THESIS ON ECONOMICS H43

Conceptualisation and Management of Green Transport Corridors

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Declaration:

Hereby I declare that this doctoral thesis, my original investigation and achievement, submitted for the doctoral degree at Tallinn University of Technology has not been submitted for any academic degree.

Kristina Hunke

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MAJANDUS H43

Roheliste transpordikoridoride kontseptsioon ja juhtimine

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TTÜ KIRJASTUS

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The structure of this thesis is based on the following six scientific articles. The author of this thesis contributed in one article as single author and in five articles as co-author.

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II. Hunke, K. (2013). Transnational e-services for efficient oversize logistics. Prause, G.; Venesaar, U.; Kersten, W. (Eds.) (2013). *International Business - Baltic Business Development* (73 - 91), Tallinn 2013. Peter Lang Verlag.
III. Daduna, J.; Hunke, K.; Prause, G. (2012). Analysis of Short Sea Shipping-Based Logistics Corridors in the Baltic Sea Region. *Journal of Shipping and Ocean Engineering*, 2(5, Serial Number 8), 304 - 319.
IV. Prause, G.; Hunke, K. (2014). Sustainable Entrepreneurship along green corridors. *Journal of Entrepreneurship and Sustainability Issues*, 1(3), 124 - 133.
V. Hunke, K.; Prause, G. (2013). Management of Green Corridor Performance. *Transport and Telecommunication*, 14(4), 292 - 299.
VI. Hunke, K.; Prause, G. (2014). Sustainable supply chain management in German automotive industry: experiences and success factors. *Journal of Security and Sustainability Issues*, 3(3), 15 - 22.

The author's contribution to the publications

In the following the author's contribution to these academic papers is presented.

I. Secure and Sustainable Supply Chain Management: Integrated ICT-Systems for Green Transport Corridors:
The author of this thesis contributed in the deployment of scientific theories to the topic of ICT management and controlling in the field of research. She formulated frame conditions for an integrated ICT system in the Green Transport Corridor concept.

II. Transnational e-services for efficient oversize logistics:
The author of this thesis was single author of the academic paper. The author conducted the assessment of national e-service solutions, organised focus group meetings and led expert workshops in order to ensure the economic relevance of such systems. As a result the author developed a concept for a transnational e-

service for oversize transportation in four countries which was realised during "Oversize Baltic" EU-funded project.

III. Analysis of Short Sea Shipping-Based Logistics Corridors in the Baltic Sea Region:
The author of this thesis contributed in the application of the Operations Research model to identify the impact of Short Sea Shipping in the dimension of time, costs and CO_2 emissions.

IV. Sustainable Entrepreneurship along green corridors:
The author of this thesis contributed to the merger of two co-disciplinary research fields: Entrepreneurship and transport science. The definition of the Green Transport Corridor concept in the frame of cluster theory was created by the author of this thesis.

V. Management of Green Corridor Performance:
The author of this thesis contributed with the theoretical framework and application of cross-disciplinary theories. Furthermore, the author developed a concept for performance monitoring by application of Key Performance Indicators in the Green Transport Corridor concept.

VI. Sustainable supply chain management in German automotive industry: experiences and success factors:
The author of this thesis conducted the literature review and analysis of the theoretical topic as well as the description of the case studies in order to examine economic effects of green supply chain management for small and medium sized companies as well as global players.

Other publications related to this doctoral dissertation

As a result of this research the author published as single author or co-author the following articles, conference proceedings, and book chapters:

1. Hunke, K.; Prause, G. (2012). Hub Development along Green Transport Corridors in Baltic Sea Region. Blecker, T.; Kersten, W.; Ringle, C. (Eds.). *Pioneering Supply Chain Design* (265 - 282). Hamburg: University of Technology
2. Wahl, M.; Hunke, K.; Prause, G. (2013). Stakeholder Typologies in Green Transport Corridor Governance. Kersten, W.; Blecker, T.; Ringle, C. (Eds.). *Sustainability and Collaboration in Supply Chain Management: A Comprehensive Insight into Current Management Approach* (143 - 162). Köln: Joseph Eul Verlag

3. Hunke, K. (2010). Size does matter. *Baltic Transport Journal*, 6(38), 60 - 61.
4. Prause, G.; Hunke, K. (2013). Ecological Controlling of Green Transport Corridors by Key Performance Indicators. In: *Proceedings of the III. International Conference of Controlling "Green Controlling": International Conference "Green Controlling*", 17 - 17 May 2013, St. Petersburg. (Eds.) Falko, S., 2013, 214 - 224.
5. Daduna, J.; Hunke, K.; Prause, G. (2012). Logistics Corridors and Short Sea Shipping in the Baltic Sea Area. *Proceedings of the 2012 International Research Conference on Short Sea Shipping*, Estoril - Portugal (2101 - 2117).Copenhagen Business School
6. Hunke, K. (2012). Transnational E-services in Oversize Cargo Logistics. Prause, G.; Hunke, K.; Thessel, F. (Eds.). *Transnational Aspects of End-user Oriented E-services in the Baltic Sea Region* (186 - 189). Berlin: Berliner Wissenschafts-Verlag

Abbreviations

BSR	Baltic Sea Region
BGLC	Bothnian Green Logistics Corridor
CO_2	Carbon dioxide
CRQ	Central research question
DE	Germany
e.g.	for example
et al.	and others
EU	European Union
EWTC II	East-West-Transport-Corridor II
FI	Finland
FTLAP	Freight Transport Logistics Action Plan
GTC	Green Transport Corridor
HICL	Hamburg International Conference of Logistics
i.a.	among others
ICT	Information and Communication Technologies
i.e.	this means
ISO	International Organization for Standardization
KPI	Key Performance Indicators
LT	Lithuania
NECL	North-East-Cargo-Link
OR	Operations Research
OTIN	Oversize Transport Information Network
RBGC	Rail Baltica Growth Corridor
SME	Small and Medium sized Enterprises
SO_2	Sulfur dioxide
SSS	Short Sea Shipping
UK	United Kingdom

INTRODUCTION

As the European General Directorate on Mobility and Transport announced recently, “freight transport is expected to grow by 80% by 2050” (EC 2014). The new EU transport infrastructure policy will aim at “nine implementing corridors on the core network” (EC 2014). Transport corridors are a concentration of freight traffic between major hubs and by relatively long distances of transport, therefore “each corridor must include three transport modes, three [EU] Member States and two cross-border sections (EC 2014)”. In substance, it is co-modality that enables the choice of efficient transport along the transport route. There has been a huge amount of research focusing on linear intermodal transportation and the impact of Operations Research (OR) in planning optimised routes for intermodal transports. The main research fields are road and rail transport, transhipment, transport mode choice and route planning (Bontekoning and Priemus, 2004; Bontekoning et al. 2004). There have been attempts to develop Europe-wide intermodal transport systems in order to be competitive against single road transportation (Woxenius 1998). One aspect in intermodal transport development has not been covered by these attempts: the integration of special cargo shipment (oversize transport). Oversize transport (when a load exceeds the limits of mass and/or dimensions and cannot be split into units) is an increasing market which should not be left out of the comprehensive development of intermodal transportation networks like Green Transport Corridors (GTCs).

The hub-and-spoke model for multi-dimensional integration of green marketing and sustainable supply chain management, developed by Liu et al. (2012), integrated more dimensions to the single point-to-point transportation. This theoretical model already indicates the importance of multi-dimensional development of supply chains in the direction of a network like the GTC. In regard to inland shipping and the hinterland accessibility in such networks, the literature (Caris et al. 2012, Gekara and Chhetri 2013) provides early indications for successful implementation. Liedtke and Friedrich (2012) analysed the concept of logistics networks in the context of behavioural freight transport modelling. Their model is based on two characteristics: the changeability of networks within models (fixed, partially variable and variable networks) and the form of cost functions mapped (economies of scale, constant average cost, and diseconomies of scale). However, the cooperation among the stakeholders in such a complex network structure on an intercultural and socio-economic level remains untouched in previous researches.

Environmental footprints of these developed transport corridors in Europe were assessed by Carballo-Penela et al. (2012) and Dekker et al. (2012). Also, additional research in early years (Murphy et al. 1994) shows the impact of environmental issues in logistics, as the reduction of energy consumption can be seen as one of the main drivers in future development. The European Commission states in its new transport policy that the aim is to “reduce greenhouse gas emissions in transport by 60% by 2050” (EC 2014). Some researchers tried to assess the performance of transport corridors beyond the environmental impact. So, the operational status and the infrastructure can play a major role in the overall GTC performance (Madan and Shinya 2012).

However, the previous authors concluded that the future focus of research should be on the system and multi-player perspective and the type of organizational innovations, and through the application of ICT-systems, as Clausen et al (2012) described. The **research problem** is that earlier attempts show how difficult and challenging it might be to implement such a vision from the academic research into the reality of economic life. Therefore, this thesis does not give an idealistic concept for the GTC, but a realistic one. Initial key aspects of developing a GTC are demonstrated, as well as an approach to find a management level in order to maximize the economic, environmental and social benefits gained by implementing the GTC in the European transport networks.

The idea of GTCs was developed by political top-level in the European Union as the economic development in dense transport networks required optimization in the transport and logistics field. However, this development was not based on scientific theory. From the practical experience in the EU-funded regional development projects (EWTC II, TransBaltic, NECL, Rail Baltica Growth Corridor, Scandria, etc.) questions arose about what the implementation of the concept of a GTC means in terms of actual implementation of technologies and organizational systems, and also for the understanding of the own business strategies of the stakeholders participating in the construction of GTCs. Also the integration of Short Sea Shipping and oversize transport in a GTC concept is not covered so far. Current literature (e.g. Wölf, Ragnitz, 2001; Prause, 2010a; Prause, 2010b) does not consider the behaviours and attributes of the companies taking part in the GTC sufficiently. Certainly, the stakeholders have different intentions in participating and also expect different benefits from this. Therefore, a **research gap** exists in the compilation of existing theories in the new frame of green transportation and intermodal logistics networks (Woxenius 1998; Liedtke and Friedrich 2012; Madan and Shinya 2012) in order to be able to explain certain behaviours and influences in the GTC from the management perspective.

The **objective of this thesis** is to define the concept of a GTC by focusing on providing a theoretical approved framework for cooperation and organizational business models. By applying former approved theories like network (Bovel and Martha, 2000) and cluster strategies, stakeholder models (Freeman, 1984) and green supply chain management (Liu et al., 2012; Carballo-Penela et al., 2012; Dekker et al., 2012) a management model will be developed.

The **central research question (CRQ)** of this thesis is:

CRQ: How can Green Transport Corridors be conceptualised and managed?

1. What framework conditions and functionalities should a GTC fulfil, especially how can IT solution support help to achieve this?
2. How can organizational models and cooperation contribute to sustainable hub development along a GTC by removing existing bottlenecks?

3. What are the impacts of including the concept of Short Sea Shipping and special transportation (oversize transport) in multimodal route choice optimization?
4. What are the characteristics of the GTC properties (stakeholders) and how do they interact?
5. How can these properties be managed and governed according to their characteristics in the GTC?
6. Which success factors and economic efficiency effects can be expected by private businesses when participating in the GTC?

The **theoretical contribution** of the current research is based on the application and interpretation of GTCs in regard to existing scientific theories. So the author of this thesis set the concept of GTCs in a theoretical framework based on existing theories (Supply Chain Management, Cluster and Network Theory and Stakeholder Model) and developed a new theory for the concept of GTC management (see CRQ and subquestions). The author empirically tested the developed models and theories during participation in development projects (see 2.3 Research Methods). Therefore, the initial aspired optimization from political top-level was approved by this research.

During her research the author of this thesis published articles and research papers. A conscious selection of these articles is part of this thesis as the **individual contributions of these papers** highlight the results of the research.

PUBLICATION I: The author developed framework conditions for the establishment of a logistics network. In this context, specific ICT requirements for transport networks are elaborated. With this publication, the first subquestion of the CRQ is answered. A theory for GTC functionalities and framework conditions is presented which is supported by a required ICT system that will enable harmonised information flow, equal access for every stakeholder, common quality standards and transparency to society in order to ensure successful operation of a GTC.

PUBLICATION II: Identified bottlenecks and barriers in operation were removed by analysing the oversize transport market in the South Baltic Region, and harmonised standards for international special cargo transportation were developed. As a result the author provided a so-called Oversize Transport Strategy. Efficiency changes in ICT implementation (reference to first publication) are demonstrated by the transport permission process where the author co-developed an e-service for electronically approved transport permissions. This publication demonstrates the practical application of the developed new business and organizational models for cooperation which will lead to successful cooperation in a GTC, therefore answering the second subquestion of the CRQ.

PUBLICATION III: An intermodal route choice model was developed by integrating Short Sea Shipping. This model was applied to the European transportation network by two test corridors. With this modelling, bottlenecks and barriers in operation are identified and solutions to remove these are presented. This publication answers the third subquestion of the CRQ as it presents a value assessment for the integration of Short Sea Shipping in intermodal transport structures. It demonstrates that integrating Short Sea Shipping in GTC development will lead to the most efficient transportation in dense networks. In reference to the second publication, the integration of oversize transport is another important value for the development of GTCs.

PUBLICATION IV: The author applied existing cluster theory to logistic and transport environments and described the network design of GTCs. The role of SMEs in the transport sector is identified and their specific requirements are analysed. This publication answers the fourth subquestion of the CRQ, as investigations of GTCs from the perspective of different stakeholders enable a characterization model of the properties of a GTC. However, interrelation and interaction among these participants requires standards and steering from a higher level.

PUBLICATION V: The author applied the stakeholder model theory to interrelations between stakeholders in a GTC. The thereof developed monitoring instrument for KPI oriented systems ensures a consistent and sustainable performance of all stakeholders in the GTC. This publication answers the fifth subquestion of the CRQ because it provides a governance and steering theory according to the individual characteristics of the properties which require a comprehensive management model.

PUBLICATION VI: The author examined the economic effects of implementation of GTC concepts through a case study on SMEs as well as global players in the automotive industry. The answer to the sixth subquestion of the CRQ is that success factors and economic efficiency effects can be expected by private businesses and regional economies when participating in the GTC.

The **scientific novelty** of this current research is given by the unique application of different theoretical backgrounds in order to demonstrate and explain the concept of Green Transport Corridors and how to manage such constructs. The author of this thesis used the well-known concepts of stakeholder model and governance in a cross-sectoral application to logistics networks. The author of this thesis contributed with the following actual findings to the current research in this field:

1. Functionalities and framework conditions for the successful operation of a GTC which are supported by a required ICT system that enables harmonized information flow, equal access for every stakeholder, common quality standards and transparency to society
2. New business and organizational models for successful cooperation in a GTC and the elaboration of hub development measures
3. Application of intermodal route optimization in transnational logistics networks by integrating Short Sea Shipping and special cargo transportation (oversize transport) in the Baltic Sea Region
4. Investigations of the GTC from the perspective of different stakeholders to be able to characterize the properties of a GTC to find an appropriate governance structure in order to maximize the performance

5. Development and application of a monitoring instrument for KPI oriented systems in order to be able to ensure the consistent and sustainable performance of all stakeholders in the GTC
6. Success factors of transnational cooperation and efficiency effects enable the assessment of economic impact of GTC for each individual player and regional economy

These research findings are mainly addressed to stakeholders who directly participate in the GTC; these could be logistics centres, ports, transport forwarders, ferry companies, railway companies, and municipalities, authorities, national or regional governments.

The **structure of the thesis** is as follows: in first chapter the author describes the framework of theoretical environment of the research topic and this thesis.

In the following chapter, the theoretical approach to methodology of the thesis is explained. The study design, research methods and following activities executed by the author during the research phase are described.

As a result, the answer to the CRQ is given in the third chapter, which comprises six subchapters. Each of these chapters will answer one of the given research subquestions.

In the conclusion, the research results are evaluated and the contributions are summarised. Also the limitation of the scope of this thesis is described and indications for further research are given.

Additionally, this thesis constitutes of six scientifically approved publications in the appendix. These publications were published by the author between the years 2012 and 2014 in the frame of the research for this thesis. Each of the articles answers a designated research question and highlights the main results of this thesis.

The full or partial results of this thesis were, in addition to the review process by the mentioned known journals, approved and presented at following conferences (in chronological order):

1. Workshop 'Abnormal Transports in Europe - Services for Road Authority and Transport Industry', Hamburg. 08. March 2012. Organised by the Ministry of Science, Economic affairs and Transport of Land Schleswig-Holstein
2. International Research Conference on Short Sea Shipping in Lisbon, Portugal. 2-3 April 2012. Cargo Edições Lda
3. Final Conference in Vilnius, Lithuania. East West Transport Corridor project, Baltic Sea Region Programme 2007-2013. 07. – 08. June 2012. Region Blekinge
4. Hamburg International Conference of Logistics (HICL) 2012- Designing the Future Supply Chain - Reliable, Robust, Secure. 13. – 14. September 2012. Hamburg University of Technology
5. International Seminar on the Establishment of Maritime Logistics Cooperation in the Pan-Yellow Sea Rim, Pyeongtaek. 10. October 2012, Korea Maritime Institute & Pyeongtaek University, Korea

6. International Conference "Sustainable Growth through Green and Secure Logistics", Shanghai. 1.-2. November 2012, Shanghai Maritime University
7. A European research strategy for intermodal transport, Las Palmas de Gran Canaria, 17. – 18. April 2013. Intraregio consortium
8. III. International Conference of Controlling "Green Controlling": International Conference "Green Controlling", 17. – 17. May 2013, St. Petersburg
9. Hamburg International Conference of Logistics (HICL) 2013- Success Drivers of Logistics and Supply Chain Management. 05. - 06. September 2013. Hamburg University of Technology
10. 13th International Conference RELIABILITY and STATISTICS in TRANSPORTATION and COMMUNICATION (RelStat-13), 16. – 19. October 2013, Riga, Latvia
11. Green Corridors, Innovation, and SME Development. 10. December 2013. Moscow, Higher School of Economics Research Laboratory for Economics of Innovation.
12. 14th International Conference RELIABILITY and STATISTICS in TRANSPORTATION and COMMUNICATION (RelStat-14), 15. – 18. October 2014, Riga, Latvia

1. THEORETICAL FRAMEWORK

In order to ensure the proper implementation of innovative transport strategies and research results in the framework of the theoretical background, an extensive literature review was carried out. Because the topic of GTCs is quite uncommon in scientific literature before now, the author combined several different research approaches in order to gain knowledge about the topic. It was hardly possible to answer the defined research questions by only looking at one specific topic, for example transport science. The author combined several aspects of different sciences to be able to provide a solution which is on the one hand theoretically approved and scientifically formulated, but which is in addition practicable and achievable in business economics.

1.1. Green Transport Corridors

The term Green Transport Corridor was described in an initiative of the European Commission, in the Freight Transport Logistics Action Plan (FTLAP) from 2007. According to the FTLAP, GTCs will "reflect an integrated transport concept where short sea shipping, rail, inland waterways and road complement each other to enable the choice of environmentally friendly transport". In recent years, the EU keeps on developing the concept of GTCs through financial means (funding different projects on different national, transnational and regional levels) and through other forms of support to speed up the shift towards greener and more efficient logistic solutions in Europe.

Regional development projects (EWTC II, TransBaltic, NECL, Rail Baltica Growth Corridor, Scandria, etc.) were launched to promote territorial cooperation, all aiming at improving sustainable transportation within the European Union. The main initiator of these projects is the EU Commission. In this context, the aim of the EU Commission is to promote a mobility that is efficient, safe, secure and environmentally friendly, and to create the conditions for a competitive industry generating growth and jobs. The issues and challenges connected to this require action at European or even global level; no national government can address them successfully alone. The European Commission's Directorate-General for Mobility and Transport works in concert with the European Union Member States, European industry, citizens and stakeholders.

The EU Commission developed the term Green Transport Corridor, however implementation and further investigation was forwarded to the EU-funded regional development projects with no clear and coherent implementation strategy. Therefore, almost all projects and initiatives have a different understanding of this concept.

Prerequisites for green transport are: adequate transhipment facilities; innovative transport units and vehicles; and advanced ITS applications. The customers who choose to use a GTC expect not only environmentally friendly transport, but would like to benefit from economic advantages and cost and time savings as well. Therefore, economies of scale with bundled cargo is another factor for a GTC, offered together with reliable time tables which are not delayed due to congestions and construction works, and adapted schedules for trains, ferries and other line traffic with no idle times. The definition of the Commission Freight Transport Logistics Action Plan (FTLAP 2007) covers also the fair and non-discriminatory access to GTCs and transhipment facilities which makes it possible for every customer to participate and use the public available benefits.

During the East-West-Transport-Corridor (EWTC) II project a more practice-oriented definition for GTCs was established (EWTC II Green Corridor Manual 2012). As a result, the definition of EWTC II says that GTCs deliver transport solutions that are more economically, ecologically and socially viable than other (non-green) Transport Corridors. This definition seems to be general and not precise enough. In fact, the definition of optimum transport mode is still open and needs to be discussed further.

As a conclusion of the previous definition, the author assumes that GTC is the term describing a network of different stakeholders which in some way cooperate in intermodal transportation in a certain geographic area. The way in which this cooperation is done is still left open. The author sees the GTC as some kind of agreement among different stakeholders that, due to their business expectations and strategies, see advantages or incentives in taking part in the cooperation.

1.2. Supply Chain Management

To place the concept of GTC in context, the author used the theory of supply chain management as this represents the logistics business of each company. A GTC would bundle the logistics actions of all businesses and companies in a region. Green supply chain management is based on the principle of supply chain management with an extra add-on on green impacts, meaning environmentally friendly and efficient aspects. Supply chain management aims to fulfil the logistics needs of the production process in the company in the most efficient way. This means that suppliers, manufactures, customers and disposal companies are all involved in supply chain activities. In the context of green supply chain management, interdependency exists between conventional supply chain management and eco-programs (Sarkis 2001). This includes the approach to how ecological aspects can be considered in the whole business processes in the most effective way. Hervani et al. (2005) proposed that green supply chain management practices - which include green purchasing, green manufacturing, materials management, green distribution/marketing and reverse logistics - refer to the involvement of environmental thinking into the supply chain management from the extraction of raw materials to product design, manufacturing processes, through to delivery of the final products to the consumers and end-of-life management (Srivastava, 2007). Therefore, it can be assumed that the involvement of green aspects in the supply chain of a company also involves changes in the supply chain itself. Of course, this will in turn have an impact on the cooperative alliances with suppliers, manufactures and the customer at the end of the logistics chain. By integrating these ecological aspects of the product's entire life cycle into the overall closed-loop system, the extraction of raw materials is already taken into account, as well as processes after the useful life of a product, e.g. collection, transportation and inspection, until the product is finally disassembled, remanufactured or disposed of.

As this research indicates (reference to PUBLICATION VI), reducing the overall energy consumption will be the main challenge in the upcoming decades for development of green supply chains. The focus is on four challenges of energy consumption in the transport and logistics sector. The first obvious aim should be to reduce the energy consumption in transportation by applying new technologies and alternative power supplies. A second aim would be to rethink traditional supply chains by introducing new routing systems and possible synergy effects in transport chains. The third challenge is to solve the problem of who of the stakeholders is paying for the upcoming costs for "green" transport solutions. The last issue in a green logistics supply chain is the use of reverse logistics effectively. All of these measures are important aspects of developing a GTC so that it can serve as the backbone for companies' green logistics actions.

