports in Ukraine that will probably increase their share of car transit. The production of foreign cars in Russia brings forth a competition of transit of car parts to production facilities. Four largest car manufacturers Ford, Toyota, Nissan and GM import approximately 600 000 TEU to Russia in 2006. The forecasted amount will increase to over a million TEU in 2010 (www.seanews.ru). The combining of car part transit to high-value goods is one feasible scenario in the development of transit business. Electronic manufacturers have already extensive collaboration with car manufactures. Collaboration in the field of logistics seems a relevant option in this regard.

Car component transit is currently “seeking options”. GM Daewoo Auto Corp delivered its first container freight to St. Petersburg production facility by train in May 2007. Annual volume for this single company is considered to be approximately 14 400 TEUs. The transit operator is OAO Transkonteiner that is subsidiary of Russian railways. It is specialized in rail container transport (www.seanews.ru). In the case of Volkswagen that has production factories close to Moscow in Kaluga the OAO considers that train transit from Germany-Czech-Poland-Belarus and Russian border crossing in Brestin can be a feasible option. They predict that via that route the annual transit volume could exceed 20 000 TEUs (www.rzd.ru). These examples demonstrate that selections and competition between different routes is taking place. Considering high-value products of which Finnish route has an extensive share, the development and prerequisites of handling these joint transit needs is important also for Finnish logistics.

5. Conclusions

The economic regional and urban business development does not occur in a spatial vacuum. EU–Russia border is one of the most challenging and interesting case areas regarding EU transportation and logistics. We have discussed several identified factors that make Finnish-Russia logistical analysis important, both in the sense of basic and applied research. First, the rapid growth of Russian trade from Finland and EU will have direct implications for businesses both located in Finland and Russia. The current increase in Russian economy is also reflected to local consumer markets. The demand for high-quality products (for example cars) is increasing rapidly. A majority of the Russian car imports are transited through Finland. The continuous increase in transit flows has caused bottle-necks, particularly in road transit.

Considering the development of high-value goods in transit, Finland has a potential to continue to develop value-added services and quality level in comparison to competing routes. In addition, the continuing increase in Russian economy tends to expand the need for transit services as well as further development of infrastructure. However, there are variations. As our data has shown, the total value of transited electronics has actually decreased 2005–2007.

The understanding of current events in Finnish-Russian transit requires a broad global perspective as well as recognition of local issues. First, the global-local dialectic is particularly obvious in the field of logistics. Even though the development and political aim to enhance the border zone passage time, certain bottlenecks tend to remain as the global flow-networks are realized into local realities in the form of massive truck queues in the eastern Finland close to Russian border. Globalization and economic restructuring of international markets are among the important factors that have markedly conditioned the operations and competition between transit routes and national conditions to support this business. In the future, this is likely to continue. All in all, the problematic of high-value transport regards security, warehousing quality and interoperability of logistical chain. Finland has traditionally been regarded as well functioning and reliable route to Russian markets. This continues to be one of the major competition advantages also in the near future.

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GPS Usage in Railway for Supply Chain Management

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Abstract
The world moves from the industrial to network economy. Enterprises are buying and selling in local and international marketplaces. In many cases the trade enterprises seek to have tracking and tracing possibilities. Therefore importance of global positioning system (GPS) is rising. Then GPS is used automatic data exchange methods changing traditional manual methods. This builds efficiency in supply chain. Part of trade flows are delivered by railway. The usage of GPS application in railway depends on trade flows transportation possibilities, railway network.

The article deals with the dynamics of GPS usage, implementation initiatives in the Asian- European railways; identifies opportunities of GPS usage in railway for freight deliveries and analyses GPS development, its problems and practical, theoretical aspects; reveals tendencies related to efficient supply chain management.
In the paper used methods are systematic and statistical analysis.

Keywords: GPS, railway, supply chain, e-business, efficiency

1. Introduction

Nowadays importance of tracking and tracing between trade partners is rising. First of all tracking systems are useful because they create links between the information and the physical reality (the material flow in supply chain). Without tracking systems it would be much difficult to deal with physical material flow and its efficient co-ordination. Thus, many freight delivery services, for example, intermodal and combined transportation services would be difficult to produce without tracking systems.

Supply chain is the system of enterprises, technology, activities, information and resources involved in moving product from supplier to customer. The usage of e-business systems and GPS application in supply chain creates new opportunities for freight dispatcher and freight recipient, as the participants of supply chain.

In general e-business concept covers processes that use the Internet or other telecommunication means for the business operations. The target of e-business system is to reach higher efficiency. If trade enterprises associate their transportation activities with e-business systems, their aim is to combine data received electronically and to create efficient freight delivery operations. By using e-business system together with GPS application supply chain could more efficiently facilitate inter and intra-enterprise flows of goods, information, communication; customer service and collaboration.

The GPS may be used for managing information about the movement of goods and property, e.g. for identifying the arrival, departure, geographical place of railway transport and freight. During the last years countries are giving more attention to GPS development. 50 million of GPS devices are used worldwide. On the other hand, railway freight faces with lack of quality assurance, particularly for international freight delivery services involving several railway operators undertaking on the same route has a negative attractiveness of railway transport. This includes lack of interconnection of IT systems and problems of single wagon loads. Nowadays in the most of countries seeking to track freights trains are identified in railway stations, but this doesn't solve the problem of tracking single wagon loads. When distances between railway stations are very long, the problem of tracking freights remains also. So, this shows big potentiality of GPS to be widely developed in railway transport.

In paper dynamics of GPS usage in railway are analysed for different freight and transportation types. In the second section of the paper GPS is introduced and theoretical and practical aspects of GPS usage in railway are presented. The third section deals with efficient supply chain management. The fourth section describes the technical architecture of GPS and e-business system in railway transportation. In this section the paper focuses on visualization of freight position data and communication between trade enterprises mainly. Finally, the study leads to conclusions.

2. Global Positioning System (GPS)

For the management of property and freight a global positioning system (GPS) is used in the business enterprises mostly. This is a satellite navigation system enabling to identify the location of an object at any time and at any place with accuracy of several meters. The satellite navigation system consists of 24 satellite network that transmits signals containing time and distance (measured between three satellites) data. These data is accepted by a receiver that, with consideration to the time of signal propagation, measures the distance and identifies an accurate location on the Earth globe (Jonge 1994). Each square meter in the Earth planet system has a unique address. Using the position identification sensors the monitoring system revises data, accumulates it, analyses and represents it in the digital geographic data map. GPS is being used to monitor or keep “eyes” on pick-up and delivery operations.

In many cases the trade enterprises seek to determine the current and past locations of freight and other status of its delivery. Therefore, by using the GPS and developing e-business opportunities the freight dispatcher, recipient and the shipping company are able to exchange GPS data on the freight, which is carried through the internet. By using GPS enterprises may improve the client service and schedule freight delivery. A small acquisition price for the technology is affordable to the majority of Lithuanian freight shipment enterprises. Even insurance companies are giving discount for freight transportation companies, which are using GPS.

Theoretical and practical aspects associated with GPS usage in railway are presented below. Usage of GPS is analysed by authors Barnes, Scornavacca and Innes (2006); Cyras (2006); Faghri and Hamad (2002); Jonge (1994); McGee (1999); Palsaitis and Paliulis (2004); See (2007); Smith (2006); Steven (1993); Wu (2005).

50 million of GPS devices are used worldwide, part of them are used by business enterprises. Presently, GPS becomes a mass-consumption merchandise; such as computers, and cars. GPS is used by *DHL, UPS, Manitoulin Transport, Hödlmayr Hungaria Logistics Kft, Cemex, Atlantic Dominion Distributors, Castine Movers, Coors Distributing, Diaz Foods, Hunt Brothers Pizza, P.C. Richard, Snider Tire Inc., Georgia Crown Distributors* (Discrete Wireless 2008). Usage of GPS creates competitive advantage for freight transportation companies (BEEP 2007).

Usage of GPS in railway is analysed by Izvoltova (2004); Maki (2005); Wang, Wei, Tan, Yang and Cai (2004).

GPS is also implemented in Belgium railways. The system is implemented in industrial railways. It is used by railway transport operators as well. GPS devices are installed in 450 locomotives and report their position periodically to the centre at Brussels. Tendencies in EU also show that GPS application providers and representatives of transport sector could investigate system development at created The Integral Satellite Technology platform ISI.

The next successful eight-month satellite navigation trial using GPS on the trains was conducted with a national railway operator in Southern England. It could also tell controllers whether trains are running to timetable or train has accidentally stopped. Satellite navigation on the UK railways could feasibly use either the US GPS or Europe's Galileo system, which is expected to be up and running by 2008.

GPS is implemented in Indian railways too. Implementation of GPS in India improved efficiency of operations, while at the same time, made significant contributions to safety: if two trains happen to be moving on the same track within a distance of 3 km of each other, brakes are automatically applied bringing the trains to a stop. There are also investigations regarding GPS implementation in Chinese railways (Wang & Wei & Tan & Yang & Cai 2004).

Usage of GPS in railway for different freights and single, combined and intermodal transportation types are analysed in Tables 1 and 2.

Table 1. Usage of GPS in railway for different freight and transportation types

	Usage	**Tendencies**
Freight type level		
Freight of cars	If new cars has factory implemented GPS device, implementation of GPS in single wagons for freight tracking is not necessary.	More and more producers are installing GPS during car production. Some of examples: GPS is installed in Mercedes-Benz, Toyota; installation of GPS is discussed by Nissan.
Freight of other products	Implementation of GPS in single wagons for freight tracking is necessary.	Usually GPS is used for tracking cars, mobile phones, assets and people. Implementation of GPS in other products has no worldwide importance.

Table 2. Usage of GPS in railway for different transportation types

	Usage	Tendencies
Transportation type level		
Single transportation	Transportation is performed with railway transport. Implementation of GPS in single wagons for freight tracking is necessary.	Railway freight transport's modal share stabilised in 2006 after a period of continuous fall in EU. In general as the world is facing now with steadily raising oil prices, this could affect increase of railway transport importance again. The only EU countries Estonia and Lithuania has railway transportation share larger then the land transportation share. Tendencies in EU and China show, that longer distance is more important for railway transport. The average transport distance for railway in China is 775 km. The highest international railway freight transport share (excluding transit), based on tonnes loaded, from EU countries is in Netherlands, Slovakia, Slovenia, Luxembourg. The highest grow change of international railway freight transport share according 2003-2005 tonnes loaded from EU countries were in Sweden. Tendencies in China and Russia show, that railway transport share in total transportation have 15% of total freight volume in tones loaded. (Eurostat 2007; National Bureau of Statistics China 2005; State Committee of the Russian Federation on Statistics 2008).
Combined transportation	Transportation is performed by using several transportation types; one of them is railway. Usually railway transport is used for long distances and land transport is used for short distances transportation. Implementation of GPS in single wagons for freight tracking is necessary.	Usage of different standards for railway lines (1520 mm and 1435 mm) forces to apply combined transport. Some examples: freight from Italy to Sestokai (Lithuanian- Poland board) is transported with railway transport after freight from Sestokai to Vilnius is transported with land transport. Freight from Ukraine to Vilnius or from Kazakhstan to Vilnius is transported with railway transport, after for freight transportation till final destination (distribution centre) land transport is used.
Intermodal transportation	Transportation is performed by using railway to carry other types of the transport. Usually land transport or sea transport unit,container, is carried. Such railway service offers secured freight flows and enables a safe truck journey, even if bad weather or traffic jams obstruct roads. Implementation of GPS in land transport and in sea containers allows tracking in case of intermodal freight transportation and implementation of GPS in single wagons for freight tracking is not necessary.	New intermodal railway line Luxembourg-Perpignan (at Spain border) was opened in July 2007 with capacity of 30.000 trailers a year, the length of line is 1050 km. Development of intermodal railway lines is proposed to Poland, Czech Republic, Sweden, Austria, and Germany. (Eurostat 2007) On the other hand, Volvo, Scania, Mercedes-Benz companies are implementing GPS in land transport, so this allows tracking in case of intermodal freight transportation.

3. Efficient Supply Chain Management

Freight and supply chain security are widely acknowledged as being a matter of collaboration among all players: dispatcher, shipper, freight recipient and technology solutions provider. The second target for supply chain management is flexibility of operations, reduction of stock levels. So, tracking of freight for its recipient could allow better planning of stock levels.

With e-business system and GPS application help trade enterprises could improve the existing operations; make the processes more automated, “intelligent and mobile”. Freight dispatcher and recipient could identify the freight arrival to final destination.

Daily management of workload and job allocation is more flexible with GPS. Fast GPS data transmission speed, bigger control and management of freight delivery, helps for the trade enterprises to manage information more efficiently and reduces the operations costs. For higher efficiency freight position data could be interfaced with order management systems.

When analysing information about successful application of e-business system compiled in BEEP database it has been observed that enterprises implement new data exchange standards, orders and delivery, freight monitoring and control solutions. The implementation of e-business systems is becoming an important necessity to many leading enterprises. Also information technology enterprises take increasingly more initiatives for e-business systems development. IT enterprises establish separate organisational units for the development of e-business solutions. Therefore, the main priority of GPS and e-business system usage is related to efficiency in supply chain.

4. Technical Architecture of GPS and e-Business System in Railway Transportation

The wagon device can continuously measure different parameters, link the data with time and position information, report irregular conditions. The wagon device uses GPS to determine its geographical position. The signals emitted by satellite in the GPS are analysed at the time intervals defined in advanced or simply on request. This enables the position of the single wagons to be calculated (Wang & Wei & Tan & Yang & Cai 2004). Position of single wagon is automatically identified. Through mobile communication network freight's position data is transmitted to its monitoring system of shipping company. Technical architecture of GPS and e-business system in railway transport is presented in Figure 1.

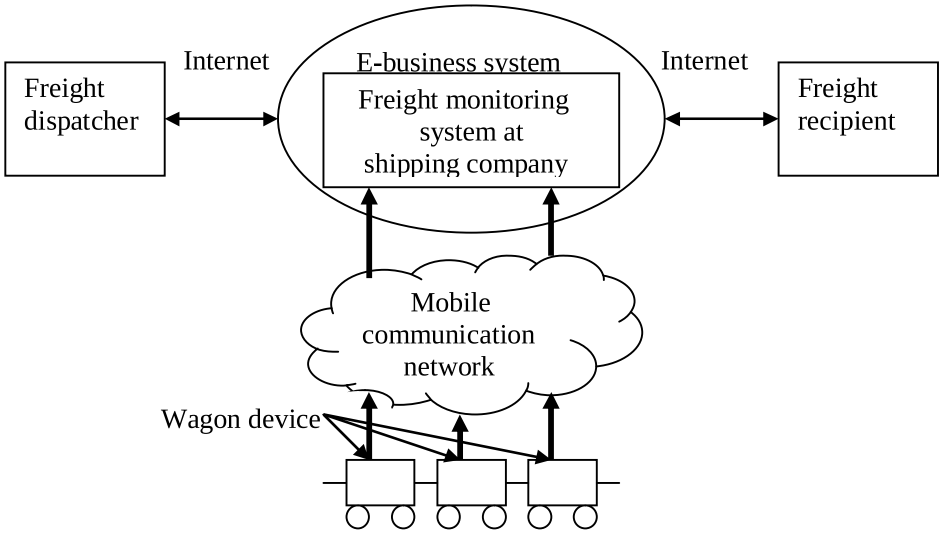

Figure 1. Technical architecture of GPS and e-business system in railway transportation.

Monitoring of data is performed by shipping company control centre. Control centre can not only receive data, the frequency of status message delivery can be changed by the control centre. The data messages are collected and stored in the database. Using the position identification sensors the transport monitoring system revises data, accumulates it, analyses and represents it in the digital geographic data map. Transport monitoring system may control the data of thousands different wagons and trains. Freight monitoring system helps to present location uploaded by each wagon device of train on digital map of the railway line. The control centre can change the area displayed and zoom in on any particular section of the railway line. Alarm conditions are reported via specific messages. The control centre can see content of alarm message by clicking the message icon on the map. In addition to the geographical map based display, the control centre has access to various reports generated automatically from the database. The control centre can also use different queries in order to display historical information. Time intervals, train of interest, types of messages could be specified with running queries.

By using e-business system freight dispatcher and freight recipient could be introduced with monitoring data. The trade enterprises could retrieve data through the internet.

5. Conclusions

Under the globalization condition it is very important to establish the conditions for efficient supply chain development.

In the most of cases freight tracking is demanded by customers. Also, the accessibility of delivery status at any time and the immediate notification of delays or other delivery problems are regarded as basic information need in the supply chain.

Nowadays implementation of GPS increases railway efficiency in case of freight delivery in single country only. Successful GPS usage in international railway transportation depends on GPS infrastructure in single countries. The higher efficiency for international freight delivery could be reached with GPS implementation in the Asian-European railways. Fast implementation of GPS in land and sea transport units will increase freight tracking possibilities for intermodal freight transportation.

While developing e-business solutions it is also important that shipping companies could actively participate in the GPS and e-business systems implementation in order to exploit maximum possibilities.

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Co-operation between the Railway Transport and the Sea Ports at Modern Stage

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Abstract
The perspective of development of co-operation between railway transport and sea ports is connected with the development of sea ports and their turnovers. In this article is the situation analysed and described in the largest sea ports of Russia, Europe but also in the whole world. The main attention is paid on the structure of the turnover of these ports which is indicative about the tendency of the specialization of these ports for the work with "mass" cargoes. It is connected with the selection of the kinds of transport, co-operating with the sea port. The increase of the sea port turnover raises new tasks for the decision of problems by the development of the railway infrastructure on the doorways to the sea port and the prognosis of development by the port railway stations and the port railway network.

Keywords: Logistics, railway station, overloading, turnover, sea port

1. Introduction

The important factor of development of modern economics and productions is international co-operation in the sphere of the making and realization by different kinds of goods. It is conditioned by the constant increase of transportations, realizing mainly in mixed traffic.

The considerable volume of these transportations is realized with the using of sea transport. Therefore, sea ports are important as the element of the transport junction, which is assured by the co-operation of some kinds of transports. Now, the main aim of transport logistics in sphere of mixed traffic is the search and the realization of decisions, creating more advantageous for the cargoes owners and the receivers by the transport service. Besides, the important moment is the condition of the transport infrastructure by sea port and the co-operating with it kinds of transport. It is influenced for the possibility of exploitation of the planning volumes of transportations and of the technical characteristics of transportations (speed of moving and the time of being by stocks in the transport system).

Such as, in the logistics is appearanced the direction, connecting with the development of transport infrastructure.

2. World's Sea Ports

The first sea ports appeared with the creation of sailing transport. Their history is as long as millenniums. In the first time, they were the simple berths, simplified the conditions of the moving people and cargoes from seashore (bank) to the ship and back. Sea ports were situated in the places, having the sufficient depth of aqua territory and more comfortable for the ship moving (bays and river coast, defending from the winds and the choppiness on the sea). As the perfect of working qualities and tonnage of the ships on the port territories were created warehouses, which were intended for the provisional storing and following realization cargoes, delivered by sea ships. The appearance of railway transport in XIX century, steam and then diesel ships, was the motive for development of real ports and constructions of new sea ports. The increasing of load capacity by ships and railway stocks led to the growth of the turnover of sea ports, the development of storage spaces in the ports, the making of new more capacity port machines for train-shipping traffic, the construction of specialized port railway stations. To 50 years of the XX century the majority of sea ports were universal, which made the overloading by all kinds of cargoes. But, with the increasing of turnover in some sea ports started to appear differences in the volume of the overloading of the some cargoes. As a result, the nomenclature of trainshipping cargoes was reduced. The increase in seaport turnover is a result of the loading and unloading such kinds of cargoes, which are the higher demand and have the physical characteristics, helping to organize the more quickly overloading of these cargoes. Such as, it is appearanced the category of cargoes, which was named in Russia – "mass cargoes". As a result, the stock (such sea as land) was changed, specialized ships, cars and autocars, appeared, it was made the new technology for transshipping of these cargoes. It was obvious the necessity of specialized the loading berth for the working with these kinds of cargoes. As the increasing of volume of this work it were formed the specialized parts of port-terminals. In present time the modern larger universal ports consist of specialized terminals. Moreover, taking into account the efficiency of these specialized terminals, it has created specialized sea ports. Especially, it is advantageous for realization of the container transportation. It is the reason of the appearance of larger container ports on all continents.

3. Analysis of Turnover of Some of the World's Biggest Sea Ports

The turnover of the each largest sea ports in the world is more than 100 million tons. In Table 1 and 2 it are presented the information about turnovers of 10 largest sea ports in the world and Europe. Among the world ports the Asian sea ports are the indisputably leaders. The turnovers of the largest European ports (excepting the Rotterdam) are lower than the turnovers of the largest world ports. It is conditioned by the fact, that largest European sea ports appeared earlier than largest Asian ports and there exist some problems in the development of these European ports.

Table 1. Turnovers of 10 largest sea ports of the world (2002-2006 years), mln tons.

Sea port	2002	2003	2004	2005	2006
Shanghai	264	315	379	443	537
Singapore	309	348	393	423	448
Rotterdam	322	328	353	370	382
Ningbo	153	185	226	268	309
Guangzhou	153	171	215	251	302
Tianjin	129	162	206	241	258
Hong Kong	193	208	221	230	232
Qindao	122	141	163	187	224
Nagoya	162	172	182	187	208
Dalian	109	126	145	170	200

Table 2. Turnovers of 10 largest sea ports of the Europe (2002-2006 years), mln tons.

Sea port	2002	2003	2004	2005	2006
Rotterdam	322	328	353	370	382
Antwerp	132	143	152	160	167
Hamburg	98	106	114	126	135
Marseilles	92	96	94	97	100
Amsterdam	70	66	73	75	84
Le Havre	68	72	76	75	74
Algeciras	55	61	66	64	72
Bremen	47	49	52	54	65
Constanza	31	33	39	47	57
Dunkirk	47	50	51	54	57

For attention, the turnovers of these sea ports were increased with the different rates of growth. In Tables 3 and 4 there are presented the results of the estimation of rates of growth by turnovers this ports. From Tables 3 and 4 it is shown, that the rates of growth by turnovers of sea ports, having the lesser turnover, are more changed.