1.3. Social Network Theory

In order to understand what a GTC means in theoretical terms, it can be helpful to see the GTC as a conglomeration of different stakeholders which act along a defined geographical area in order to achieve different goals but with the same overall objective to reduce costs, increase efficiency, minimize environmental impact and create sustainable logistics solutions. Realization of the increasing complexity of the interactions among actors along their supply chains suggests that a network perspective may better explain the emergence of collaborative practices and integrative behaviours in logistics in general and supply chain management from organization's point of view (Lee, 2005). Researchers have begun to suggest the need for a network-based view of supply chains, recognizing that the interactions between organizations in a supply chain are rarely as sequential as a chain structure would suggest (Bovel and Martha, 2000). As a whole, studies acknowledge the importance of a network structure for the effective diffusion of supply chain-related practices (Roy et al. 2006), as well as for efficiency and flexibility of the responses of the supply chain to customer expectations (Wathne and Heide, 2004).

As the stakeholders act in a coherent sense and are located in a certain geographical area, such a GTC can be described as a tubular cluster performance. Due to natural reasons, transport and logistics activities often have close relationships to strategic alliances, cooperation and collaboration agreements which can result in cluster activities. Arising from the social network theory, a GTC can be seen as a scale free network. It started from dyadic relationships between two stakeholders and grew to a broader network. Specific characteristics of scale-free networks vary with the theories and analytical tools used to create them, however, in general, scale-free networks have some common characteristics. One notable characteristic is the relatively high number of nodes with relations to other nodes which greatly exceeds the average. The nodes with most of the relations are often called hubs, and may serve specific purposes in their networks. It turns out that the major hubs are closely followed by smaller ones. These ones, in turn, are followed by other nodes with an even smaller number of degrees and so on. This hierarchy allows for a fault tolerant behaviour. If failures occur at random which, in the case of GTCs, means the drop out of a stakeholder and the vast majority of nodes are those with small degree, the likelihood that a hub would be affected is almost negligible. Even if a hub-failure occurs, the network will generally not lose its connectedness, due to the remaining hubs. On the other hand, if a few major hubs are taken out of the network, the network is turned into a set of rather isolated graphs. Thus, hubs are both the strength and weakness of scale-free networks. These properties have been studied analytically using percolation theory, which describes the behaviour of connected clusters in a random graph environment, by Cohen et al. (2000) and by Callaway et al. (2000).

Stakeholders of a GTC can be divided into links and nodes. To provide an application of the social network theory to the concept of GTCs the following table provides the individual properties of such network (Table 1) represented by stakeholders:

Table 1 Links and nodes in GTC (author's own compilation)

Links	Nodes
• Transport forwarders	• Ports
• Railway companies	• Logistics centres
• Ferry companies	• Railway stations
• Oversize transport forwarders	• Border controls/authorities
• Broker, agents	• Distribution centres

Rowley (1997) applied such a social network perspective to the stakeholder theory of the firm. Accordingly, research has started to address systems of dyadic interactions and stakeholder multiplicity, which can be also of importance for the understanding of a GTC concept. Opportunities for organizational resistance or adaptations to stakeholder expectations (Neville and Menguc, 2006; Oliver, 1991; Wolfe and Putler, 2002) can be investigated. Vurro et al. (2009) investigated the predictors of stakeholder networks for value chains. They identified two structural features of such stakeholder networks: Firstly, network density, defined as the degree of completeness of the ties between the actors in a network, has been identified as a likely determinant of corporate responsiveness in that it affects the ease of communication and efficiency of information flow across actors in the network (Meyer and Rowan, 1977; Oliver, 1991; Pfeffer and Salancik, 1978). The second predictor, the degree of centrality in the network, that is, the extent to which an organization occupies a central position in the network, has been suggested as a further influence on the attentiveness of companies to stakeholder concerns and their willingness to accommodate their requests (Rowley, 1997). How different stakeholders with different typologies can cooperate efficiently and how they might be managed can be described with the stakeholder model theory.

1.4. Stakeholder Model Theory

In contrary to the shareholder model theory, which says that in an organization or a firm only the shareholders have an interest in creating value for themselves and serving the interest of the other direct shareholders, the stakeholder model theory assumes that the firm has to serve several different stakeholders. These might not only include directly involved interest groups, but also society, employees or suppliers of third party organizations, public institutions or political stakeholders. The stakeholder approach was initiated by Freeman in 1984, but has been constantly developed during the last decades (see Donaldson and Preston (1995), Campell (1997), Wheeler and Sillanpää (1998), Spurgin (2001)) as in capitalistic markets the importance of the decisions taken by stakeholders is increasing. Decisions do not only have an impact on the organization itself but also on society and a wider group of stakeholders, mainly when it comes to environmental effects and public serving obligations, as can be assumed for the GTCs.

When it comes to governance structure of an organization like a GTC, the question of property rights also arises. Property rights theory has mainly been developed by Coase (1960), Grossman and Hart (1986) and Hart (1995). The party that possesses the rights to an asset can decide the use of it and is entitled to receive the income from it. Unfortunately, this is not obvious to distinguish in the case of GTCs as the rights of the available assets, i.e. roads, terminals, railways, land, infrastructure, etc. belongs to different stakeholders. Mainly these assets belong to public institutions which by their nature have no interest in earning income from their assets but serving the society and ensuring economic freedom. Next to the question of the property rights there are also other opinions when it comes to assets of the organization. Kay (1996), Blair (1996), Blair and Stout (1999) and Donaldson and Preston (1995) argue that the assets of the firm do not only consist of physical assets but also the skills of its employees, the expectations of customers and suppliers, and its reputation in the community. This is not only applicable to the GTC concept in general, but to every participating company on lower level as well.

One crucial aspect of governance of a GTC is still how the decision making process can be solved with such a big group of different stakeholders. Hansmann (1996) already stated that “the more groups of stakeholders there are, the more complicated it will be to reach a decision, especially as the stakeholders often have different goals”.

In order to analyse the possibilities of introducing the stakeholder model in governance of a GTC, it is important to have a clear idea of what is meant by stakeholders, such as owners. It can be assumed that stakeholders by nature are also owners of the corridor structure. Therefore the author further defines stakeholders as these parties which have a stake in the GTC and are part of the governance structure of the same, as Freeman's (1984) definition states that stakeholders are: ''…any group or individual, who can affect or is affected by the achievement of organization's objectives.'' Clarkson (1995) defines stakeholders as ''…persons or groups that have, or claim ownership, rights, or interests in a corporation and its activities, past, present, or future.'' He further differentiates between primary and secondary stakeholders. The first group includes stakeholders, like shareholders, employees, customers, suppliers, government and communities. Without their participation, the organization cannot exist. The secondary stakeholders are ''…those who influence or affect, or are influenced or affected by, the organization, but they are not engaged in transactions and are not essential for its existence.'' Examples of secondary stakeholders are the media and competing companies. Other researchers (Wheeler and Silanpää, 1998) differentiate between "social" and "non-social" stakeholders. Furthermore, there are direct and indirect stakeholders. Examples of direct social stakeholders are customers, employees and investors and examples of indirect non-social stakeholders are the natural environment and future generations, which apply very much to the concept of GTCs. As the concept for a transnational governance model, the management of a GTC is new and not completely investigated, it might be useful to assume the group of stakeholders and try to define their expectations and intentions.

Ownership typologies represent a key aspect in understanding the interests and the behaviour of stakeholders in the GTC. It is not just a legal-economic construct; it also has personal, social, political and economic value dimensions. The problem of not understanding the owners' role or behaviour, either on individual, firm or societal levels arises. The constructed ownership ideal types (Wahl et al. 2013) shed light to the phenomenon of ownership, and help to explain behaviour of stakeholders of the most important actors in GTC governance.

1.5. Organization of Theories

The underlying theories of this thesis and the solving of the CRQ are found in the fields of supply chain management, especially with focus in green developments. The author identified impacts of green supply chain management developments and the potential impact on businesses and economy. As a result of the broad literature and research results available, the author could show the need for further development and engagements in the implementation of the GTC approach.

An assumption of the author of this thesis was that a GTC could be identified as a type of network with many different stakeholders, where basic theory, i.e.

social network theory can be applied. Network theory describes the stakeholders of a network as links and nodes. The same applies to GTCs.

The third fundamental basis of the framework for this thesis is the stakeholder model. Through the research and assessment of previous research results, the author of this thesis was also able to apply common characteristics to the approach of GTCs. The identified characteristics show that each stakeholder, it might be a link or a node, has an interrelation with other stakeholders. These interrelations can be positive, meaning they strive for the same aims and objectives in the cooperation, or they might be negative which means that they aim for more controversial objectives and act controversially accordingly. The author identified parallel assumptions and methods in organizational theory and corporate structure development which can also be applied to the GTC. The theory that stakeholders have common characteristics is also relevant for the development of management bodies and governmental structures in the construct of a GTC initiative.

The following picture (Figure 1) demonstrates the synthesis of the investigated theories. Initially there is a relation between two industry companies in the way that they deliver or receive some products along a supply chain. The first objective in the elaboration of the theoretical framework is to find the "greenest" way of this transhipment. This can be easily identified by application of Operations Research with single or multi-criteria maximization. However, developing the bilateral relations further by involving more stakeholders the understanding of network theory is necessary. The two companies are still start and end points of this transhipment, but more stakeholders participate in the network of logistics services. As the number of stakeholders increases the characteristics of this network become manifold. Different stakeholders also mean different expectations, values, behaviours and actions. So, in order to manage these manifold properties, the stakeholder model theory is applied in this research.

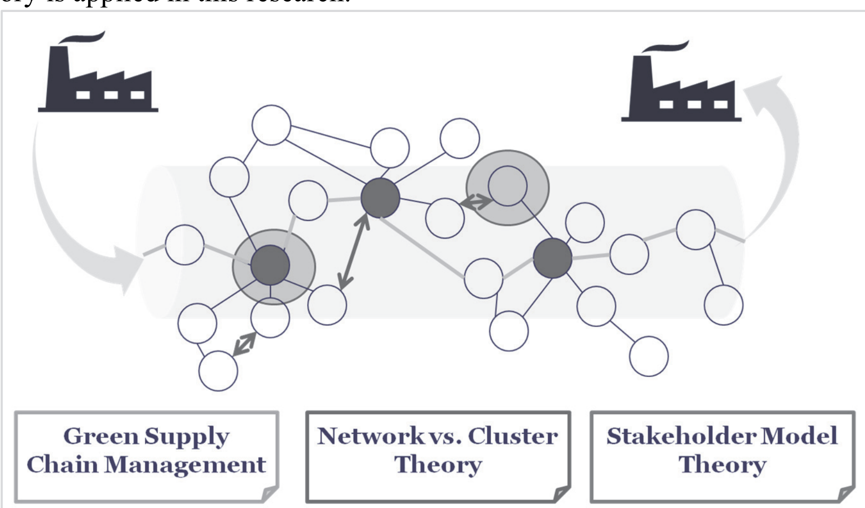

Figure 1 GTC in theoretical framework (author's own compilation)

To conclude, the analysis of the previous theories explains the theoretical context of a GTC concept. A GTC can be understood as a kind of cluster with stakeholders who cooperate in order to achieve efficiencies. However, the dynamics in the GTC are explained in more detail through network theory. Different expectations and behaviours require a common strategy, respectively a steering organ in higher level. In order to develop such kind of governance structure the stakeholder model theory is applied.

2. METHODOLOGY

2.1. Theoretical Approach

As previously stated, the definitions of a GTC vary according to individual focuses. The Commission Freight Transport Logistics Action Plan (FTLAP 2007) describes GTCs as a concentration of freight traffic between major hubs and by relatively long distances of transport. However, this definition is quite open and does not describe how to develop and manage a GTC. The inter-relational cooperation of different stakeholders of the GTC has not been investigated so far. As Creswell (2003) stated, "if a concept or phenomenon needs to be understood because little research has been done on it, then it merits a qualitative approach". Primarily, the author of this thesis used a qualitative approach to the problem solving. In substance, well-known theories from other research fields (supply chain management, social network theory, and stakeholder model theory) were applied. However, furthermore, this thesis was developed with concurrent procedures, in which the "researcher converges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem" (Creswell 2003). Therefore, in this research the author employed practices of both qualitative and quantitative research. The author collected both forms of data at the same time during the study and then integrated the information in the interpretation of the overall results.

The qualitative research in the frame of this thesis included narrative research which is a form of inquiry in which the researcher asks one or more individuals to provide stories about their experiences. This information is then retold or restoried by the researcher into a narrative chronology (Creswell 2003). In the end, the narrative combines views from the individual's life with those of the researcher's life in a collaborative narrative (Clandinin & Connelly, 2004). The author of this thesis conducted several expert interviews with open ended-questions with individuals which were involved in GTC development (see 2.3.2 Data Collection).

Another method applied in this thesis was the planning and conducting of case studies. Through case studies, the researcher explores in depth a program, an event, an activity, a process, or one or more individuals (Creswell 2003). The case(s) are normally bounded by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time (Stake, 1995). During the current study research, the author carried out several case studies with private stakeholders and assessments of logistic processes in ports, logistics centers, ferry connection and road planning authorities (see 2.3.1 Project Participation).

Additionally, during project participation the author of this thesis used other field methods such as observations and interviews (qualitative data), which were combined with traditional surveys (quantitative data) (Creswell 2003). With the survey, the author was able to test the developed theories and identified functionalities for successful GTC implementation (see 3.1.1 Functionalities and Framework Conditions) as well as key performance indicators (see 3.2.2 Performance Management by Key Performance Indicators).

2.2. Study Design

The research design describes how the study was designed and how the author of this thesis approached the task solving. According to Robson (1993) a distinction is made between “fixed” and “flexible” or, synonymously, “quantitative” and “qualitative” research designs. As the current research uses mainly the qualitative approach, the research design can be regarded as flexible design. The reason for this flexible research design is the fact that the main contribution of this research is the inclusion of soft factors like culture, attitudes, behaviours and values of the GTC stakeholders.

Figure 2 visualizes the study design of this research. The research tasks are completed consequentially as they build upon one another. Therefore, the total research is more set up as a two step approach. First it is the development of a concept of a uniform GTC which can be applied universally. The second step is the actual implementation and research on management and success factors for successful implementation of GTC.

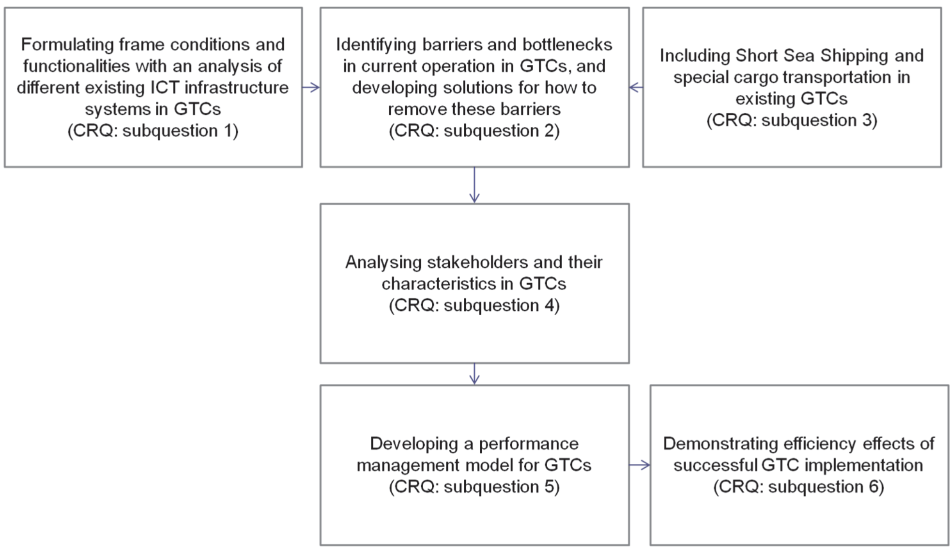

Figure 2 Study design (author’s own compilation)

The structure of the research was driven by the stated CRQ which arose from the defined research gap (see INTRODUCTION). The author started with a grounded theory research which is a systematic research process that works to develop “a process, and action or an interaction about a substantive topic” (Creswell 2012). The author analysed existing research and literature on this topic. The author identified common functionalities of a successful GTC and was able to provide best framework conditions for the successful implementation (CRQ: subquestion 1). In addition, the need for an adequate ITC-system was discussed during this research and was implemented on a test GTC for oversize transports, which has a system that is already running live.

Hubs are considered as the main logistics nodes in the network structure of GTCs. As they are quite crucial for the failure-free existence of such a network, these hubs need special attention in regard to development and adaptation. The author of this thesis analysed, during case studies and extensive series of expert interviews, different hubs in a test GTC in the Baltic Sea Region and defined barriers and so called bottlenecks in their operational services (CRQ: subquestions 2).

Next to the literature review on green supply chain management, the basic assumption was that intermodal transport and transnational co-modality, especially Short Sea Shipping and oversize transport, are current business developments in the transport and logistics sector. As part of the research, the author analysed the impact of green factors in transportation with a quantitative measure, and provided an assessment of different transport modes numerically in order to create a green transport network (CRQ: subquestion 3).

Furthermore, the theoretical framework for the establishment of the GTC was investigated. Previous research and knowledge gained from practical experiences showed that the concept of network design and structure can be well adapted to assess the theoretical structure of a GTC. There is some research at hand to classify the concept of GTCs in the network theory and stakeholder model. During this research the different values and expectations of the stakeholders in a GTC are classified into specific types and categorised according to their role, expectations and value commitment in the construct of the GTC (CRQ: subquestion 4).

By studying the context of the stakeholders and in collaboration with participants, the author developed a management model and governance structure according to the role and behaviour of the individual stakeholders in the GTC (CRQ: subquestion 5).

When a GTC is implemented and stakeholders participate in the GTC, efficiency effects can be measured with a test of the previous theories (CRQ: subquestion 6). This thesis demonstrates success factors for implementation of GTCs for private companies and business economics by employing statistical procedures.

2.3. Research Methods

The research method of the current thesis was driven by the qualitative approach and flexible research design. The qualitative method investigates the why and how of decision making, not just quantitative decisions. Hence, smaller but focused samples are more often used than large samples. This involves describing in details specific situations by using research tools which are described as follows.

2.3.1. Project Participation

The author actively took part in some of the EU-funded regional development projects:

- November 2009 – June 2011: Oversize Baltic
- August 2010 – June 2012: EWTC II
- September 2012 – September 2013: Baltic Transport Cluster
- Representative in project meetings of: TransBaltic, BalticBird, NECL, Scandria, Sonora, RBGC, BGLC

Participation in the projects enabled access to very recent data, as the partnership of these projects was represented by a broad range of different organizations - partly public and partly private. Private stakeholders could contribute with actual and significant input from their daily business. Information was collected mainly during project meetings and workshops.

Focus group meetings were conducted in order to investigate specific topics in more detail and with more professional focus. These focus group meetings took place during the duration of EU funded East-West-Transport-Corridor II Project, which aims to implement a GTC concept between the South Baltic Sea and Black Sea Region. In work package 5A (Hub development) a benchmark on best performances should indicate the solutions for hub development by eliminating existing bottlenecks. During the period from spring 2010 until the end of the project in summer 2012, the author of this thesis collected basic information for the secondary data analysis of the selected hubs. The objective was to gather common information which would make it possible to compare this information in the following benchmarking. During a seminar workshop for hub development, specific development measures and investments were selected from the task partners and were analysed and proposals were formulated. The result is a list of development measures for future-oriented investments in the selected hubs (see 3.1.2).

2.3.2. Data Collection

Additionally to the general project participation the author of this thesis also conducted qualitative expert interviews with participants (10 expert interviews with C-level representatives). These participants were also public stakeholders, i.e. municipalities, cities, regional and national governments, and private stakeholders, i.e. freight forwarders, service/equipment provider, and partly public and private stakeholders, e.g. port authorities, railway companies. Much information about the topic of transnational oversize transport (in order to elaborate the final solution) was gained during the project duration of almost 3 years of the South Baltic Programme project “Oversize Baltic”. The author of this thesis was the responsible component leader for the strategic analysis of the national markets for oversize transport across all transport modes (road, rail, short sea shipping and inland waterways) for the four participating countries:

Germany, Sweden, Poland and Lithuania. This included the profound investigation of the legal environment in these regions, as well as the research into existing and planned transnational services in European Union and smaller interregional initiatives. In addition to the field research, more primary information was collected from individual meetings with experts in the project “Oversize Baltic” and beyond. A number of visits of experts from the field of logistics and oversize transports helped the author to gain information about single case studies, individual challenges and successful solutions. These meetings were held with responsible managers from the ports in Rostock, Wismar, Sassnitz, Klaipeda, Fredericia, Karlshamn, Tallinn, Muuga, Paldiski, and Stettin. Additionally, the author held phone conferences with these experts during the research phase. A workshop organised by the Easyway project in March 2012 offered the author of this thesis the possibility to present and introduce the transnational e-service OTIN (Oversize Transport Information Network) as a direct outcome of the “Oversize Baltic” project to the customers and industry representatives. During this workshop, the accessibility and the customer-oriented approach was discussed. The result was positive as this is a well-developed tool which aims to improve user-friendliness and reduce the bureaucratic burden for oversize transport permissions.

2.3.3. Second Data Analysis

Another focus of the research into GTC concepts was on the official governmental communication about regional development plans in transport and logistics. These papers were also analysed by the author and implemented in this dissertation.

Additionally to the desktop review of these papers the author visited and took part in dissemination events of these programs and development plans. An example of these events is the Hamburg International Conference of Logistics (HICL). As supply chain management and logistics is a highly dynamic field, players in the field are constantly confronted with new operational issues and questions. Since 2006, through its focused annual conference HICL and proceedings, the institute of Logistics and General Management at Hamburg University of Technology seeks to unearth and highlight these issues by bringing together a critical mass of researchers attempting to address these questions with new insights, concepts and methodologies and to offer the latest solutions and processes. The International Research Conference on Short Sea Shipping, Lisboa, has fostered its theme to be “Sustainable Short Sea Shipping Challenges and Opportunities”. Numerous topics have been presented by worldwide researchers and governmental representatives. Qualitative valuable contribution and professional exchange with other stakeholders made it possible to further develop the innovative transport strategies of this dissertation. The comprehensive view on the topic was given by the involvement of such a broad range of stakeholders.

The Baltic Sea Region Programme 2007-2013 organised a Baltic Sea Region Programme conference in Oslo. Achievements of transnational cooperation as well as planning the next programme period 2014-2020 were on the agenda of the stakeholders of the Baltic Sea Region Programme during the year 2012. At the Programme Conference, the impact of transnational cooperation was demonstrated when successful projects continue working as thematic clusters (energy, innovation, transport and Baltic Sea waters). Also valuable to the author's research were the view into the future of the European Territorial Cooperation 2014-2020, and the discussion about the relationship between the EU Strategy for the Baltic Sea Region and the evolving Baltic Sea Region Programme 2014-2020.

To conclude, the qualitative approach and the flexible research design allowed the author to investigate the problem of research in a very comprehensive way. The relatively unknown theoretical concept of GTCs was explained by literature review and application to existing theories. Additionally, observation, expert interviews, focus group meetings and case studies were the main methods of this research. With the results obtained, the author was able to answer the research questions in a qualitative way.