It is characteristic for sea ports, having the largest turnover that there are the higher rates of growth by the turnovers in the beginning, and the lower rates when the size of turnover is hear from the size of actual carrying capacity. It is very important, that among the largest sea ports the leaders are sea ports, which are specialized by the container transportations.

Table 3. The rates of growth by the turnovers of the 10 largest sea port of the world (2002 – 2006 years), %

Sea port	2003/2002	2004/2003	2005/2004	2006/2005
Shanghai	19.47	20.39	16.67	21.22
Singapore	12.56	13.14	7.52	5.96
Rotterdam	1.96	7.5	4.96	3.11
Ningbo	21.05	21.98	18.9	15.05
Guangzhou	11.61	25.77	16.59	20.37
Tianjin	25.43	27.44	17.07	6.88
Hong Kong	7.84	6.41	4.17	3.52
Qindao	15.4	15.47	14.81	19.91
Nagoya	6.37	6	2.63	11.17
Dalian	16.13	15.24	17.08	17.65

Table 4. The rates of growth by the turnovers of the 10 largest European sea ports (2002 – 2006 years), %

Sea port	2003/2002	2004/2003	2005/2004	2006/2005
Rotterdam	1.96	7.5	4.96	3.11
Antwerp	8.59	6.58	5.12	4.56
Humburg	8.91	7.62	9.88	7.24
Marseilles	3.47	-1.47	2.66	3.52
Amsterdam	-6.83	11.6	2.33	12.7
Le Havre	5.61	6.57	-1.58	-1.6
Algeciras	10.67	7.35	-3.35	13.07
Bremen	4.94	6.95	3.63	20.11
Constanza	8.44	16.47	19.53	22.8
Dunkirk	5.49	2	4.9	5.79

By the information of year 2007, the largest container ports of world were Singapore (27.932 mln TEU), Shanghai (26.15 mln TEU), Hong Kong (23.881 mln TEU), Shenzen (21.099 mln TEU), Busan (13.26 mln TEU), Rotterdam (10.791 mln TEU), …, Hamburg (9.89 mln TEU –

9 place), …, Antwerp (8.176 mln TEU – 14 place), …, Bremen and Bremerhaven (4.921 mln TEU – 20 place).

Among these ports there are European sea ports. Their turnovers are lower than the container turnovers of the Asian ports. Besides Rotterdam, Hamburg, Antwerp and Bremen, among the container sea ports of Europe it is possible to note – Gioia Tauro (3.455 mln TEU) and Algeciras (3.414 mln TEU). The sea ports of Finnish Gulf have the lower container turnovers than the largest European container ports: S-Petersburg (1.698 mln TEU – 16 place), Kotka (0.519 mln TEU – 33 place), and Helsinki (0.431 mln TEU – 37 place).

In Tables 5 and 6 there are the estimation of the rates of growth by container turnover of largest sea ports in the world and Europe. It can be seen that the rates of growth by container turnovers is more than the rates of growth by the common turnovers of these ports.

It could be argued that the turnovers of these ports are increased owing to the growth of the volume of the container transportation.

Table 5. The rates of growth by container turnover of 6 largest sea ports in the world (2003-2007), %

Sea port	2004/2003	2005/2004	2006/2005	2007/2006
Singapore	15.9	8.73	6.9	12.67
Shanghai	29.02	24.26	20.1	20.4
Hong Kong	7.51	20.2	4.96	1.45
Shenzen	28.87	18.57	14.03	14.24
Busan	10.48	3.07	1.65	10.14
Rotterdam	16.07	12.01	3.9	11.79

Table 6. The rates of growth by container turnover of the some European ports (2003-2007), %

Sea port	2004/2003	2005/2004	2006/2005	2007/2006
Rotterdam	16.07	12.01	3.9	11.79
Humburg	14.09	15.49	9.57	11.6
Antwerp	11.37	6.99	8.17	16.5
Bremen and Bremerhaven	8.71	7.67	19.14	10.38
Gioia Tauro	5.19	-3.07	-7.02	17.22
Algeciras	13.4	8.27	2.36	4.89
S-Petersburg	18.92	45.02	29.35	17.1
Kotka	21.19	12.58	23.16	14.82
Helsinki	5.92	-8	-9.35	3.36

The increase in container transportation confirms that in the modern conditions the growth of turnover by sea ports is provided with the reducing of kinds of cargoes, the overloading in the port. For example, it is examined the structure of the turnovers by some large sea ports. In Table 7 it is presented the information about the specific weight by main groups of cargoes, overloading the port of the Rotterdam.

Table 7. The specific weight by main groups of cargoes in the turnover by port of Rotterdam, %

Group of cargoes	2006	2007	2007/2006
Bulk	23.06	22.31	3.30%
Liquid	46.26	45.87	5.70%
General	30.72	31.82	10.40%

The largest group of cargoes in the turnover of sea port Rotterdam is liquid products, and main part of this group is the oil. It's part in the common turnover of this port – 25.98% (year 2006) and 23.84% (year 2007). Among the general cargoes is choosed the containers. The part of this category in the common turnover of sea port – 24.83% (year 2006) and 23.84% (year 2007). These two groups of cargoes constitute more than 50% of the common turnover of this sea port. In this sea port the rates of growth in general cargo is two or three times higher than for other cargoes. In the first place it is provided with the container transportation.

The increasing of the container turnover of the Rotterdam port in many respects are dependent of the container stream from the other sea ports of the world. Such as, is the definite degree, it is characterized the container turnovers of these ports. In Table 8 is presented the information about the container cargoes streams between Rotterdam and Baltic Sea ports.

Table 8. The characteristics of container streams between Rotterdam and Baltic Sea ports in 2006 year. Figures in brackets is the correlation of container streams from the sea ports of different places of Baltic Sea.

Country	Number of containers, cont.	The part in the container turnover of Rotterdam, %	Mass of cargoes in the containers, tonnes	The part in the container turnover of Rotterdam, %
Germany	248	0.1	4507	0.13
Denmark	749	0.3	2387	0.07
Sweden	12068	4.88	203407	5.65
Baltic Sea	4183 (34.66%)		53482 (26.29%)	
The Gulf of Bothnia	7885 (65.34%)		149925 (73.71%)	
Estonia	3830	1.55	56058	1.56
Baltic Sea	4 (0.1%)			
The Gulf of Finland	3826 (99.9%)		56058 (100%)	
Finland	69232	28.02	995982	27.66
The Gulf of Finland	61181 (88.37%)		844970 (84.84%)	
The Gulf of Bothnia	8051 (11.63%)		151012 (15.16%)	
Russia	139163	56.32	2052564	57.01
Baltic Sea	9427 (6.77%)		96003 (4.68%)	
The Gulf of Finland	129736 (93.23%)		1956561 (95.32%)	
Latvia	1844	0.75	22705	0.63
Lithuania	13647	5.52	189117	5.25
Poland	6309	2.56	73689	2.04
All	247090		3600416	

The information in Table 8 shows us that during year 2006 significant part, 78.82%, of container transports between Rotterdam and Baltic Sea ports was shipped into the ports of Finnish Gulf.

The common containers stream between Rotterdam and Russian and Finnish ports was 85% from sea ports of there countries in 2006 it was entranced the analogical value between Rotterdam and Baltic Sea ports.

In the main, in Rotterdam from sea ports of these countries in 2006 it was entranced the loaded container stream (from 18 to 91%, average – 65.39%). The base of this container stream is formed from 20 and 40 foot containers (average- 37.97%, 50.45% accordingly).

In New York sea port the main part of the turnover is formed with bulk cargoes (60 - 70% of the turnover). From 1991 to 2007 years the rates of growth by the common turnover of this sea port average not more 4.88%, bulk cargoes – 4.25%, and containers – 6.70%.

In Nagoya the port of containers in the common turnover was 21 - 23%. The analysic of the information about the Nagoya port turnover from 2001 to 2006 years show that the rates of growth common and container turnovers practically coincided. In this case the average rates of growth common and container turnover were 6.54% and 6.59% accordingly.

In Table 9 and 10 are the information about the results of the works by one of the largest in Europe sea port union – Bremen and Bremerhaven (from 2001 to 2006 years).

It is interesting to note that the Bremerhaven specialized with the general cargoes and Bremen with bulk cargoes (see Figures 1-4).

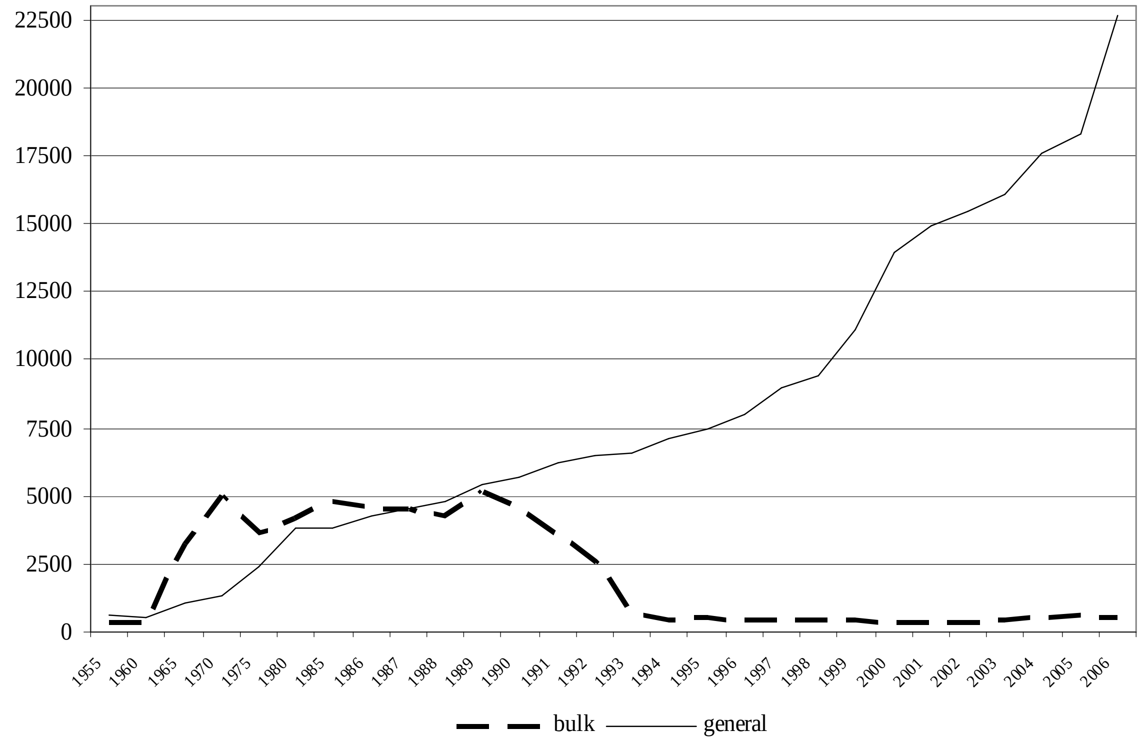

Figure 1. The turnover of Bremerhaven (th. tons)

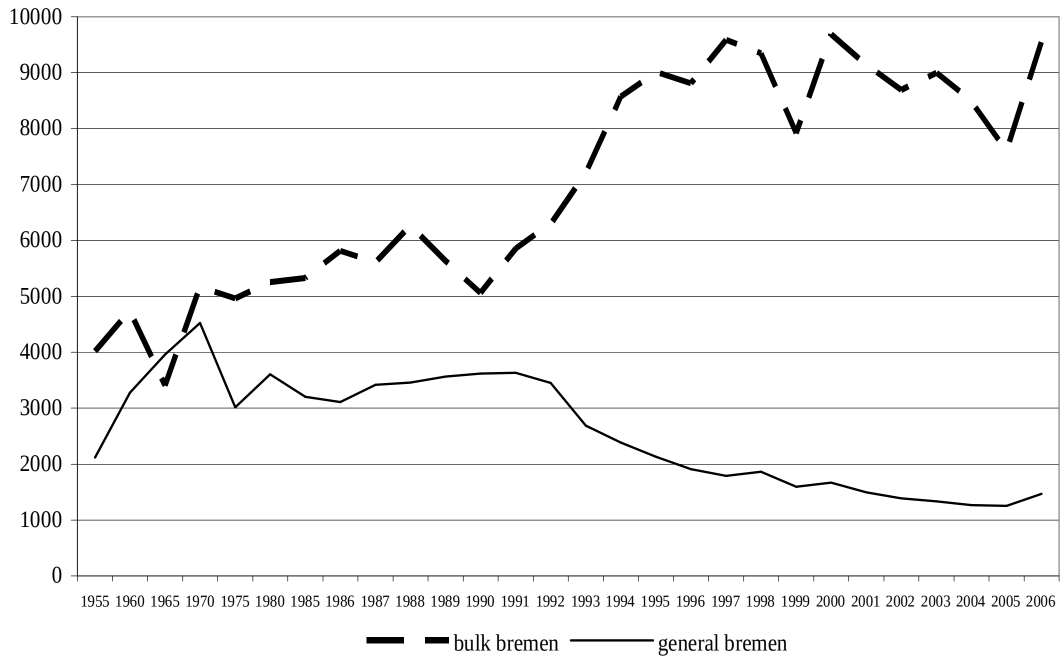

Figure 2. The turnover of Bremen (th. tons)

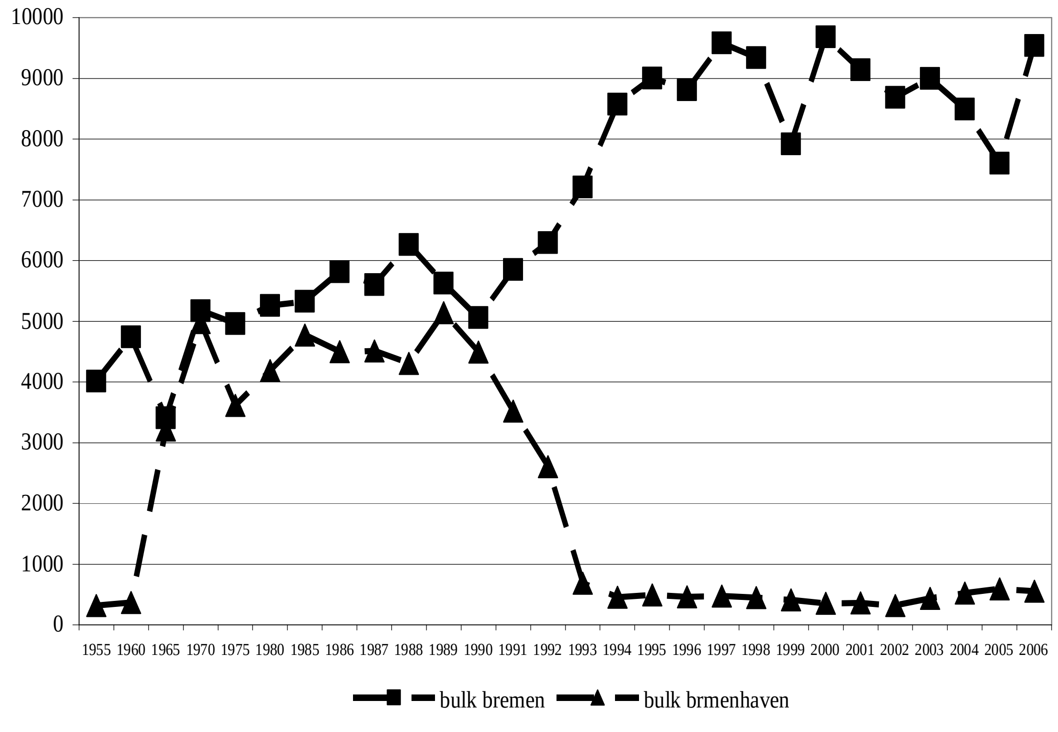

Figure 3. The bulk turnover in Bremen and Bremerhaven (th. tons)

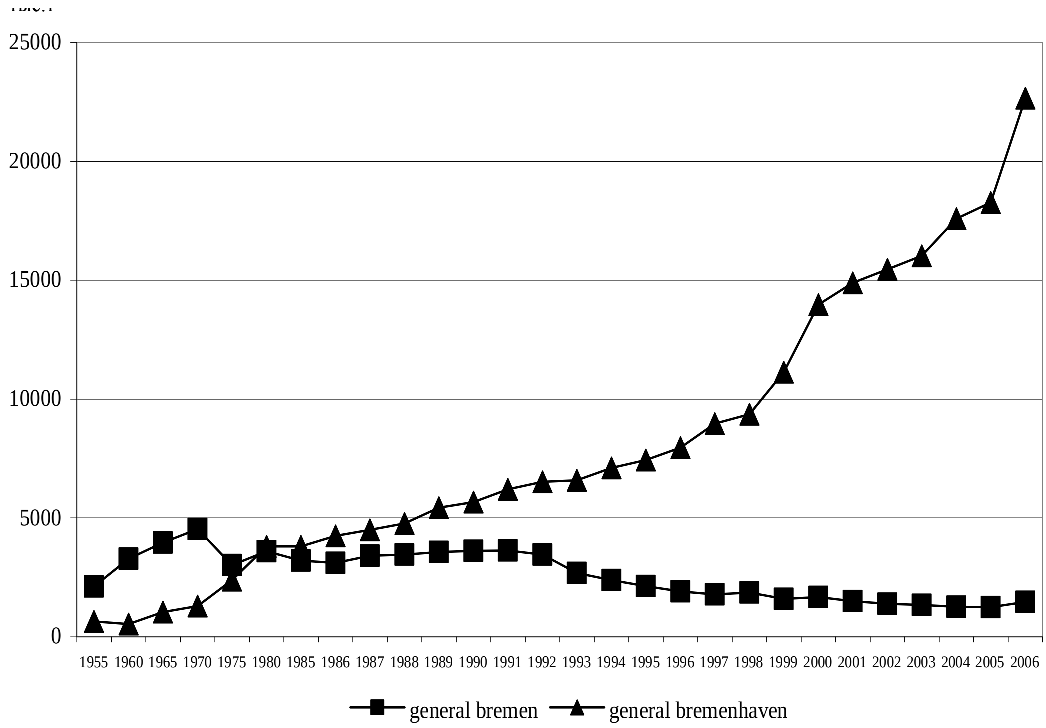

Figure 4. The general turnover in Bremen and Bremerhaven, th tons.

Table 9. The characteristics of the turnover Bremen – Bremerhaven from 2001 to 2006 years

Index	2001	2002	2003	2004	2005	2006
Common turnover, th.tonn	46028.9	46518.9	48887.8	52319	54190.3	64556.5
Container turnover, th.tonn	29475.8	30287	31888.9	35088.1	37334.7	44804.1
The part of the container turnover in common turnover, %	64.0	65.1	65.2	67.1	68.9	69.4
The part of Bremerhaven in common turnover, %	92.2	99.3	99.2	99.4	99.0	99.6

Table 10. The rates of growth by Bremen and Bremerhaven from 2001 to 2006 years.

Index	2002/2001	2003/2002	2004/2003	2005/2004	2006/2005
The growth of common turnover, %	1.06	5.09	7.02	3.58	19.13
The growth of container turnover, %	2.75	5.29	10.03	6.04	20.01

It is pointed, that the containers are formed 83% of the general cargoes in Bremen and Bremerhaven. Table 9 show, that other cargoes are not more 30 - 36% of the common turnover. There are oil, ores, solid mineral fuels and metals.

It is should be noted that the rates of growth by the container turnover were higher than the rates of growth by common turnover this ports union. This is confirmed that there is a tendency to specialize in modern sea ports. The analysis of the work of Russian sea ports show that those tendencies are in these ports. Such in St. Petersburg (by information of 2007) the nearly 63% of the common turnover is from there kinds of cargoes: oil and oil products (24.68%), containers (28.73%) and metals (9.59%). From 2001 to 2007 years the average rates of growth by oil and containers turnovers were 9.35% and 20.97% accordingly (the average rates of growth by common turnover was 8.67%).

In Novorossiisk in 2006 year the oil turnover was 74.38% and metal turnover was 10.19% from the common turnover of this sea port.

From 2002 to 2006 years the average rates growth by turnover of these kinds of cargoes were 3.75% and 3.05% accordingly, and the average rates of growth by common turnover of this port was 4.15%.

Such as, it is obvious, that in present time, the main kinds of cargoes in Novorossiisk port is oil and oil products. In port Vostochi the coal is 91.66% from the common turnover. From 1999 to 2007 years the average rates of growth by coal turnover was 8.91% and by common turnover was 7.73%.

This is the confirmation of the supposition, that the increasing of the turnover by modern sea port is provided from 1 - 2 kinds of cargoes. This is emphasized, that the specialized these ports are expected to take a share in the future too.

The characteristics of some Russian ports are presented in Figures 5 and 6.

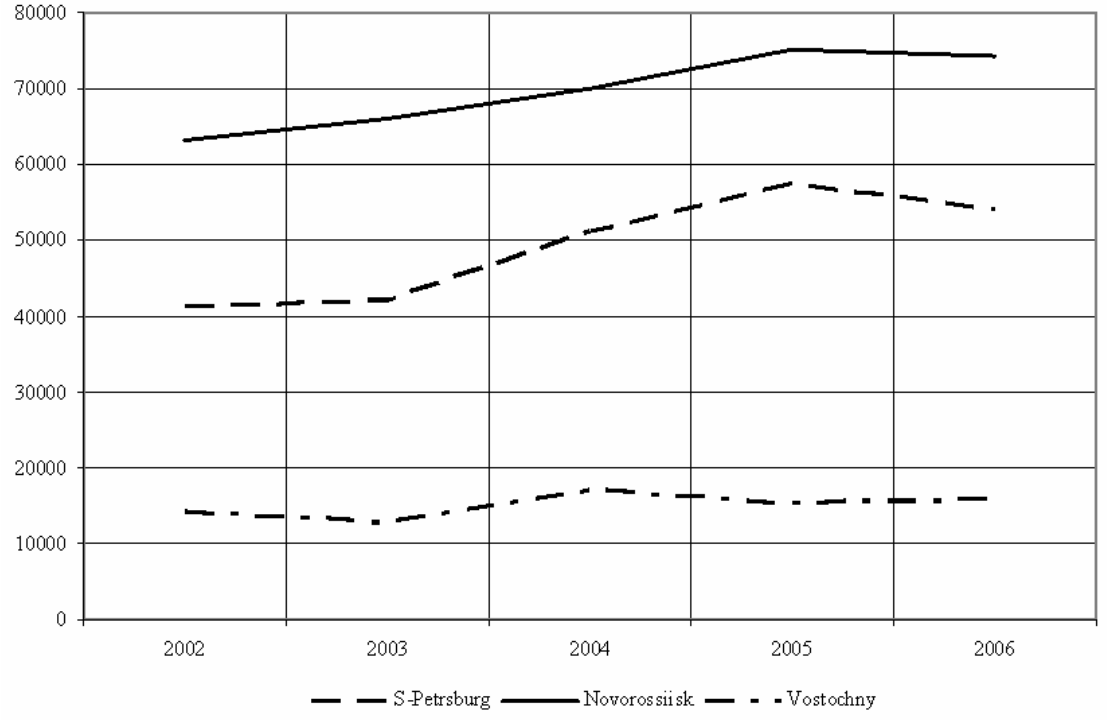

Figure 5. The turnovers of some Russian sea ports, years 2002 – 2006, th. tons.