3. RESULTS AND CONTRIBUTIONS

3.1. Conceptualisation of Green Transport Corridors

This chapter presents the first results of the two-step approach towards solving the CRQ: "How can Green Transport Corridors be conceptualised and managed?" While subchapters 3.1.1 – 3.1.3 cover first part of the research question (conceptualisation), subchapters 3.2.1 – 3.2.3 cover second part of the research question (management).

The following subquestions of the CRQ are answered:

a) What framework conditions and functionalities should a GTC fulfil, especially how can IT solution support help to achieve this?
b) How can organizational models and cooperation contribute to sustainable hub development along a GTC by removing existing bottlenecks?
c) What are the impacts of including the concept of Short Sea Shipping and special transportation (oversize transport) in multimodal route choice optimization?

3.1.1. Functionalities and Framework Conditions

Since the requirement of bureaucratic regulations is quite high in the transport sector the implementation of ICT instruments and applications is one big issue in increasing efficiency and development of cooperation.

The author of this thesis viewed the implementation of integral ICT-systems for freight transportation in various testing grounds. As a result, by taking into account all discussed features of ICT-systems of the main GTC projects in the Baltic Sea Region together, it can be concluded that an appropriate ICT-system for the support of GTCs should facilitate specific functionalities (see Table 2).

Table 2 Framework conditions of an ICT-solution for GTC

Functionalities of GTC and framework conditions for integrated ICT applications	
▪ Open architecture with standardised interfaces ▪ Real time data information systems and electronic data interchange ▪ Transport optimization (intermodal route planning)	▪ Loads bundling and consolidation ▪ Cost calculation ▪ CO_2 emissions calculation ▪ Purchase of transport services ▪ Transport monitoring

Furthermore, such an integrated transportation ICT-system can bring together the big market players in logistics and trade, as well as the SME sector in logistics, to achieve cheaper and more environmentally friendly transport. By taking into account the discussed issues, the advantages of such an integrated ICT-system can be expressed by the following points:

- Increased accessibility of inter-modal freight transport solutions, i.e. the gain of door-to-door co-modal solutions together with environmental and logistics performance attributes.
- Improved synchronization of logistics processes and better utilization of logistic resources.
- Enhanced reliability of inter-modal services and better adaptability of logistics solutions through dynamic updated information.
- Reduced costs and effort for the management of complex transport chains.
- Possibility to use standardised electronic logistics documents like waybills and customs information along the transport chains.
- Creation of an open transport spot market along the involved GTCs including the possibility of a fair participation of the SME logistics sector.

The comparative analysis of the running GTC projects in the BSR brought to light that up to now it is possible to formulate minimum requirements for the provided functionalities that an integrated logistics platform system has to offer:

- Generation of inter-modal door-to-door transport alternatives comprising the whole transport chain planning.
- Transport chain visualization.
- Multi-criteria transport optimization tool.
- Calculation and measurements of energy consumption and CO_2 emissions.
- Standardised electronic data interchange in order to be able to integrate corporate systems using different communication standards.
- Information about logistics nodes, available services and service booking.
- Parking information and booking parking places.
- Up-to-date information about traffic and weather conditions.
- Transport tracking and monitoring
- Negotiation, contracting and booking system.
- Financial settlements.

During the research for this thesis the author developed a solution for ICT applications in the transport sector. Knowing the fact that in most European countries, oversize transport requires special permission from responsible transport authorities, which leads to large bureaucratic burden for all stakeholders, the author focused on efficiency increases in this process. The solution is a running web-based management and permission system for oversize transport forwarders which is described as follows:

Over the past few years, some countries have tried to follow the European guidelines on electronic government and have implemented e-service solutions for the application of transport permissions. In addition to obvious differences (such as language barriers, missing information about local routes and roads, and different tariff systems); invisible cultural differences might also appear. Transport forwarders who would like to execute transport abroad need to have profound knowledge about the foreign market, the infrastructure status and also business cultures of foreign partner companies. During the analysis of the different countries it turned out that business culture differs in regard to corruption, bribery and inconsistency in tariff systems. Regional transport companies might have a very good working network with companies abroad which work in alliances for transnational transports. However, next to the "unofficial" cooperation when it comes to knowledge exchange for route planning, personnel exchange with local experience and agreements on return shipments, the cooperation on the administration level was also requested. For many, mainly small companies, it requires a great effort to learn about the foreign legislation, legal requirements and permission procedures. The bureaucratic burden on these companies is tremendously high compared to their actual business, namely executing a transport with oversize cargo. Therefore, the EU-funded project "Oversize Baltic" introduced a platform for transnational permission application.

However, the identified necessary functionalities represent the more technical part of the requirements that have to be fulfilled by an integrated ICT-system. The more challenging task is to understand the individual soft factors and characteristics of a GTC and the realization of the organizational and political framework.

3.1.2. New Business Models for Hub Development

By assessing the bottlenecks for cooperation in a transport network such as a GTC, the author identified two possible solution steps:

1. Innovative cooperation and management models for logistics hubs like ports can realize synergy effects and raise efficiency of logistics facilities
2. New legal and organizational business models can help to realize modern logistics centres, which facilitate GTC concepts.

The considered measures have in common that they contribute to the development of GTCs and that they require at least a minimum amount of investment of capital or resources which can be contributed by the hub owners, operators, customer interest groups and public bodies.

As a result the author of this thesis provided a report on future investments for hub development (reference to Hunke and Prause 2012). This report can contribute significantly to the development of a GTC.

Best practice examples identify successful solutions for sustainable implementation of hub development and measures in order to offer and promote an efficient, environmentally and customer-friendly, secure, and reliable transhipment route. Transhipment hubs within the GTCs will secure smooth transfer between the modes of transport while serving the regions around.

3.1.3. Co-modality and Oversize Transports

During the research for this thesis a multimodal transport route choice in the Baltic Sea Region was elaborated. It is assumed that only a single objective function is possible as there are several reasons for this. Transport forwarders as well as customers have their own preferred objective when executing a transport. In today's transport business, many stakeholders influence certain transport route choices for individual reasons. For example, due to prestige reasons, some businesses prefer a green and sustainable transport which will give the route choice with lowest CO_2 emissions more power than it would be for decision makers who focus in profit maximization (lowest costs). Furthermore, different transported goods require different sources for optimization, e.g. up to date electronic equipment needs fast transportation in order to serve the demand market in time. Additionally some products need special attention which is not covered by this single source problem as in the case of refrigerated products, which require a continuous supply of electricity for cooling the reefer containers. This could also have an impact on the choice of the transport mode and on the route. As these reasons depend on individual cases in the real transport world, a more qualitative approach is required here.

For future research, the designed model can be enlarged by various additional nodes and links. The data provided for the given nodes and links which were used in this thesis are verified whereas more information on additional nodes and links would need to be gathered. This was out of the scope of this research, so only the two selected routes were considered.

The core element of these multimodal transport chains should be the maritime transport Short Sea Shipping. Therefore, these two routes were selected: 1) from Leeds (UK) to Jonava (LT), and 2) from Neumarkt / Upper Palatinate (DE) to Tampere (FI). In order to cover the whole Baltic Sea Region route 1 describes an exemplary multimodal transport chain from the Western to the Eastern part of the region, whereas route 2 describes the transportation in a North-South direction via the Baltic Sea.

In general, it becomes obvious that rail freight possesses comparatively few favourable values, although, by taking into account the performance characteristics, quite different results should be expected. Besides the lack of (technical) interoperability in the cross-border traffic, the rationale behind this statement can be traced back to different gauges, different power supplies and not or only partially compliant control and safety technology. In addition, there are (still existing) inefficiencies in the organizational processes along with the lack of, or an underdeveloped, competition derived from the absence of consistently enforced deregulation. One important aspect in this respect is the missing (or less regarded) separation of responsibilities for the rail network infrastructure and the (operative) transport services.

In detail, the following picture has been observed:

- *Costs:* The lowest cost constellations emerge in case of a high proportion of short sea shipping, whereas transportation by road (and rail) tends to result in higher costs. The rationale behind this result is the bundling effects in short sea shipping as well as the disadvantages of road and rail freight transport inherent in the particular system.

- *Transport duration:* A high proportion of transportation services by truck leads to the most favourable solution, while the rail freight appears to generate significant disadvantages. The performance indicators of these two transport modes comply with this result as well. A very good infrastructure for a mono-modal road transport is available and allows a high flexibility in operations, whereas the rail system is more fixed and therefore unveils some inefficiency, especially in single wagonload transport.

- *CO_2 emissions*: A large proportion of short sea shipping in the transport execution also compared to the rail freight transport is considered as an advantageous one. A proportionate increase of the road freight transport operations, however, yields clearly less favourable values. Nevertheless, new regulations like the subsequent stages of the EURO-X-norm for diesel engines will lead to significant changes regarding pollution emissions, thus changing the prevailing relations.

As the results of the two examples examined indicate, solutions can be achieved due to suitable infrastructural requirements and associated service offerings, where the criteria for solutions are not considered to be totally opposite. In other words, there are acceptable compromise solutions, especially with respect to transport costs and CO_2 emissions. However, these results must always be understood as a decision option, i. e. which transport process is being executed is an operational decision considering the case-specific requirements. The information about available alternatives may influence decisions, even with a view to better integration of environmental effects (at a corresponding cost situation).

Integration of oversize transport in the GTC development was made by elaborating a strategy for oversize transports in the Baltic Sea Region. Transportation with special and over dimensional cargo is analogical to the standard freight GTC characterised by links and nodes. The links are roads, railways and ferry lines, all have in common that they provide space, equipment and infrastructure conditions (e.g. bridges, road surface) for transport of oversize cargo. Logistics nodes are represented mainly by ports in this region, as they are the few places which can provide the required equipment for handling and shifting over-dimensional cargo from one transport mode to another, or place it for storage.

The network for oversize transportations can be divided into different parameters, according to transport means and cargo classes. The usage of suitable transport means depends on the weight and dimensions of the oversized cargo. Some cargo does not fit on a road truck, some needs to be transported to various locations where no access other than by road is possible. In such cases, where a high increase in oversized transports is expected, it might be efficient to build new connections, either road reconstructions or new railways (e.g. in the seaport hinterland in order to supply offshore wind parks). If such a need is confirmed, it may be reasonable to bundle oversize transport clients, since the conditions for an oversize transport permit are the same for every business, regardless of the sector, company size or transport volume. However, there is no defined route, functioning as a GTC so far, since oversized cargo transported in this region is treated more or less individually. This fact leads to a need for further investigation and integration of oversize transports as the forecasts show that the demand is still increasing for these types of cargo.

To conclude, the conceptualisation of GTCs is based on setting up a framework for successful implementation. Certain frame conditions and functionalities will lead to harmonized standards and equal access for every stakeholder of the GTC. With concrete measures on hub development, existing bottlenecks and barriers can be removed and will provide efficient performance of the GTC. Integrating Short Sea Shipping and oversize transports in the development is one crucial aspect in conceptualisation and will lead to coherent performances for all businesses participating in GTCs.

3.2. Management of Green Transport Corridors

This chapter presents the second pillar of the two-step approach towards solving the CRQ.

The following subquestions of the CRQ are answered:

a) What are the characteristics of the GTC properties (stakeholders) and how do they interact?
b) How can these properties be managed and governed according to their characteristics in the GTC?
c) Which success factors and economic efficiency effects can be expected by private businesses when participating in the GTC?

3.2.1. Characteristics and Organizational Levels of a Green Transport Corridor

Ownership typology represents a key stone in the understanding of the interests and the behaviour of stakeholders in any economic system, also in a GTC, as it is understood by the author of this thesis. Every stakeholder organization is not just a legal-economic construct; it has also personal, social, political, and cultural value dimensions. The problem of not understanding the individual role or behaviour, either on company or political level arises. The basic assumption of the author of this thesis is that all stakeholders, which are represented by their nature, location or task in the construct, are depending on each other and have influences on the actions in the GTC. However, as these stakeholders are private, public, or private-public, they also differ in the type of their activities and responsibilities. Also their objectives, strategies and values differ. For example, a private transport forwarder would only consider making a green business, and also take the risk to pay higher costs, if the outcome would be positive for the business. On the other hand a public institution, e.g. a road authority, has different aims, namely to fulfil their public service obligations and to provide a road infrastructure to the public. For them the economic benefit is not the primary motivation to be a part of a logistics network GTC.

The author of this thesis applied previously constructed ownership ideal types to the construct of a GTC. This research helps to explain the behaviour of stakeholders of a GTC and describes the characteristics of such a network.

According to the network theory, the stakeholders can be divided into smaller nodes and actors, which function as hubs along the GTC. What makes a GTC also specific and more complex than a logistics network is the geographical and political scope. The GTC covers several countries, regions and terrestrial and maritime areas as well as national, regional and transnational political bodies. One could assume that the stakeholder with the highest political power is also the stakeholder with the highest degree, i.e. represents a hub in the network. However, by looking deeper into the actual performance of a GTC and the role the individual stakeholders play, it becomes obvious that the hubs are rather represented by other institutions.

Ports and logistics centres

Ports and strategically planned logistic centres are considered as hubs due to their location. Because of the connection to many transport modes (sea, inland waterways, roads and railways) the cargo is shifted or stored for a certain time period. When looking at the ideal transport chain along the GTC, every cargo has to pass the main hubs at least twice during their entry and exit points. This simple fact makes the ports or logistic centres a very crucial part of the GTC. Owners of hubs and logistics centres can be private, but also public bodies. Either way, they aim to cover their running costs and earn additional income from their offered activities.

Logistic forwarders

Logistic forwarders, such as rail companies, international courier services, and ferry lines, are not dependent on one geographical location. Besides their company size they are rather considered as a hub due to their close and manifold relations to other stakeholders in the GTC. They provide large portions of equipment (containers, trucks, ferries, rail wagons) along with the professional knowledge and skills of their employees. Therefore, they are a crucial part of the performance of the network operations in the GTC.

Logistic forwarders are almost fully owned by private companies and respectively represent a stakeholder group which is interested in generating value and income for their own shareholders. They will only act as stakeholders of a common GTC if the savings through cooperation are higher than the costs.

Political institutions on several levels

Political institutions of all levels in all countries represent the national or regional governments. Governments are rarely interested in earning income for themselves from establishing a GTC. However, they are obliged to represent the local market economy and ensure the best framework conditions so that private companies can perform well. This also includes equal access to all GTC activities. From that point of view, they fulfil a representing function. Additionally, as governments support the GTC activities with public funds, society as a whole is interested in the investments. Therefore the political institutions act as agents for the general society.

A summary of the characteristics of the main stakeholders in a GTC is presented in the following figure (Figure 3).

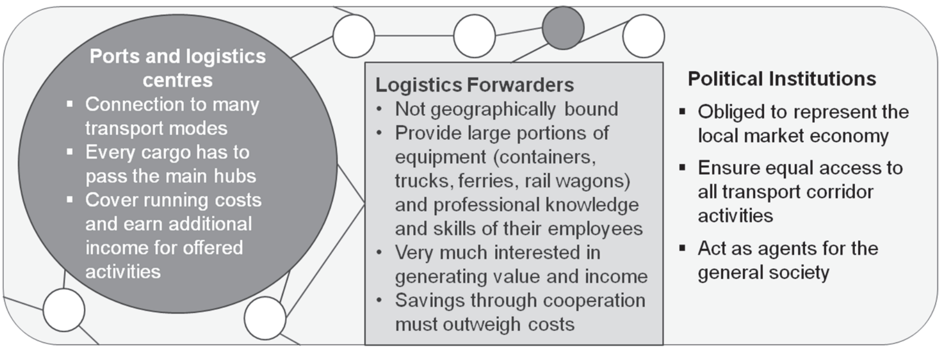

Figure 3 Characteristics of Stakeholders in GTCs (author's own compilation)

Based on the individual stakeholder types of a GTC, a governance structure and body should be designed in accordance with the existing stakeholder's values and objectives. Furthermore, it has to be taken into account that missing values in the existing GTC structure have to be fixed by inclusion of corresponding new stakeholders for the GTC.

Practically, in order to safeguard sustainable and prosperous GTC development, professional and evolutionary corporate governance is needed which is oriented on the long term objectives of the stakeholders as well as on overall objectives and values for the GTC. Here the presented typology gives the opportunity to understand and harmonize the individual values of stakeholders on the local level with the general GTC objectives on the overall level. It is obvious that enlightened, competent, professional ultimate owners know what results they expect from the network development in the long run and it is also clear that they succeed in a dynamic environment only if the overall values of all GTC stakeholders are corresponding to the individual ones.

3.2.2. Performance Management by Key Performance Indicators

There are different aspects that will influence the performance of GTCs. Performance can be measured on three levels: economic efficiency, environmental efficiency and social efficiency. In order to measure these efficiencies the factors are separated into enabling and operational criteria. Enabling criteria describe the settings of the GTC in regard to the hard infrastructure, meaning roads, railways, terminals, ports, etc. The soft infrastructure includes the information and communication systems which supports the transport logistics services offered in the defined GTC or set of factors. Other aspects enabling the performance of such a network are regional, national and international policies and regulations which apply to all stakeholders. Operational aspects describe the geographical settings of a GTC as well as the transport and logistics solution which were developed by new and innovative business models. The implementation of transport techniques will also have a direct impact on the performance of a GTC measured by given KPIs.

PUBLICATION V provides a set of KPIs which were developed during the research and already tested practically in some testing GTCs. These KPIs stimulate improvements of the GTC infrastructure and facilitate the cooperation of all stakeholders in the GTC in order to improve total performance.

Table 3 Performance areas of GTCs (source: EWTC II, adaptation by author)

Performance areas	Operational indicators	Enabling indicators
Economic efficiency	Total cargo volumes On time delivery (harmonised timetables)	GTC capacity Communication and planning tools
Environmental efficiency	Total energy use Greenhouse gases, CO_2 emissions Engine standards ISO 9001 dangerous goods ISO 14 000	Alternative fuels filling stations
Social efficiency	ISO 31 000 ISO 39 000	Safe truck parking Common safety rating Fenced terminals

Economic efficiency and service quality performance of a GTC can be demonstrated by the total cargo volumes. Large cargo volumes increase the attractiveness of a GTC as it might influence decisions from potential stakeholders as to whether to accept the GTC or not. Furthermore, efficiency and service quality is reflected by the ability of the stakeholders to provide on time delivery. It is measured by the arrival time in relation to transport timetables. A key element with regard to on-time delivery is a uniform provider and shipper entity for measuring lead times and its arrival time with relevant precision. The enabling performance under this area is the GTC capacity, which is set by the enabling criteria of hard and soft infrastructure and policies.

Total energy use aims to describe the general environmental efficiency. Indirectly, it also describes the extent the traffic flow is efficient when, for example idle times, empty returns and long waiting times are reduced. In addition, operational performance in regard to the environmental efficiency can be measured on fuel consumption, as it enables the calculation (if needed) of SO_2, given the legal fuel conditions or the actual quality used. In case renewable energy resources are used, the emitted Greenhouse gases (carbon dioxide, methane and nitrous oxide) can describe the impact on climate affecting emissions of the GTC. As an enabling indicator the availability of the corresponding fuel stations must be measured by assessing the numbers of traditional fuel stations and alternative fuel stations. The more alternative fuel stations are available, the more the environmental efficiency can be assumed.

Engine standards (including after treatment devices) which are regulated for all stakeholders of a certain GTC can also be used as a performance indicator as they indirectly describe the emissions related to impact on health and nature. Further indicators are related to dangerous goods, which are already regulated quite strictly by international standards (e.g. ISO 9001 dangerous goods) and are therefore, quite known to measure the safety aspects of the GTC.

Social efficiency can also be measured by operational performance of the GTC. Indicators and common standards are already precisely stated in the ISO norms for risk management (ISO 31 000 and ISO 39 000). In these norms the cargo security aspects are regulated as well as the traffic safety aspects, initially these are meant for organizations but can also be transferred to the monitoring of a GTC (e.g. road traffic accidents). Another indicator for social performance can be measured with the sick leave rates of companies, fluctuation by employee turnover, the number of temporary employees and workers and the average salary level, and salary differences between the stakeholders of the GTC. These indicators will give an indication of how the social performance is developed today. Indicators which enable social performance in regard to cargo security and safety are the consistent usage of fenced terminal areas with access controls and safe truck parking systems along the GTC. (EWTC 2012)

3.2.3. Efficiency Effects on Private Business Performance

When considering all the measures which are described previously, the question still remains if and how the private business sector, mainly SMEs in the logistics sector, can benefit from this. The author of this thesis showed an approach to provide a framework for sustainable development by applying the

GTC concept in the entrepreneurial environment (reference to PUBLICATION IV). SMEs are seen as the main stakeholders and also the main beneficiaries in this process.

SMEs are by their operational nature heavily integrated in the development and performance of GTC concepts. They cover the highest amount of logistic activities in a macro-regional view of supply chain performance. This applies to both traditional views from the past as well as the green supply chain management in future development. However, the research approach of this thesis emphasises the integration of entrepreneurs into GTCs by stressing the requirement of harmonized regulations with openness for all actors enhancing the position of private sector businesses as stakeholders in the GTCs. This will give perfect framework conditions for the development of individual performance and also the economy of regions and markets which are affected by the GTC.

Another aspect researched by the author of this thesis and the co-authors looked at measurable performance increase due to greening their logistics activities and becoming part of a GTC network (reference PUBLICATION VI). The results of this research are:

a. In general, green supply chain management leads to better performance in terms of indicators such as
    - environmental protection and
    - efficient usage of resources.
b. Companies are aware of the environmental issues but are still lacking behind realizing the full potential of GTCs. Most businesses need more incentives to make environmental investments and become part of a cooperation network, either by law or by economic motivations.
c. Green and sustainable supply chain management in the private business sector leads to cost reductions and a better business performance.
d. Consumers in the market appreciate the sustainable business strategies companies employ. So, next to the measureable direct economic benefits, the green image of a company helps to strengthen the market position for further sustainable development.

To conclude, management of GTCs is a task which impacts many stakeholders and also many organizational levels in a GTC. Current research demonstrates that the stakeholders of a GTC differ in their expectations, values, behaviours and attitudes. The management model must cover these described characteristics. A multi-level KPI system will evaluate the performance of each stakeholder and the GTC as a whole. When fulfilling the KPI to a high degree, the GTC can be claimed efficient and “green” as the evaluation in private business economics showed.

CONCLUSION

As previous research has shown, co-modal transport solutions are the backbone of well functioning transport networks. However, the author of this thesis identified even more required developments when implementing the concept of Green Transport Corridors (GTCs). The fact that, compared to earlier research, the current development of transportation is not driven by single point-to-point connections but instead by the network approach, is one issue in the conceptualisation of GTCs. The author of this thesis applied cluster theory and the stakeholder model to the current research field of transport science. Whereas previous studies did not consider the management aspect and inter-relational cooperation among stakeholders in a transport network, the author of this thesis provides a theoretical solution of a GTC management model with practically implemented governance structures. A fundamental and innovative methodological approach and the application of qualitative research methods delivered unique research results. Their approval contributes to the concrete successful implementation of the GTC concept in the transport and logistics science field. The accessibility of inter-modal freight transport solutions can be achieved by using the results of this current research. This will lead to a measurable increase in environmental and logistics performance attributes of the European transport network.