In Table 10 there is information about the specialized Russian sea port – Primorsk.

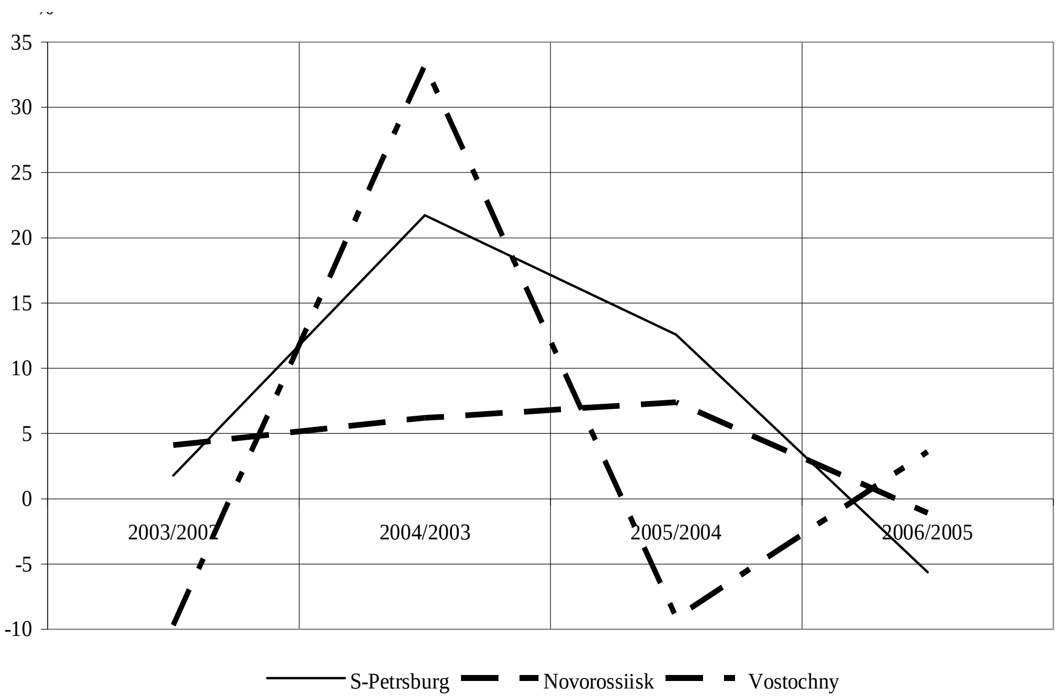

Figure 6. The rates of the growth by the turnover of some Russian ports, years 2002 –

2006, %.

Table 10. The cargo turnover by sea port in Primorsk

Index	2002	2003	2004	2005	2006	2007
Turnover, th.tonn	12402.9	17685.3	44565.4	57337.2	66078.1	74226.9

The average rates of growth by turnover of this port was 50.12% from 2002 to 2007 years. The adducing information about largest sea ports in the world, Europe and Russia allow to recive the confirmation about the tendency to specialized sea ports. Especially, it should be noted that the increase in container transportation, which are allowed to reduce the variety of cargoes, getting in the sea port by owing to these transportations in the containers. It is allowed to simplify the process of the overloading works in the port and reduce the time for the realization of these operations.

4. Co-operation of the Railway Transport and the Sea Ports.

Now, the share of railway transport in the freight transports from the European sea ports is low. The territorial parameters of the majority of the European countries are reduced. If there is a good developed motive car network, the highway transport is more economical effective than railway, especially for the container transportation. Such as, the railway part of the turnover of Rotterdam port is 4.08%. The analysis of the structure by the turnover of this port (by the kinds of transport) from 2002 to 2006 years allow to determine that the average rates of growth by railway part of the turnover of this port – 11.76%. The same indices for the river and highway transports are 5.31% and 7.56% accordingly. From this it follow, that the railway transport has the some perspectives for the reinforcement its position in port of Rotterdam. The different kinds of cargoes delivered in Rotterdam by railway.

In Antwerp the railway share in the common turnover is 14.85%. The intermodal transportation is 37.85% of the railway share of the port turnover. Among the cargoes, delivering in this port by railway, there are the metals, ores, solid mineral fuels and others.

There is a developed railway network in Bremen and Bremerhaven, because the railway transport is using for the container transportation in these ports too.

In Russia the railway part of the common turnover of the sea ports is 60-90%. By reason of this, it is that the structure of cargoes turnovers by these ports are prevailed oil and oil products, ores, metals, and building materials. There are some reasons for the using of the railway transport. The enterprises, which produce these cargoes, are situated far from the sea ports. Besides, the railway stock has the higher load capacity and the Russian network is more developed than the networks of the other kinds of transport.

In last period it should be given consideration to the trip working of trains, taking in account the tendencies in the development of Russian sea ports. It is allowed to provide the entrance of the necessary volume of cargoes in the port. It is reduced the period of accumulation of the ship lots. In Table 11 it is presented the information about the structure of the routing cargoes streams, which is received in the railway stations New Port and Avtovo, co-operating with the St. Petersburg port.

Table 11. The structure of the routing trains streams, which is received in the railway stations New Port and Avtovo (2006 year), %

Kinds of cargoes	New Port	Avtovo
Metals	47	12
Containers	12	9
Oil and oil products	16	44
Chemicals and fertilizers	25	30
Coal	-	5
Wood	0.3	-

Table 11 shows that the base of the routing trains streams consist of trains with the cargoes, which is represented such more significant for the turnover of St. Petersburg sea port. The other Russian ports have the analogical situations.

In last years the situation with the oil and containers is changed. Often, the pipes are used for the oil transportation in the Russian sea ports and the highway transport is used for the transportation of the containers. But now, the railway transport is main partner for the Russian sea ports. The Russian railways are the part of some continental transport corridors. Because, it may be supposed, that the part of the railway transport in the co-operation with the European sea ports in the future.

Railway transport is more ecological than other kinds of transport. It have the higher carrier capacity, the stability, the lower cost price of the transportation than the highway transport. The transportation by railway has some advantages in the operating management and the planning of periods by the receiving of cargoes. The railway stock can be used for transportation of the different cargoes.

The cargoes transportation by railway practically does not influence to the loading highway network and the cities streets (in contrast to highway transport). Besides it is necessary to determinate to economical profitable of kinds of transport, co-operating with the sea ports.

5. Conclusions

The modern transport logistics should be given main considerations for the organization-economical part of the transportation. One of its aims is increasing of the volume of the transportation, because it is connected with the development of the production and the acceleration of the sale. But the organisation and management decisions have the limit influence for the increasing of the volume of the transportation.

On the whole there are directed for the reducing of the transportation time, for the increasing of the efficiency of the using by the stock and the transport infrastructure. But, the decision of these tasks (to a considerable extent) is depended from the conditions of the transport infrastructure (the railway tracks and highway routes, the station track development and the number of railway stations, the technical equipments, numbers of berths and warehouses in the sea port, and others).

Among the main organization decisions in the sphere of transport logistics it should be noted the development of intermodal and multimodal transportations, the increasing of the part of the routing by cargoes, which is delivered in the sea ports, the rational combination of through (car – ship) and warehousing (warehouse – ship) versions of the overloading operations in the sea ports.

The realization of these decision are depended from the location and number of the railway stations on the route of the cargoes transportation, these possibilities for the realization of the necessary operations with trains and cargoes, the advisability of the construction of the new railway tracks (new railway stations) and the warehouses in the sea ports, the conditions of real railway network in the sea port and the necessity of its modernization.

It allows to determinate the succession and the content of organization and management measures in the co-operation between the sea port and the land transport.

Because transport and logistics companies and the owners of the transport infrastructure must to decide the questions of the perfection of processes by cargoes transportation in common.

For example, the specialization of the sea ports stimulate the development of the routing of transportation, the making up the trains with cargoes for the specialized terminals. The increasing of the container transportation demand the construction of new and the reconstruction of the operate warehouses in the sea port.

Such as, for the working out of the logistic decision, it must be examined and appraised the perspectives of the development of transport infrastructure for the ensuring of the prognosis volumes of the transportations with the maintenance of the economical and technical demands, laying to it.

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Liberalization of the Railway Industry in Europe: A Process View

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Abstract
Recent years have been flavoured with continuous attempts to implement deregulation and privatization schemes into the railway markets in Europe in order to be able to shift the tendency of occupying roads toward rail. While some countries such as the UK, or Sweden managed to reap benefits in the long term out of these reform packages, others are left far behind. The focus of this scrutiny is on analysing the current state of matters in former Eastern block economies: Poland and Hungary. The central objective is to elaborate a process view on liberalization initiatives driven by European Commission so that it would be possible for countries to set up better policies to control the efforts as a whole. The study also compares the progress in Poland and Hungary to the current outlook of the industry in early adopters such as the US, Sweden and the UK.

Keywords: Railways, liberalization process, Poland, Hungary

1. Introduction

There are many countries all over the globe where reforms of railways industry take only their very first step. However there are also examples of United States (US), Sweden, United Kingdom (UK) that managed to render this previously loss generating sector into a profitable one. Even though the pioneer economies managed their transformation endeavour well, some of them had painful moments - the UK with Railtrack bankruptcy - and there are still areas that need attention – the loss generating Amtrack in the US. It can be assumed that these reengineering initiatives bound to become increasingly complex for governments to implement in the future as the consequence of ongoing globalization of the world trade and logistics services (Arvis et al. 2007; Economist Intelligence Unit, 2007). Therefore there is a need for exploration of international railway transport development to shed a light on the context of fair competition (IBM Consulting Services 2006; Ibanez 2006). The central objective is to elaborate a high level process view on liberalization scheme so that it would be possible for countries to set up better policies to control the efforts in an integrated manner. The focal research questions are the following ones: Is there a sequence of stages in these liberalization schemes that are in place regardless of the strategy of the governments to implement the policies to render railway industry? What are the major difficulties the examined countries experience in implementing the liberalization agenda?

By establishing phases for these kinds of policy packages, measures can be set up to be able to monitor the efficiency of the sets of activities to be carried out. In addition, gaining further understanding on these initiatives, one can also predict in a more precise manner the magnitude and nature of investments needed to help this transportation mode to gain ground in competition with road transport. It can be argued that these aims are especially pivotal in the case of railway, since regional interoperability and productivity enhancements in Europe are highly troublesome to achieve as the consequence of historical development: Railway industry possess more country specific technical standards compared to road infrastructure.

This scrutiny is structured in a following manner: in Section 2 the experience of western economies are examined to extrapolate the main stages of these large scale transformation programs. Here the attention is on the US, the UK, and Sweden. In Section 3 the focus is on Poland and Hungary whereas in the fourth section the process model for liberalization initiatives is at stake and the examined countries are compared to each other. Finally some concluding remarks are presented and future research paths are proposed.

2. Railway Industry Liberalization: Review through a Glance at the Pioneer Countries

The US has been referred in many contexts as to one of the special case with regard to railway restructuring policies. This is because the whole system of railway network is in the hand of private actors and the sector is not entitled to any financial support from the government for example in relation to infrastructure upgrading investments (Silverthone 2008). Since the beginning of the 1980‘s through a set of considered policy agendas the US government managed to minimize its involvement in the industry that is now a viable option to any investor. Actually very recent research studies showed that inter-modal rail freight is a more sustainable option compared to road haulage in terms of social and private costs (Gorman 2008). The firm and precise implementation of Staggers Act opened up competition through which the strongest operators evolved to control the markets: Burlington Northern Santa Fe (BNSF) is nowadays a global firm engaging in business creating in China.

The main themes of the still ongoing process were the integrated model of operation control and infrastructure management, rail track renting, massive layoffs and customised solution provision for contractual partner enterprises through service level agreements (Szekely et al. 2007). A more detailed investigation reveals that the sequence of procedures were in line with a specific pattern: first legislative measure was adopted by the government and the decision on the implementation of it was confirmed. After that as a result of increasing competition there was a “play- offs” between railway companies for market share capturing. In the third stage further consolidation took place among the actors after which the willingness of investors began to reappear: Warren Buffet reinvested into BNSF during 2007 many times. Still there is a need for new investments into the infrastructure as railways in the US cannot realize its full potential without public backup (Association of American Railroads 2008).

The way of progress in *the UK*, confirms that this line of occurrences might not be just a matter of chance. After British Railways was split according to a governmental decision, little by little small operators emerged but as Railtrack (currently Network Rail Ltd) exemplified, the situation was not that bright: This network manager firm that should have planned the strategic moves for long term investment scenarios, focused on short term objectives and in the end it was delisted from stock markets and bankrupted in 2001. Nowadays there are however many business actors on the railway market that is a target of mergers and acquisitions (Haywood 2007). In 2002 huge investments plans have been accepted worth of £34 billion to raise safety level and renew infrastructure (Hilmola et al. 2007a).

Sweden chose the same strategy as the UK, but in overall for this country the progress was not that speedy. The main reason is the retention of the control in the hand of the government. On the freight side there are already a great amount of private operators though the position of the governmental owned former incumbent company – Green Cargo – is still well over 70 percent whereas on the passenger side only specific routes selected by officials are open to free competition (Szekely et al. 2007). The process is not going that much forward as a consequence of lack of increasing demand and proper incentives but nevertheless the final outcome is still positive (Jensen & Stelling 2007). Especially the passenger side need more radical changes to render competition and to create favourable condition for the entry of private companies.

3. Railway Industry Liberalization: Review on Poland and Hungary

The following sections review the progress of liberalization in the railway transportation sector in the above mentioned countries. The objective is to reveal the sources of divergent forces inhibiting the full implementation of EU directives and the reasons for stagnating of the rail sector in general. It seems to be nowadays a general trend to impose more market oriented approach in the EU in many industry segments to respond to the threats generated by the dynamic nature of globalisation. Standardization and harmonization of business policies is conceived as a core tool to synchronize efforts in minimizing risk in increasingly turbulent environment (Boeri et al 2006; Ibanez yet al. 2006).

The situation in Eastern Europe is similar into a large extent to that of in the western economies. Previously state supported sectors having monopoly position in the market have great difficulties to break even despite radical measures. In both countries the former incumbent enterprises can still restrict the competition according to their preferences despite the impressive amount of issued operating licences. In both cases umbrella organization has been created to limit the costs for coordination problems.

In *Poland* from the news of the market it can be seen that the symptoms are just the same as in Hungary both on the passenger as well as the freight side: Not enough demand, and road is actually eating rail share all the time (Melck 2008, Hungarian Rail Office 2008). In fact it has been forecasted that by 2020 in Poland railway passenger service would decrease by 15 to 25 percent and simultaneously individual transport would surge by 50 to 75 percent (United Nations Economic Commission for Europe 2007b). These trends prevail despite the fact that in the long term rail service should be of a better, more sustainable solution for the complications caused by congestion and pollution. Poland on the other hand managed to stop the declining tendency at least with regard to cargo and showed up impressive results: From 1997 to 2006 the volumes in tonnes (thousands) rose from 8078 to 150923 which is equal to 18 fold increase. Passenger volumes dropped from 330313 to 217410 (thousands) during the same period equalling to a fall of 34 percent. The tendency is kind of similar in relation to passenger and freight tonnes kms: Between 1997 and 2006 passenger kms came down by 15 percent from 19928 to 16971 millions kms. On the freight side in Poland a huge increase took place: from 1859 to 42651 kms, being a 23 fold upsurge. At the same time on the human resource side from 1997 to 2006 the number of employees working for PKP Group was reduced by 45 percent from 226369 to 125894. (International Union of Railways 2007.)

When examining the available statistics available on time series data of rail traffic between 1997 and 2006, in the case of *Hungary* volumes on the passenger side came down and with regard to freight transportation the situation essentially remained the same. Freight cargo figures improved by 2.9 percent from 45492 to 46777 thousands tonnes while passengers volume decreased by 2.8 percent from 123210 to 119814 thousands. In terms of tonkms the figures stayed approximately the same level: A slight increase of 5 percent from 6394 to 6742 millions km can be noticed In Hungary again growth was not that significant during this 10 year period: a 19 percent upswing is noticeable from 7803 to 9279 millions km. Employment in the railway industry dropped too: From 61557 to 38084 i.e. being a 38 percent decrease. (International Union of Railways 2007.)

In order to be able to have a view on the potential of railway in the future to become a real competitor for road haulage in these countries, statistical data was examined on volumes of freight intermodal traffic on railway. The results are than compared to the development of total volumes of freight cargo on rail.

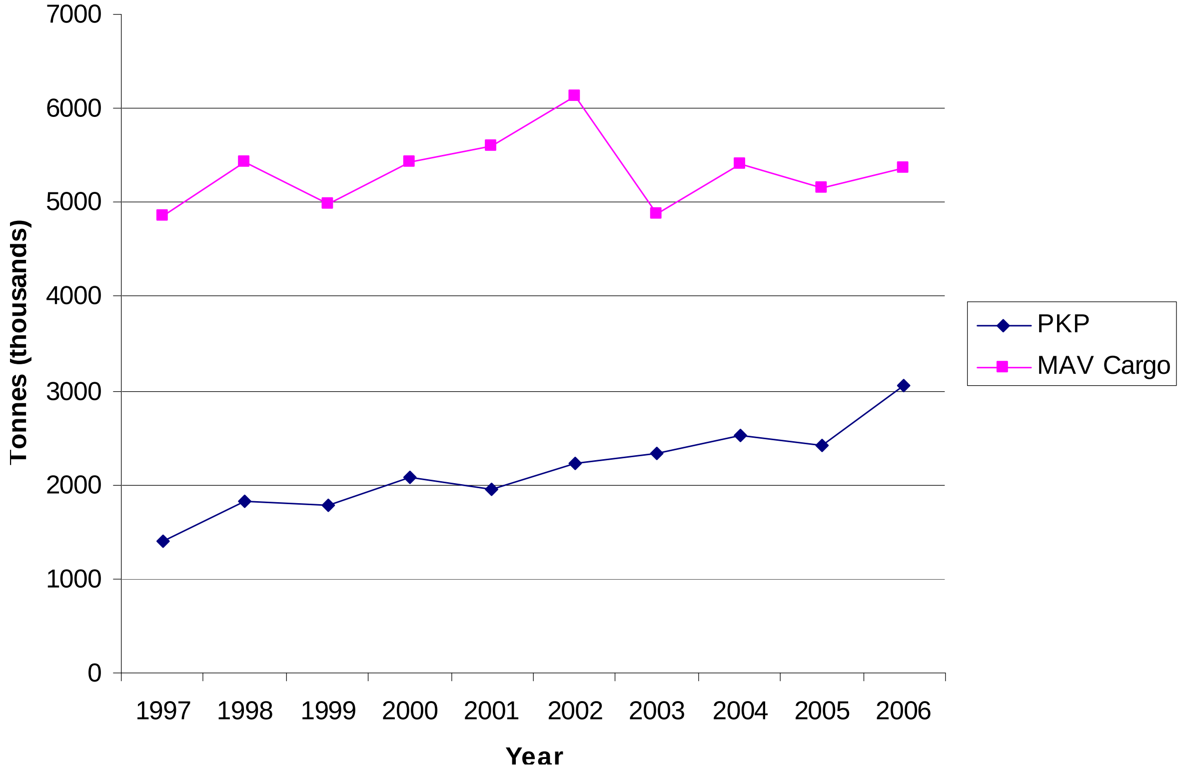

Figure 1. The performance development of incumbent companies of Poland and Hungary in intermodal freight traffic in terms of tonnes. (International Union of Railways 2007)

From Figure 1 it can be seen that in from a long term view the PKP Group is more competitive with respect to the amount of intermodal cargo transported, though the level is still much lower when compared to MAV Cargo. Volumes have been on rise in Poland steadily since 1997 ending up in 2006 with a figure that is 217 percent higher in comparison to the one in 1997. MAV Cargo on the other hand has had many fluctuations in between and especially the drop from 2002 to 2003 is significant: a 20 percent decrease from 6138 to 4889 thousands tonnes. When focusing on data on intermodal freight tonne-km available in the same database, the difference between these counties becomes even more obvious: Poland is way ahead of Hungary. For example, in 1997 PKP Group carried freights along 1859 millions tonne-km whereas the same indicator for MAV was 7803 millions tonne-km. In 2006 the same measure for PKP Group was 42651 millions tonne-km, but MAV reached only 9279 millions tonne-km. In so it can be claimed that PKP Group managed its transformation process much better in comparison with MAV.

When looking at the total tonne-km on country level, the data available from the EU &

Eurostat (2007) reveals that during the period of 1995 – 2006 in Poland freights travelled on tracks decreased significantly. From 68.20 billions tonne-km in 1995 to 53.62 billions tonne-km in 2006: A drop of 21 percent took place. In Hungary one can perceive an increase of 21 percent from 8.40 billions tonne-km in 1995 to 10.17 billions tonne-km in 2006. In this light the achievement of PKP Group is even better.

4. Methodology and Limitations

Literature review concerning railway liberalization process was accomplished in countries that are considered to be the best in their way of managing this transformation of rail sector. In so these are meant to be a comparison point for further investigation. The primary sources of information are the websites of national transport ministries, infrastructure operators, service providers and other public international agencies such as the European Union and The World Bank. Scientific journals are reviewed too to secure the reliability of the main arguments.

This scrutiny relied mainly on secondary data. This limitation was overcame by using quality sources of certified organisations, such as websites of transport ministries, railway undertakings, infrastructure operators and other public European agencies were referred to reach the most updated information. One additional limitation was that the focus of the numerical data analysis was on former incumbent companies, ignoring the emerging group of competitors.

5. Discussion

It can be suggested that one source of uncompetitiveness of the freight rail markets in the analyzed countries stems from the inappropriate level and structure of the track access charges. It can be seen that both in Poland and Hungary these charges are based on multiple requirements and so they are not flexible enough to respond the change in the economic environment (Melck 2008; Belmonte 2007). Especially as setting track access charges might work as a double edged sward: The infrastructure manager use them to maintain and develop the network, but the higher the price level is fixed at, the more share it takes from the income of the operators. In a loss producing industry, if access charges rise too much, operators that run publicly subsidized passenger connections might need to opt for more direct subsidies from the government. On the other hand, in case decision makers allow dropping fees in a significant manner, sooner or later this maneuver might lead to over-charging freight trains and/or postponing renewals into future and resulting in a lack of capacity of the network in the short term (OECD 2005).

In theory the guidance is set: Charges should stimulate incentives in using the infrastructure more efficiently, it ought to be in connection to the costs caused by the maintenance and development needed and disclose the possibility of discriminating users (Belmonte 2007). Even the European Commission has already prepared further communication package as to how to implement the price system in order to be able to fulfill the requirements (see OECD 2005). Still the interpretation of these principles differs between countries thus leading to divergent practices that disturb the output in the end. These lines of procedures are understandable as even within the EU countries are in a very different economic situation. It can be however argued that in the long run as economic integration goes ahead, every country should apply the basic principles in the same fashion and have a space for adjusting within a frame of additional specific rules. Recently a study shed a light on different types of practices where the inappropriate setting of track access charges stimulates exceptional financial uncertainty and therefore weakens the competitiveness of railway sectors:

There are countries where the fees determined are far below the minimum required represented by marginal costs covering renewals. Marginal cost should be seen as a definite lowest possible point for charges. In some other cases there are instances where freight service ends up covering the gap caused by the costs of passenger connections to be able to minimize the need for public support for these loss producing passenger lines. According to the findings this is the state of matters especially when the infrastructure manager is to operate under a high or full cost recovery scheme, while the network under control is not used to full capacity. A third kind of obstacle can be observed in the strategy countries structure charges along international corridors. Some implementations support incentives to consolidate loads and run fewer but longer trains in one country, whereas the other mainstream approach is to promote operating short, light trains in other country along the corridor. These divergences in strategic considerations cause increasing coordination costs of international connections as a consequence of the complexities caused by these in train path planning procedures. (OECD 2005.)

With regard to Poland and Hungary the competitiveness of the rail sector is weak as track access charges are relatively on high level from a European perspective and the networks are used below their capacities (OECD 2005). To improve the state of circumstances these countries are eliminating the unprofitable parts of the networks though without social acceptance (United Nations Economic Commission for Europe 2007a). Still cross financing passenger rail traffic from the profits of the freight sector is a fact that undermine the competitiveness of this mode. In striving for reducing this trend officials are about to deploy another solution: Replacing passenger rail connections with bus service is a viable option to save costs

It can be seen that these business transformation efforts tend to last many years, but rather decades while the complexities involved are extensive. Figure 1 below depicts the developed process model for liberalization of railways industry. It can be pointed out that in the course of proceedings from stage to stage profitability of this transportation mode is improving only little by little: During the first phase railways are producing deficits and governmental support has been increasing for a long period of time. In the second phase leading companies break-even, but governmental subsidiaries are still needed though in most cases in smaller scale, while in the third period, the railway sector in general may show some minor profits. During the last interval, not only profitability but also dividends increase, and eventually shareholders might fuel new capital into the businesses. In an optimal case these development trends can lead to environment which is an incubator for novel business models or completely new activities.

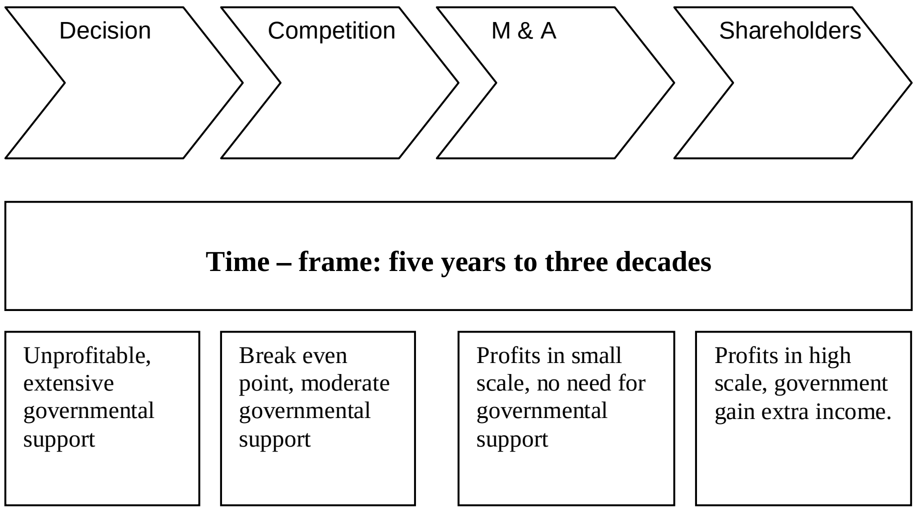

Figure 2. The process view on liberalization of railway industry (Adapted from Szekely & Hilmola, 2007)

It can be argued that while Hungary and Poland are both similar transition economies, these countries are at the moment similar stage in the liberalization process: In Poland the progress has already been visible, showing positive results; PKP Group has the chance of being able to produce profit within the next decade. The dominancy of the former monopoly operator has considerably weakened, while at the same time recently large amount of licenses has been issued. Still in 2007 only PKP Intercity was able to show positive results and profits while the debts of the Group remained at the same level and infrastructure is worsening all the time without being able to guarantee the capacity extensions needed (United Nations Economic Commission for Europe 2007b; Kühl 2007; Grudzinska 2006). In Hungary the situation is much similar: the debts of MAV Group are immense, there is no available capital for infrastructure investments (United Nations Economic Commission for Europe 2007a). Investments into the infrastructure would be essential to be able to locate future growth into the sector and leverage its effects of positive externalities (Quinet et al. 2004). In both cases the governments has realised the seriousness of the situation and are about to take action to make improvements on the state of issues: In Poland, official initiative was launched to prepare a feasibility study on investigating the construction high speed passenger rail connection between major cities of Warsaw Poznan and Warsaw Wroclaw (PMR Ltd., 2008). In Hungary the circumstances were such that the decision makers simply put on the shares of

MAV Cargo onto a public offering competition that was won in the end by the Austrian Cargo (New Europe 2008). In so Hungary bypassed the phase of competition and entered straight to mergers & acquisitions.

6. Conclusions

In overall it can be argued that the single major problem for the countries under analysis is how to stimulate greater competition on the rail markets. The situation is serious as road transport eats all time the share of rail on the continuously increasing markets. In so for these countries it is difficult to enter the second stage of rail liberalization process. When compared to the most advanced countries of US, the UK or Sweden, it seems that while those countries are well ahead of Poland and Hungary, the problems in stimulating competition are somewhat the same qualities: How to impose incentives on the markets. In these former socialist countries the small market share of private companies indicates that the liberalisation process has not resulted in the success it was supposed to deliver with regard to quality of services, cost reductions or productivity improvements.

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Principles of Formation of Transport and Logistic Complex Common Information Area

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Abstract
Trends in contemporary international transport market in the sphere of information interaction are tending towards creation and integration of information systems of logistics partners. The use of isolated information systems for implementation of adjacent operations at the border of interaction of different kinds of transport and at the border crossings leads to duplication of operations, complication of the technological process and increment of time needed for treatment and transportation of goods. JSC RZD and other main Russian transport companies have to conform to the international level in the sphere of information interaction and transit from close information area to integration of information resources.

The formation of Common Information area of transport and logistic complex of Northwest region of the Russian Federation will allow to realize elaborations in the field of the newest information technologies, which give fundamentally new opportunities in management of all spheres of transport interaction, and to solve several problems e.g.: tracing financial information about goods transportation, using of public information as well as integration with existing information systems and control of all transportation stages and increase of goods delivery speed.

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

1. Introduction

Market of transport and logistics services in the world is currently passing through a process of fundamental changes that have a radical impact on the role and scope of its participants and the structure of their relationship. The main driving forces at the market are:

- Globalization of companies;
- The concentration of the companies on the key tasks and outsourcing of non-core directions;
- The desire to reduce the size of the logistics chain and optimize costs at its phases;
- Reduction of the product life cycle and development of new approaches to marketing and product distribution, increased role of innovation, and rapid development of Internet-based business.

These changes lead to repositioning and introducing new strategies in the logistics operators` practice. The major trends are:

- Consolidation in the industry through a merger;
- Growing role of information technologies and data transmission systems and the further complication of the logistics solutions through the increasing introduction of IT;
- Departure from specialized services and concentration on providing complete logistics solutions;
- Strengthening the influence of global transportation and logistics companies (about 35% of the market are accounted for 30 largest companies);
- The ongoing consolidation of the market, primarily through international mergers and acquisitions and entry into new geographic markets;
- Growing role of value-added services to improve the competitiveness of market operators.

The real need for integration of information resources is becoming inherent to all business companies regardless of industry sector. Today's conditions for the development of Russian economy require creating conditions for the unification of industrial, commercial enterprises and companies serving the infrastructure of the market to integrated logistics systems. They can quickly ship products to consumer, on time and at minimal costs. The application of information technology does not just help in the work, but also saves significant resources.

2. Russian Transport Market and Logistics Services

The development of the Russian transport market and logistics services, changes of competitive conditions in the market will directly depend on the following factors of external and internal order:

- Prospects for Russia’s WTO accession;
- Enlargement of the European Union to the east;
- Increased trade with China and increasing needs in the creation of new transport corridors, including the transit of goods through Russia;
- Globalization of activities of transnational corporations and western retail chains;

- The expansion of international logistics companies;
- Maintaining high rates of economic growth;
- The positive dynamics of industrial production and retail trade;
- Increased export-import operations and changes in the structure of foreign trade;
- Shifts in the composition of demand for transportation and logistics services;
- The pace of consolidation logistics market;
- Status of freight logistics infrastructure and investment in industry dynamics.

Increased investment attractiveness of Russia, foreign direct investment inflows into the country, as well as speeding up negotiations for the adoption of Russia's WTO accession will stimulate increased competition in key sectors of the economy, including the market for transportation services and storage of goods. Enlargement of the European Union and the growth of trade with China, as well as the creation of new transport corridors will lead to an increase in both incoming and outgoing traffic.

Prospects for the development of the transport component of the Russian market of logistics services depend on the following factors:

- The dynamics of economic growth and consumer demand;
- The level of development of transport infrastructure;
- The condition of vehicles and rolling stock in terms of matching the commercial and technical requirements;
- Compliance of quality and cost of services with clients` needs;
- Administrative and legislative regulation aimed at enhancing the competitiveness of Russian carriers;
- The effectiveness of the mechanisms of state support for projects in the transport sector, the level of investment.

3. Reasons for Establishing the Common Information Area of Transport and Logistic Complex

The real need for integration of information resources is becoming inherent to all business companies regardless of industry sector. Today's conditions for the development of Russian economy require to create conditions for the unification of industrial, commercial enterprises and companies serving the infrastructure of the market to integrated logistics systems. They can quickly ship products to consumers, on time and at minimal costs.

With increasing traffic volumes, continued significant downtime wagon trains with the goods in anticipation of the filing of fronts to unload. The reasons for this situation are unwillingness and inability of a consignee to plan the process of loading in a closed information area. Each of the companies or organizations involved in the transport, treat the information as a trade secret even when information exchange is essential, if not the only way to communicate with partners.

The development of isolated local stations and organizations ACS (Automatic Control System) leads to complication of work method and it is not a modern way of development. The use of various information systems to carry out related operations on the border interaction between railway and port and transporter and terminal complexes as well as on the border of Russia and other countries leads to duplication of information, complication the process and as a result increasing in handling time, transit time and the number of errors in the work of ACS, railway support personnel, transporters, stevedores, logisticians and border guards. JSC «RZD» and major transport companies in Russia are obliged to conform to international level in the field of information exchange and turn from a closed information area to the Integration of information resources.

The reasons for establishing the common information area for combining information systems of different transport companies and organizations engaged in transportation are determined by the application of integrated logistics approach based on the following principles:

- New understanding of market and logistics mechanisms as a strategic element in the implementation and development of competitive business opportunities;
- The real prospects and trends for the integration of logistics chains participants among themselves and the development of new organizational forms - of logistics networking;
- Technological capabilities in the field of advanced information technologies, offering a fundamentally new opportunities for the management of all areas of production and

commercial activity;

- Creating a logistics interaction environment of different modes of transport, improving the reliability of applications and targets, for effective interaction and logistics tracking of goods traffic.

4. Objectives of the Common Information Area and Opportunities for the Organization of Transport

The main areas of functioning of the Common Information Area of transport and logistics complex in Northwest region of Russia are:

- Organization integrated escort of goods traffic;
- Information services for forwarding companies and operating companies (including stevedores and sea carriers);
- Organization of information interaction with border and customs control services;
- Informatization of integrated logistics services, including services for the storage and distribution of goods;
- Logistics Management - the optimization of logistics business processes to any insider of the transport services market.

Creating the Common Information Area of transport and logistics complex in Northwest region of Russia 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. It will also help to solve the following tasks:

- Allowance to each insider of the transport market orient freely in the information area.
- Provision of reliable information and forecasts about traffic flows to authorities and administration of St. Petersburg and constituent units of Northwest region for effective management decisions;
- Implement opportunities for integration with informational system of EU countries and access to international logistics network for international traffic;
- The use of public information as well as integration with existing IT systems;

- Analysis and coordination of transportation offices, forwarding companies, customs, banks and other transport logistics organizations activity;
- Strengthening the role of information and logistics centers (by modes of transport) and transforming them into an analytical tool for management and control «critical points» of inter-sectoral collaboration;
- Control the whole chain of transport and improving the speed of delivery of goods;
- Accounting and control all stages of electronic documents, the application of Electronic Digital Signature for the interaction of all participants in the transport process;
- Tracking the sequence of events which result from the geographic movement of cargo and change its status in real time;
- Tracking financial information about goods traffic.

5. Target Groups of the Common Information Area

The implementation of the Common Information Area provides advantages for the realization of various business goals and results in the change of many factors of interaction as well as improving values and strengthening the role of trusting relationship in the transport complex. Many improvements will be beneficial to all transport market insiders. We select the main directions of improvement in each of the interested groups:

For the authorities and administration of St. Petersburg and constituent units of Northwest region.

- Obtaining reliable information about the situation on the transport objects in real time and the appearance of possible analysis and forecasting as well as the adoption of driving solutions to improve the situation.

For Baltic countries` railways and Oktyabrskaya railway, the branch of JSC «RZD».

- Detection the real situation at key stations to improve traffic management and reduce delivery times of cargoes;
- Obtaining reliable and timely information from transport companies, port authorities,

customs authorities and authorities of Northwest region of Russian Federation;

For port Services, marine transportation companies of Russia and the Baltic countries.

- Management loading and storage resource assessment of the situation with trains, wagons, cars, it means goods, access way to ports.
- The getting timely information from the railway companies, customs authorities and authorities of Northwest region of Russian Federation;

For the customs authorities of Northwest region, Finland, the Baltic countries.

- The getting preliminary information from transport companies and cargo carriers about cargoes approaching and sound management of their own resources.
- Timely transfer information to transport companies about the procedure, timing and possible implementation of export-import traffic.
- Reducing time of paper handling.

Automobile transport and forwarding companies.

- The getting timely information from the customs, railway, sea carriers and authorities of Northwest region of Russia.
- The getting information in real time about the location of cargo or other moving object.

6. Comparison and Integration with Existing Systems

There are some implemented projects on management of information resources of intermodal transport in Russia at this time. They more or less fill the gaps of information network. The main systems are presented in the following paragraphs.

ACS «Cargo Express»

«Cargo Express» is dynamic program, which reflects technological situation in the selected object management (for example railway network, station, port, etc.) at any given time. Also several information systems were created such as logistics histogram AS LOGO, KaLiBRI system, the system of automation of client logistics functions (ALFK). ACS "Cargo Express" Implements the following functional capabilities:

- The ensuring rail workers who carry out the management functions in practice at all levels of transportation (for example industrial plants connecting stations, port and border stations, control road and network devices) by common information, which is available in real time for timely evaluation of the operational environment and emerging events in order to prevent possible difficulties.
- Improved information support of goods traffic technology. The qualitative analysis of the situation on the basis of full information about the customer, load and its features and the provide information for planning in a convenient form (integration with the system ETRAN).
- Information support of a common technological process at the stations, which are adjacent to the port, border and large enterprises. Data issuance of loads, appointed to the district.
- Automated formation and the introduction of conventional prohibitions and restrictions.
- Information interaction between ACS station and ACS port. (Information about the location and condition of the goods in wagon or container enters the ACS station from a superior system ACS road at the time of goods dispatching from loading station).

ADS Information and logistics centre (ADS ILS).

The system which has been functioning in Oktyabrskaya railway Information and Logistics Centre since the October 2002 have been installed to reduce transport costs. Generally it focuses on the exchange of information in multimodal transport export-import goods through the organization of information interaction of all participants of multimodal transport as well as improving coordination of their activities. At this time, the system participates in the exchange of information with such ports as: St. Petersburg, Vysotsky, Murmansk, and Vysotsk - "LUKOIL".

ADS Information and logistics centre implements the following functional capabilities:

- The transmission of information occurs in two directions:
  - information transmitted from ACS port to ADS ILS is about approaching the ships and data of ships moored to the quay, availability of cargo at the port, as well as shifting-days plan-application.
  - Information about the loading port, the deployment of goods in the network JSC «RZD» and their arrival at the station is transmitted from ACS station in the ADS ILS.
- ADS ILS creates dynamic electronic diagrams of cargo areas of port and railway stations. Also the diagrams include information about ships at the port roads, a position at the cargo fronts, packing storage sites and berthing warehouses.
- ADS ILS solicits information from the higher-level system of railway (ASOUP) about approaching goods to the certain port with decompositions of types. Assessment of a situation may be done with various queries from railway information systems.

Software "TRANS-MANAGER"

The system of motor transport (for example software "TRANS-MANAGER" (www.autotrans.info) is intended for motor transport and forwarding companies to optimize all phases of work: from management applications / transport / treaties to accounting, financial control and analysis. Software "TRANS-MANAGER" provides users such functional capabilities as the following:

- Office applications for transportation. One document can describe practically the whole process of transportation for one or more customers at once, from loading and unloading operations, insurance, reception / shipment from the warehouse on the readiness to transfer from one vehicle to another. In doing so, all relationships with each of the participants-contractors involved in transporting goods, are controlled.
- Forming reports. All the major reports now have the opportunity of graphs and histograms representation. It allows to see conditions and productivity of the work much better;
- Built tariffication of all transport services, through the formation of price list with

specifying all the necessary requisites;

- Management of access through the issuance of group permits and installation of detailed descriptions of access for each user;
- Statement and maintenance of primary documentation: Acc, Act, Invoice. The program includes support software of work with primary accounting documents. Numbering documents and ways of allocating taxes are perfectly compatible and integrated with accounting software family "1C";
- Ability to import data from Excel and dBase spreadsheets. This program block is intended for the transition from the other programs to "TRANS-manager".

Information System in Hamburg «DAKOSY»

«DAKOSY» system is the best European experience in implementing information systems and organization of information space. It is used in port of Hamburg and it covers more than 150 forwarding and 500 transport companies.

Principles of the introduction of Information System in Hamburg (DAKOSY) were realistic. Right from the start «DAKOSY» was designed close to the users needs.

«DAKOSY» was created in 1982 by the transport department of Hamburg in order to ensure electronic data interchange (EDI) and to speed up the process of transshipment. At present «DAKOSY» is not just within the scope of Hamburg. It has to do with logistics chains between Hamburg and its rear areas. «DAKOSY» is based on a central database, which allows keeping and processing information.

The main directions of the system:

- Information Network Center. *EDP / EDI DAKOSY* offers EDI and EDP systems interfaces all transport companies. These interfaces are required for rapid logistics chain connection. «DAKOSY» is designed as an open system EDI: in other words, computers connected to it are not made by the same manufacturer, but different well -known manufacturers of commercial logistics.
- Implementation of «Paperless port» idea. «Paperless port» scheme was initiated by berth operators in 1995 under the project *«DHU»* (The Hamburg Quay Operators Data Processing Company). It includes standard and paperless

processing of loaded containers at the port of Hamburg. Applied programs DAKOSY - GEGIS, HABIS and ZAPP - include an integrated paperless communication.

- *HABIS* is operation and information system of port railway. HABIS system connects transport systems EDP of seaports with the similar systems of the German railway. It ensures quick and free interchange of information between Railway clients (forwarders, straight-line agents and shipping agents) and complexes for the processing of goods (berth operators, etc.). HABIS transmits information in electronic form about all railway transport both incoming to the port of Hamburg and departing from there.
- *GEGIS* is information system for dangerous goods at the port of Hamburg. Since January 1997, all movement of dangerous goods was recorded by EDI GEGIS (Dangerous Goods Information System) in accordance with the requirements for electronic filing of the Port Security Rules). EDI notification provides accurate information about the time and location and can be used to compile an exact picture of the current situation.
- *ZAPP* is Electronic Customs Export Monitoring in the Paperless Port. ZAPP system came into effect in 1997. It was designed all actors in the export process such as exporters, forwarders, straight-line agents, shipping companies and mooring operators to have an electronic link with the Customs Hamburg via «DAKOSY». ZAPP complies with all requirements of Customs. Electronic export data optimizes customs monitoring and allows the Customs to take a decision on lot of goods directly before loading, and if there is a doubt, to interrupt it without delaying traffic. Using ZAPP is mandatory for all partners participating transportation process. Customs expects them to provide electronic data through ZAPP. Original documents are provided to the Customs later.