Additionally, the development of sustainable and environmentally friendly solutions for transportation and logistics will be the most crucial factor for developing the economy, especially in the dense logistics network of the European Union. This thesis provides hands-on results for private stakeholders as well as (trans-) national or regional governance institutions which might be ultimately responsible for the management of GTCs. Practical applicability of the research findings (e-service for transport permissions, KPI measurement on stakeholders, and efficiency effects of GTCs) were already approved during this research. Additionally, this thesis comprises directions for further investigations in future research projects which lay beyond the current thesis scope.

This thesis constitutes a review paper and six academic approved papers, each of them highlighting a research result in the CRQ.

PUBLICATION I: A literature review and new implemented comparative studies among leading research and development projects (EWTC II, TransBaltic, NECL, Rail Baltica Growth Corridor, Scandria, etc.) show the functionalities and frame conditions for the implementation of the GTC concept. Another aspect of innovative research in this paper is the elaboration of other factors for successful implementation of GTCs. This is the establishment of adequate transhipment facilities and cooperative business structures among the logistics players as they are quite crucial for the failure-free existence of such a network.

PUBLICATION II: A solution for the special cargo involvement was demonstrated by the implementation of the oversize transport strategy in the Baltic Sea Region which was developed by the author of this thesis. Practical efficiency solutions are demonstrated in the form of the ICT system, which was developed during this research and implemented in a pilot region.

PUBLICATION III: The author analysed the impact of green factors in transportation and provided an assessment of different transport modes in order to create a green transport network. The method applied showed route optimization by applying Short Sea Shipping into the network of the transport modes. With this theory for integrating Short Sea Shipping in GTC development, the routes were optimized and can be considered a part of the GTC as they demonstrate the green solution for transportation along defined routes.

PUBLICATION IV: One further impact assessment was made in the respect to the fact that investigations showed that the main portion of stakeholders in the GTC are privately run small business or single entrepreneurs. Therefore, the advantages and disadvantages for small business were demonstrated when these companies become part of such a described GTC. The result of this publication is a characteristics model of stakeholders in GTC.

PUBLICATION V: According to the management potential of a GTC the author of this thesis shows the typologies of the individual stakeholders of the GTC who represent the characteristics of such a network. This operation is evaluated by a management theory based on KPIs which are developed during project participation and are applied to the theoretical framework of stakeholder management. Additionally, the author sees the GTC concept as a construct where different stakeholders with different business strategies, objectives, values and business cultures attempt to cooperate in order to benefit from the joint agreement. Naturally, such cooperation can only be failure-free if all stakeholders are satisfied in their needs to an acceptable extent. If this is not the case, or the (transnational) business environment requires that some neutral institution take over the management role, an additional artificial management body would need to be created.

PUBLICATION VI: As the impact is not only on each single company but also on the economy of a nation or region, the question arises if there are measurable indicators for the efficiency of a GTC? Therefore, the advantages and disadvantages for small businesses were demonstrated when these companies become part of such a described logistics network.

The author of this research was able to answer the critical research question: “How can GTCs be conceptualised and managed?” by application and interpretation of the GTC concept in regard to existing scientific theories. The author of this thesis set the concept of GTCs in a theoretical framework and developed new theories for the development and management of GTCs. In the following the theoretical and practical contribution of this thesis are demonstrated.

Theoretical contribution of the thesis

The current research provides a theory for successful implementation of the GTC concept as functionalities and framework conditions for the successful operation of a GTC are identified. Increased accessibility and improved synchronization of logistics processes and better utilization of logistic resources will lead to better performance of the stakeholders in the GTC. These functionalities are supported by a required ICT system that enables harmonised information flow, equal access for every stakeholder, common quality standards and transparency to society. Previous research showed that application of intermodal route optimization in transnational logistics networks can demonstrate efficiency savings by Operations Research models. With this thesis the author demonstrates a value assessment model for integrated Short Sea Shipping and special cargo transportation (oversize transport) in transport structures and also demonstrates efficiency effects when implementing this model.

Another theoretical contribution is in the field of stakeholder management and governance modelling. Investigations of the GTC from the perspective of different stakeholders enabled the author of this thesis to characterize the properties of a GTC to find an appropriate governance structure in order to maximize the performance. Development and application of a monitoring theory for KPI oriented systems in order to be able to ensure the consistent and sustainable performance of all stakeholders in the GTC concluded the theoretical contributions.

Practical contribution of the thesis

The author of this thesis empirically tested the developed theories and models in various development projects. So, the developed new business and organizational models for successful cooperation in a GTC were approved. Practical case studies and focus group meetings with private entrepreneurs and companies identified bottlenecks and barriers in operation. A solution handbook summarized the development measures which need to be taken in order to remove these bottlenecks.

The research results of this thesis show success factors of transnational cooperation and efficiency effects when taking part in a GTC. The author of this thesis was able to assess the economic impact of GTCs for individual players and regional economy in the framework of the automotive industry.

Practicability of the research results is shown by the feedback on the results from private companies. Implementation workshops for private transport companies were conducted by the author of this thesis. The private companies and entrepreneurs were introduced to the e-service (Oversize Transport Information Network), which was co-developed by the author of this thesis. These workshops demonstrated potential efficiency gains and had good acceptance from private companies.

Limitations and further Research

The present thesis reveals that there are specific topics representing crucial factors for the development of GTCs. However, especially in the field of implementation of ICT applications, the existing ICT-systems of the running regional development projects do not support corresponding functionalities. The most important functionalities which are missing are related to contracting, finance, return logistics and logistics pricing (Info Broker, 2012; TransBaltic, 2012; Prause et al., 2010; Theofanis and Boile, 2009):

- All analysed ICT-tools support and focus on technical and organizational aspects of inter-modal transport planning but business and contracting related aspects of transportation have been neglected. One reason is that transport service providers give special business conditions for different clients and cargo, and they are not eager to be transparent with this information (Prause et al., 2010).
- Invoicing and payment services are hardly mentioned in the existing ICT-systems (TransBaltic, 2012).
- Return of logistics assets including containers and train platforms is not considered in existing ICT-systems, although big traffic is related to empty containers. A software module dealing with empty logistics assets may reduce the cost of containerized traffic and make transport greener (Wolf et al., 2012; Theofanis and Boile, 2009).
- All transport planning tools are based on transport tariffs stored in a database. However, freight rates are rather flexible being comparable to spot market prices in road transport or being subject to volume discounts in the case of railway and maritime carriers. Hence, the existing models in the ICT-systems are too rigid and simple to model the reality in a GTC environment (Info Broker, 2012; TransBaltic, 2012).

A special frame condition for ICT-systems in a GTC is set by the KPIs which up until now have been individually developed, and which are still part of the on-going research activities. In the future, one important task will be the integration of existing ICT-tools of the sustainable transport projects into one integral ICT-system with extended functionality, in order to be able to better utilize the available capacities and move efficiently towards efficient and sustainable logistics. The author of this thesis thinks that a further investigation of measurement methods like the Balanced Scorecard of Kaplan et al. (1992) would be beneficial future research to conduct.

Since an integral ICT-system for GTCs is still a topic of the future, it is recommendable to use an open architecture, which one is able to integrate and exchange information with pre-existing systems. Related to the issue of open architecture is the question of the definition and use of standards, since businesses using data standards like Global Standards 1 (GS1), Universal Business Language (UBL), United Nations Electronic Data Interchange For Administration, Commerce and Transport (EDIFACT) were not focused on the modelling of transportation processes, so the need for the development of standards regarding the description of logistics service, logistics nodes and other logistics objects still exists. The existing standardizations can offer solutions for regions or branches, but there is no appropriate general solution for general multi-modal transport sector until now.

When it comes to management and governance of a GTC the research does not provide a universal model for the monitoring of such a new construct. The given KPIs elaborated by the author of this thesis show valuable measurement of performance of operational and enabling factors, however, they do not reflect the sustainable development of a GTC. Further KPIs could be factors which can be measured by the age, gender, level of education, and experiences of the employees of the stakeholders in a GTC. Additionally it might be valuable to assess the impact of cultural dimensions and society aspects like level of innovation or risk perspective in the monitoring process of a GTC.

Future development of the GTC concept is set on the high level agenda of the European Commission. However, “past experience has shown that it is very difficult to implement cross border and other transport projects in different member states in a co-ordinated way. It is very easy, in fact, to create divergent systems and connections and create more bottlenecks” (EC 2014). Therefore a uniform approach with structured development is required and will be represented by so called “corridor platforms” (EC 2014).

Concluding, it can be stated that, this present thesis gives valuable contributions to the further development of the GTC concept by addressing its specific CRQ. The thesis provides a realistic concept for GTC development. It includes the integration of new transport business (Short Sea Shipping and oversize transports) and provides a management model for steering different stakeholders according to their characteristics. Practical approval demonstrates that the implementation can lead to efficiency increase of overall performance in transport business. On the other hand, there are still challenges left, which are to be discussed and addressed by future research initiatives.

REFERENCES

Auramo, J.; Kauremaa, J.; Tanskanen, K. (2005). Benefits of IT in supply chain management – an explorative study of progressive companies, *International Journal of Physical Distribution and Logistics Management* 35(2): 82–100.

Blair, M. (1996). Ownership and Control. Washington: Brookings Institution.

Blair, M. M., & Stout, L. A. (1999). A Team Production Theory of Corporate Law. *Virginia Law Review*, Vol. 85, No. 2, 248-328

Bontekoning, Y.; Macharis, C.; Trip, J. (2004). Is a new applied transport research field emerging? – A review of intermodal rail-truck freight transport literature, *Transportation Research Part A* 38, 1-34

Bontekoning Y., Priemus H. (2004). Breakthrough innovations in intermodal freight transport. *Transport Planning and Technology* 27 (5), 335-345

Bovel, D., & Martha, J. (2000). From Supply Chain to Value Net. *The Journal of Business Strategy*, 21(4), 24–28.

Callaway, D. S., Newman, M. E. J., Strogatz, S. H., & Watts, D. J. (2000). Network Robustness and Fragility: Percolation on Random Graphs. *Physical Review Letters*, 85 (25), 5468–5471.

Campell, A. (1997). Stakeholders: The Case in Favour. *Long Range Planning*, 30 (3), 446–449.

Caris, A., Macharis, C., Janssens, G.K., (2012). Corridor network design in hinterland transportation systems. *Flexible Services and Manufacturing Journal* 24 (3), 294-319.

Clandinin D. J., Connelly F. M. (2004). Narrative Inquiry: Experience and Story in Qualitative Research. Jossey-Bass; 1 edition (2004)

Clarkson, M. B. E. (1995). A Stakeholder Framework for Analyzing and Evaluating Corporate Social Performance. *Academy of Management Review*, 20 (1), 92–117.

Clausen, U.; Geiger, C.; Behmer, C. (2012). Green corridors by means of ICT applications. *Procedia - Social and Behavioral Sciences* 48, 1877 – 1886

Coase, R. H. (1960). The Problem of Social Cost. *Journal of Law and Economics*, 3, 1–44.

Cohen, R., Erez, K., Ben-Avraham, D., & Havlin, S. (2000). Resilience of the Internet to Random Breakdowns. *Physical Review Letters*, 85 (21), 4626–4628.

COM (2001). White Paper: European transport policy for 2010: time to decide. *Commission of the European Communities*. Brussels

COM (2011). Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. *Commission of European Communities*. Brussels

Creswell, J. W. (2003). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications, 2003

Creswell, J.W. (2012). Educational research: Planning, conducting, and evaluating quantitative and qualitative research. Upper Saddle River, NJ: Prentice Hall.

Daduna, J.; Hunke, K.; Prause, G. (2012). Analysis of Short Sea Shipping-Based Logistics Corridors in the Baltic Sea Region, *Journal of Shipping and Ocean Engineering*, Vol. 2, No. 5, 304-319

Donaldson, T., & Preston, L. (1995). The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications. *Academy of Management Review*, 20 (1), 65–91.

EC (2014). Press release "New EU transport infrastructure policy – background". European Commission, 11.09.2014 available under: http://europa.eu/rapid/press-release_MEMO-14-525_en.htm (15.10.2014)

EWTC II Green Corridor Manual (2012). Green Corridor Manual – Task 3B of the EWTC II project. Region Blekinge

FTLAP (2007). Communication from the Commission: Freight Transport Logistics Action Plan. *Commission of European Communities*. Brussels

Freeman, R. E. (1984). Strategic management: A stakeholder approach. Boston: Pitman.

Gekara, V., Chhetri, P., (2013). Upstream transport corridor inefficiencies and the implications for port performance: a case analysis of Mombasa Port and the Northern Corridor. *Maritime Policy and Management* 40 (6) 559

Grossman, S. J., & Hart, O. D. (1986). The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. *Journal of Political Economy*, 94 (4), 691–719.

Hansmann, H. (1996). The Ownership of Enterprise. Cambridge, MA: *Harvard University Press.*

Hart, O. (1995). Firms, Contracts and Financial Structure. London*: Oxford University Press*.

Hervani A.A., M.M. Helms, J. Sarkis (2005). Performance measurement for green supply chain management. *Benchmarking: An International Journal,* 12 (4), 330–353

Hunke, K. (2012). Transnational e-services for efficient oversize logistics. Prause, G.; Venesaar, U.; Kersten, W. (Eds.) (2013). *International Business - Baltic Business Development*, Tallinn 2013. Peter Lang Verlag

Hunke, K., Prause, G. (2012). Hub Development along Green Transport Corridors in Baltic Sea Region. In T. Blecker, W. Kersten, & C. M. Ringle (Eds.), *Pioneering Supply Chain Design - A comprehensive Insight into emerging Trends, Technologies and Applications,* Lohmar-Köln: Josef-Eul-Verlag. 265-282

Info Broker (2012). A key to efficient performance with as small ecological footprint as possible. *EWTC II*, Net.Port Karlshamn

Kaplan, R., Norten, D. (1992). The Balanced Scorecard – Measures that drive performance. *Harvard Business Review* Nr. 92105, January-February 1992

Kay, J. (1996). The Business of Economics is Business. London: *Oxford University Press*.

Ketikidis, K.; Koh, S.; Dimitriadis, N.; Gunasekaran, A.; Kehajova, M. (2008). The use of information systems for logistics and supply chain management in South East Europe: Current status and future direction. *Omega-International Journal of Management Science* 36(4): 592–599.

Kranke, A., Schmied, M., Schön, D.A. (2011): CO_2-Berechnung in der Logistik - Datenquellen, Formeln, Standards. (Vogel) München

Lee, P. D. (2005). Measuring Supply Chain Integration: A Social Network Approach. *Supply Chain Forum: An International Journal* 6 (2), 58–67.

Liedtke, G., Friedrich, H., (2012). Generation of logistics networks in freight transportation models. *Transportation* 39 (6), 1335-1351

Lortz, A. / Rausch, A. / Rogge, D. / Spahl, T. (2010): CO_2-Bilanzierung zur Gestaltung klimafreundlicher Transportketten bei BASF. in: Schönberger, R. / Elbert, R. (Hrsg.): *Dimensionen der Logistik - Funktionen, Institutionen und Handlungsebenen.* (Gabler) Wiesbaden, 211–243

Meyer, J. W., & Rowan, B. (1977). Institutionalised Organizations: Formal Structure as Myth and Ceremony. *American Journal of Sociology*, 83 (2), 340–363.

Murphy, P.R., Poist, R.F., Braunschweig, C.D., (1994). Management of environmental issues in logistics: Current status and future potential. *Transportation Journal* 34 (1), 48

Neville, B. A., & Menguc, B. (2006). Stakeholder Multiplicity: Toward an Understanding of the Interactions between Stakeholders. *Journal of Business Ethics*, 66 (4), 377–391.

Oliver, C. (1991). Strategic Responses to Institutional Processes. *Academy of Management Review*, 16 (1), 405–425.

Pfeffer, J., & Salancik, G. R. (1978). The External Control of Organizations: A Resource Dependence Perspective. New York: Harper and Row.

Prause, G. (2010)a. SME in Service Cluster - A regional Study, in: Kramer, J.; Prause, G.; Sepp, J. (Eds.) *Baltic Business and Socio-Economic Development 2007: 3rd International Conference,* Tallinn, Estonia, June 17-19, 2007. Berlin: Berliner Wissenschafts-Verlag, 349–360.

Prause, G. (2010)b. Logistics-related Entrepreneurship and Regional Development - An empiric Study, in: Kramer, J..; Prause, G.; Sepp, J. (Eds.). *Baltic Business and Socio-Economic Development 2007: 3rd International Conference,* Tallinn, Estonia, June 17-19, 2007. Berlin: Berliner Wissenschafts-Verlag, 329–348

Prause, G.; Hunke, K. (2014). Sustainable Entrepreneurship along green corridors. *Journal of Entrepreneurship and Sustainability Issues*, 1 (3), 124 - 133.

Prause, G.; Kron, E.; Beifert, A. (2010). Final ICT Report of the project “Innovation Network – Logistics Cluster Wismar Seaport”, Wismar

Robson, C. (1993). Real-world research: A resource for social scientists and practitioner – researchers. Malden: Blackwell Publishing.

Rowley, T. J. (1997). Moving Beyond Dyadic Ties: A Network Theory of Stakeholder Influences. *Academy of Management Journal*, 22 (4), 887–910.

Roy, J., Nollet, J., & Beaulieu, M. (2006). Reverse Logistics Network and Governance Structures. *Supply Chain Forum: An International Journal*, 7 (2), 58–67.

Sarkis, J. (2001): Introduction. Greener Management International 35 (3), 21-25

Simchi-Levi, D.; Kaminsky, P.; Simchi-Levi, E. 2003. Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies. *McGraw-Hill*, New York.

Spurgin, E. W. (2001). Do Shareholders Have Obligations to Stakeholders? *Journal of Business Ethics*, 33, 287–297.

Srivastava, S.K., (2007). Green supply-chain management: a state- of- the- art literature review. *International Journal of Management Review*, 9 (1), 53–80

Stake, R. E. (1995). The Art of Case Study Research. SAGE Publications, 1995

Theofanis, S.; Boile, M. (2009). Empty marine container logistics facts, issues and management strategies, *Geojournal*, Vol. 74, No. 1, 51-65

TransBaltic (2012). Review of the ICT tools supporting green logistics developed in the INTERREG transport projects. Poznan

Vurro, C., Russo, A., & Perrini, F. (2009). Shaping Sustainable Value Chains: Network Determinants of Supply Chain Governance Models. *Journal of Business Ethics*, 90 (4), 607-621.

Wahl, M.; Hunke, K.; Prause, G. (2013). Stakeholder Typologies in Green Transport Corridor Governance. Kersten, W.; Blecker, T.; Ringle, C. (Eds.). *Sustainability and Collaboration in Supply Chain Management: A Comprehensive Insight into Current Management Approach* (143 - 162). Köln: Joseph Eul Verlag

Wathne, K. H.; Heide, J. B. (2004). Relationship Governance in a Supply Chain Network. *Journal of Marketing*, 68 (1), 73–89.

Wheeler, D.; Sillanpää, M. (1998). Including the Stakeholders: the Business Case. *Long Range Planning* 31 (2), 201–210.

Wölfl, A.; Ragnitz, J. (2001). Netzwerkaktivitäten und Produktivitätslücke Ostdeutschlands, *Wirtschaft im Wandel* 13: 315–319.

Wolf, J.; Herz, N.; Fläming, H. (2012). Empty Container Logistics: Hamburg-Baltic Sea Region, *TransBaltic Report of Work Package 5.2*, Hamburg University of Technology

Wolfe, R. A., & Putler, D. S. (2002). How Tight Are the Ties That Bind Stakeholder Groups? *Organization Science*, 13 (1), 64–80.

Woxenius, J. (1998). Development of Small-Scale Intermodal Freight Transportation in A System Context. *Report 34; Department of Transportation and Logistic*s, Göteborg, Sweden. ISBN: 91-7197-630-2

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SECURE AND SUSTAINABLE SUPPLY CHAIN MANAGEMENT: INTEGRATED ICT-SYSTEMS FOR GREEN TRANSPORT CORRIDORS

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Abstract. In the EU White Paper on Transport 2011 the emphasis was laid on green transport corridors, i.e. transhipment routes with concentration of freight traffic between major hubs and by relatively long distances of transport marked by reduced environmental and climate impact while increasing safety and efficiency with application of sustainable logistics solutions. Green transport is based on inter-modality and advanced ICT-systems improving traffic management, increase efficiency and better integrate the logistics components of a corridor. Until today only the first steps have been realised in the implementation of green corridor concepts, so that concrete requirements and frame conditions for ICT-systems of green corridors are described on conceptual basis. Baltic Sea Region (BSR) enjoys a vanguard position in the development and realisation of green transport concepts in Europe and some research projects delivered already the first results for the requirements of ICT-systems supporting green transport corridors. Of special importance is the EU initiative "East-West Transport Corridor (EWTC II)" since for the first time a green corridor manual has been presented formulating recommendations and requirements of green transport corridors to European level. The authors took part in some important green transport corridor initiatives around the Baltic Sea, including EWTC project, and were involved in related research activities. This paper aims at pointing out the current status and the future direction of ICT-systems for green transport corridors, especially under the viewpoint of secure and sustainable green corridor management.

Keywords: sustainable supply chain management, green transport corridors, ICT- systems, secure inter-modal logistics

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1. Introduction

Despite recent economic turbulences the growth rates of economies and exporting economic sectors (e.g. Dudzevičiūtė 2013; Tvaronavičienė 2014) further increase of trade volumes is expected to continue in the future increasing the demands in the performance of logistics networks (Prause, Hunke 2014; Tvaronavičienė *et al.* 2013, Vasiliūnaitė 2014). The current estimations for Europe are predicting a 50% increase in passenger and freight transport within the next 20 years (Tetraplan 2009). The European Commission reacted on the development by presenting the White Paper on Transport 2011 setting the political framework for an EU Transport Policy Development in order to build for the next decades a competitive European transport system that will increase mobility and employment, remove major barriers in key areas and reduce fuel consumption. The emphasis in this approach is laid on green transport corridors, i.e. European transhipment route with concentration of freight traffic between major hubs and by relatively long distances of transport marked by reduced environmental and climate impact while increasing safety and efficiency with application of sustainable logistics solutions, inter-modality, ICT-infrastructure, common and open legal regulations and strategically placed transhipment nodes (COM 2011).

So in a couple of international initiatives, concepts for green transportation corridors have been developed, partly implemented and tested in order to find a more practical approach to the issue. The Baltic Sea Region (BSR) is an important arena for sustainable transport projects since in several logistics projects on European and regional level aspects of green transportation have been studied in order to design more efficient and safe processes for multi-modal transport (BSR Transportcluster 2012). All these projects highlight the efficient use of the available transport infrastructure, inter-modality and high-performance ICT-solutions together with intelligent transport systems (ITS) as main pillars for green corridors.

The results of the most important green transport projects in BSR lead to clear requirements and a list of needed functionalities which have to be provided by ICT-systems for the management of green corridor performance. The paper will give an overview over existing ICT-solutions for the major green corridor projects in the BSR, whereas an inside view will be given for the East-West Transport Corridor project (EWTC II) implementing an inter-modal green transport corridor between the South Baltic Sea and the Black Sea Region.

The last part of the paper will be dedicated to a comparative analysis of ICT-systems for the most important green corridor projects in the BSR including Scandria, TransBaltic and North East Cargo Link II. The conclusion part will highlight common functionalities and features of the current ICT-systems as well as missing areas, which have to be filled in the future. Finally, the question of requirements for a future integrated green corridor ICT-system will be discussed.