Application of these systems in the Common Information Area will provide an opportunity for the integration with other information systems (*ETRAN, DBS ASU, ASU PS, and RAYU).* Besides Common Information Area's could be one of the main points in such EU-financed project as *LOGNET* and it will allow to respond to the changes in the information interaction in international and intermodal transportation more thoughtfully.

7. Information Technology and Solutions

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

The Common Information Area will be able to realize various modern technologies:

- Technologies, which can be used by the staff of the transport companies. (GPS or GLONASS will be integrated with the PPC and apply for drivers, storekeeper, etc.);
- The use of wireless communications technology, whose market at the moment is growing at an enormous pace. It is especially true of the wireless networks WLAN-networks (Wireless Local Area Network);
- To build deployed information area Cluster technologies may be used. 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 linked to databases;
- The possibility of the use of outsourcing, and reducing the costs of the maintaining information infrastructure.

By using of the Common Information Area companies would be able to realize various tasks, which are existing and being on foot:

- The use equipment of satellite navigation systems (GPS, GLONASS, Inmarsat) to determine the location of the facility, as well as the use of various, modern communications to deliver information to users. CIS will allow to trace the entire route of the car, wagon, ship, aircraft or important cargo container;
- The use of RFID and bar-coding to manage storage facilities and the control of the goods in the terminal complexes;
- Implementation of Electronic Atlas of railways and highways of Northwest region, as well as the Baltic. (Getting background information about infrastructure, belongings,

coding, etc.);

- The use the Internet - tracking systems to check the state of transportation on any mode of transport, to find the goods in the warehouse or in places of transshipment;
- The establishing a system for calculating fees for transportation by different modes of transport. In addition there are handbooks of customs duties for all modes of transport and guides to the fines and additional fees for the transportation of valuable and dangerous goods;
- For companies which engage in international transportation there is an implement opportunities for integration with informational system of EU countries to count the delivery speed, to calculate transportation costs for the transportation to get information about the state of transportation by any mode of transport. In addition, there is an interactive map of transport corridors and finding the goods on the territory of these corridors.

The access to the Common Information Area can be exercised by the one of two options and the use of each of these options is determined by the requirement of each case. The first option provides access via the Internet using WEB-technology and using WEB-interface. The second option installs remote platforms and organization of communication between databases. Both versions of connecting to the Common Information Area imply the use of publicly available information and integration with existing IT systems that operate in the organization (program of management and logistics of warehouse or carrier, accounting programs, server station ACS and ACS network scale).

8. Assessment of the Functioning and Problem of Introduction of a Common Information Area Logistics System

The basis for the assessment of any information system is the relationship of the cost of system implementation and a positive effect from the realization of innovation (improving quality of service, reducing costs, increasing productivity or receiving additional financial benefits). Due to the fact that the Common Information Area covers a large number of elements of transportation and logistics process, attempts to assess the benefits for a particular mode of transport or for certain transactions will not reveal all the positive effects and trends. Warehousing, transportation, government intervention and other subsystems logistics costs depend on each other. Attempts to minimize the costs of any single activity can lead to the increase all costs in the logistics. The Common Information Area, therefore, involves all the key innovation activities of transport and logistics complex of Northwest Russia in the light of information flows and strengthening the role of responsibility.

The creating the Common Information Area raises a number of problems whose solution will be beneficial to all participants in intermodal transport:

- Study of the market, forecasting demand for a new information system, identifying the best targets that will be effective;
- Creating new ways to redistribute information and improve the process of transportation on the basis of optimal control of information flows;
- Search rational forms of interaction between transport companies, the Common Information Area and authorities of St. Petersburg and constituent units of Northwest region.
- Building different models of functioning Common Information Area to meet the demand of different target audiences;
- The ongoing need to improve the quality of information product which help to withstand competition in foreign markets;
- Consideration of the application outsourcing, to reduce the cost of stages of development and functioning.

Russia is currently taking some steps to introduce technologies that are seen as a tool for organizing and informational support of all participants who produce and sell products in all stages of the life cycle. Effective use of this tool is possible on the basis of an integrated logistics, which is the "nucleus" of the Common Information Area.

9. Conclusions

Proposals which are presented in this article is one of the steps in identifying new transport concept plan and the creation of the new system, the Common Information Area of transport and logistics complex of Northwest region of Russia, which will provide advanced products and services to the transport industry and its customers. This will allow controlling the sequence of events which result from the geographic movement of goods and change its status, from sending the goods by provider to obtaining goods by customer (without dividing into transport, storage and international components). Besides, the system will allow tracking financial information about product: not only the value of the goods, but also the associated additional costs. By this system there will be able to realize the advantages of a single point of access to information about services relating to all modes of transport, and will facilitate the integration of traffic flows in intermodal transport chain. The Common Information Area should be seen not as a static system, but as a continuous forward movement.

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Research Note: Transportation's Informational Support

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Abstract.
Active optimization of transportation informational support is being conducted, aimed at organizing effective train movement management and realizing logistics methods in the sphere of transport services. Basis for this is corporative digital backbone network and system of informational-management complexes, dealing with different problems of transportation process. Technologies of risk analysis, implementation of electronic document circulation and optimization of management structures are first-priority technologies in current reorganization.

Keywords: Informational technologies, transportation management, transport services

Currently one of the main tasks for Russian railways is organizing effective transportation and expenditure cutting, based on advanced informational technologies implementation in all spheres of railway transportation. Carrying-out target development programs for telecommunications and informatization of Russian railways, accelerated modernization of technological communication means and railway automation allow to perform a change-over to centralized management of the whole complex of transportation and transport services.

Implemented systems cause deep changes in labor conditions for railway managerial staff. New modern control technologies are brought to the forefront: risk analysis, bank technologies, logistics etc.

Railway transport control system based on these technologies suggests common informational space all over Russian railway system and unique database for all information technologies complexes. A vast telecommunication network based on the most advanced technologies is created to carry out this program. Today corporative digital backbone network is operating almost all over Russian Federation. It is based on SDH equipment and ATM technology. The medium for the network is fiber-optic links and satellite channels. The possibility to transmit data through digital channels at high speed made active implementation of information technologies in Russian railways possible.

Establishing informational interaction between freight owner, transport operator and other participants of transportation process suggests implementation of paperless technology of processing carriage documents. Integration and optimization of solutions in the field of processing carriage and other technological and financial documentation implies active use of electronic document circulation. At the same time problems of standardization of documents and drawing up pay bills for transport services in all kinds of communication, including export, import, transit and instate communication, are being solved.

To increase reliability of transmitted information about rail tonnage and transported freight, railway services use national system of rail tonnage authentication “Palma”, which allows monitoring transportations in real-time mode. Successful operation of such informational-control and informational complexes as: SIRIUS (network integrated Russian informational-control system), DISPARK (system of accounting and analysis of locomotive fleet dislocation), EK IODV (unique complex for railway memorandum bills processing), IOMM (complex for integrated processing of locomotive driver’s route), GID-Ural-VNIIZT (system of train sheet processing), ASOUP (automated system for trains movement operational management) and many others, increases notably transportation management quality.

As a result of implementation of modern informational technologies and electronic documents, disappears the necessity to use manual work in important segments of transportation management chain. Freight transportation plan analysis allows defining tendencies detrimental for the main management system goal – ensuring agreed delivery of freight to consumers. Dynamics and deviations of deliveries in different branches of transport network are taken into account. Forecasted values of transportation process parameters are used in optimal planning of freight traffic by means of solving dynamical transport problem and with the use of simulation models of transport communications network, in order to assess effectiveness of plans and develop operative decisions.

At present, systems of informational interaction between transport management centers and methods of developing management technologies are being actively developed. Situation management center forms the strategy (priorities) of resolving conflicts between control systems making claims for shared transport resources, to maintain transport communication. Objects controlled by situation management center are local systems of freight traffic management, each of them controls definite network of transport communications. Situation management allows reacting flexibly on changing customer demands, market situation and transport infrastructure. Including situation management center into freight traffic control system ensures flexibility of strategic transportation management.

Complex of informational-management systems, ensuring optimally agreed cargo delivery to customer in definite management area, forms Transport Control Center. Optimal traffic management determines a new level of customer service and development of economic affairs of the country. More favorable conditions are created for producers and for coordinating railway transportation with other kinds of transport. In the process of Transport Control Centers operation there appears an effect of forming dynamic reserves – optimal management reduces the necessity of goods stocks for consumers and freight holders, it also reduces considerably the necessity of transport resources prior reserving to satisfy customer demand. Besides, rational freight delivery to ports and border-crossing terminals provides the opportunity of economic and appropriate use of rail tonnage.

Several important problems, aimed at realizing logistics methods in the sphere of transport services, are being solved nowadays. Among them is providing data on state of industry, transport and market situation for Russian railways. Collecting such data, as well as planning transportations (considering this information), is fulfilled through network of subsidiaries of Center of premium transport service (CFTO), which is subordinate to the vice-president of “Russian Railways” company. Informational infrastructure is being actively developed; active work is conducted to draw together legal bases of different countries. Terminal warehouse complex management direction is being created (Figure 1).

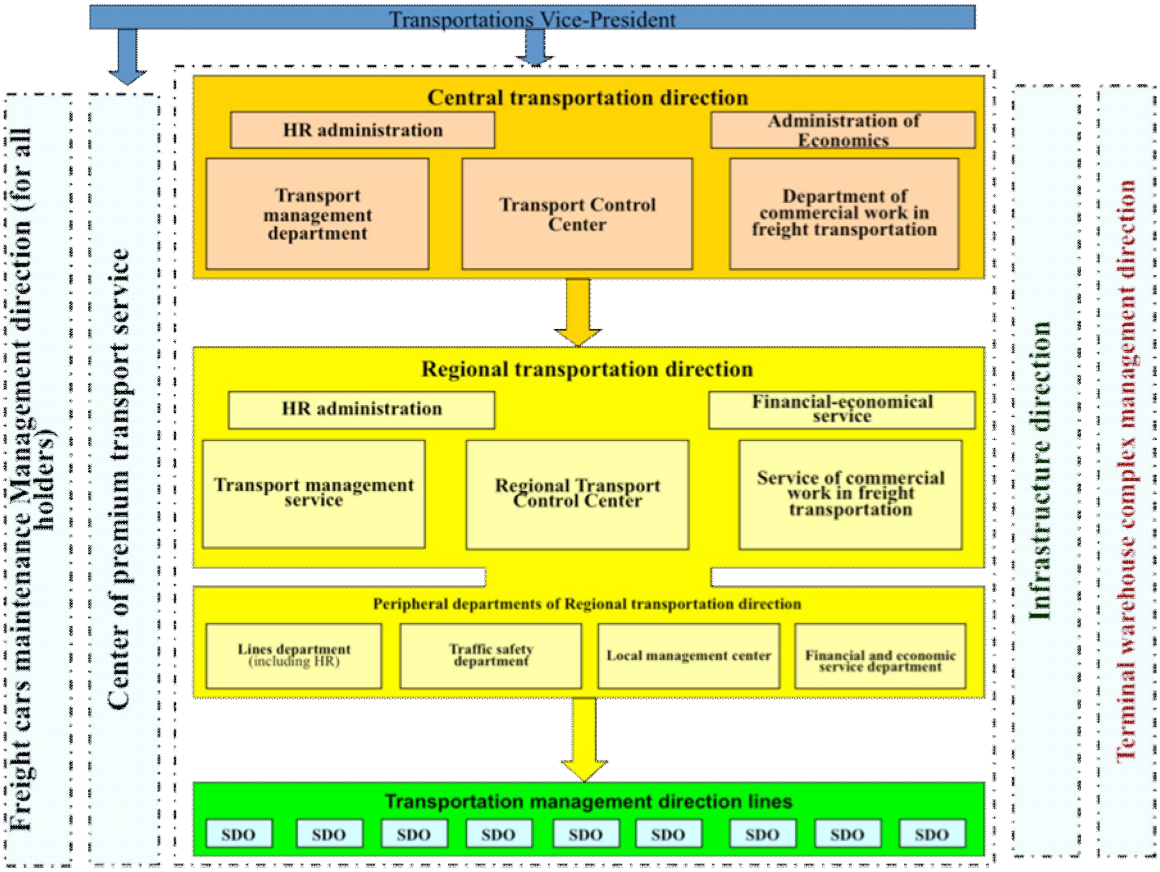

Figure 1. Transportation management system

Nowadays such network tasks are being solved, as: controlling transferring of trains and cars in inter-road and border-line division points; controlling trains and freight delivery to the largest sea ports; controlling passenger trains movement; controlling circular routes; controlling and analyzing car fleet usage in Commonwealth of Independent States and in Baltic states.

Perspective of further railway transport informatization is obvious – it suggests optimization of management, increasing effectiveness and stability of railway operation in Russia.

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Enterprise Resource Planning Systems in Higher Education

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Abstract
Information systems and technology are becoming more and more important in the industry. Consequently, it is important to include these in any modern logistics education. This paper describes how ERP-systems are utilized in logistics education programs and courses at University of Skövde (Sweden). The objective of this paper is to highlight the importance of information systems and technology in a modern logistics education.

Keywords: Enterprise Resource Planning Systems, logistics, higher education

1. Introduction

Information systems and technology are becoming more and more important in the industry. Increased competition and globalization have radically changed the business environment and resulted in companies' need to reduce total costs in the entire supply chain, shorten lead-times, reduce inventories, expand product assortment, provide more reliable deliveries, as well as improve customer service, quality, and efficiently coordinate world-wide demand, supply and production (Li et al., 2006; Umble et al., 2003). To accomplish these objectives, effective enterprise information systems are required (Liao et al., 2007; Sun et al., 2005). Moreover, the implementation and integration of information systems support information sharing and supply chain alignment, which can considerably reduce demand uncertainty, demand variability amplification, and inventory levels.

As illustrated in Figure 1, information systems and technology are supposed to increase the efficiency of individual supply chain processes, that is, efficient utilization of resources, such as transportation, warehousing, inventory control, order processing, and logistics administration (Mentzer and Konrad, 1991). They should also facilitate intra-organizational and inter-organizational integration across the supply chain, that is, the integration between different systems, as well as enable collaboration with supply chain members (Kumar and Diesel, 1996).

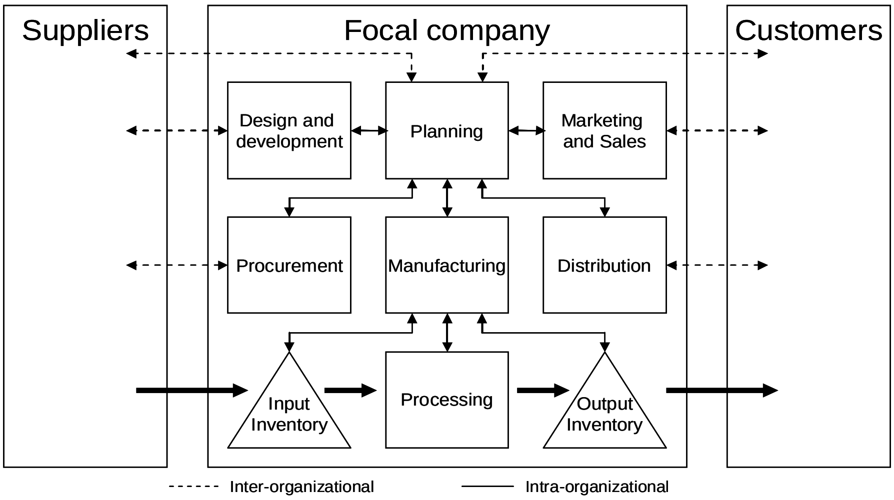

Figure 1. Application and system integration in the supply chain.

Information systems and technologies are crucial to the development of efficient and effective supply chains and the utilization has numerous advantages. At a strategic level, Alkadi et al. (2003) highlight that utilization of information systems and technology can increase the efficiency of supply chains. Moreover, Williams et al., (1997) underline that the use of information systems and technology can increase the alignment between supply chain strategy and business strategy. In addition, Kotha et al. (2000) and Byrd and Davidson (2003) emphasize that the exploitation of information systems and technology in supply chains can increase overall growth and profitability. On a more operational level, Kincade et al. (2001) have linked the utilization of information systems and technology to an increase in product offerings and customer service levels, while Brandbyberry et al. (1999) have linked the employment of information systems and technology to an increase in quality and timeliness of production information.

There exists numerous of information systems and technology to support different functions and processes in the company and across the supply chain. One of the most commonly used enterprise information systems is an Enterprise Resource Planning (ERP) system. An ERP-system integrates all necessary business functions within an enterprise, such as product planning, purchasing, inventory control, sales, financial and human resources, into a single system with a shared database. This system is the central piece in any attempt to create information system for the whole supply chain (Liao et al, 2007; Yang et al., 2007).

Because ERP-systems have become common in the modern industry to improve supply chain efficiency and effectiveness, it has also become important to include these in any modern logistics education. In this paper the utilization of ERP-systems in logistics education programs and courses at University of Skövde (Sweden) are described. The University of Skövde currently provides three logistics education programs and approximately 20 courses. The objective of this paper is to highlight the importance of information systems and technology in a modern logistics education.

The remaining of this paper is structured as follows. In Section 2, the ERP-system is described in more detail. Thereafter, Section 3 in brief presents the ERP-system Navision. Section 4 describes how ERP-systems are utilized in logistics education program and courses at University of Skövde (Sweden). Finally the paper is summarized.

2. Enterprise Resource Planning Systems

An ERP-system 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 database (Liao et al, 2007; Yang et al., 2007). The key idea of the ERP-system is using information technology to achieve the capability to plan and integrate enterprise-wide resources (Kumar et al, 2003).

The ERP-system is increasingly important in modern business, because of its ability to integrate the flow of material, finance, and information to support organizational strategies (Yusuf et al., 2004). The ERP-system was developed and derived from the previous Materials Requirement Planning (MRP) systems and Manufacturing Resource Planning (MRPII) systems (Yang et al., 2007).

A successfully implemented ERP-system can offer companies several benefits, for example, automated business processes, timely access to management information, and improving SCM through, for example, the use of e-commerce (Yusuf et al., 2004).

The selection of an appropriate ERP-system and its implementation are not easy tasks. 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) an ERP-system remains an essential research topic.

Moreover, training is vital of retaining the value of an ERP-system investment. The users have to be educated in the system otherwise companies will not benefit from and an ERP-system investment. Unfortunately, it is usually the case that companies reduce costs regarding this issue.

3. Microsoft Dynamics NAV

Microsoft Dynamics NAV (formerly Microsoft Navision) is a fully integrated ERP-system for small and mid-sized organizations that delivers functionality for all aspects of operational and financial activities of a business (NAV, 2008). It is includes functionality to support financial and relationship management, distribution and manufacturing.

Navision uses a graphical user interface (windows) that allows the user to enter and maintain financial and other business activities in one place, work in several windows concurrently and locate, choose and execute various activities (NAV, 2008). Figure 1 displays the main application window – including a work window and the navigation pane.

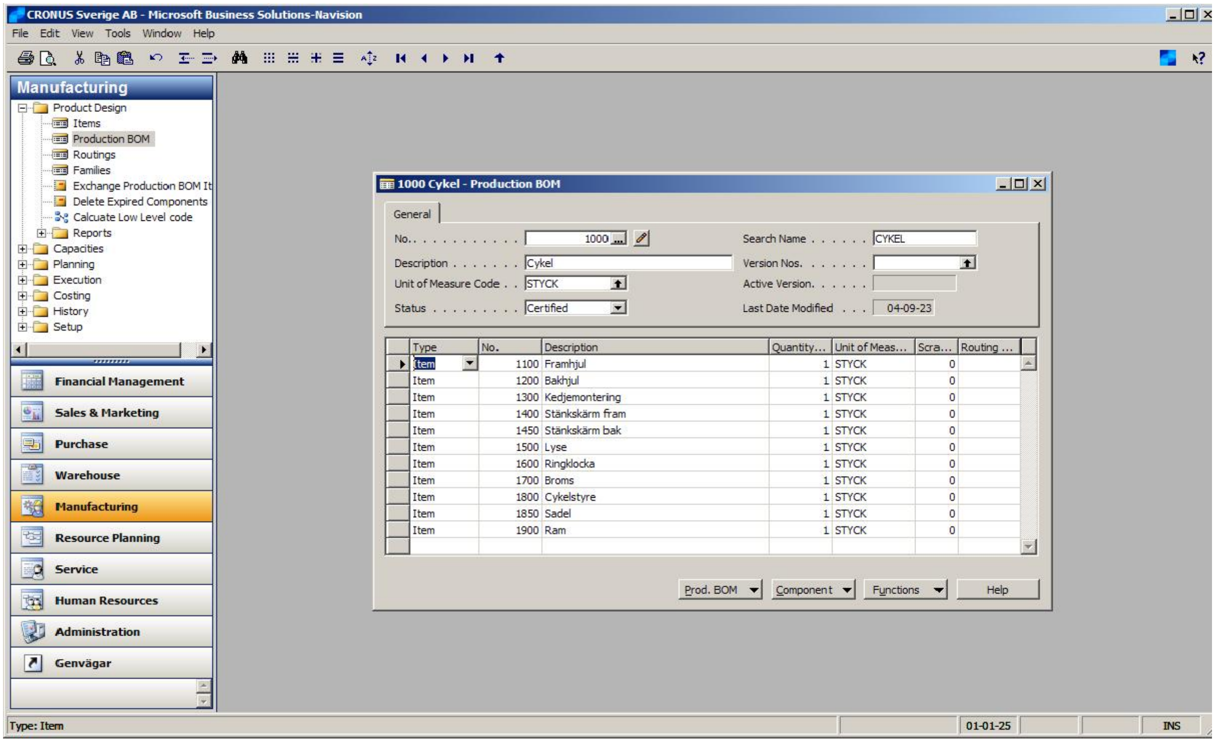

Figure 2. Main application window - showing the navigation pane and a work window

Basically the system helps the user to organize daily routines, locate information quickly and manage business information and activities. The system has over 30 thousand installations and over 300 thousand users in over 50 countries (NAV, 2008).

The system incorporates several modules each addressing different business activities, functions and processes in the organization (NAV, 2008). Table 1 display some of the modules incorporated in Microsoft Dynamics NAV along with their functions and utilities.