2. Methodology

Since the appearance of the first Transport White Paper (COM (2001) 370 final) of the European Commission (EC) in 2001 the necessity of shifting volumes of the dominant road traffic to other efficient transport modes is being expressed constantly. The goal was linked to the preparation of an environmental-friendly transport sector, and at the same time to provide securer and efficient transportation by reducing accidents, congestions and negative impacts through emissions, i.e. noise and pollution. After the revision of the EU Transport White paper (COM (2006) 314 final) in 2006, the concept of green corridors was introduced in the Freight Transport Logistics Action Plan (FTLAP 2007).

Since the EU enlargement in 2004 several initiatives were launched in BSR aiming at improving sustainable transportation in European Union. The first inside view in the logistics and ICT situation in BSR was given by the Interreg III project "LogOn Baltic – Developing Regions through Spatial Planning and Logistics & ICT Competence" during the years 2006 and 2007. The empirical activities of LogOn Baltic included a logistics survey, an ICT-survey and expert interviews, which were conducted in the project regions with a total of more than 1,200 participating companies (LogOn Baltic 2008; Kersten *et al.* 2007; Kron and Prause 2008).

Between 2008 and 2013 in a larger number of national and international projects about inter-modal and green transport concepts were developed and tested in BSR. Important initiatives like Green Corridor of the Swedish Logistics Forum, East-West Transport Corridor, TransBaltic or SuperGreen had different objectives but their results were based on expert interviews, surveys and case studies. Since the authors were involved in the empiric studies of some BSR projects or had access to relevant project results the methodology of the paper includes a literature review and analysis of theoretical material in the context of transport corridors and ICT application. Expert interviews and survey results which cover the whole BSR are tools for investigating the practical application of developed ICT systems. Furthermore, the paper uses a comparable analysis of the research outputs of relevant BSR projects to achieve research-based requirements for green corridor ICT-systems.

3. Conceptual background

In order to understand what a transport corridor means by theoretical backgrounds it can be helpful to see the corridor as a conglomeration of different stakeholders which act along a defined geographical area in order to achieve different goals but with the same objective to reduce costs, increase efficiency, minimize environmental impact and create safe and sustainable logistics solutions. Realization of the increasing complexity of the interactions among acting organisations along their supply chains suggest that a network perspective may better explain the emergence of collaborative practices and integrative behaviours in logistics in general and supply chain management from organisation's point of view. Furthermore studies acknowledge the importance of a network structure for the effective diffusion of supply chain-related practices (Roy *et al.* 2006) and for the efficiency and the flexibility of responses of the supply chain to customer expectations (Wathne, Heide 2004). As the stakeholders act in a coherent sense and are located in a certain geographical area such a transport corridor can be described as a tubular service cluster. For the example for the EWTC green corridor, linking in its kernel Sweden, Lithuania, Belarus and Ukraine, the tubular cluster has the following shape (Figure 1).

Fig.1. Green transport corridor as a tubular service cluster

Source: authors

Figure 1 highlights already a couple of interesting questions arising with green corridors. First topic is related to intercultural issues since different business cultures, different business models and different legal systems have to be harmonized. Another important issue is related to governance of green corridors since the heterogeneous set of stakeholders together with their own interests and agendas have to be unified in order to run and develop the whole green corridor.

Arising from the social network theory a transport corridor can be seen as a scale-free network, starting from dyadic relationships between two stakeholders and growing to a broader network. The behaviour of organisations in such systems as well as the impact on them has been studied and explained in resource dependence theory by Pfeffer and Salancik (1978) and by Meyer and Rowan (1977) in new institutionalism theory. Specific characteristics of scale-free networks vary with the theories and analytical tools used to create them, however, in general, scale-free networks have some common characteristics. One notable characteristic is the relative high number of nodes with relations to other nodes which greatly exceeds the average. The nodes with most of the relations are called "hubs", and may serve specific purposes in their networks. It turns out that the major hubs are closely followed by smaller ones. These ones, in turn, are followed by other nodes with an even smaller number of degrees and so on. This hierarchy allows for a fault tolerant behaviour. If failures occur at random which, in the case of transport corridors, means the drop out of a stakeholder and the vast majority of nodes are those with small degree, the likelihood that a hub would be affected is almost negligible. Even if a hub-failure occurs, the network will generally not lose its connectedness, due to the remaining hubs. On the other hand, if a few major hubs are taken out of the network, the network is turned into a set of rather isolated graphs. Thus, hubs are both strength and weakness of scale-free networks. These properties have been studied analytically using percolation theory by Cohen *et al.* (2000) and by Callaway *et al.* (2000).

Rowley (1997) applied such a social network perspective to the stakeholder theory of the firm. Accordingly, research has started to address systems of dyadic interactions and stakeholder multiplicity, which can be also of importance for the understanding of a transport corridor concept. Opportunities for organizational resistance or adaptations to stakeholder expectations (Neville, Menguc 2006; Oliver 1991; Wolfe, Putler 2002) can be investigated. Vurro *et al.* (2009) investigated the predictors for stakeholder networks for value chains and identified two structural features of such stakeholder networks: Firstly, network density, defined as the degree of completeness of the ties between the actors in a network, has been identified as a likely determinant of corporate responsiveness in that it affects the ease of communication and efficiency of information flow across actors in the network. The second predictor, the degree of centrality in the network, that is, the extent to which an organization occupies a central position in the network, has been suggested as a further influence on the attentiveness of companies to stakeholder concerns and their willingness to accommodate their requests (Rowley 1997). When seeing the green corridor as network of supply chains with the participation of various stakeholders it is necessary to understand how these stakeholders can communicate and cooperate. As the focus of this paper is laid on the role of ICT in these networks the theoretical background is given.

A literature review reveals an abundance of existing articles about the role of ICT in logistics and supply chain management covering a wide range of issues including enterprise resource planning (ERP), e-business as well as new technologies and other information systems for improving the supply chain management (Auramo *et al.* 2005; Ketikidis *et al.* 2008). By following the argumentation of Auramo *et al.* (2005) the commonly viewed functional roles of ICT in supply chain management can be classified into three categories:

- Transaction execution
- Collaboration and coordination
- Decision support.

A more concrete interpretation of the benefits of ICT in supply chain management has been formulated by Cross (2000) and Simchi-Levi *et al.* (2003):

- Reducing friction in transaction through cost-effective information flow
- Providing information, availability and visibility
- Enabling single point of contact for data

Empiric studies on ICT in supply chain management confirmed that the theoretical results described in the literature are in line with the perception of supply chain managers in companies since the involved practitioners stressed accordingly as the main benefits of ICT use in supply chain management (Grieger 2004; Auramo *et al.* 2005; Ketikidis *et al.* 2008):

- Improvement of information quality and quantity
- Improvement in operational efficiency
- Costs saving
- Reduction of lead time
- Enhancement of service level
- Higher flexibility.

Additionally it has to be emphasised the big differences between small and medium-sized enterprises (SMEs) and larger companies in ICT use in logistics and supply chain management due to large price differences among the existing information systems (Ketikidis *et al.* 2008). Consequently not every enterprise can afford sophisticated ERP or supply chain management systems making it complicated to integrate ICT-systems of the SME sector into supply chain management solutions.

The research results and corresponding literature is significantly reduced when it comes to ICT related topics in the context of inter-modality and even more limited in the context of the specific role of ICT in green corridors since these topics are part of on-going research activities (Bontekoning *et al.* 2004; Clausen *et al.* 2012). Since multi-modal transport corridors are built of networks of logistics companies and other corridor components their management depends on powerful ICT-systems (Daduna *et al.* 2012). Sander and Premus (2002) stressed the function of information in supply chain management referring to the glue that hold the collaborating business structures in the supply chain together whereas Evangelista (2002) stated that the role of ICT in supply chain management can be described as key integration element.

OSullivan and Patel (2004) pointed out that a lack of integration within and across different transport modes generate additional costs for the users so that Gustafsson (2008) proposed in order to make intermodal transport as attractive as road based transport the integration between traffic and transport management is necessary. Oh (2011) was able to show that a modal-shift including supporting ICT-systems is a powerful measure towards green transportation since a reduction of 15% of greenhouse emissions can be achieved. But beside these special results the specific role and needed functionalities of ICT-systems in the context of green corridors is still part of recent research activities so that only a few number of publications exist (Clausen *et al.* 2012).

4. Network structures and ICT-systems

According to the Freight Transport Logistics Action Plan green corridors reflect an "integrated transport concept where short sea shipping, rail, inland waterways and road complement each other to enable the choice of environmentally friendly transport" stressing the multi-modal and green aspects (FTLAP 2007). In order to speed up the realisation of green corridor concepts in Europe in recent years an increasing number of initiatives have been started on national and transnational level to support the shift towards greener and more efficient logistic solutions. Main initiatives are East-West-Transport-Corridor (EWTC II), TransBaltic, Scandria and North-East-Cargo-Link (NECL II).

By taking into account the results of these initiatives the current situation shows that the main characteristics of a green corridor and conditions that make a transport corridor actually green are varying but it is already visible that there are also common topics, which are recognised by all green corridor initiatives (Hunke, Prause 2012). Firstly, it is inter-modality, which enables the choice of environmental-friendly transport along the transport route, since reduced emissions is one of the obvious objectives of a greener transportation. Other important factors for green transport are adequate transhipment facilities, innovative transport units and vehicles, and advanced ITS-applications, which can be considered as requirements for green corridors, since the customers who chose to use a transport corridor expect not only environmental-friendly transport but would like to benefit from economic advantages and cost and time savings as well.

Therefore, economies of scale with bundled cargo together with high load factors are other factors for a green corridor, offered together with reliable time tables and adapted schedules for trains, ferries and other line traffic (Notteboom 2008; Daduna *et al.* 2012). The definition of the Commission covers also the fair and non-discriminatory access to corridors and transhipment facilities that make it possible for every customer to participate in the corridor and use the public available benefits. One approach to achieve these requirements for the implementation of green transport corridors is the development and establishment of an ICT-system.

4.1. Frame requirements for ICT-systems

The use of ICT-systems in the logistic networks depends heavily on the acceptance of the stakeholders. The technology acceptance model postulated by Davis *et al.* (1989) describes that the degree of user acceptance of technology has a positive effect on the usage of technology, which in turn also affects the performance of the network. According to DeLone and McLean (1992), the patterns and frequency of ICT-use are influential factors of individual impact such as quality, productivity and performance. Transferred from organizational theory the study of Igbaria and Tan (1997) of 625 employees in a large organization shows that user satisfaction on individual performance was actually related to ICT-use, therefore suggesting the ICT-use variable as an indicator of performance.

Vice versa, already the results of the research project LogOn Baltic project revealed huge differences in the logistics competences around the BSR, which are still valid until recent times (LPI 2012). As a result of the comparison of regions with different levels of competence, the LogOn Baltic has brought to light that the BSR regions with higher logistics competence enjoyed a higher degree of ICT-use in logistics as well as a significant higher level of outsourced logistics ICT-services linked to an advanced level of sophistication of used logistics ICT-systems. Another important observation was that the focus in outsourcing of logistics ICT-solutions was laid on closed and company oriented systems (Kron, Prause 2008). Expert interviews revealed that the landscape of inter-company logistics ICT-systems is dominated by larger production companies and logistics service providers to safeguard the control of their individual supply chains and to realise dedicated platforms for sourcing of transport services mainly from regional SMEs (Prause *et al.* 2010).

The requirement for openness and harmonisation applies also to supporting ICT-systems of green corridors which is in line with the results about multimodal transport systems. The set targets are in conflict with the still dominating situation in BSR which can be characterised by a rather closed and dedicated ICT-landscape in logistics (OSullivan, Patel 2004; Gustafsson 2008; Kron, Prause 2008; Prause *et al.* 2010).

4.2. Functional range of ICT-systems

A way to increase effectiveness and to decrease cost of the business' activities in the supply chain is the optimization of activities in the supply chain on a cross company level within a network. While many existing IT-solutions offer effective means of managing business processes within companies, a cross-company management of the business processes requires different stakeholder's cooperation. An e-platform is a solution to facilitate such collaboration. "A digital information exchange is a key to facilitating transports, improving transport system efficiency, and reducing negative impacts on the environment because it allows corridor actors to plan better and react quicker and more appropriately" (EWTC 2012). The ideal e-platform is a virtual environment that facilitates business activities of logistic service providers and customers needing shipment. Integration of supply chain processes and companies increases the per-

formance and security of supply chain management. Key benefits, resulting from integration provided by an e-platform are:
- take advantage of new supply and distribution channels,
- reduce cost of distribution system,
- exchange knowledge via open partner systems,
- increase quality and range of added value services.
- shorten supply chain through elimination of intermediary companies,
- gain quick access to vast knowledge on companies and goods (data mining),
- simplify and reduce time of ordering and distribution,
- enable customers to track orders,
- expand activity area to global market (Baltic. AirCargo.Net 2012).

Geographical information plays also an important role for many business activity decisions. GIS service provides input to decision supporting tools and visual feedback to gain a better insight by tying geographical location information with relevant aspects of business activities. Spatial data and information about terrestrial transport modes are required so that the customer can view details of chosen infrastructure element. Visualization should include the position of all the relevant objects to supply chain management: goods, routes, facilities (warehouses, distribution centres, ports, rail stations etc.) and companies (e.g. material handling, customs, etc.). An e-platform provides opportunities to get valuable information for business intelligence. Gathered standardized statistical information on transactions is an input that allows performing various marketing analyses, developing business strategies and more accurately estimating demand for services traded on the platform. Implementation of semantic web technology will further increase analytical capabilities.

Platform usages itself provide wide range of information on demand, customers interest in available services, desired transport routes, destinations etc. Actual demand for a given service is more accurate information than interview results. This information is valuable for service providers planning their business and can be easily obtained by platform operator. (Baltic.AirCargo.Net 2012)

5. Application in practice

The EWTC II project plays in several senses a specific role among all green corridor projects in BSR since it aims to improve East-West trade routes between the Baltic Sea and the Black Sea Region by enhancing interoperability between different infrastructures, standards and systems, as well as removal of physical and operational bottlenecks, especially on the EU borders. But also on EU transport policy level EWTC II project has a vanguard position since for the first time a green corridor manual has been developed which will be used as a blue print for all future green transport initiatives and which has been forwarded to EU political level.

Special attention in the project was paid to co-modality, especially to rail transport including European and Russian gauge size together with short sea shipping in this corridor. The backbone of the project consists of the container train Viking, which shuttles between Klaipeda and Illichevsk via Minsk and Kiev. The Viking train is linked to Karlshamn in South Sweden by a ferry line and from Illichevsk via short sea shipping routes to destinations in the Black Sea. Due to these extensions, the EWTC II can be considered as a part of the Transport Corridor Europe-Caucasus-Asia (TRACECA) being able to attract new freight flows from Central Asia and China to Europe (Kusch *et al.* 2011).

The development of the ICT-system for the East-West Transport Corridor was influenced on theoretical considerations of Gustafsson (2008) and the results of "Green Corridor" initiative of the Swedish Logistics Forum (EWTC II 2012). Since the existing proposals were not practical enough to meet the needs of the East-West Transport Corridor, a special task 3C in the EWTC II was initiated for the development of a fitting ICT-system. On the base of expert interviews and surveys it was possible to specify 15 criterions for the ICT/ITS of the EWTC II, which have to be fulfilled in order to facilitate secure and sustainable transport, improve transport system efficiency, and reduce the negative impact of transports on the environment (Info Broker 2012):
1. Increase load factors from currently 30-50% to above 50% (EEA 2010; Notteboom 2008).
2. Usage of digital waybills will increase inter-modal transport efficiency.
3. Intelligent truck parking systems increase corridor efficiency by reducing up to 1h per driver and day for seeking safe parking areas (EWTC II 2012).
4. Better information at transfer nodes of the corridor by terminal service providers reduces waiting

times.
5. Up-to-date traffic information within the supply chain allows drivers and other operators to choose alternative routes.
6. Automatic Identification System data (AIS) about ship locations and estimated time of arrivals allow better resource management.
7. Access to up-to-date local weather data allows carriers to re-route or re-schedule transports.
8. Better matching of broadcasted transport information with the needs of logistics actors.
9. Standardisation and harmonisation of ICT-system interfaces and electronic documents for e-Freight enables more efficient multi-modal transports.
10. Easing of small cargo shipments by rail and sea in order to increase inter-modal operations related to rail and maritime transport since cur-rently small shipments are dominated by road transport causing big carbon foot-prints.
11. Reduce idle costs by sharing of transport units, since too many low-rated and utilized transport units are scattered around ports, terminals and transfer nodes.
12. More efficient management of transnational oversized cargo transports by facilitating time-con-suming entry processes and reduction of related bureaucracy.
13. Intelligent Port Access Control by using open integrated ICT-systems for pre-registration according to the EU security and terrorist regulations as well as transnational transports for reduction of delays at the port gates.
14. Implementation of data exchange between major transport hubs in the corridor will increase transport efficiency.
15. Improved cargo tracking would facilitate resource planning for consignors, consignees and transport operators.

These 15 requirements set the frame for the development of the ICT-system of EWCT II corridor in order to facilitate the surface transport sector by offering simple means to reduce costs and problems associated with accessing and exchanging relevant information by stressing the specific needs related to secure inter-modality and sustainability. The transport and traffic information components shall safeguard high efficiency, increase safety and reduce the environmental impact on green corridors by sharing information among the actors of the inter-modal transport process including briefings about current situation of traffic, weather, cargo position and port access in the corridor. The emphasis of the parking information system was motivated to ensure high levels of security and quality and enhanced seamless traffic flows.

The contribution of the ICT-solution to the realisation of a green corridor concept can be assessed by Key Performance Indicators (KPI) being developed in order to benchmark considered green corridors (Clausen *et al.* 2012). The KPIs of the EWTC II green corridor concept, used the KPI system of the Super-Green (2010) project as a starting point, but their scope was enlarged by stressing social and economic aspects of the sustainability of the corridor (EWTC II 2012). As a result, the sustainable performance of the developed ICT-tool can be easily benchmarked when using these key performance indicators.

Furthermore, the TransBaltic project with its ICT-system "Logit 4SEE™" is another practical application. The ICT-system can be characterised as an ICT-tool for planning inter-modal chains giving the transport users the possibility to select the best alternative for door-to-door transports by delivering cost and time calculations to be able to find the optimal modal mix. "Logit 4SEE™" represents a multi-modal transport planning and monitoring system that allows a transparent supply chain management on the base of a web based application (TransBaltic 2012). Specific functionalities of "Logit 4SEE™" are:

- Description and registration of logistics offers of logistics service providers in the ICT-system including time schedules or duration of their transport services.
- Providing transport requests from registered customers for transport and logistics services containing transport instructions.
- Transport planning system calculating transit time, costs or CO_2 emission.
- Transport execution and monitoring of cargo along the transport chain including all kinds of cargo status information.
- Support of electronic inter-operability between actors involved in multi-modal transport chains using UBL standards for electronic documents in transport.
- Loads consolidation system from different transport orders going in the same direction for partial or whole transport chain.

The Scandria ICT-system can be regarded as an optimised version of the EcoTransIT tool for the Baltic Sea ferry transport inside the Scandria corridor. The Scandria ICT-system is a web-based online tool for inter-modal route planning, infrastructure information and for evaluating changes of inter-modal freight nodes and networks with a geographical focus on the area between the Adriatic Sea and Baltic Sea including road, rail, inland waterway, short sea shipping, and ferry networks. The main functionalities, covered by the Scandria ICT-system are (Scandria 2012):

- Inter-modal routing system offering alternative routes between inter-modal terminals.
- ICT-tool offering the usage of fixed relations in the routing process by taking under account already used inter-modal transport services by a transport operator and by offering different options for transport modes for routes in graphical form.
- Accessibility analysis tool analysing and optimising the accessibility of inter-modal terminals according to time, distance, energy consumption or costs.
- Terminal information tool providing information about terminal infrastructure, services and organisation.
- Scenario tool allowing the creation and comparison of different scenarios depending on the network and terminal parameters.

The NECL II system can be characterised as a logistic ICT-solution for transport matching. For the development of the ICT-tool, a full work package 5 of NECL II was dedicated in order to realise a fully operating transport matching system with a focus on the decrease of existing volumes of empty or partially loaded transports. The functionality of the NECL II system is laid on (NECL II 2012):

- Choice between alternative transport routes.
- Comparison of alternative transport routes.
- Possibility to optimise routes by cost, time, CO_2 emission
- Multi-criteria optimisation of transport routes.

6. Results of practical realization

It should be recalled that all considered green corridor projects accept the already discussed definitions and requirements of European Union about green transport corridors as well as the results of the "Green Corridor" initiative of Swedish Logistics Forum. All in all, by taking into account all discussed features of ICT-systems of the main green corridor projects in the BSR together with Northern understanding of a green transport corridor, it can be concluded that an appropriate ICT-system for the support of green corridors should facilitate the following functionalities:

- Routes planning
- Open architecture
- Standardisation of interfaces
- Electronic data interchange
- Transport optimisation
- Real time data information systems
- Inter-modal route planning
- Loads bundling and consolidation
- Cost calculation
- CO_2 emissions calculation
- Purchase of transport services
- Transport monitoring.

Additionally, the comparable analysis reveals that there are specific topics representing crucial factors for the development of green transport corridors but the existing ICT-systems of the BSR green corridor projects are not supporting corresponding functionalities. The most important missing functionalities are related to contracting, finance, return logistics and logistics pricing (Info Broker 2012; TransBaltic 2012; Prause *et al.* 2010; Theofanis, Boile 2009):

- All analysed green corridor ICT-tools support and focus on technical and organisational aspects of inter-modal transport planning but business and contracting related aspects of transportation have been neglected. One reason is that transport service providers give special business conditions for different clients and cargo, and they are not eager to be transparent with this information (Prause *et al.* 2010).
- Invoicing and payment services are hardly mentioned in the existing ICT-systems (TransBaltic 2012).
- Return of logistics assets including containers and train platforms is not considered in existing ICT-systems although big traffic is related to empty containers. A software module dealing with empty logistics assets may reduce the cost of containerised traffic and make transport greener (Wolf *et al.* 2012; Theofanis, Boile 2009).
- All transport planning tools are based on transport tariffs stored in a database. But freight rates are rather flexible being comparable to spot market prices in road transport or being subject to volume discounts in case of railway and maritime carriers. Hence, the existing models in the ICT-systems are too rigid and simple to model the reality in green transportation (Info Broker 2012; TransBaltic 2012).

Since the development of green corridor together with their ICT-systems is still on-going inside and outside BSR it will be only a question of time until these missing functionalities will be tackled in upcoming green corridor projects. A special frame condition on green corridor ICT-systems is set by the key performance indicators which are until now individually developed by each green corridor project in BSR and which are still part of the on-going research activities. In the considered BSR cases these key performance indicators are also impacting the functionalities of the green corridor ICT-systems.