Table 1. Modules, Functions and Utilities Incorporated in Microsoft Dynamics NAV

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

Microsoft Dynamics NAV is designed to work smoothly with other Microsoft products such as Microsoft Office, Microsoft SQL Server, and Microsoft Windows (NAV, 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 (NAV, 2008). The commerce portal capabilities incorporated in the system also allow creation of a Web site to work easier with customers and partners. Additionally, the system can be integrated with a wide range of other software products, so that the company can make the most of its IT investment (NAV, 2008).

4. Enterprise Resource Planning Systems in Higher Education

ERP-systems have been utilized in logistics education programs at University since 1995. In the beginning, the ERP-system Scala were used, primary in manufacturing planning and control courses, to illustrate how production planning can be conducted through information system. Nowadays, the ERP-system Navision is used and the system is also utilized in more courses, such as “fundamentals of logistics”, “logistics for industrial manufacturing” and “information and communication technology”.

In the “fundamentals of logistics” course, the student basically follows an order through an organization to learn how to handle all the steps in the order fulfillment processes, from creating the order to shipping and invoicing the order, in a modern ERP-system. The order handling process is the cornerstone in all companies to achieve high customer service level and an ERP-system can help organize, plan and manage this process. This could for instance involve help keeping the company’s customers satisfied through an instant and accurate response to inquiries concerning, for example, delivery time or the price of the product. Moreover, the system aid sales transaction registration by adjusting customer balance and updating inventory availability. Likewise, the system aid purchase transaction registration by ensuring that it is based on the most favorable terms, such as delivery time and price and that the associated inventory and financial information is registered correctly. Additionally, the system helps to record the relevant sales and purchase agreement details (with customers and vendors) once and then simply reuse this information when creating new orders. Table 2 display the major areas incorporated in the course and the specific objectives within each area.

Table 2. Major areas incorporated in the "Fundamentals of Logistics" course and the specific objectives within each area

Area	Objectives
Mange items	Create new items (item cards)
	Learn the purpose of all fields and functions on the item card
	Identify and use the functions provided on the item card
	Get insight to an item's availability over time
	Analyze item figures with statistics windows and reports
Process purchases	Perform a complete purchase process and learn how it connects to other application areas
(Purchase Order Mangement)	Create new vendors (vendor cards)
	Create, post, and review purchase orders
	Process the receipt and invoicing of inventory items
	Create, post, and review purchase invoices
	Process the purchase of non-inventory goods or services with purchase invoices
	Plan and make payments to creditors
	Use the Suggest Vendor Payments function
	Make payments manually by selecting open entries to apply
	Adjust general ledger entries with the general journal
	Use general journal registers to follow the audit trail of all transaction types
Sales processes	Perform a complete sales process and learn how it connects to other application areas
(Sales Order Management)	Create new customers (customer cards)
	Create a sales quote and convert it to a sales order
	Create, post, and review sales orders
	Process the shipment and invoicing of goods
	Receive payments from customers
	Use the Aged Accounts Receivable report

In the "Logistics for Industrial Manufacturing" course, the students learn more about manufacturing management in a modern ERP-system. Manufacturing is a key element in almost every organisation and concerns how the company plans for and then executes the plan to produce or acquire products and resources. It is a quite complex process, which an ERP-system can help organize, plan and manage. This involves the definition of a product set up in item numbers, bills of material (the listing of all parts, purchased and produced, that are required to make an item) and routings (manufacturing process steps and instructions). Moreover, the company need to establish inventory or raw materials needed to produce the end items. Finally, the company based on the demand need to manage inventory levels and production to meet that demand. Table 3 display the major areas incorporated in the course and the specific objectives within each area.

Table 3. Major areas incorporated in the "Logistics for Industrial Manufacturing" course and the specific objectives within each area

Area	Objectives
Manufacturing	Create, copy, and change Bill of Materials (BOM)
	Create, copy and change routing (Bill of operations - BOM)
	Use Capacity Journals
	Use Capacity Reports
	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

Additionally, a new flexible course recently has been developed. This course is entirely dedicated to ERP-systems and Navision in particular and comprises 7.5 higher education credits and is on basic level (approximately 200 hours of study). This course, entitled "Introduction to the ERP-system Navision", is described in more detail below.

Course: Introduction to the ERP-system Navision

Training is vital to retain the value of a large ERP-system investment. However, employees often are busy and training is an issue that usually is ignored by many companies. Consequently, students in logistics education programs and courses could benefit from knowledge and skills in ERP-systems and companies need flexible training courses for their employees. When investing in Microsoft Dynamics NAV, the system developer also provides several flexible training courses. The users basically can choose either e-learning, instructor-led training, or self-paced study using training materials.

The University of Skövde has access to these training manuals through an Academic Alliance and these are used in the "Introduction to the ERP-system Navision" course. The objective of this course is to give the students basic knowledge concerning an ERP-system's functions and possibilities, but also skills in Microsoft Dynamics NAV. Moreover, when the course has ended, the student can contact Microsoft to perform a certification exam to validate their training.

As highlighted above, Microsoft Dynamics NAV incorporates several modules but in this course the students can only choose one of the following directions:

§ Financials management

§ Manufacturing

- § Trade and inventory management
- § Warehouse Management

The course consists of two lectures (8 hours) and five instructor-supported computer lessons (20 hours). One of the lectures, introduce the course and discuss ERP-systems in general by focusing on their functions and possibilities while the other lecture give 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 instructor-supported computer lessons. Between each of the five computer lessons the students work at home through provided demo installation and e-learning materials. This allows the students to learn at their own pace. This course is currently a summer course and therefore it is quite compact and intense. However, it is rather easy to extend the time period to make it more flexible. Table 4 display the major areas incorporated in the course and the specific objectives within each area.

Table 4. Major areas incorporated in the "Introduction to the ERP-system Navision" course and the specific objectives within each area

Area	**Objectives**
Trade	Manage sales transactions
	Create and use sales prices and discounts
	Process sales of items with substitutions and cross references
	Process sales of nonstock items
	Manage purchase transactions
	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
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
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	Create, copy, and edit Bill of Materials (BOM)
	Create, copy and edit routing (Bill of operations - BOM)
	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

5. Conclusions

Information systems and technology, particular ERP-systems, has become a necessity in modern businesses. Consequently, it is important to incorporate these aspects in modern logistics education programs and courses. It is not enough with theoretical knowledge; practical knowledge is required as well. This paper describes how ERP-systems are utilized in education programs and courses at University of Skövde (Sweden) to give their students theoretical as well as practical knowledge regarding information systems and technology in general and ERP-systems in particular.

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Globalization and International Division of Work: New Ways of Co-operation within Lean Production Networks – Evidence from Russia, Finland & Sweden

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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). This finding also got ground in our literature review – 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 three case studies verify literature findings, and shed some North-European and Russian perspective on the research regarding this topic. Based on findings, both Finnish and Swedish case companies are increasingly favoring foreign suppliers, and emphasis is especially on developing economies. Also integration of product life-cycles on the logistics decisions is vital, and input factor in logistics configuration decisions. Russian manufacturing unit case study, operating near-by Finnish border, reveals that properly working logistics flow is essential for business success, since deliveries are not limited to Finnish Original Equipment Manufacturers or Russian markets, but Russian case company needs to manage shipments directly to China and India too. International shipments are managed through Finland, while manufacturing base is located in Russia.

Keywords: Lean production, production networks, emerging economies, 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). To manage their operations in a turbulent environment of international trade, firms are forced to introduce novel strategies to be able to have some kind of control over the dynamics of markets. This research is to investigate the essence and consequences of globalization on the international division of work within the context of production network. In the following theoretical settings will be considered in general terms after which the exploration will be leveraged to the state of matters present in developing economies.

In this research work analysis is focused on several companies through a descriptive case study approach. Three manufacturing enterprise examined represent divergent industry sectors, while being mainly based in different countries: Sweden, Finland and Russia. The aim is to gain insight on the processes involved in managing product flows and the way they evolve and function 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, where modifications on international operations within lean framework are the main aim.

This research is structured as follows: In the following Section 2 we review literature from lean production with 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 three case studies conducted. Thereafter, in Section 4 three cases are introduced, where first case represents Russian company operating in subcontracting industry, followed by end product manufacturers from Finland and Sweden. 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 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. In order to be able to outline the theory platform for examining these kinds of business systems, academic articles on the relevant topic are collected and examined.

Table 1. Article summaries on globalization and lean production networks

Aurthor(s) / Title	Major arguments	Additional information
Krishnamurathy, Rajesh & Yauch, A. Charlene (2007) Leagile Manufacturing: a proposed corporate infrastructure	It is possible for a multi business unit corporation to apply both lean and agile concepts. The decoupling point separating lean and agile units must exist. With a combined approach the organizational structure of the company should include both centralized as decentralized units.	In this case study only one company is examined where there is one centralized sales unit and many decentralized lean production units that operate on a make to order principle focusing on specific domains of product and manufacturing processes.
Vonderembse, A. Mark et. al (2006) Designing supply chains: toward theory development	Standardized products that have low variety in demand, with stable value propositions are best to fit to a lean strategy whereas innovative goods are better to set into an agile environment. Hybrid products and services include both lean and agile approaches at the same time.	Innovative services may include components produced by lean philosophy. Especially during the late stage of life cycle an innovative offering may turn into a lean output. This same line of thought is applicable to hybrid products.
Agarwal, Ashish et al. (2006) Modelling the metrics for lean agile and leagile supply chain: An ANP approach	Nowadays there is a need for supply chains to include characteristics of both lean and agile methodologies. Changes are of ordinary facts in turbulent business environment and a company must be able to adapt itself to a new situation in a cost effective manner optimizing its usage of resources.	Lean supply chains are oriented toward physical costs reduction, optimizing purchasing components by employing algorithmic forecasting mechanisms. Information enrichment ability is of pivotal importance to be able to compress lead time and eliminate waste.
Hines, Peter et al. (2006) Towards lean products life cycle management	The literature on lean product development lacks of studies concentrating high innovation low volume multiple product environments. In many cases large IT/electronics and automotive sectors are examined. People are regarded as passive resources and treated as an extension to machinery or workflow.	By far most of the process mapping efforts have focused solely on order fulfillment processes and the tool used incapable of capturing relevant features of performance of the process in target.
Papadopoulou, T. C. & Özbayrak, M. (2005) Leaness: experience from the journey to date	With regard to critical implementation elements of the lean concept there is no consensus at the moment: This might stem from the fact that platform was created in a very specific production context. Enrichment of contents takes place continuously as a result of constantly evolving practical novel cases.	The term ”Lean Enterprise” embraces the characteristics of responsiveness, agility and flexibility and it is a strategy to comply with the challenges posed by globalization and increasing competition. The ambiguous definitions and debates on the origin of evolution render in many cases the lean concepts obsolete.

From the article summaries it can be concluded that there seems to be some confusion on how lean thinking is to be applied and the effects it has on the production network. 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 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).

Table 2. Current problems with lean manufacturing in supply chains in developing economies.

Aurthor(s) / Title	Major arguments	Additional information
Taj, Shahram (2008) Lean manufacturing performance in China: assessment of 65 manufacturing plants	According to the results in China currently the petroleum industry is the leading sector applying lean concept followed by computer, telecommunications and electronics. In terms of production system design, layout design, volume/mix flexibility requires more attention from managers.	On the other hand it can be seen that progress in the adaptation of lean principles took well place too: On time delivery of finished goods and overall defect rates scored high among the participated companies. These findings of this study are well in line with other ones conducted recently in China.
Lorentz, et al. (2008) SCM in emerging market economies: a review of the literature and analysis of the Russian grocery retail sector	The grocery sector in Russia is still dominated by domestic players and possibly foreign presence into the markets will take place through acquisitions. Retailers are better off in case forming vertical integration with manufacturers so as to have access to low price, satisfactory quality and availability of resources.	The two primary area of market potential will be the ones around St. Petersburg and Moscow and only in these regions growth of revenues is achievable for retail chains. Further concentration of dominance is expected as successful companies will list on stock markets and acquire higher stakes of market share and productivity gains.
Hilmola, et al. (2008) Export based strategy or manufacturing establishment? Speculating with Russian market	Despite the opportunities stemming from the immense size of retail market, Russia is still conceived as an instable operating environment where problems with logistics incoming flows and distributions outweigh the benefits from cheap labor base.	It can be argued that still nowadays the food retail sector in Russia is flavored by vertical integration and ownership base control. These themes lead to centralized control mechanisms and lack of competition. At the same time there are weak or missing linkages between the interface of suppliers and customers.
Mesquita et al. (2007) Determinants of firm competitiveness in Latin American emerging economies	In the Brazil automotive industry horizontal cooperative arrangement do not have positive impact on the performance of suppliers. Only firm level investments in lean techniques are not enough to achieve performance advancement especially in emerging economies, where strong institutions are missing.	Intra-firm measures to increase competitiveness are highly appreciated among managers in this sector and these senior leaders tend to pay less attention to the benefits that might stem from collaborating with public partners. Public authorities must generate trust in the private sector to foster competitiveness.
Saad et al. (2006) An investigation of supply chain performance measurement in the Indian automotive sector	The practices are focused on innovation schemes driven by tangible factors such as cost and productivity goals. Hierarchical structures are still dominant among the companies. Technical skills are considered most important in the education of personnel among the firms and joint problem solving is not seen as necessary.	Suppliers with superior technical expertise and experience are more likely to access better chances to have a contact with a manufacturer. In so it can be concluded that the whole philosophy on new concepts related to supply chain management are not adopted still in a full extent.

The article summaries above message about the current state of strong formal control of governments on business activities in general in developing countries, making it inevitable for these economic regions to leverage liberalization policies within firm regulatory context (Boeri eat al. 2006). Only this way lean concept can be incorporated into the business mentality of the managers of private and public enterprises. The core aim of these reforms could be to generate incentives for private parties to fuel into the system much more capital benefiting the outcome of lean revitalization of operation models of business organizations. 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). A critical component in implementing lean production structures is an adequate transportation and logistics infrastructure. 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

Three cases represented in this research work are mostly first outcome from the research project concerning intermodal transportation solutions within Southern Finland and larger St. Petersburg region in Russia (Leningrad oblast). Therefore, 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, but also included visit on one manufacturing site. Interviews in these cases took 1.5-2 hours, and were concentrated on transportation,

transportation mode selection and distribution issues. Secondary importance was given for manufacturing structure used and supplier network management issues. Interviews were completed during Spring 2008, and are the input for European Union funded project Lognet, which is funded by Tacis neighborhood programme. Our intention is to review number of cases (roughly 5-7) from these two countries, and analyze how intermodal (combined), and especially railway transportation, could be used more on company operations. These two cases reported in this paper are verified by company management, in order that we have drawn correct conclusions from interviews.

As a comparison point for Finnish and Russian cases we are using case study completed for Swedish manufacturer, which is operating on consumer business, and supplies mostly its products to Northern Europe as well as former Eastern Europe countries, and Russia. Swedish manufacturer case illustrates further, what kind of requirements supplies have to enter global consumer business, where technologies and trends change, and product innovation and shorter life-cycles set their restrictions on logistical solutions. Swedish case is also based on qualitative interview of company's key manager during year 2007. Among the interview we were able to get familiar with internal documents of the company as well as published material by the company for larger audience (press releases and annual reports). As first two cases in our research work are not publicly listed companies, and are medium sized, Swedish company represents an organization being publicly listed, and has several billion USD size in terms of sales.

4. Case-Study Analyses

A Case of a Subcontractor Operating in Vyborg, Russia: Manufacturer CJCS Trafo, Vyborg (Leningrad Oblast)

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).

Company manufactures inductive components and performs electro-mechanical assembly in the city of Vyborg, Russian Federation, close to the border between Finland (EU) and Russia. Manufacturing unit is comprised of two different buildings, located near-by each other in industrial district of Vyborg. According to CJCS Trafo (2008) webpages manufacturing unit is a supplier of power supply transformers to several international power supply producers in Europe and the US, producing power supplies for such clients as Nokia, ABB, Ericsson, General Electric, Elcoteq, Kone and Videoton. The most of the production is exported to or via Finland, but there also exist some clients in Russia. International shipments are also increasing nowadays, and products are even being directly delivered to Asia (e.g. China and India) in small but increasing volumes.

The customer services and purchase management is located in Helsinki, Finland; the logistics and warehousing in the Finnish city of Imatra near-by Russian border in South-Eastern Finland, while manufacturing and assembly is being completed in Russian city of Vyborg, only 35 kilometers from the border (Vyborg belongs to Leningrad oblast – larger St. Petersburg region). 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.

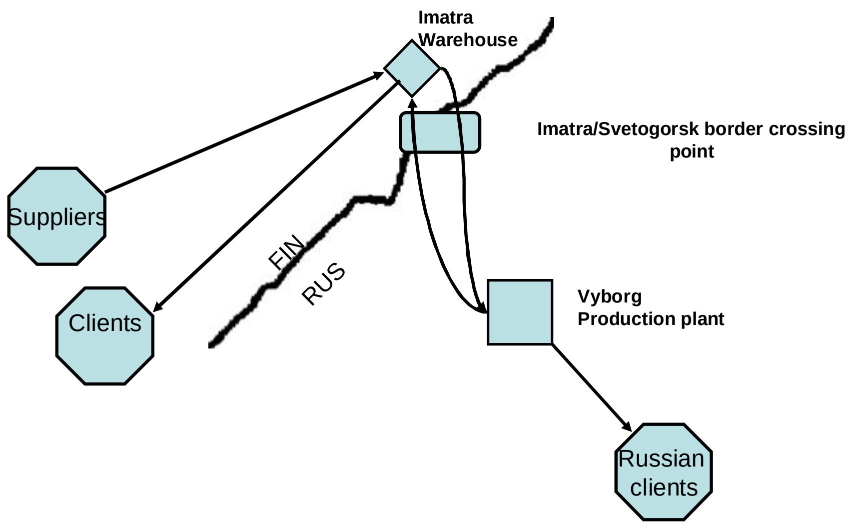

Figure 1. Component, semi-finished and finished product flows of the CJSC Trafo.

Company possesses their own transportation fleet, including 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. In case their own fleet can not fulfill all the transport needed, additional transportation services will be bought from transportation companies. Currently Trafo is also selling its customs handling services for other manufacturers near-by its premises in Vyborg – 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. 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 – some time ago it was enough that trucks once in a week brought items to Imatra warehouse, but nowadays demand is for two or three times in a week. This is mostly due to time pressure and low inventory levels of their customers – if some shipment misses truck delivery to Finland by one day, it needs sometimes to wait additional six days at Vyborg. Same time manufacturing unit in Finland or abroad is having material stock-outs, and their delivery performance is disturbed as well as efficiency will decrease.

The logistics operations in Vyborg are controlled by a group of three persons. Logistics manager is the head of the group and one person is taking care of the incoming cargo and another is taking care of the outgoing cargo. Totally the company employees 30 people in administration and from 150 – 200 people in production, depending on the amount orders placed by their customers. However, it should be noted that 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, as it is being compared with western countries, for example in Finland equivalent workers salary is 6-8 times higher. However, management emphasized that benefits do not directly translate on higher profits and efficiency. Control of production related operations in Russia is very intensive, and country has long traditions for this; different officials and inspectors (like customs, finance inspection, working conditions, fire department etc.) frequently visit production facilities. Although these visits could benefit manufacturer in terms of developing operations further, they quite often take long amount of higher management working time, and production efficiency suffers greatly. So, even if the production resources might be competitive in salary wise, benefits of it could be easily eroded with additional inspections. This situation is not new, e.g. one Swedish manufacturer reported similar difficulties operating in Russian environment through its manufacturing unit (salary in production was low, but low efficiency and inspection eroded all of the possible benefits, 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. In this way large scale fluctuations between seasons in demand are eliminated.

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).

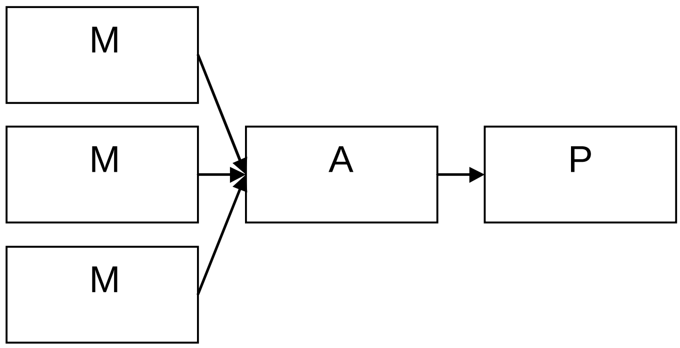

Figure 2. Supply chain structure of Q-tech (M = manufacturing, A = Assembly, P = Packing). Source for reporting structure: Tuominen et al. (2006: 44)

Within the next five years the majority of production is going to be transferred to lower labor countries such as the 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. There does not exist transport vehicle in the ownership of the company and the trucks or vessels needed are accessed trough leasing contacts. For not opting rail, the main reason is that the components pertinent to marina or pontoon solutions are sensitive and require 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.

Swedish White Goods Producer and the Internationalization of Supplier Network and Importance of Product Development Integration

Swedish white goods producer is a global leader in home appliances and appliances for professional use. They sell more than 40 million products every year to consumers and professionals in 150 countries. The largest markets are in Europe and North America and the strongest market position is in Europe. Company employs tens of thousands employees and is multi-billion company as measured with sales. The product range includes refrigerators, dishwashers, washing machines, vacuum cleaners and cookers. The products are sold under several brands, but the major share of products is sold under the company brand.

The case company is nowadays working in an increasingly competitive industry characterized by intense competition, increased global product standardization, and shorter product life cycles. To survive in this new environment firms' needs to create a truly consumer-driven organization by focusing on consumer-oriented product development (to create an efficient and effective product flow), branding (to develop a strong global brand) and supply materials and products on demand (to create an efficient and effective demand flow). Thus, company has defined Brand, Product Flow, and Demand flow as their major business processes. All these processes are currently in-house, but company regards the brand and product flow process as more important then the demand flow process, which in theory could be outsourced in the future. In order for this to happen, the brand needs to be strong and the product flow process needs to be very efficient and effective.