In the future, one important task will be the integration of the existing ICT-tools of the green transport projects around the BSR into one integrated ICT-system of extended functionality in order to be able to utilise the available capacities around the BSR more efficiently towards a greener logistics. Such an integrated transportation ICT-system can bring together the big market players in logistics and trade as well as SME sector in logistics to realise a cheaper and more environmental-friendly transport. By taking into account the discussed issues the advantages of integrated ICT-system can be expressed by the following point:

- Increased accessibility of inter-modal freight transport solutions, i.e. the gain of door-to-door co-modal solutions together with environmental and logistics performance attributes.
- Improved synchronisation of logistics processes and better utilisation of logistic resources.
- Enhanced reliability of inter-modal services and better adaptability of logistics solutions through dynamic updated information.
- Reduced costs and effort for the management of complex transport chains.
- Possibility to use standardised electronic logistics documents like waybills and customs information along the transport chains.
- Creation of an open transport spot market along the involved green corridors including the possibility of a fair participation of logistics SME sector.

Since a fully working integrated ICT-system for green corridors is still a topic of the future, it is recommendable to use an open architecture able to integrate and exchange information with already existing systems. Related to the issue of open architecture is the question of the definition and use of standards, since businesses using data standards like Global Standards 1 (GS1), Universal Business Language (UBL), United Nations Electronic Data Interchange For Administration, Commerce and Transport (EDIFACT) were not focussed on the modelling of transportation processes, so there exists still the need for the development of standards regarding the description of logistics service, logistics nodes and other logistics objects. The existing standardisations can offer solutions for regions or branches, but there is no appropriate general solution for general multi-modal transport sector until now.

The comparative analysis of the running green corridor projects in the BSR brought to light that up to now it is possible to formulate minimum requirements for the provided functionalities that an integrated logistics platform system has to offer:

- Generation of inter-modal door-to-door transport alternatives comprising the whole transport chain planning.
- Transport chain visualisation.
- Multi-criteria transport optimisation tool.
- Calculation and measurements of energy consumption and CO_2 emissions.
- Standardised electronic data interchange in order to be able to integrate corporate systems using different communication standards.
- Information about logistics nodes, available services and service booking.
- Parking information and booking parking places.
- Up-to-date information about traffic and weather conditions.
- Transport tracking and monitoring
- Negotiation, contracting and booking system.
- Financial settlements.

However, these necessary functionalities are representing the more technical part of the requirements that have to be fulfilled by an integrated ICT-system. The more challenging task is to realise the organisational and political framework for such system architecture. By summing up the results of green corridor initiatives from BSR together with the discussions of the paper it can be stated that integrated ICT-systems have to meet the following system requirements (Green Corridor 2010; Info Broker 2012; TransBaltic 2012):

- Open architecture.
- Oriented on standards.
- Focus on inter-operability and co-modality.
- Independent of technology.

- Endorsed and adopted by major freight ICT-systems providers and logistics operators.
- Support the European transport and logistics system to be more efficient and environmental-friendly.
- Creation of a fair and balanced transport spot market within the corridors enabling market leaders and SMEs to interact at a low cost.

Especially the realisation of the last point represents a task which is placed far beyond technical questions because it needs to convince the current logistics players to open their closed ICT-systems and to integrate them into a common logistics platform which is linked to loss of their influence and market power. In order to succeed with these tasks, more research on green corridor business models and the possible benefits of integral corridor management systems for all participants will be necessary.

Another strong barrier for the implementation of green corridor ICT-systems is related with the fact that creating open data bases comprising freight tariffs and contracting conditions in order to be able to build transparent spot markets is again a political sensitive topic, where more incentives than general arguments have to be developed in order to increase the will to participate among the main logistics players in a green corridor. In case of the acceptance of participation of a critical mass of logistics companies in such systems, it is still necessary to develop a communication system between these co-operating companies and to agree on underlying business models, standards of documents and messages. But an important constraint for successful future applications and solutions in BSR is to be open and affordable for the small and medium companies due to the dominance of SME sector in logistics.

Conclusions

Green transport corridors play a growing role as transhipment routes for long distance freight traffic based on multi-modality and supporting ICT-systems. When it comes to the realisation of green corridor concepts, only a few pilot projects exist until now giving the opportunity to develop and test green corridor solutions together with their ICT-systems (EWTC II 2012; Info Broker 2012; TransBaltic 2012). The management and monitoring of the performance of green corridors is based on key performance indicators which are until now individually developed by each green corridor project in BSR and which are still part of the on-going research activities. These KPIs together with general demands on green corridors prove a high impact on the functionalities of supporting green corridor ICT systems (Green Corridor 2010).

The main future task will be the integration of the existing ICT tools of the BSR green transport projects into one overall integrated ICT-system of extended functionality facilitating and coordinating the available capacities around the BSR more efficiently towards a greener logistics. Such an overall integrated transportation ICT-system has to offer an ICT-platform for the different stakeholders of BSR logistics, to realise their cooperation according to the frame conditions and to improve the performance, safety and efficiency of green corridors.

Even if the final structure of such an overall system is still open, already now some cornerstones of such ICT-systems for green corridors are visible since they will rely on open architecture, use standards and realise green and democratic models for efficient multimodal logistics markets. Especially the realisation of the last point represents a task which is placed far beyond technical questions because it needs to convince the current logistics players of open their closed ICT-systems and to integrate them into an integrated logistics platform which is linked to the loss of their influence and market power. In order to succeed with these tasks, more research on green corridor business models and on potential benefits of integral corridor management systems for all participants is necessary.

But beside the discussed technical issues the results of the first implemented green corridors in BSR already revealed that political and cultural topics play also a crucial role for the acceptance and success of the green corridor concept. Important preconditions for the implementation of green corridor ICT-systems are related to transparency, cooperation and trust since the creation of open data bases comprising freight tariffs and contracting conditions are necessary to build transparent spot markets but at the same time these strategic and political sensitive topics represent main obstacles for the participation among the main logistics players in a green corridor.

So in order to safeguard the success of green corridor concepts the scope of research has to include cultural and political topics touching issues beyond ICT-systems so that the participation of a critical mass of logistics companies in such systems can be realised. But the solutions of these questions need a lot of further research which is on the agenda in running and upcoming green corridor projects.

References

Auramo, J.; Kauremaa, J.; Tanskanen, K. 2005. Benefits of IT in supply chain management – an explorative study of progressive companies, *International Journal of Physical Distribution and Logistics Management* 35(2): 82–100.

Baltic.AirCargo.Net. 2012. To-Be-Concept in the frame of Baltic.AirCargo.Net project. High Competence Network e.V. Available on the Internet: <http://www.balticaircargo.net/uploads/media/To-be-Concept_for_ICT_platform.pdf>.

Bontekoning, Y.; Macharis, C.; Trip, J. 2004. Is a new applied transport research field emerging? – A review of intermodal rail-truck freight transport literature, *Transportation Research Part A* 38: 1–34.

BSR Transportcluster. 2012. Available from: <http://transport-cluster.eu/>. (Assessed 15 March 2013)

Callaway, D.; Newman, M.; Strogatz, S.; Watts, D. 2000. Network robustness and fragility: Percolation on random graphs, *Physical Review Letters* 85: 5468–5471.

Clausen, U.; Geiger, C.; Behmer, C. 2012. Green corridors by means of ICT applications, *Procedia - Social and Behavioral Sciences* 48: 1877–1886.

Cohen, R.; Erez, K.; Ben-Avraham, D.; Havlin, S. 2000. Resilience of the Internet to random breakdowns, *Physical Review Letters* 85: 4626–4628.

COM. 2001. White Paper: European transport policy for 2010: time to decide. Commission of the European Communities. Brussels, 12.09.2001.

COM. 2006. Keep Europe moving - Sustainable mobility for our continent, Mid-term review of the European Commission's 2001 Transport White Paper. Commission of European Communities. Brussels, 22.06.2006.

COM. 2011. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. Commission of European Communities. Brussels, 28.03.2011.

Cross, G. 2000. How e-business is transforming supply chain management, *Journal of Business Strategy* 21(2): 36–39.

Daduna, J.; Hunke, K.; Prause, G. 2012. Analysis of Short Sea Shipping-Based Logistics Corridors in the Baltic Sea Region, *Journal of Shipping and Ocean Engineering* 2(5): 304–319.

Davis, F. D.; Bagozzi, R. P.; Warshaw, P. R. 1989. User Acceptance of Computer Technology: A Comparison of Two Theoretical Models, *Management Science* 35(8): 982–1003.

DeLone, W. H. and McLean, E. R. 1992. Information Systems Success: The Quest for the Dependent Variable, *Information Systems Research* 3(1): 60–95.

Dudzevičiūtė, G. 2013. Lithuanian manufacturing trends in the context of developed and developing countries, *Entrepreneurship and Sustainability Issues* 1(1): 55–66. DOI: http://dx.doi.org/10.9770/jesi.2013.1.1(6)

EEA. 2010. Load factors for freight transport (TERM 030) - Assessment published 04.10.2010 by European Environment Agency. Available from: <http://www.eea.europa.eu/data-and-maps/indicators/load-factors-for-freight-transport-1#toc-1>. (Assessed 10 April 2013)

Evangelista, P. 2002. The role of ICT in the logistics integration process of shipping lines, *Pomorski zbornik* 40(1): 61–78.

EWTC II Green Corridor Manual. 2012. Green Corridor Manual – Task 3B of the EWTC II project. Region Blekinge.

FTLAP. 2007. Communication from the Commission: Freight Transport Logistics Action Plan. Commission of European Communities. Brussels, 18.10.2007.

Green Corridor. 2010. Regeringskansliet – Government Offices of Sweden. Green Corridors. 15.06.2010.

Grieger, M. 2004. An empirical study of business processes across internet-based electronic marketplaces – a supply chain management perspective, *Business Process Management Journal* 10(1): 80–100.

Gustafsson, I. 2008. *Interaction Infrastructure – A holistic approach to support comodality for freight*. Blekinge Institute of Technology, Doctoral Thesis No. 2008:01, School of Technoculture, Humanities and Planning. Karlskrona.

Hunke, K.; Prause G. 2012. Hub Development along Green Transport Corridors in Baltic Sea Region, in Blecker, Th.; Kersten, W.; Ringle, Ch. (Eds.). *Pioneering Supply Chain Design - A comprehensive Insight into emerging Trends, Technologies and Applications*. Josef-Eul-Verlag, Lohmar-Köln, 265–282.

Igbaria, M.; Tan, M. 1997. The Consequences of Information Technology Acceptance on Subsequent Individual Performance, *Information & Management* 32(3): 113–121.

Info Broker. 2012. A key to efficient performance with as small ecological footprint as possible. EWTC II, Net.Port Karlshamn.

Kersten, W.; Boeger, M.; Schroeder, M.; Singer, C. 2007. Developing Regions through Spatial Planning and Logistics & ICT competence – final report. As part of the publication series of the EU project LogOn

Baltic, Turku School of Economics, Report No. 1:2007, Turku.

Ketikidis, K.; Koh, S.; Dimitriadis, N.; Gunasekaran, A.; Kehajova, M. 2008. The use of information systems for logistics and supply chain management in South East Europe: Current status and future direction, *Omega-International Journal of Management Science* 36(4): 592–599.

Kron, E.; Prause, G. 2008. LogOn Baltic aggregated ICT Survey Report, Turku School of Economics, Turku.

Kusch, T.; Prause, G.; Hunke, K. 2011. The East-West Transport Corridor and the Shuttle Train "Viking", WDP-Series 13/2011, Wismar 2011.

LPI. 2012. Logistics Performance Index. Available from: <http://lpisurvey.worldbank.org>. (Assessed 18 March 2013).

LogOn Baltic (2008). Key Objectives. Available from <http://info.tse.fi/logonbaltic/uudetsivut/logonbaltic.asp> (Assessed 12 December 2013).

Meyer, J.; Rowan, B. 1977. Institutionalized Organizations: Formal Structure as Myth and Ceremony, *American Journal of Sociology* 83: 340–363.

NECL II. 2012. Final Report on WP 5.1: Logistic ICT solution for operative Transport Matching. Available from <http://midnordictc.net> (Assessed 12 November 2012).

Neville, B.; Menguc, B. 2006. Stakeholder multiplicity: Toward an understanding of the interactions between stakeholders, *Journal of business ethics* 66(4): 377–391.

Notteboom, T. 2008. Bundling of freight flows and hinterland network developments, in Konings, R.; Priemus, H.; Nijkamp, P. (Eds.). *The future of intermodal freight transport - Operations, design and policy.* (Elgar) Chelten-ham. Northhampton, MA, 66–88.

Oh, J. 2011. *Innovation in transport for green growth*. Presented at 2011 World Bank Transport Forum, March 2011.

Oliver, C. 1991. Strategic Responses to Institutional Processes, *The Academy of Management Review* 16(1): 145–179.

OSullivan, J.; Patel, T. 2004. Fragmentation in transport operations and the case for system integrity, *Transport Policy* 11: 215–225.

Pfeffer, J.; Salancik, G. 1978. *The external control of organizations*. New York

Prause, G.; Hunke, K. 2014. Sustainable entrepreneurship along green corridor, *Entrepreneurship and Sustainability Issues* 1(3): 124–133. DOI: http://dx.doi.org/10.9770/jesi.2014.1.3(1)

Prause, G.; Kron, E.; Beifert, A. 2010. Final ICT Report of the project "Innovation Network–Logistics Cluster Wismar Seaport", Wismar.

Roy, J.; Nollet, J.; Beaulieu, M. 2006. Reverse logistics networks and governance structure. *Supply Chain Forum: An International Journal in Supply Chain Management* 7(2): 58–67.

Rowley, T. 1997. Moving beyond dyadic ties: A network theory of stakeholder influences, *Academic Management Review* 22: 887–910.

Sander, N.; Premus, R. 2002. IT applications in Supply Chain Organisations: a link between competitive priorities and organisational benefits, *Journal of Business Logistics* 23(1): 65–83.

Scandria. 2012. Logistics Business Development Strategy. Scandinavian-Adriatic Corridor for Growth and Innovation, Final Report.

Simchi-Levi, D.; Kaminsky, P.; Simchi-Levi, E. 2003. *Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies.* McGraw-Hill, New York.

SuperGreen. 2010. Available from: <http://www.supergreenproject.eu/> (Assessed 16 April 2012)

Tetraplan. 2009. TRANSvisions: Report on Transport Scenarios with a 20 and 40 Year Horizon, Final Report, EC DG TREN.

Theofanis, S.; Boile, M. 2009. Empty marine container logistics facts, issues and management strategies, *Geojournal* 74(1): 51–65.

TransBaltic. 2012. Review of the ICT tools supporting green logistics developed in the INTERREG transport projects. Poznan.

Tvaronavičienė, M. 2014. If industrial sector development is sustainable: Lithuania compared to the EU, *Entrepreneurship and Sustainability Issues* 1(3):134–142. DOI: http://dx.doi.org/10.9770/jesi.2014.1.3(2)

Tvaronavičienė, M.; Grybaitė, V.; Tunčikienė, Ž. 2013. Globalization drivers in developed and less developed countries: if consistent patterns can be traced, *Journal of Security and Sustainability Issues* 2(4): 5–11. DOI: http://dx.doi.org/10.9770/jssi.2013.2.4(1)

Vasiliūnaitė, R. 2014. Sustainable development: methodological approaches toward issues, *Journal of Security and Sustainability Issues* 3(3): 69–75 DOI: http://dx.doi.org/10.9770/jssi.2014.3.3(6)

Vurro, C.; Russo, A.; Perrini, F. 2009. Shaping sustainable value chains: Network determinants of supply chain governance models, *Journal of Business Ethics* 90 (4): 607–621.

Wathne, K.; Heide, J. 2004. Relationship Governance in a Supply Chain Network, *Journal of Marketing* 68 (1): 73–89.

Wolf, J.; Herz, N.; Fläming, H. 2012. Empty Container Logistics: Hamburg-Baltic Sea Region, TransBaltic Report of Work Package 5.2, Hamburg University of Technology.

Wolfe, R.; Pulter D. 2002. How tight are the Ties that bind Stakeholder Groups, *Organization Science* 13(1): 64–80.

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Transnational e-services for efficient oversize logistics

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Abstract

The implementation of the renewable energy Directive (2009/28/EC) of the European Commission and the resulting national renewable energy action plans of the member states opened up the market and trade of renewable energy power plants and innovative power generating systems. Especially, the demand for the exchange and transshipment of this project cargo to and from the Eastern countries increased. Thus, large generators and windmills need to be shipped eastwards to the Baltic States from mostly Western European origins. The transshipment of these oversize cargos causes comprehensive operations with a lot of bureaucracy as well as losses of time and money due to the need to build and reconstruct infrastructure, i.e. roads and bridges along the route, and long and time consuming permission processes and the relatively inexperienced personnel of transport operators.

Oversize and abnormal transports are over-dimensioned vehicles, usually carrying the project cargo, or vehicles with heavy load of goods on roads, railways, inland waterways and in short sea shipping. However, next to the growing number of project cargo transports, the trend leans towards heavier cargo movements of goods with abnormal road trucks. This paper will provide an analysis of selected national laws and regulations in the South Baltic Sea Region and will show differences and non-conformities but will also demonstrate similarities which can allow opportunities for perspective cooperation for international oversize transports.

Oversize transports normally require special permission from responsible transport authorities; mostly it is the official road authority or national road service. Today many approaches aim at making the permission process easier, thanks to so called one-stop-shop solutions for all oversize transports. This paper will demonstrate different national e-services, e. g. the German online application system called VEMAGS (Verfahrensmanagement für Großraum- und Schwertransporte) as well as a multinational solution resulting from a European funded project "Oversize Baltic" in South Baltic Programme which is called OTIN (Oversize Transport Information Network).

Practical experiences from transport forwarders and industry clients substantiate the necessity of such coherent application services as the role of transnational oversize transports is an increasing share of the daily business. Transport forwarders are mainly characterized as small and medium-sized

companies with high personal competence and high level of regional competitive advantages when it comes to route planning and transport execution. The dedicated time to permission processing is a bureaucratic burden for every company and an optimization and harmonization of the process will make the whole transport sector for transnational oversize cargo transport more efficient.

Introduction

The implementation of the renewable energy Directive (COM 2009/28/EC) of the European Commission and the resulting national renewable energy action plans of the member states opened up the market and trade of renewable energy power plants and innovative power generating systems. New trade routes had to be found and demand for the exchange and transhipment of goods increased.

Demand for the usage of renewable energy power plants especially in Eastern Europe has increased enormously in the last years but, unfortunately, the industries of these countries are not yet ready to design and produce these innovative power generating systems for own demand. Therefore, large generators and windmills need to be shipped from Western Europe eastwards to the Baltic States. At the beginning such operations caused a lot of bureaucracy as well as losses of time and money because of the need to build and reconstruct parts of the roads and bridges along the way, long permission processes at administration level and the inexperienced personnel of transport operators.

South Baltic Sea region, including Mecklenburg-Vorpommern in Germany, Southern Sweden, and Denmark is a very important export and transit market for these oversized transports to the Eastern countries due to its logistical location and connections to the new EU Member States. In addition to the increasing demand in regional oversized transports, worldwide project cargo (single segments of ships, power plants, machines, etc.) is becoming bigger and heavier with each year. According to the maritime transport forecast for 2025, prepared on behalf of the German Federal Ministry of Transport, Building and Urban Development (MV 2025), total goods handling in the four German ports included in the study: Rostock, Sassnitz/Mukran, Stralsund and Wismar, will more than double from just under 30 mln tonnes in 2004 to over 73 mln tonnes by 2025. The assumption is that the demand for handling oversized cargo will increase in this period correspondingly. Due to these facts, a new oversized transport strategy for the whole South Baltic Sea region, prepared in relation to the EU project "Oversize Baltic", will gain high importance in future years. This includes the implementation of an innovative platform for e-solutions for application procedures. It is called Oversize Transport Information Network (OTIN). Furthermore, the infrastructure will be adjusted and improved as well as the safety of oversize transports. There are public benefits to outline, i.e. low congestions on roads and railways, lower emissions due to innovative transport routes and means, and consumer cost savings due to economical transport solutions.

Methodology

The objective of this research is to find a regional strategy for oversize transport in South Baltic Sea region and a design frame for a transnational e-service platform for permit issuing. The different kinds of oversize transport are observed, the actual cargo as well as the possible transports in the future. The legal environment, on European level as well as on individual national level, will be analysed. Differences and similarities, which will have an influence on the implementation of a transnational solution, will be shown. Finally, the businesses which benefit from an advanced oversize transport strategy and an implemented e-service are analysed and optimization procedures are provided.

In order to gather all necessary information for the development of this oversize strategy a number of different sources are used. Firstly, secondary information is collected according to the internet sources and publications from governmental institutions, private stakeholders and networks and initiatives. Due to the fact that secondary information was rarely and mostly limited to legal regulations and governmental guidelines, primary information was necessary to analyze the oversize transport topic. Therefore a few events according to this topic were visited and individual meetings with experts from this field were conducted.

The literature about oversize transports is very rarely even though some theoretical approaches for safety based analysis of heavy load transport (Wang et al., 2007; Yin et al. 2008) could be found in the literature. Furthermore, the density for juridical analysis of existing legislation is quite high (Kuehl and Lemmer 2009; Rebler 2004). However, this approach is very nationally oriented and does not imply to the aim of this research paper as it was only focused on implementation and providing interfaces between existing legal systems. To give recommendation for the change and adaptation of law regulations would be by far above the possible scope of this research.

Much information about the topic of transnational oversize transport was gained during the project duration of almost 3 years of the South Baltic Programme project "Oversize Baltic". The author was responsible component leader for the strategic analysis of the national markets for oversize transport in all transport modes (road, rail, short sea shipping and inland waterways) for the four participating countries: Germany, Sweden, Poland and Lithuania. This includes also the profound investigation of the legal environment in these regions as well as the research about existing and planned transnational services in European Union and smaller interregional initiatives. One official information point in the internet is the homepage of http://transportxxl.eu which was created by an international project with European funds by several European countries. It provides a detailed overview about legislation and guidelines in the field of oversize road transports. However, it is still only limited to the participating regions and did not offer information about some of the national situations for the countries of interest in this research.

Additionally to the field research more primary information was collected from individual meetings with experts in the project "Oversize Baltic" and beyond. A number of visits of experts from the field of logistics and oversize transports helped to gain information about single case studies, individual challenges and successful solutions (cf. interview with André Lau Schwertransporte 2010). These meetings were held in Rostock and Wismar with international guests from the Baltic Sea States but also some cross-border visits were made to e.g. Klaipeda, Karlshamn, and Stettin. Additionally there were phone conferences with these experts during the research phase. A workshop organized by the Easyway project in March 2012 offered the possibility to present and introduce the transnational e-service OTIN (Oversize Transport Information Network) as a direct outcome of the "Oversize Baltic" project to the customers and industry representatives. During this workshop the accessibility and the customer-oriented approach was discussed. The result was positive as this is a very well developed tool which aims at improving the user-friendliness and the reduction of the bureaucratic burden for oversize transport permissions.

Definition of oversize transport

A look at the European transport statistics shows that oversize cargo is transported mostly by road. This transport mean is considered as the cheapest way and most flexible mean of transportation even though road transport encounters difficulties, arising from infrastructural and law limitations. New technological approaches and the globalization implies new technologies, like transport of the whole complete production line, so called “project cargo” where the whole compact production line or its part is being transported already assembled. After transportation by either road, rail, short sea shipping or inland shipping transport, projects are installed readymade in previously designated places accessible to the means of transport.

The choice of transport mean and designated route is generally very limited by the parameters of cargo. The transport availability of production and delivery places is crucial as well. Furthermore, some huge elements as transformers, turbines generators are also being transported by all available means of transport. Construction of wind energy installations cannot be exercised without oversize transport, since most of the components of one wind turbine exceed standard dimension. Road transport of oversize units (constructions, machinery) means considerable challenges. This is due to the on-going infrastructural expansion and renovations of roads, which might cause the necessity to deviate from the assumed route. Another barrier is connected to trees along the road, traffic lights and curve diameters of the road which hinder oversize movement.

Resuming from the different kinds of project cargo there exist no unique definition of oversize cargo. This is due to the multiplicity of forms which that kind of cargo has, including heavy lifts, over width, over height units and cargo, which exceeds axle load. Oversized and abnormal transports are over-dimensioned vehicles, usually carrying the project cargo, or vehicles with heavy load of goods over 40 tonnes. German law regulations specify that an oversized transport is only allowed if the cargo is non-divisible (transport other than in one piece is impossible). However, next to the growing number of project cargo transports, the trend leans towards heavier cargo movements of goods with abnormal road trucks. A towing vehicle with trailer is allowed to have a maximum length of 18.75 m and a weight of 40 tonnes. There are initiatives and test cases for trucks with a length of 25.25 m and weight up to 60 tonnes. In other European countries, in Sweden for example, these trucks are already running. There are also special handling installations (terminals, factory sites, ports and docks) for oversize transport. It could be said, that in all cases "oversize" determinants are:

1) cargo dimensions,
2) cargo weight,
3) available cargo space on the vehicle,
4) permissible pressure and stress on the loading surface,
5) permissible stress on surface of road and railways.

An additional important element is the shape of the cargo, because its irregular geometry could negatively affect static and dynamic stability of the vehicle. In every case handling, stowage and securing of such cargo must be done under the supervision of surveyors, proper calculations should be made prior to the transport, and necessary permits and certificates should be obtained. (SBSR Oversize Strategy 2011)

As in all other European countries, oversize transport in Germany requires special permission from responsible transport authorities, mostly it is the official road authority of the according Federal state. Today the permission process has been made easier, thanks to a one-stop-shop system for all oversize transports throughout Germany, called VEMAGS (Verfahrensmanagement für Großraum- und Schwertransporte). The operators are not bound to apply for permission at a specific authority (e.g. the starting point of the transport route or the location of the business) but can choose their preferred authority. Also, there are possibilities for a transport operator to apply for multiple permissions or long-term permission, which are bound to certain vehicle combinations or on fixed routes.

Legal basis for oversize transport

There exists an European Council Directive 96/53/EC, laying down the basis for the maximum authorised dimensions and the maximum authorised weights and relating parameters for certain road vehicles circulating in national and international traffic for abnormal road transports in Europe. However, the real implementation and application of these legal recommendations is left to the respective countries. Therefore the following chapter will show differences as well as similarities in the legal framework of the four analysed countries: Germany, Poland, Sweden and Lithuania.

There are a number of legal requirements concerning oversize transportation in Germany. Such transportations diverge from the norm of “Straßenverkehrs-Zulassungs-Ordnung (StVZO)“. It is a regulation based on § 6 “Straßenverkehrsgesetz”, enacted by the Ministry of Transport, Building and regional Development. They cause immoderate using of roads and so they need a permission according to § 29 (3) StVO. Basis for this permission is an exception permit pursuant to § 70 StVZO. Depending on size and freight escort vehicles or police escort are required.

Above that, such transports are just allowed at specific periods. During holidays using of several motorways is principally not allowed. These periods are called „off-time“. Oversize transports are allowed to proceed only between Monday and Friday 9 a.m. and 3 p.m.. Nearly all transportations with a width above 3.2 meters have to be realized during the night between 10 p.m. and 6 a.m.

The regulation in Poland is based on several national acts and laws. Oversize cargo transport is regulated by many acts of law issued by the Ministry. The most important ones are:

- Act of June 20th 1997 - Road traffic law (section II - Road traffic; chapter 5: Order and traffic safety on roads; chapter 4: Conditions for use of vehicles on the road - Art. 61 – 64, Dz. U. z 2003 r. Nr 58, poz. 515);
- Act of March 21th 1985, about public roads (Dz. U. z 2007 r. Nr 19, poz. 115);
- Act of September 6th 2001 r. about road transport (Dz. U. 2004 r. Nr 204 poz. 2088);
- Decree of the Minister of December 31st 2002 on vehicles technical conditions and range of their necessary equipment (Dz. U. z 2003 r. Nr 32, poz. 262 ze zm.)
- Decree of the Minister of December 16th 2004 r. on special conditions and permits issuing procedure for oversize vehicles transit (Dz. U. Nr 267, poz. 2660);
- Decree of the Infrastructural of July 26th 2004 about costs connected with transit route defining (Dz. U. Nr 170, poz. 1792);

- Decree of the Home Affairs and Administration of December 30th 2002, about road traffic control (Dz. U. z 2003 r. Nr 14, poz. 144 ze zm.);
- Decree of the Infrastructural Minister of April 26th 2004 about vehicles which make pilotage (Dz. U. Nr 110, poz. 1165).

Abundance of documents do not foster easiness and coherence of law applied to carriers, forwarders and institutions that operate oversize vehicle transport. Currently, there could be observed some effort to change and simplify existing Road Traffic Law and other acts with the aim to reorganize existing legal order in discussed area. The new act is being widely discussed and opened for public consultation.

The public road network in Sweden is divided into three weight classes: Weight Class 1 (BK1), Weight Class 2 (BK2) and Weight Class 3 (BK3). The highest weights are permitted on the BK1 road network, whose weight regulations apply on some 94 % of the public road network. Abnormal transports within Sweden require an exemption (permit) from the traffic regulation (trafikförordningen, SFS 1998:1276). If the transport concerns only one municipality the application must be sent to that municipality (the local authority). If the transport route concerns more than one municipality the application must be sent to the Swedish Transport Administration (Trafikverket). Certain wide transports can be performed without a permit (the wide load does not exceed 3.1/3.5 m), if certain conditions are fulfilled (Transportstyrelsen VVFS 2005:102).

The maximum allowed vehicle dimensions, permissible axle(s) load, and the total weight allowed on Lithuanian roads have been set forth by Lithuanian Minister of Transport Decree 18-02-2002 No.3-66 on the approval of the authorized maximum dimensions of vehicles, permitted axle(s) load, and total mass. Vehicles with heavy goods above the permissible weight and size are only allowed with track operator or an authorized authority permit. Oversize and heavy transport permits for use of national roads are granted by State Road Transport Inspectorate under Ministry of Transport, and permits for urban trips – by track operator, i.e. a relative municipality of administrative unit. Heavy vehicle permit authorization and payment of public road taxes are regulated by Minister of Transport Decree 20-04-2006 No.3-150 on public road tax for heavy vehicles in Republic of Lithuania Payment, Administration, Control and Licensing Procedure. (Oversize Transport Handbook – Lithuania 2011)

Procedures for issuing permits

Oversize transports must have a valid permit which has to be obtained from the responsible authority. For this purpose a request with addressor, receiver, measurements of loads, weights, vehicle registration number, axial distances and axle loads, number of wheels per axle and description of the route have to be conveyed. The responsible authority gives this request to consultation and waits for agreement and issues the permission. In Germany e.g. it is also common, that oversize transport companies have a continuous permit for one year.

In the last years, some countries tried to follow the European guidelines on electronically government and implemented e-service solutions for the application of transport permissions. Since 2007 there is a new permission system for oversize transports in Germany. It includes all authorities of the 16 Federal States and is called VEMAGS (Verfahrensmanagement für Großraum- und Schwertransporte).

The VEMAGS-system is a tool which was developed to simplify and quicken the permission process of oversize transports all over Germany. It was initiated by the European Union aiming to provide a comprehensive system for oversize transport in the whole EU-region. Germany took the chance and established this VEMAGS-system even before the agreed deadline. VEMAGS replaces the earlier telefax-method which had long waiting times and high transfer costs and was not economical anymore. The new system provides the whole process beginning with the application up to the approval and the actual transport in the road in real time. Important industries like construction industry and the energy sector asked strongly for such a new system. All stakeholders of the permission process for oversize transports in the Federal Republic of Germany benefit from the implementation of the VEMAGS-system. These stakeholders are applicants, permission authorities, administrations, road traffic authorities, responsible road enterprises and the police. The applicants can simply submit their application via the VEMAGS-system to the responsible permission authorities. They are supported by a routing planning tool and a template system which stores their previous submitted data.

The VEMAGS-systems covers following aspects:

- structure of an operations management tool (internet instead of telefax/phone)
- communication platform und distribution of application data
- status tracking
- filing
- cooperation with existing systems (e.g. of the German military)
- training concept
- collection of data of bridges and buildings
- classified road nets including turns
- collection of routes with special requirements

For using the VEMAGS-system only a simple internet access and a browser are necessary. The huge servers which keep the systems running are located in middle Germany and bundle and spread the relevant information to the responsible permission authorities in the federal states (*german*: Länder). There is no admission fee. The approval of the application according to the German legislation and guidelines is very complicated and comprehensive. The delivery of the approval is still possible via telefax, post mail or by personal pick up at the authority. If the applicant has the opportunity of a digital signature which itself has some technical requirements he can use it and gets the approval digitally as well. In Germany, this digital signature is the only way to circumvent the official signature with stamp of an authority.

The user who would like to submit an application for the transport of oversize cargo in Germany needs to register at the VEMAGS homepage. Some business data and formal information like name, address and so on are required. After the registration the user can fill in the application form (see attached a paper version). The user must define the route he wants to travel, the information about his transport vehicle and of course the dimensions of his cargo (weight, height, length, …) and can also attach additional files. If everything is filled in he can submit the application. The VEMAGS-system automatically scans the application for mistakes or missing information. This application is now transferred in real time to the responsible authorities. The user can decide by his own, to which authority he might submit the application. It can be the location of the business, the starting point of the travelled routes or any other authority in Germany. The application is now dealt by the permission authority. The permission authority which is responsible for the submitted application proofs again if the application is complete and worth further approval. If so, the authority sends the application to the other authorities which are affected through the route of the transport. They have to decide whether the transport is possible on the suggested roads or whether there are some limitations. In this case the authority can suggest another route for the oversize transport and send this suggestion back to the responsible authority and further back to the applicant. As soon as all other involved authorities assign the approval of this transport the applicant gets his approval back and can start the transportation.

The safety concept is designed according to the BSI-Standard 100-2 and other relevant standards of the Federal Republic of Germany. In the process the following issues are considered: Analysis of the structure of the application process, the required safety levels for different data, defined in three levels (normal, high and very high) and categories (availability, confidentiality and integrity). According to these results the demand for safety of the single components is assessed. These assessments must be also in accordance to the privacy data protection laws and the transport laws.

The most important motivation for the implementation of the VEMAGS-system was the enormous cost and time savings not only for the applicants but also for the permission authorities and road traffic authorities. Since the applicants already use the computer for the commercial correspondence and the editing of bookings and purchase orders it seems to be reasonable to use it also for the application for transport permission. Earlier they had to fill in an application form manually and telefax or send it via post mail to the responsible permission authority. This step is redundant with VEMAGS. They can simply transfer the application via internet directly to the permission authority. The permission authority distributes the application further to other relevant authorities via internet. Through this digital correspondence the whole permission process can be shortened by half of the time. Earlier the process took about five working days and today the average process takes two or three days. Cost savings are next to the cuttings of personnel costs for the manual editing the abolition of the mailing costs for telefax, phone or by post delivery.

In Sweden the application must be made to the local municipality or to the national transport authority. The application must contain information on the applicant, the desired transport route (including loading and delivery site), the vehicle or vehicle combination, type of load, the axle loads, the gross vehicle weight and the dimensions of the vehicle or vehicle combination including load. For heavy transports (with load) a consignor´s affirmation must be attached to the application. The consignor’s affirmation contains information on the consignor, dimensions and total weight of the load, and includes a statutory declaration on the accuracy of the data provided. For heavy transports or transports which exceed the maximum authorized lengths, vehicle registration documents must be included, if the vehicles not are registered in Sweden.

The Swedish Transport Administration can make the following types of permits:

1. a specific permit for one transport on a certain route (valid for one month),

2. a specific permit for repeatedly transports on a certain route (valid for one month, or up to one year), or
3. a long term permit (general permit) for a certain road network (valid for one year).

The period of validity of the permits and type of permits varies depending on the dimensions and weights. Every permit contains the conditions which are valid for the actual transport. When carrying out the transport, conditions for the marking of overwide and overlong vehicles must be observed. These conditions also deal with the use of private escort vehicles and traffic directors. Furthermore, it is the driver's responsibility to assess whether the route is passable for his transport with respect to road construction sites and road clearance (height). If signs or other road equipment must be removed for the passage of the transport, permission must be requested from the respective owners. Sometimes escort may be required for the transport. In these cases licensed traffic directors must be contacted before the transport starts in order to make preparations. Sweden has this system with private traffic directors since 2005. They have the legal right to direct, stop and give instructions to other road-users. Other road-user must obey a traffic director. In some cases the police may overtake an escort, but that is rare nowadays. The application procedure usually takes three workdays. However, a longer processing period is required if the permit can only be issued in connection with a police escort. Permits are normally valid for a one- month period. In the case of regularly repeated transports, permits can be issued with a validity period of up to one year. The application fee ranges from 600 to 1200 SEK (55 to 110 Euros), depending on the width, length and weight of the transport.

A new regulation is approved from 1st of October 2010 which allows exemptions from regulations of maximum width and length. (TSFS-nr 2010:141, Färd med bred odelbar last, and Färd med lång odelbar last). The new regulation allows:

- transports with wide indivisible cargo up to 350 cm
- transports with long vehicle (long indivisible cargo) up to 30 meter if certain specifications of the vehicle are fulfilled

Combination of exceeding of both width and length is not allowed. The conditions regarding route checking's, signs on the vehicle etc. are the same as before. There is also an updated regulation concerning road assistance approved from 1st of October 2010. (TSFS-nr 2010:139, Föreskrifter och allmänna råd om vägtransportledare). In the new regulation are some clarifications and some simplifications made.

Since year 2011, in Sweden there is a new web-based system in operation. The system is called TRIX - Transport exemption management system for internal and external users. Until now the system only exist in a Swedish version however, an English version is planned. The system gives access to the entire application system and also offers simulation possibilities. The system has following options:

- Simple application
- Advanced application
- Possibility to simulations

Frequent applicants will get authorisation after education as user of the entire system. The system gives the customer an overview over conditions for their transport in respect to vehicles, routes, bridges and over restrictions. Benefits for the user are a better understanding for the permitting system, faster and more simplified process to get transport permission. Benefits for the permitting authority, the Swedish Transport Administration, are less phone calls and a more cost effective permitting system.

In Poland, General Directorate for National Roads and Motorways and Directors of Customs are responsible for issuing permits for carriers and forwarder transporting oversize cargo. The permits include:

- permit for single transit of oversize vehicle in appointed time (no longer than 7 days) and route, issued by the General Directorate for National Roads and Motorways,
- permit for single transit in appointed time (72 hours) for oversize vehicle crossing the Polish border, issued by the Customs Director, for vehicles satisfying minimum one of following conditions:
  - height, total weight are normative,
  - total width does not exceed 3 m,
  - total length exceeds permissible value not more than 2 m,
  - axle loads exceed permissible value not more than 15 %.

Carriers and forwarders contact authority, which is issuing the permit, by telephone, fax or e-mail. Application is usually available on the website. Fulfilled and signed application can be send by fax or e-mail and original paper can be delivered afterwards. There is application generator available on the internet website of the General Directorate for National Roads and Motorways, Central Department in Warsaw (www.gddkia.gov.pl), which is also available in German and English. Usually customers prefer to get the permit personally, because they are in a hurry, but there is possibility to send it by post at the expense of the applicant.

Application to get permit for oversize cargo transit has to include:

- name and address of the entrepreneur and the person acting on behalf of him,
- term and addresses of the beginning and the end of transit ,and in case if transport starts or ends outside borders of the country - the place of border crossing,
- type of cargo and its total weight.
- unladen vehicle data: brand, registration number, weight, permissible cargo capacity, number of axles and number of wheels on every axle (in case of combined transport, this data is given separately for motor vehicle and trailer),
- dimensions and total weight of single vehicle/road train with and without cargo,
- wheel base and each axle load of laden vehicle,
- scheme of cargo stowing on the vehicle/trailer.

There are no corridors dedicated for oversize vehicles and every time transit route is agreed with road directors of community, region, voivodship and divisions of GDDKiA. Transit route is appointed on the principle "the shortest way that fulfils requirements on width, accessible load per axel/axles". Sometimes the shortest distance between two waypoints is to be elongated due to the obstructions on the shortest planned route. If detour is enforced, which is required regularly, three times longer distance has to be worked out. If road transport of one cargo unit is impossible, it is suggested to divide it or to change the mean of transport. Practically no refusal is observed, because applications are fulfilled after phone conference and customer knows beforehand if the transport operation could be done. Frequently, preplanning of the route is needed so the carriers analyse the chances for the best passage. In some extreme cases, the additional expertise for permissible pressure on the road surface is to be done at the expense of an applicant.

According to the regulations, the maximum period for issuing the permit is 30 days, but practically the administration needs not more than two weeks. In some cases the permit is issued in two days. Issuance fee is established by a special computer program, which is used in the General Directorate for National Roads and Motorways. The longer route and the greater dimension excess the more expensive issuance fee is. Maximum price could be over 10.000 PLN.

In Lithuania, both permit provision and charges are established and framed by the Ministry of Transport and Communications of the Republic of Lithuania. The issue of permits falls to the State Road Transport Inspectorate under the Ministry of Transport and Communications.

Inspectorate issues permits to drive on the state roads vehicles (their combinations), the dimensions and (or) axle(s) weight and (or) vehicle weight with or without load exceed the maximum authorized. Loads can be carried by over-dimensioned or heavy goods vehicles (their combinations) on the state roads having paid the fee for the use of the state roads and obtained a permit. The permit can be issued only for carriage of an indivisible load and if such load may not be carried by other type of vehicles or there is not point to carry them by other types of vehicles. In order to obtain a permit to drive on the state roads over-dimensioned and heavy goods vehicles (their combinations) the application should be submitted to the State Road Transport Inspectorate.

A permit shall be issued or refused on certain grounds within 5 working days from the date when the application has been received. In case of driving a over-dimensioned vehicle (their combination), when the vehicle (their combination) becomes dangerous for safe traffic, i.e. when the maximum authorized dimensions are exceeded more then: height - 50 cm, (or) width - 100 cm, and (or) length - 500 cm, and (or) a heavy goods vehicle (their combinations, when the authorized axle weight exceeds 8 tons, when the weight of a loaded vehicle (their combination) exceeds the authorized weight by two or more times, the permit shall be issued or refused on certain grounds within 20 days from the date when the application has been received.

Upon receive the permit two different documents confirming payment of the state fees should be presented:

1) Which is for issue of permit
2) Fee for use of the state roads. State fees must be paid when a decision to issue a permit is taken, in accordance with rates effective on the day of payment and before issuing the permit.

The fees for the permit and roads range depending on the width, length and weight of the transport, thus every case is calculated individually.

The demonstration of these national application and permission issuing procedure show differences when it comes to transnational transports in the region. Every country requires valid permissions from the transport forwarder and the truck driver. In addition to obvious difficulties like language barriers, missing information about routes and roads, different tariff systems also invisible cultural differences might appear. Transport forwarders which would like to execute transport also abroad need to have profound knowledge about the foreign market, the infrastructure status and also business cultures of foreign partner companies. During the analysis of the different countries it turned out that business culture differs in regard to corruption, bride and inconsistency in tariff systems. Regional transport companies might have a very good working network with companies abroad which work in alliances for transnational transports. However, next to the “unofficial” cooperation when it comes to knowledge exchange for route planning, personnel exchange with local experience and agreements on return shipments, the cooperation on the administration level was also requested.

For many, mainly small companies, is it a great effort to learn about the foreign legislation, legal requirements and permission procedures. The bureaucratic burden on these companies is tremendously high compared to their actual business, namely executing a transport with oversize cargo. Therefore, the European funded project “Oversize Baltic” aimed at introducing a platform for transnational permission application.

OTIN (http://otin.transportoversize.eu)

The OTIN (Oversize Transport Information Network) is a result of the European funded project “Oversize Baltic”. During two years project time partners from Lithuania, Poland, Sweden and Germany aimed to improve the quality of oversize cargo transport services and large freight functional (operational) compatibility in the South Baltic Sea region. The OTIN system is designed to help transport companies to get information about oversize cargo transportation on how to obtain necessary national permissions. The system is adjusted to already existing systems in Sweden, Germany, Poland and Lithuania, thus significantly improving the accessibility of permits issuing services in the region.

The OTIN system is open for every person interested. To get the access a registration on the project webpage (www.transportoversize.eu) is necessary. The available company register lists all participating companies with short profiles and contact information. After successful registration the username and password for access to OTIN system is sent to the applicant. The OTIN system itself provides a data storage for company information, like contact person, address, telephone number, fleet of vehicles, preferred origin of transports, and so on. As soon as the applicant would like to apply for a permit, he/she can select the countries through which the transport will be executed. Automatically all necessary information for each national permission system (e.g. Vemags, TRIX) is requested from the applicant. No double entry is necessary but through OTIN the information is bundled and forwarded to the respective authority in the selected country. The application process is then handled by the national authority which also issues the permission directly to the applicant. Additionally the successful permission is stored in OTIN and can be viewed, printed, saved and used for next application by the applicant at any time.