The case company has launched several cost reduction programs to free capital to invest in product development and creating attractive brand. Firstly, they have started a restructuring program in 2004 aimed at creating a competitive production structure in the long term. The costs of this program are estimated at approximately SEK 8 billion. When it is finalized in 2010, more than half of the products will originate from low-cost countries, and savings will amount to approximately SEK 3 billion annually from 2010 onwards. Secondly, the case company is implementing a global program for more efficient production, and it is based on proven methods for improving production that have been developed both in-house and externally. Program has been implemented with great success in plants that manufacture kitchen and laundry products. In 2007, it will be implemented in facilities for production of vacuum cleaners and professional products. Finally, company has started to purchase more materials from suppliers in low-cost countries in order to additionally reduce costs. Cost for purchased goods and services represents about 70% of cost of goods sold – most important input item to be managed. It is therefore obviously very critical to manage these costs in the most efficient way. The share of purchases from low-cost countries has risen from approximately 30 percent in 2004 to 40 percent in 2006. Another priority is to engage the purchasing function at an earlier phase of product development. In 2006, the case company achieved savings in purchasing of approximately SEK 1.9 billion.

Products are the very core of company's business, and success in this area is closely linked to the amount of resources as well as methods and tools to ensure that they develop the right products, based on consumer insight, to lowest possible cost at the right time. In order to realize this, the case company has developed a process for consumer-focused product development entitled Product Management Flow (PMF). PMF is a global and holistic process for managing products – from the cradle to the grave – and it describes all areas of creating and selling products. As the project director puts it: "*The PMF first identifies what kind of mines there exists and then in which mines the chance of finding diamonds are highest. Finally the diamonds are polished and put on the market.*"

The PMF is run by the product line manager with support from the consumer innovation program. It was introduced in 2004 and over the next couple of years it will be implemented in all product lines. It consists of three sub-processes the: (1) strategic market plan, (2) product creation process, and (3) commercial launch process (see Figure 3 in below).

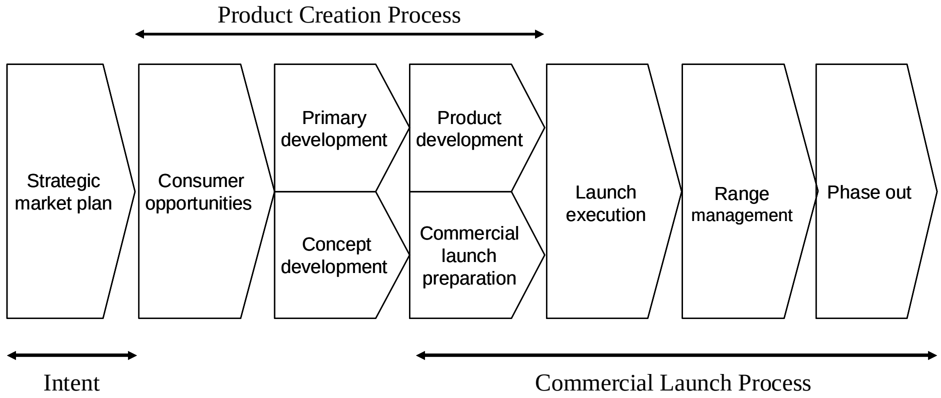

Figure 3. Product Management Flow – white good's producer's way of taking products to the market.

Identifying global consumer trends and segmenting consumers enables them to offer products with more relevant and attractive design, on the basis of fewer product platforms. The goal is to create products that are adapted to local needs together with products that can be sold world-wide on the basis of common global needs. Employees from many functions are involved, at this time there are no logisticians. Furthermore the PMF includes a structured working method, with check and decision points to make sure that no steps are omitted.

5. Conclusions

In theory through agility supply chains are to achieve more responsiveness and flexibility than lean oriented value chains, but in practice leanness itself can stimulate to agility and flexibility. However, in the lean enterprise organization model partnerships might not become the dominant form of cooperation due to the asymmetric distribution of power of the actors involved (Albino et al 2007). Since the product development process and supply network efficiency are the two most significant contributors to responsiveness of a supply chain, simple flat process based industrial district enterprise models complemented with appropriate service level agreement between the partners seems to be essential in the future (Saad et al. 2007). In this manner collaborative framework such as Collaborative Planning, Forecasting and Replenishment for production network could be adapted better to the dynamic business environments of today (see Danese 2004). 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. Excessive regulation imposed by central government and the lack of incentives are the primary barriers for implementing flatter team oriented network enterprise architectures.

Our research showed via empirical part that in practice manufacturing companies integrate their supply chains to be able to both cut out cost and to simplify the complexities in their supply chain relationships. As such these measures lead to better responsiveness in their ability to meet customer requirements. Firms usually have difficulties in Russia as a result of rigorously regulated market control mechanisms imposed by governmental agencies. The only way in most cases to get forward is to integrate vertically within the supply chains and building personal contacts with official authorities. Russian and Chinese markets are so attractive that enterprises are not afraid of investing more in those developing regions of the world.

As a further research in this area, we have intention to continue with case companies, and add several interviews more to get proper understanding, how intermodal transportation solutions should be directed to serve industry operating in Southern Finland and larger St. Petersburg region. Thereafter, we would like to construct possible solutions within co-operation among transportation companies, and freight forwarders. Also pilot cases would be beneficial in order to show and report real-life implications of such systems in this demanding operating environment. In research side our case descriptions and proposed solutions should be compared on operating modes and case reports in other developing economies, such as Mexico, Brazil, Thailand, India, and China. Advanced concepts of lean and agility should be modified into these environments, and further epistemology is needed.

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Research Note: St. Petersburg Logistics Infrastructure – Terminals and Warehouses

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1. Introduction

The St. Petersburg Transport and Logistics Network (TLN) is the next largest to Moscow with regard to volume of cargo handled and to the number of passengers served. It has the most complicated industrial and territorial structure both in Russia and in Europe.

Interaction of six types of external transport and several types of domestic ones (urban transport network and commuter service) form the structure of the St. Petersburg TLN, which embraces transport infrastructure and terminal and warehouses facilities in the territory of St. Petersburg and adjoining areas of the Leningrad oblast and a part of water area of the Gulf of Finland.

Federal and local highways, city avenues and roads alongside with railroads and waterways of general use comprise the basic transport network of the St. Petersburg TLN that is 6000 km long. Many facilities of the railroad network in the territory of the city are closely connected with other transport facilities: external, suburban and urban so that diversified transport terminals have been created.

From year to year highly intensive cargo flow growth has also affected logistics, for example, container handling volumes have increased by factor of 10 up to 1.5 million TEU in t. Petersburg only, and due to increased prosperity, growth of consumption is going to continue as strong in the future too.

2. Terminals and Warehouses in St. Petersburg

A challenging problem of insufficient infrastructure development is the lack of area near the port to set up freight terminals for storing, handling and distributing cargo. There is much lesser storage area in St. Petersburg port than in major transport hubs of Europe. Technological facilities of the port terminals are of very low standards. This causes low freight handling and traffic of goods.

The total area of warehouses in St. Petersburg according to statistics of the City Agency on Management of Real Estate Inventory and Valuation totals 5 million square metres. The total number of separate warehouse buildings amounts to 3308 with total area of 4.2 million square metres. The area of integrated warehouses totals 0.7 million square metres.

Almost half of all city terminals with the area of 2.6 million square metres are meant to service foreign trade freight turnover. Among them - 2.0 million square metres is the port area, while 0.6 million square metres – inside the city terminals which perform storing, re-packing and customs clearance functions.

Storage facilities are of the following types:

- 3.9 percent are logistics centres and warehouses within science parks;
- 13.2 percent are integrated storage facilities (ground floor facilities and basements);
- 82.9 percent are reconstructed storage facilities (former production facilities)

The types of warehouses with regard to equipment and facilities in the territory of the city are following:

- A class – 5 percent (about 200 thousand sq. metres)
- B class – 4 percent
- C class – 79.8 percent
- D class – 11.2 percent (including integrated storage facilities).

One of main features of Saint-Petersburg transport-logistics services market is that container cargo flow in the port generates big share of income. The St. Petersburg port is a leading one in Russia in the field of containers transshipment. In 2006 it reached 60% of whole container transshipment volume in Russian Federation and this cargo gave 77 bln. Rub income or 47% of whole St. Petersburg transport-logistics services market volume. In the last years the growth of container cargo flow in Saint-Petersburg is significant and equal to 25-30% per year.

The second after container cargo in rapidness of growth is demand for logistics services from trade business. For the recent few years Saint-Petersburg trade complex is skyrocketing and create significant needs in sell premises, up to day warehouses and sufficient ways of supplying. It occurs due to the *trade nets* part growth in the St. Petersburg trade structure, which well functioning is impossible without contemporary logistics methods. Absence of adequate distributing service offers enforces trade nets to construct their own warehouses and organize transport departments.

There is insufficient use of international cargo transportation advantages in Saint-Petersburg, especially containers. Now less then 20% of container flow is handled at terminal complexes of Saint-Petersburg. The rest is transit. So, the lost profit appreciated by experts is as high as 13-15 bln. Rub per year.

3. Main Territories for Logistics Development in St. Petersburg

For aims of modernization, development and efficiency growth of transport and logistics in Saint-Petersburg City Government Committee for transport and Transit Policy has created Development Strategy, approved by government document N 741 of 03.07.2007. The part of this Strategy is devoted to logistics terminals and warehouses.

According to this concept were defined permitted and expedience zones for logistics infrastructure location. (24 zones, main 12 are presented in Table1).

Table 1. Main territories for development of terminal-warehousing infrastructure in Saint-Petersburg.

N	Territory name	Crude location parameters
1	« Beloostrov»	North-West of City not far from "Scandinavia" motorway
2	« Bronka»	South-West of City, not far from "Lomonosov"
3	« Ighora Plants»	Kolpino, South
4	« Kupchinskaya»	South-West
5	« Neva»	Right riverside
6	« Obukhovo»	Left riverside
7	« Parnas»	North-East of the City
8	« Predportovaya»	South-South-West of the City
9	« Ruchyi»	North of the City near Ring Road
10	« Shushary»	South of the City near Ring Road
11	« South-Western»	
12	Port «Gorskaya»	South, near cross of RR and Motorway Primorskoye
13	«Pulkovo»	South, near Airport
14	« Osonovaya Roscha»	North-West of the City

Projects for constructing of new terminals and warehouses in these areas are priority for the Governance, because of their responsibility for engineer and transport infrastructure at these territories.

According to the concept objects near Ring Road are in priority of Customs for location of Custom posts.

4. Volume of Terminals and Warehouses in Saint-Petersburg

Among class A warehouses 21% are refrigerating (low temperature) with main zones of location: Big Port Saint-Petersburg, Gorelovo, Sofiyskaya street.

Table 2. Volume of terminals and warehouses in Saint-Petersburg.

Category	Number	Class A	Class B	Rail+Motor access	Motor access
In Action (>5000 sqm)	By 50	9%	28%	18%	82%
Under construction	By 20	75%	25%	70%	30%
Planning phase	By 15	93%	7%	82%	11%

Table 3. Area of main terminals in St.Petersburg, sq-metres.

	Company/ Terminal	In action	Under construction	Planning Stage	Total
1	EuroAsia-Logistics	-	206,000	585,000	791,000
2	Megapolis LEN CAD	-	-	250,000	250,000
3	MLP Utkina Zavod	80,200	122,400	-	202,600
4	Theorema-Terminal	110,000	87,700	-	197,700
5	Containerships	6,000	-	140,000	146,000
6	Interterminal	51,580	57,450	-	108,300
7	Sterkh	5,000	95,000	-	100,000
8	EuroSib	4,500	25,000	50,000	80,000
9	Transsphere	6,000	-	64,000	70,000

5. Characteristics of St. Petersburg Terminal-Warehouse Estate Market

Deficit is appreciated as 1,5 – 3,0 mln. sqm. The up today offer structure is: 3% - class A ,8% - class B, the rest- class C and D. 80% of objects are built for own needs. There is significant event, approving the beginning of market development and activities - first international buy in 2008: Fund Fleming Family & Partners bought class A acting terminal 14 500 sq. m owned by PNK Logistics. In the very beginning after start-up the class A terminals vacancy is 1,1%, class B - 4.2%, class C - nearly 10%. It means, that the highest market potential in Saint-Petersburg of our days have warehouses of A and B class. Prices for square meter in 2007: in London 216 € and growth for the last year was 3,6%, in Moscow 170 € and 0%, in Saint-Petersburg 140 € and 7,1%. It is obvious, that the rate of terminals and logistics services market development in Saint-Petersburg is very high. The warehouse business profitability according to specialist's appreciation in Moscow is 11%, in Saint-Petersburg - 14%. Rent level of warehouse area for one square meter per year is:

- Class A - 105-130 $ (triple net) + 40 $ (VAT and general services)
- Class B - 80-100 $ + 30 $
- Class C - 60-90 $ + 20 $.

Practice of Railway Tariff Regulation in Russia and Other Countries

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Abstract
The Russian railways have done a difficult way from introduction in 1892 "Regulations about tariffs" up to "the Price-list 10-01" and "the Tariff policy of railways of CIS-countries on transportations of cargoes in the international trade"; considerable experience in the decision of a tariff question - one of the most actual in economic life of the country- is saved up.

For maintenance of development of competitive relations, attraction of investments and constructions of a new rolling stock the Tariff manual №1 determines the following principles of tariffs construction:

- cost-based method: taking into account cost prices of transportations –
- the account of solvency of a cargo (division of all cargoes into 3 classes)
- implementation of a wagon and infrastructural components
- deeper differentiation tariffs with depending on technology of transportation

Despite the implementation of these principles, « the Price-list 10-01 » not to the full answers the requirement of equation of interests of railway branch and users of services.

In the international transportation tariff policy is more flexible, used for attraction of freight flow with system of discounts. So, for example, tariffs are reduced on the majority of routes, that promotes development of transit on territory of Russia.

In this paper we try to analyze disadvantages of existing tariff system and offer variants of changing it for more effective work of railway transport.

Keywords: Tariffs, principles, disadvantages of tariff system

1. Introduction

The tariff policy in the field of railway transport is one of the most important problem in economic life of the country. Basically, the tariffs are not only payments and gathering, taken for transportations and transport services, but also rules of their calculation.

At the present stage Russia tariff system have to be reformed. Some goals of this are:

- Simplification of tariff system, maintenance of transparency and understanding for users and for executors of transportation process
- Realization of uniform system of formation of the profit depending on a capital intensity and laboriousness of transportations and services
- Realization of transition at formation of tariffs and calculation of tariff rates from present priorities (wagon and distance) to new priorities (delivery and time of delivery)

- Differentiation of a tariff levels with taking into account objective conditions and factors.
- To enter as the basic concept "delivery" and to strengthen the tariff importance of parameter “time of delivery”

2. Principles of Formation of Railway Rates in Russia.

Nowadays formation of a tariff in Russia uses two approaches: cost-based pricing providing a covering of operational expenses, investment costs, and marketing principle, taking into account "solvency" of transport consumers.

Let's consider each of these methods separately. Cost-based pricing means, that the basis of the tariff are the cost of transportation of cargoes. Tariff is calculated under the formula mainly:

$$(1)\ \Pi = A + B \times L,$$

Where A - a payment for start-final operations, rubles

B - the rate for movement operations, established in view of loading the car, distance of transportation, rubles.

L - average “zone” distance, in km

The following operations and services are in a tariff part of start-final operations:

- The notice on arrival of cargoes
- operating repair of empty cars of the park of RZD by preparation them for loading
- Maintenance and service of wagons
- Maintenance and service of containers of the RZD park
- Examination of wagons of the RZD park in the technical and commercial attitude
- Preparation tank-wagons for loading
- Preparing for departure and distribution of cargoes, registration of transportation documents

- Shunting work for forming of trains of various categories
- Technological operations with containers.

For profit of transportations the tariff includes the certain profit level which is incorporated in rates for operations.

The marketing approach means differentiation of tariffs depending on several factors five of which are presented

I. Solvency of a client.

All cargoes are broken into 3 tariff classes (75 groups):

- 1 class - mass cargoes and raw material
- 2 class - mineral oil, food
- 3 class - goods.

For each class the correction factor is established.

II. Type of wagons

Tariffs are calculated separately for the universal, specialized cars, and also transporters.

III. Wagons and containers property

All wagons are divided into general park (RZD owned wagons) and park of private operators. This condition allows developing institute of operator as division of the tariff on wagons (15%) and infrastructural (85 %) shares, that stimulates development of a competition, and consignors of goods can choose between services of RZD and independent operators.

IV. Category of deliveries

Categories of deliveries depending on a unit of account used for the given deliveries payments. Car deliveries mean that a payment collected for transportation of the car. Prominent feature *of fine* sending is that the payment is raised for weight of sending. The payment for transportation *of a rail rolling stock* is defined on the basis of run of each axis of a rolling stock.

V. Sphere of application

"*Blanket*" tariffs operate for the cargoes transported on territory of Russia. *Exclusive* tariffs are applied for the big volumes and stability of transportations in the certain direction and for the given distance, for cargoes transportation in a steady empty direction, for cargoes in so-called "consignor block-trains". Reduced rates are established for some periods of time: for example, seasonal transportation of a crop. Special group of tariffs are contractual, which represent group of tariffs with fixed extra charges to "blanket" tariffs.

Considering the principles described above and basing on methodology of market pricing with reference to working legal and economic conditions, tariff is calculated under the formula:

$$\text{(2)} \quad \Pi = W \times Q \times L \times k_{\text{попр}} \times k_{\text{инд}},$$

Where W - the rate, rubles for 10 ton-kms

Q - Weight of a cargo, kg

L - Distance, km

$k_{\text{попр}}$ - correction factor

$k_{\text{инд}}$ - the factor of indexation which is taking into account solvency of manufacturers, a direction of transportation, and also export orientation of industries.

3. Normative Documents Regulating Tariff Policy in Russia.

Depending on a kind of the transportation (internal, international, transit) the payment for rail transportation inside country is estimated in conformity with "Price-list 10-01" or for export-import and transit transportations with "Tariff policy of railways of the state-participants of the CIS-countries".

International Transportations of cargoes by railways

In the interstate message the tariff is adjusted by system of tariff manuals:

1. Tariff manual № 1 (the Price-list 10-01 "Tariffs for transportations and the services of an infrastructure, which are carried out by the Russian railways"),
2. Tariff manual №2 (Rules of application of rates of a payment for using of wagons

and containers of the Federal railway transportation)

3. Tariff manual №3 (Rules of application of gathering for the additional operations connected to transportation of cargoes on the Federal railway transportation).

The tariff manual № 2 defines a payment for using cars and containers, and also the order of calculation and the size of such kinds of gathering, as gathering for default of the application, gathering for application of special conditions of transportation, gathering for realization of technical study and consultation and other gathering.

The tariff manual № 3 defines rules of application of gathering for the additional operations connected to transportation of cargoes on a federal railway transportation.

The tariff manual № 1 is the basic document at calculation payments and consists of 2 parts: the first part is devoted to rules of application of tariffs, and the second contains calculation tables of payments for transportation.

The first part includes three units and some appendices. Section 2 of a tariff manual adjusts the transportation with participation of several railroads and multimodal transportations with participation of other types of transport where the following procedures of payments are described:

1. On the Tariff Manual № 4 the tariff distance is defined
2. The properties of deliveries: type and a ownership of the car, the container, the locomotive are established.
3. Position for cargo, a tariff class of a cargo is defined.
4. Number of the tariff circuit and correction factors is defined
5. Under calculation tables the payment is defined.

In other cases the payment is estimated as the sum of a payment for use of an infrastructure and locomotives RZD and payments for use of cars of the general park, increased on correction factor.

Tariff circuits are divided into big groups for next cargoes:

1. Cargoes in universal wagons
2. Cargoes in own or rented universal containers.
3. Empty own or rented universal containers

4. Cargoes in specialized containers
5. Bulky cargoes
6. Dangerous cargoes
7. Small deliveries
8. A rolling stock on the axes.

In addition to section 2 of the Tariff Manual №1 in the appendix №6 gathering and payments are established:

- Payment for travel of a conductor in cargo or in the separate wagon depending on distance
- Gathering for the declared value of the cargo.
- Payment for transportation in the accelerated container train.

The payment for transportation on the Russian railways export and import cargoes in the direct international transportations, in the indirect international transportation through boundary transfer stations of the Russian Federation (except for transit) is defined by section 3 “Price-list 10-01”, which contains payments rates (are accepted in roubles and rates of additional gathering, rules of calculation transportation payments are incorporated into tariff circuits 116-133).

Correction factors are applied to the given rates:

- Factor on transportation of mass cargoes
- Factor depending on a kind of the message, a direction, range
- Factor depending on directions and conditions of transportation

Changes in section 2 and 3 Tariff Manuals № 1, brought by indexation of tariffs, allow to react to a situation developing in the transport market in due time.

International Transportations of cargoes through the territory of Russia

The procedure of payments of tariff rates on transportations of cargoes in the international transportation is described in the Tariff Policy of Railways of CIS-countries (TP) on the basis of which International railway transit tariff (MTT) and Uniform transit tariff (ETT) are developed.

TP was signed between administrations of railways with a view of the coordinated application of tariffs and definition of principles of their formation within the limits of countries - participants. TP affirms for each charter year at tariff conferences not less than for 2 months prior to the beginning of one year. TP includes some sections. Section 1 defines sphere of action and a rule of application. Section 2 defines the procedure of payments of rates for transit transportations from the third countries in the third countries. Section 3 defines the procedure of payments of rates for transportations of cargoes in/from the countries of the CIS and the Estonian Republic in/from the third countries, and also between stations of railways - participants of the Tariff agreement. Also in TP enters the section devoted to additional gathering.

TP defines application of base rates of a payment for transportations on the basis of rates of transit tariffs:

- Uniform transit tariff (ETT) – by transportation cargoes transit to China, Vietnam, and Mongolia (and from these countries).
- International transit tariff (MTT) – in other cases.

Additional factors and the indexes are applied to the rates of transit tariffs depending on range of transportations, weights of deliveries, ownership of car, carrying capacity of the container, number of cars in refrigerator section, belonging of a cargo to mass directions of transportation.

TP provides application of the following additional gathering:

- Gathering for an overload of a cargo in cars of other track
- Gathering for rearrangement of cars on carriages of other track
- Gathering for customs inspection of a cargo along the line
- Gathering for a ferry of a cargo
- Other kinds of additional gathering

Charge of payments in TP is carried out in US dollars. At recalculation of rates of payments the factor of recalculation of the Swiss francs in US dollars, which appears on-line the administrative Office of the Tariff policy not less than for one month prior to the beginning of charter year is applied.

4. Foreign Practice of the Organization of Regulation of Railroad Rates.

In foreign practice there is a set of practical decisions in the field of the organization of management by railway transportation, regulations of activity of the transport companies, formations of tariffs which use for development of effective methods of formation of tariffs in Russia can be.

Practice of USA and Canada

Railways of USA serve almost all branches of national economy, giving clients effective and rather cheap services. Railways in USA are private, vertically integrated. Each railway firm has an own network with accompanying infrastructure and renders services in transportations in this network. Since 1980 railways are not adjusted by the governmental regulating bodies, and are independent.

The tariff system on a railway transportation of USA is developed in coordination with development of railway transportation. Long time for each road there were own tariffs. Tariffs were under construction on the basis of transport properties of cargoes, depending on use of a rolling stock, on the basis of the cost price.

Tariffs totaled a plenty of classes of cargoes and were defined by multiplication of the rate of a base class to the appropriate factor. A part of tariffs for transportation of the concrete goods between the certain items were below class. Decrease of the tariff stimulated increase of use of routing trains at transportations of coal, ore, a grain and other bulk cargoes.

In practice of the analysis and an establishment of tariffs for cargo rail transportation in USA the approach to an estimation of the general marginal level of tariffs is used: if the tariff of the transport general purpose company exceeds 180 % from size of variable expenses such tariff can be subject to consideration on council on ground transport.

The size of incomes coordinates with volume and structure of a market demand, conditions of a competition and other factors. As a whole the tariff is established on the basis of costs of transportation and consumer cost. The lowest border of the tariff are direct costs, the top border is various and depends on the price of the goods, a difference between the price of the goods in destination and departures, the importance of transportation for the consumer, and a competitive price of similar production. In practice of regulation the rate of return makes 6-8 % of the invested capital.

Historically in Canada there was a mixed structure of railway branch. The large company belonging to the state, and the large private (individual) company give practically all volume of services in the national market of railway services. The Canadian railway network is vertically integrated.

Prominent feature for Canada is regulation of transportations of a grain. Tariffs for transportation of a grain are considered as a political question.

The current legislation obliges the railway companies to publish the information on existing tariffs in the event that consignors will demand it. In practice almost all transportations (except for grain freight) are carried out according to confidential contracts, which are not subject to regulation.

The European experience of integration of infrastructures

The problem of the all-European transport policy consists of creation in Europe a free general commodity market with uniform economic space, with free moving people, capitals and the goods.

The international transport organizations have reached uniformity in differentiation of tariff rates on weight of a cargo, distance of transportation. Principles and levels of construction of internal tariffs are unified with international.

Railways of Germany are the state enterprises. The federal government annually covers transportations costs.

Use of adjustable tariffs for freight traffic is stopped. Tariffs of railways of Germany are changed by annual indexation. The withdrawal from system of tariff of cargoes on values, reduction of quantity of classes is consistently made. In a basis of distribution of cargoes on a level of the tariff a transport attributes - specific loading volume. However value of a cargo is not excluded from tariffing, widely used in exclusive tariffs, in agreements with clientele, by granting discounts and extra charges.

On the French railways freight rates are established with the National society of the French railways. Any decrease (reduction) of incomes owing to tariffs is compensated by state. Except for officially published tariffs contractual tariffs for concrete transportations are applied.

Procedure of definition of the tariff includes three stages: definition of the current costs, definition of investments and definition of rate of return. The size of investments is defined on the basis of expert estimations of experts. Thus, criterion at definition of the bottom border of investments is the price of the capital, and top – the income on the investment on an example of concrete branches. Limitation of public funds for grants, investments and credits compels the state bodies to carry out liberalization in management of railways.

Problem of a tariff policy on types of transport in EU carry to the category key. Special interest represents experience of tariff of cost of services of a railway infrastructure. Variants (theoretical) constructions of payments for using an infrastructure set. In Table 1 the set of approaches and methods of tariff setting, which in different forms are considered and approved in the European countries, is given.

Table 1. Approaches to tariff setting for services of an infrastructure.

The conditional name of a method	The main features (principles) of a method
1. On a basis “marginal expenses of short run”	The principle of definition additional cost of use existing infrastructure is used by concrete train
2. On a basis “marginal expenses of long run”	The principle of definition of additional cost of the added train is used. In a case when the infrastructure is optimum adapted to concrete transportation.
3. On the basis of real average expenses	In quality to a basis of calculations the most different parameters separately and in a combination (a distance of run, time, axial loading) are considered
4. The unicomponent tariff	The principle of averaging of constants and the variable expenses expressed in one rate is used
5. On the basis of auction sales	The principle of exhibiting лотов on auction is used
6. On the basis of a method of consecutive "grinding in" of the established settlement tariff	The principle of purpose of the price and its(her) subsequent updating is used depending on change of demand
7. A method of an establishment of contractual tariffs on the basis of direct negotiations	The principle of direct negotiations on all conditions, connected with the price is used, switching and investments.
8. A method with use of receptions of a method of tariffing on Ramsey	“Factors Ramsey” for definition of a parity of quotations in the certain proportionality to flexibility of concrete demand for service are used

It is considered the simplest method of setting tariffs on the basis of the average expenses. The big opportunities are provided with the approach to tariffs under the double tariff as changes in an infrastructure, on demand of operators or those who gives the grant, can be reflected by change of the fixed element of the two-component tariff. The sense of the two-component tariff is that its fixed part can be considered as solvency, but leaves an opportunity to the operator to increase the price up to a level providing the minimal losses in transportations.

In the majority of the European countries at formation of system of payments for using an infrastructure the principle of a full covering of costs is used. Despite of technical distinctions in construction of a payment this principle is realized in Germany, France, Belgium, Italy and Austria.

Let's consider, how examples, variants of construction of payments for using an infrastructure on railways of Italy and Germany.

Variant of Italy

Let's allocate the most essential positions of construction of a payment for using an infrastructure in Italy. The national railway network of Italy is divided into 50 tariff zones. In Table 2 the accepted characteristic of tariff zones is submitted.

Table 2. Characteristic of tariff zones for construction of a payment for using an infrastructure.

Category of sites of a way	Quantity of zones	Average extent, km	General extent of sites of the given category, km
Central lines	8	80-90	700
Commercial lines	39	140	5500
Minor zone	Uniform tariff zone	-	7300
a network with small traffic	Uniform tariff zone	-	2500
Service lines	Uniform tariff zone	-	250

The payment is defined in calculation on a concrete route; unit is the kilometer of a route. The general payment for using an infrastructure for every train represents the sum of three components:

- Payment for a site equivalent to the regional tariff - payment "A"
- Payment for use, determined in the speed - payment "B"
- Payment “for traction” (electric power)

For each tariff zone the price is specified.

Structure of the general payment (without the electric power) approximately following:

- Payment "A" - 40 % from the general (common) payment
- Payment "B" - 60 % from the general (common) payment

Each of payments has the features. Some features of construction of payment "A":

- For a network with small volume of transportations on which available capacities considerably exceed demand, the part of the tariff determined by site, is not paid
- In comparable measurement the sizes of a payment are lower for trains using a minor network, and higher for intercity trains using sites of a network in base networks or units.

Some features of construction of payment "B":

- for base of calculations for definition of a part of a payment for an infrastructure, determined speed, the minor network with small volume of transportations where the price is 1.00 € / km fixed at a level is accepted
- for the basic commercial network the price, since base value of 1.00 € / km, differentiating raises depending on three parameters: density of transportations or level of a saturation of a line with differentiation from time of day, weight and speed of a train, a difference between commercial speed and standard speed.

Thus, for the basic network and for junctions the part of the tariff adhered to speed, raises in case of a growing demand and is reduced, if demand is small. It allows involving alternative routes and ranges of time better. Parity of the sizes of a payment for using an infrastructure is shown in Tables 3 and 4.

Table 3. Parity of the sizes of a payment for using an infrastructure depending on the characteristic of line.

Type of a site of a way	The price, euro	Ratio, %
Units	51.65	111
Base, double-track site (250 kms / þ)	64.56	139
Base, double-track site (200 kms / þ)	56.81	122
Base, single-track	49.06	106
Minor network (area with the blanket tariff)	46.48	100

Table 4. Parity of specific sizes of a payment (euro / km) for access to an infrastructure, depending on speed and "density of transportations".

Relative speed, %	**Density of transportations of a line, %**			
	0-80	*80-120*	*120-200*	*More than 200*
0-20	0.9	1	1.25	1.83
20-50	0.98	1.08	1.33	1.92
50-100	1.57	1.67	1.92	2.5
More than 100	2.23	2.33	2.58	3.17

Variant of Germany

The tariff circuit of payment for using a railway route includes three base components:

- a base tariff
- "a product of a route"
- system of special factors

The base tariff is defined depending on a category of a route. For this purpose in a railway network it is allocated 9 categories. In Table 5 qualitative and quantitative characteristics of these categories are given.

Table 5. Classification of railway lines.

Designation of a category	The basic distinctive attributes	Parity in levels of the base tariff
Intercity lines		
F1	Lines for high-speed transportations (speed is higher than 200 km / h)	160
F2	Lines for all types of transportations on which structures can move with speed of 161-200 km / h	106
F3	Lines for the mixed transportations (the basic speed of 101-160 km / h)	102
F4	Lines for inter-regional transportations (speed of 101-160 km / h)	100
F5	Lines for several inter-regional transportations (speed of 101-1120 km / h)	96
F6	Lines basically of the suburban passenger message (speed of 101-160 km / h)	90
Branch lines		
Z1	Lines for all types of transportations (speed up to 100 km / h)	100
Z2	Lines with the elementary control systems (speed less than 50 km / h)	104
Inside-city lines		
S1	Lines basically or only for inside-city movement	70

Despite differences in circuits of construction of system of payments for using infrastructure on the Italian and German railways, there is a unity in basic approaches to construction of tariff systems.

It is possible to allocate the following approaches uniting these circuits:

- Fractional and severe classification of routes and sites of the way, taking into account qualitative distinctions
- Allocation of passenger routes
- The generalized criterion of division of a routing network is economic parameters
- The main qualitative attributes of a high system is the number of strips, speed of the message, congestion of a line, a kind of the message
- It is taken into account (through extra charges, discounts or special factors) regional and other features of concrete routes or a rolling stock

5. Conclusions

In this paper we tried to review existing systems of railway rates, especially in Russia, and in some other countries as well. Addressing to the Russian system of railway tariffs, it is possible to find out imperfection: a level of tariff rates is high, and their parities on the basic structural sections of tariffs does not correspond to real expenses.

For elimination of these disadvantages it is necessary to reconsider the main normative document “Price-list 10-01”, in particular to reconsider existing division of cargoes into classes. A basis for revision change of structure and a direction of freight traffics should be. Today 60 % of cargoes are a raw material. Thus, it is possible to lower risk of unprofitable transportations of mass cargoes of the first class (wood, oil and coal). As it is necessary to reconsider existing dependence of the tariff on distance of transportation: the concept “the is farther distance, the more favorably transportation works only for users of services of a railway transportation and does not reflect interrelation the income - charge of the railway that does not give an opportunity to receive profit so, and to invest in reconstruction of a rolling stock and an infrastructure. More favorable tariffs for transportations of cargoes for a long distance stimulate occurrence of irrational transportations (for example, counter transportations of an empty rolling stock).

Using foreign experience as a base, it is possible to allocate a number of decisions of these problems:

1. To strengthen the importance of factors “time of delivery”, “the size of delivery” and a regularity of deliveries
2. To change methods of definition of cost of services of an infrastructure, wagons and locomotive components
3. To carry out differentiation of cost of start-final operations depending on conditions of their performance
4. To remove ineffective tariff mechanisms (tariff classes)
5. To take into account objective distinctions in operating conditions (regional factors, factors of a regularity, feature of routes)
6. To involve a time principle of definition of tariffs
7. Allocation of regional and main tariffs and mechanisms of their

differentiation.

Due to these measures we will receive flexible, stable system of regulation of the tariffs, distinguished by a high degree of forecasting.

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Research Note: Special Issues of Overweight and Oversized Freight Transports

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Abstract
Construction of new automobile factories, oil and gas pipe-lines and development of harbor complexes in North-West region of Russia and also construction works for Olympic Games in Sochi-2014 – these leads to rising of transportation of specialized machines, huge metal constructions and equipment – cargoes that by weight or dimensions should be classified as oversized or overweighed. But not only railways could be used as main mode of these transportations. Conclusions are made what are strong sides of railways in transportation of oversized and overweight cargoes.

Keywords: Oversized cargos, overweight cargoes, project transports, railway wagons

1. Introduction

At railway transport cargo is classified as oversized, if it does not fulfill following criteria: When paced in open wagon on straight horizontal part of track, cargo with packing and fastening should not reach out from main clearance of loading, or part of cargo reaches out of main loading clearance in curves. By means of specialized wagons transported overweight cargoes could be fitted on rail better than what is the case with universal models. Special wagons usually also lower the oversized diameters of troublesome cargo.

By construction of chassis, there exist following types of wagons: platform, squared, welled, coupled and articulated. In amount of axles there are options for 4, 6, 8, 12, 16 and 24-axles. The more axles – more wagonload of wagon can carry. Platform wagons (Figure 1) have loading area, covered with metal plate. They are used for transportation of overweight cargoes with “small” index of oversized cargo and long-length cargoes.

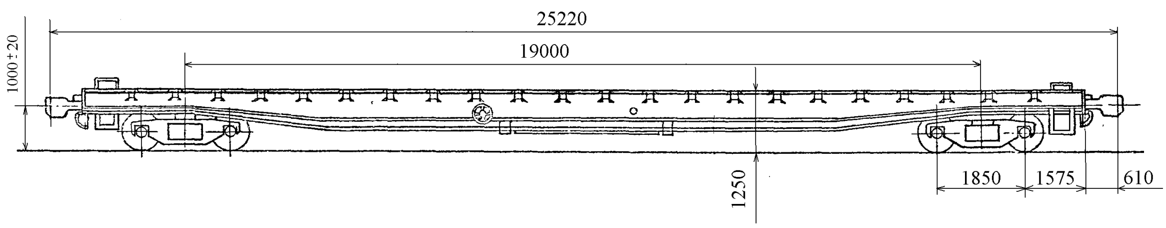

Figure 1. Platform wagon with carrying capacity of 64 tons, number 3931

Squared wagons (Figure 2) have lowered loading area with small length 7.0 – 11.5 meters. By means of this lowered area "high" cargoes can be transported very effectively.

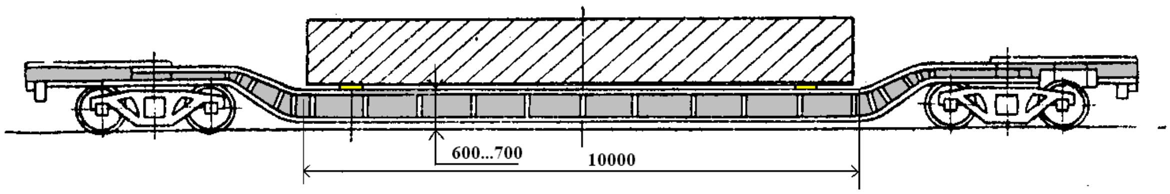

Figure 2. Squared transporter with carrying capacity of 55 tons, number 3903

Wagons with sidings (Figure 3) have chassis with two longitudinal vertical beams making "hole" in which oversized cargo could be placed. Cargoes with big diameter or height are transported by means of these transporters: huge engineering tools, working wheels of hydro-turbines, parts of stators etc.

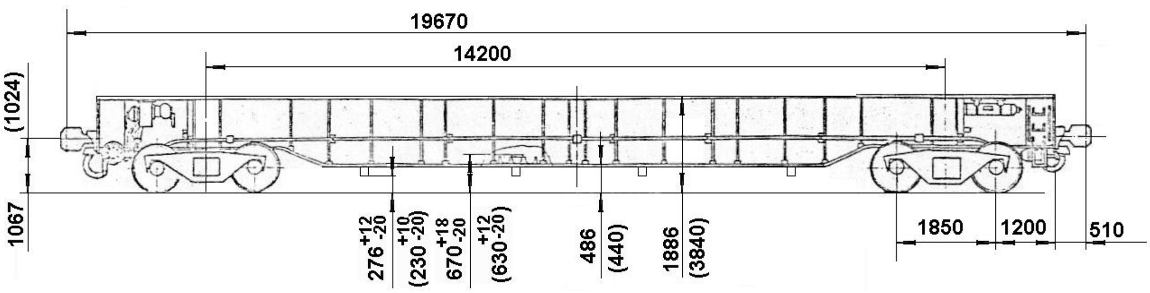

Figure 3. Welled transporter with carrying capacity of 61 tons, number 3941

Coupled transporters (Figure 4) consist of two 4-, 8- or 12-axled platforms with turnstiles and additional platforms, used for long length cargoes with the weight up to 340 tons, and length up to 65 meters.

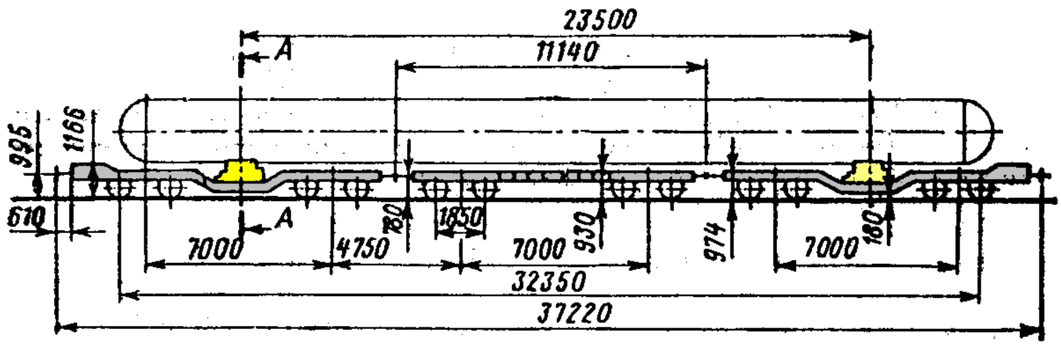

Figure 4. Coupled wagon with carrying capacity of 120 tons with one additional platform.

Articulated wagons consist two separate parts on which cargo is leaned. Cargo is transported. Cargo becomes part of the transporter and takes all dynamical forces during transportation. For using this kind of wagon special project should be developed and special agreement with Wagons department of JSC RZD should be signed. Articulated transporters developed for transportation of oversized and overweight cargoes with mass up to 500 tons (transformers, stators etc).

Main parameters of wagons are described in Table 1. Wagons are special rolling stock and prepared for loading process under an order of railway administration or department of transportation of RZD by request of consignor only if they have schemes of loading prepared under special conditions. Using of wagons owned by consignor or leased from another operator for international transportation is applied with current rules of operation and numerical count of owned cargo wagons.

Table 1. Main characteristics of wagons.

Number of transporter	**Carrying capacity, tons**	**Number of axles**	**Length, mm**	**Base, mm**	**Size of loading area, mm**		**Height of loading area**		**Tare, tons**
					Width	**Length**	**Empty**	**Loaded**	
Platform transporters									
3935	120	8	24130	16000	2770	16000	1286	1347	53.6
3932	92	6	25220	17200	2900	24000	1358	1358	40
3931	64	4	25220	19000	2700	24000	1250	1250	29
Squared transporters									
3929	225	16	40830	25400	2400	11500	980	1146	123.5
3928	220	16	38230	22800	2400	8900	910	1056	122
3927	200	16	38430	23490	2240	8000	918	1060	124.1
3926	180	16	38370	25170	2240	11545	1000	1000	164
3916	150	12	27040	17000	2400	7312	738	738	111
3912	120	8	26250	18120	2570	10000	670	842	56.5
3908	100	8	24250	16120	2400	8000	700	720	60.8
3903	55	4	19470	14000	2450	10000	683	717	29.3
3902	63	4	19380	14000	2600	10000	560	641	31
3900	62	4	15580	10200	2400	6000	570	570	25.9
Welled transporters									
3948	120	8	25280	16850	2440	10800	747	697	56
3941	61	4	19670	14200	2700	11400	670	650	30
Coupled transporters									
3976	340	24	46840	23420	1900	25070	1430	1430	45
3974	240	16	55410	38280	2260	40000	1180	1200	37
3961	120	8	37220	23500	2120	24400	1056	1090	49.7
3960	120	8	26080	12360	2120	13260	1056	1090	55

2. Advantages and Disadvantages of Railway Transportation of Oversized and Overweight Cargoes

Automobile transport companies for oversized and overweight deliveries are more popular – they are using flexibility, but railway transport has its own positive elements. First of all, network of railways in Russia is more geographically distributed as compared to automobile transport, especially for Northern region of Russia (some regions even does not have own federal highways!). Amount usable automobile roads greatly declining in autumn-spring seasons, and in contrary rail tracks are working for full year. Secondly, there is possibility to transport over-oversized and over-overweight cargoes that do not suite road transports. For example, some kinds of transformers, bridge constructions etc.

One more reason for transportation of oversized and overweight cargoes by railways –

shorter time of delivery with long transportation distance. More than 90% of oversized cargoes are having haulage of 3000 km or more. Also by railway someone could transport big volumes of cargoes simultaneously. Even whole factories could be transported by railway. Consignor often has to transport cargoes by means of railways only, because consignees do not have loading facilities for automobile transport. But at the same time clients of railways say that main problem point in organization of oversized and overweight deliveries is bureaucratic system of document preparation. Only for concordance of loading scheme can take for 7 days. System of developing of loading schemes are not computerized still, drawings are mostly handmade.

One more difficulties in organization of transportation is lack of freight wagons, and its very old age. At present time nobody is buying specialized rolling stock. Nevertheless possibility exits that private operators will invest on these, as oversized and overweight cargo offers special tariffs to be applied.

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