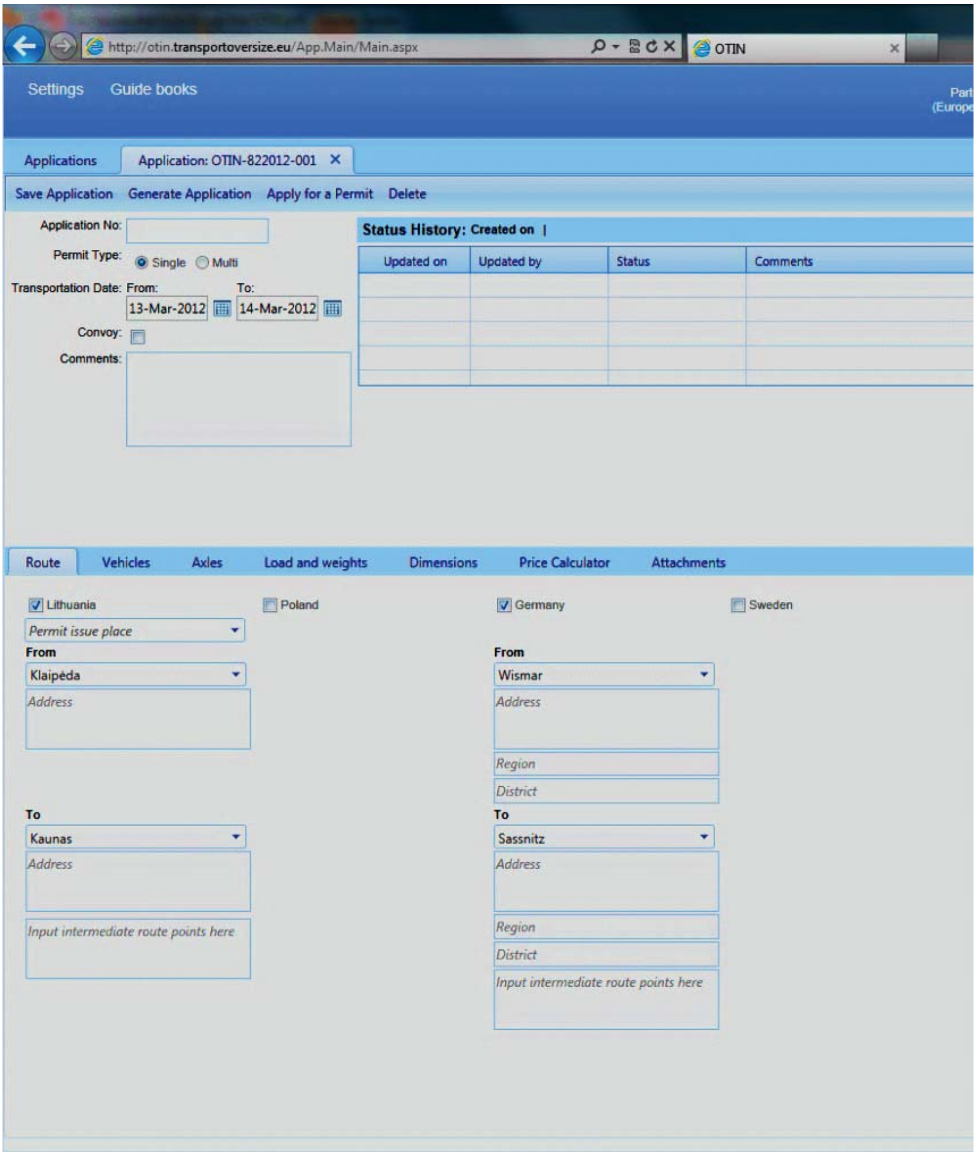

Figure 1 Screenshot of OTIN application

Even though the one-stop-shop for oversize transport permissions was the first step, better cross-border legislation and regulations need to be implemented in order to harmonize the oversize transports in the South Baltic Sea Region. Further optimizations need to be found for the already limited capacities of the motorways and railways of the federal state. A further increase of individual public transport and the freight transports can be expected which might lead to even higher maintenance costs (e.g. faster abrasion of the roads), more likely congestions both for passenger and freight transport, and less safety. This might have an influence on limitations for oversize transports with higher restrictions on safety, allowed transport times and permission fees.

The clients

In order to be able to adjust the information network of oversize transports to the demanding business sector, this segment should be analysed. Transport clients are numerous, since not only local manufacturers use oversize transport in/ from/ to the regions, but also because the transit market is large. Two of the largest players in the oversize transport market are the maritime industry and wind power energy sector.

There are many large-scale industrial locations, e.g. shipbuilding yards (Neptun Werft), offshore pipeline construction companies (EEW Special Pipe Constructions GmbH), construction companies for ships' engines (Mecklenburger Metallguss) and sites for maritime logistics in the region, which require over-dimensioned transports and very heavy lifts. Furthermore, the Ministry of Agriculture, the Environment and Consumer Protection of Mecklenburg-Vorpommern expects a complete power supply through renewable energy sources by 2050. This leads to the assumption that demand for windmills will increase in the following decades. Not only there, however, but in other regions of Europe (Eastern Europe and the Baltic states) as well, establishing Germany as one of the most important locations for construction and export of windmills. In order to ensure a smooth transport chain for oversized cargo movements, specifically the East-West connections need to be more efficient.

Products transported regularly in the South Baltic region, not only internally but also as exports, are windmills and their parts. A standard housing of a windmill weighs around 70 tonnes, new ones even more than 100 tonnes and the tower segments have a length of more than 22 m and a diameter of around 4 m. Considering that normal bridges across German roads have heights of 4.2 m and the tower segment lies on a trailer, leads to the fact that there is almost no headroom left for the transport vehicle under the bridges. These make the transport of such a product challenging for the operator and the customers who burden the costs for route planning, reconstructions and time investments in the end. All roads, curves, bridges and bottlenecks must be checked and approved even before such an operation starts.

The network for such transportations can be divided into different parameters, according to transport means and cargo classes. The usage of suitable transport means depends on the weight and dimensions of the oversized cargo. Some cargo does not fit on a road truck, some need to be transported to various locations where no other access than by road is possible.

In such cases, where a high increase in oversized transports is expected, it might be efficient to build new connections, either road reconstructions or new railways (e.g. in the seaport hinterland in order to supply offshore wind parks). If such a need is confirmed, it may be reasonable to cluster oversize transport clients, since the conditions for a transport permit in Germany are the same for every business, regardless of the sector, company size or transport volume. However, there is no defined route, functioning as a corridor so far, since oversized cargo transported in this region is treated more or less individually.

South Baltic Sea region is not only a strategic location for new technological developments and construction, but also a very important transit market for oversized cargo. The main partners for the transit trade are Germany, the Scandinavian countries, Baltic States (with further connections to

Russia), Poland, and neighbouring countries to the south. The increasing demand for oversize transports in the Baltic States and Russia will strengthen the South Baltic Sea region even more as a transit and export market.

The region has the logistical potential to fulfil the requirements of the transport strategy for oversized transports, which will only increase in the future. The main transport routes already exist and will be renewed and enlarged over the next years. Also, the seaports are assumed to be well prepared for oversize transports and are able to fulfil the positions as logistics centres in the oversize transport network.

References

COM (2009/28)EC) (2009). Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

Kuehl, T., Lemmer, H. (2009). *Mehr Sicherheit fuer Grossraum- und Schwertransporte*, Polizei Verkehr + Technik, Vol. 54 176-7

Lukauskas, V. (2011). *A Guide to Oversize and Heavy Transport through Klaipeda Port*, Klaipeda, found under http://www.transportoversize.eu/files/Main/strategy/Oversize%20Transport%20Guidebook%20-%20Lithuania.pdf (21.05.2012)

2025 Forecast for Transport Interdependencies across Germany, found under http://www.bmvbs.de/cae/servlet/contentblob/43992/publicationFile/1131/2025-forecast-for-transport-interdependencies-across-germany-summary.pdf (21.05.2012)

Rebler, A. (2004). *Das System von Ausnahmegenehmigungen und Erlaubnissen nach der StVO und StVZO, dargestellt am Beispiel der Grossraum- und Schwertransporte*, NVZ Neue Zeitschrift für Verkehrsrecht, Vol. 17 450-2

SBSR Oversize Transport Strategy (2011) found under http://www.transportoversize.eu/files/Main/strategy/SBSR%20Oversize%20Strategy%202011.pdf (21.05.2012)

Trafikförordning (1998:1276) found under https://lagen.nu/1998:1276 (21.05.2012)

Transportstyrelsen (2005:102); found under http://www.transportstyrelsen.se/Global/Regler/TSFS_svenska/TSFS%202010/TSFS%202010-143.pdf (21.05.2012)

VEMAGS (2009). *VEMAGS Auswertung*, Hessisches Landesamt für Straßen- und Verkehrswesen

Wang, W.; Lu C.; Li Y.; Zhang H. (2007). *Basic Economic Measures in Long-term Effective Mechanism for Administering Overload and Oversize of Motor Vehicles.* Journal of Highway and Transportation Research and Development. Vol. 06

Yin X.; Wang Y.; Jia S. (2008). *Study on the Strategy of Managing Exceeding Limit and Overload Transportation Based on Transporter's Risk Preference.* Logistics Technology. Vol. 04

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Analysis of Short Sea Shipping-Based Logistics Corridors in the Baltic Sea Region

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Abstract: Despite recent turbulences in global economy, the growth of global trade volumes is expected to continue in the future, leading to increased demands on the performance of logistics networks. The political framework for EU (European Union) Transport Policy Development is presented in the EU White Paper on Transport 2011 in order to build a competitive European transport system. One significant aspect is the promotion of multimodal transport in order to decrease terrestrial transport services (road and rail) and to increase services in the maritime transport sector, especially considering the relief of road and railway infrastructure. Looking at the present situation, SSS (Short Sea Shipping) is already used in many different transport fields all around the world. However, there still exists a great potential which currently is not used or not sufficiently exploited for many different reasons. In order to identify the potential use of SSS in multimodal transport, different scenarios in the Baltic Sea Region and the adjoining hinterland have been developed pointing out alternative solutions for routing. These options are analyzed in detail and evaluated from different perspectives (i.e. transport and handling costs, time consumption and transport-related emissions). Afterwards, advantages and disadvantages of each alternative will be examined by taking into account economic and ecological aspects in making decision.

Key words: Short sea shipping, multimodal transportation, transport route optimization.

1. Introduction

Increasing globalization of industry and trade which is evermore being shaped by global dislocated structures of procurement, production and distribution results in significant demands set on the performance of (transport) logistics systems. In this respect, both the different transport modes and the macro logistic framework conditions, especially those concerning the transport and communications infrastructure, have been affected. Only in case of a (quantitatively and qualitatively) sufficient extent of these particular structures it will be possible to build and control internationally oriented supply chains in an efficient way (especially along with multimodal freight transport).

The main focus of this paper lays on development patterns in the Baltic Sea Region and its connection to the North Sea Area which for historical reasons might be regarded as one homogenous commercial space. This is particularly evident when referring to the structures of the Hanseatic League and its significant economic and political importance in the Middle Ages [1]. With regard to the geopolitical developments in the 20th Century, especially after the Second World War, these economic structures growing over the last centuries have been largely resolved as a result of political bloc buildings. After the collapse of the Soviet-dominated economic area of the COMECON (Council for Mutual Economic Assistance), now more than 20 years ago, however, the historically developed structures regained to a certain extent their traditional relevance, as the political boundaries have largely lost their meaning in many areas in the course of the EU (European Union) enlargement processes.

In 1994, Pan-European corridors were defined [2, 3]

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in order to meet changing demands in the Central and Southeast European Regions as well. These corridors have to ensure connections both to the former EU territory (westbound) and to the Russian Federation (eastbound). On the basis of traffic flows and developments forecasted as well as by bearing in mind political objectives regarding the realization of a (future) common European economic area, specific transport corridors were developed which must build the backbone of highly efficient transport network structures including the partly realized TEN-T (Trans European Transport Network) [4-7]. Major focus is put here on terrestrial systems of road and rail transport as well as freight transport on inland waterways [8, 9]. In the maritime field, the SSS [10-13] as well as the RSS (River Sea Shipping) are considered as the main transport modes [14, 15].

The provision and maintenance of the associated infrastructure in contrast to the largely deregulated (operational) transport execution is understood as a primary task of governmental responsibility [16, 17], even if this view has been critically discussed, especially when referred to the issue of non-state forms of financing [16, 18]. However, a strategic (and long-term) planning of basic structures is indispensable in order to ensure a cross-country consistency of the corridor or network structures [19] and an efficient linkage of various transport modes. Nevertheless, this can only be achieved under governmental auspices as well as by taking into consideration the balanced interests. The focus here is on the design of multimodal transport chains aiming to combine the system-specific benefits of available transport modes under economic and environmental aspects.

The following discussion places emphasis on the (multimodal) freight transport, since it plays a decisive role in international logistics and reveals the greatest potential in terms of a sustainable competitiveness. First, essential aspects of the structural design of transport corridors and related (traffic) logistic processes will be examined. Subsequently, possible transportation options between the North and the Baltic Sea are viewed and analyzed in terms of (technical and logistical) performance. In this respect, questions regarding the modal shift and prevention of traffic-induced emissions are dealt with. The paper concludes by providing statements for the design of sustainable transport concepts in the light of reasonable and cost-performance oriented aspects.

2. Structures of Transport Corridors

The modal-related infrastructure plays a crucial role in the design of transport corridors. In addition to the spatial implementation (or availability) and the capacitive design of routes as well as their intermodal network, the logistics facilities are essential too. Here, there is a need to cover different transport modes which demonstrate differentiated case-related benefits due to the general framework. With regard to the efficient organization of operational processes, the field of partly mode-specific ICT (information and communication technologies) systems should be considered as another significant factor. This requires the use of high-performance ICT-based systems for planning as well as for monitoring and control. The discussion below proceeds by briefly reviewing and analyzing these four particular areas.

2.1 Network Structures

In order to design more efficient processes for the multimodal transport, especially in combination with transcontinental and intercontinental structures of demand, appropriate network structures are needed to map the existing (and future) flows of goods. Since these are not dependent on national boundaries but rather are subject to structural realities of the economic areas, a cross-border (and cross-mode) coordination of the infrastructure is absolutely necessary [19], as well as the efficient use of available investment funds. This means that it is primarily a political task which, in addition to the development of regional structures, also has to integrate the needs of spatial linkages of the economy.

On this basis, higher-level structures necessary for the design of transport processes at the macro logistical level emerge within the EU sphere (including neighboring countries) through the Pan-European corridors along with the TEN-T projects. Currently, there are defined ten corridors [2, 3, 20] and 30 priority TEN-T projects [4-7] as shown in Figs. 1-2. Regardless of the actual status of planning and implementation, they form a (European-wide) framework for a targeted development as well as a restructuring and expanding of the (transport logistics) macrostructures. However, the potential performance of area-wide network structures can only be achieved due to consistent implementation which is currently not yet (or only with limitations) possible because of the time required for the planning and realization. Additionally, there exist financial restrictions in the public sector as well as general discussions concerning upcoming application for financing [21].

Although these basic structures are essential from the transport and economic point of view, they are, however, subject to some critical remarks [22]. Major criticism points to the concentration of transport investments in the existing economic structures. As a result, a key objective of the EU emphasizing the harmonization of living conditions, e.g. the EU-wide economic and social cohesion, is being neglected. Therefore, it has to be counteracted that investments with limited availability lead to a significant restriction resulting in forced setting of priorities. Besides, the EU-wide competition and the resulting development opportunities can only be realized if a sufficient mobility of people and goods is ensured.

Fig. 1 Overview TEN-T projects.

Fig. 2 Overview Pan-European corridors.

2.2 Logistics Facilities

In transport networks, the nodes provide not only the starting and destination points of transport flows but also the basis for a targeted organization of flows of goods. In this light, the structuring of multimodal transport chains has the priority within the intercontinental and transcontinental supply chains [23-27]. The nodes are regarded as logistics facilities with (hierarchical) varying functionality and dimensioning. The focus here is on the bi-modal or tri-modal combinations of different transport modes and, in an extended form, on the provision of services in the field of warehousing, distribution, and (logistics related) services [28-30].

Within the basic structures (in terms of the transport functions) the following (maritime and terrestrial) facilities can be located:

- SCT (seaport container terminals) with international hub function and multimodal linkages [26, 31-35], within trunk and feeder networks. Considering the area in question the focus lays primarily on the SCT of the north range along with the dominant ports in this region of Antwerp, Rotterdam and Hamburg;
- Regional and local SCT in the SSS with a normally restricted hinterland constitute the predominant form, e.g. in the Baltic Sea Region;
- Inland ports with regional and local function and, if it is applicable, in connection to the RSS (river-sea shipping);
- Hinterland terminals with supra-regional function (e.g. in the form of MegaHubs with the focus on rail/road transshipments) [26, 31, 34, 37, 38];
- Regional and local transshipment terminals with (bi- or multimodal) cargo transport, especially taking into account the access to railway freight transport.

The crucial point appears to be in this context the scale of investments required for the handling equipment and its payback, especially in case of local and regional facilities. In terms of the (currently) available solutions [39] terminals with lower turnover levels can rarely be operated economically thus reducing potential rail/road transshipment possibilities and restricting the access to rail transport. Different technologies in a simplified (and therefore cost-efficient) horizontal cargo handling, e.g. the system Mobiler (or Cargo Domino) [40, 41] and the (rolling highway) system ModaLohr [42, 43] are already being tested operationally. Whether these technical solutions are likely to be sustainable ones from operational and economic perspective it still needs to be proven.

By integrating further features into the design of logistics facilities, e.g. warehousing, distribution and services, the following basic forms can be distinguished (primarily related to the logistical hinterland structures) which comprise a hierarchically graded structure [28, 44-46]:

- Freight villages with supra-regional (or international) relevance [45, 47, 48] which should serve as a basis for the European-wide network of freight transport;
- Regional freight distribution centers for a spatially limited aggregation and disaggregation of freight flows [49]. These can also be Dedicated Warehouses [45] which, for instance, have been operated by logistics service providers on behalf of (online) retail trading companies;
- City terminals or UCC (urban consolidation centers) along with a locally oriented distribution in major cities as well as metropolitan areas [50-53]. In this case, the objective is to take full advantage of bundling effects (e.g. including city logistics concepts) as well as enable a customer oriented delivery of goods.

A schematic overview of the structural contexts of the logistics facilities concerned is given in Fig. 3.

In practice, however, the above listed (basic) forms with a largely clear delineation are rarely to be found. The rationale behind this might be the very complex objectives associated with freight facilities as a result of different interests of participants (and stakeholders) [45]. Therefore, with regard to particular structural conditions, facilities adapted functionally and spatially should be taken as a starting point. This is the case, in particular, when dealing with the question of generating synergy effects, e.g. by spatial linkages between rail/road hinterland terminals and logistics facilities [25]. Accordingly, these facilities are reflected through functional combination of services in transportation, warehousing and logistics service providing. Similar development patterns emerge in the SCT as well [54, 55].

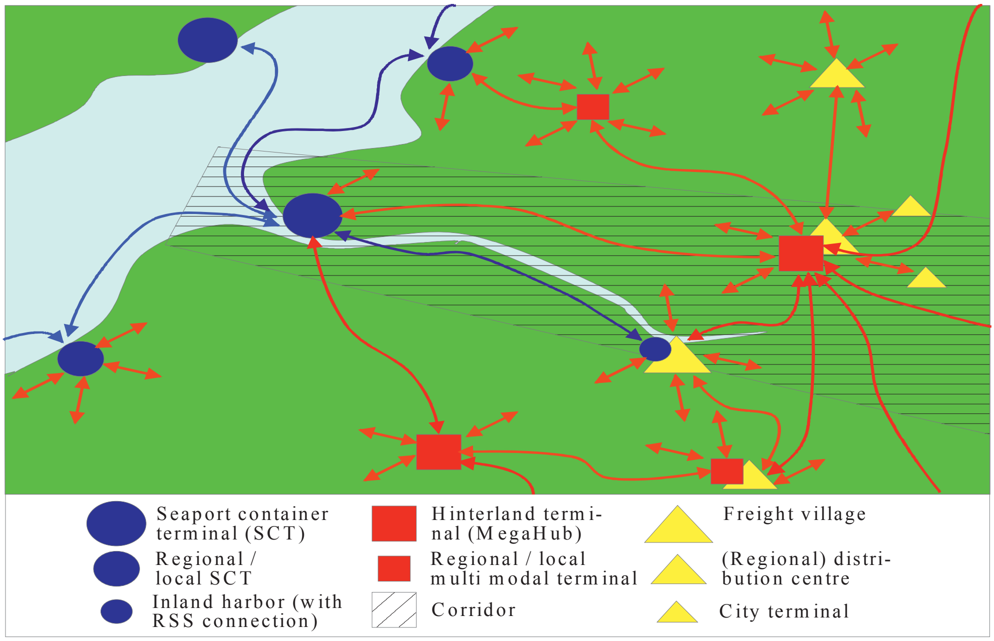

Fig. 3 Corridor formation and network of logistics facilities.

2.3 Transport Modes

Available transport modes with the transport systems truck, rail and barge (in inland waterway transport) as well as vessels in the SSS and the RSS can be described by systemic (qualitative and quantitative) performance indicators that are referred to as values of transportation services. These enable a comparison according to their technical and functional capabilities in transport operations [56, 57]:

- Quickness of transport operations: sum of driving speed and the (technically or organizationally related) dwell time which, in this context, may not be understood as punctuality in terms of process control system;
- Ability for bulk goods forwarding: available capacity of the transport mode used and the amount of costs for transporting a unit of weight or volume of a given good;
- Ability to form (dense) networks: possibility of establishing direct transportation links between shippers and customers, e.g. if pre-carriage and on-carriage operations become necessary, the ability to form a transportation network is reduced;
- (Time-related) predictability of transport operations: this indicator implies the compliance with the service times scheduled (on the basis of timetables) as well as ensuring the planned duration of transportation services;
- Frequency of available transport services in a given period of time and on specific routes: scope of operations, depending on the amount of existing potentials on the routes concerned;
- Security and free of malfunction: appearance of external influences on transport operations that hamper the continuity of operational flows;
- Convenience: presence of possibilities to access the transportation networks, e.g. what effort is required to initiate the transport execution by applying an appropriate mode of transport.

An assessment of the transport modes according to their (economic and technical) performance indicators is shown in Table 1.

Table 1 Comparison of systems on the basis of economic efficiency.

Performance indicators	Transport mode					
	Truck	Train	Barge	(Deep) sea vessel	Air-craft	Net-works*
Quickness of transport services	++	+	-	-	++	+
Ability to forward bulk goods	--	++	++	++	--	++
Ability to form (dense) networks	++	-	-	--	-	--
(Time-related) predictability of transportation services	+	+	o	o	+	+
Frequency of available transport services	++	o	o	-	o	++
Security and free of malfunctions	o	++	+	+	++	++
Convenience (access to available transport modes)	++	-	-	--	--	-

Rating: ++ Excellent / + Good / o Indifferent / - Not so good / -- Poor
* Pipeline, tube, and cable networks

However, in this respect, the organizational framework needs to be considered which has significant impact on the efficiency of service providing processes, as it is currently the case, in particular, in the rail freight transport [58, 59].

By leaving aside such points of discussion, with regard to the efficiency and sustainability in transport execution the focus should be put on the multimodal transport chains, rather than the use of individual transport modes (usually the road transport), even if this kind of transportation is technically possible. A high performance quality is only achieved due to a demand-oriented combination of the positive performance indicators of diverse transport modes, i.e. within network structures. However, there cannot be a universally applicable standard solution, since the transportation and logistical needs of shippers influence the necessary framework.

2.4 Information and Communication Systems

Powerful ICT systems serve as inevitable prerequisite for an efficient (and sustainable) planning, monitoring and control of (transport-related) logistics processes [60]. In addition to the systems in macro logistics sector, there exist three further application areas at the operational level [61]. These ones need to be regarded as differentiated.

ICT systems related to infrastructure within the (modal-related) control, signaling and safety technology which are used to monitor and control traffic flows at the macro logistics level. In this context, these are, for instance, the ERTMS (European Rail Traffic Management System) [62] or the RIS (River Information Services) [63, 64]. Both of them are currently being established (within the EU). These particular systems serve primarily for the technical supervision and control of operations that influence the structuring of transportation processes.

ICT systems applied in logistics facilities as a basis for (computer-aided) co-operation of all enterprises and (public) institutions in this sector. The main focus here is on planning and monitoring internal processes and, to a certain extent, external interconnections as well. The DAKOSY system (Data Communication System of the Port of Hamburg) can serve as an example [65].

User-group-related ICT systems for computer-aided interconnection of (closed) groups or individual sectors, such as the ELWIS (Electronic Waterway Information System) for inland waterways in the Federal Republic of Germany [66] or the IATA CASS (IATA Cargo Accounts Settlement System) used within the air freight transport operations [67]. Internal ICT systems can be used for planning, monitoring and control of internal (as well as cross-company) processes. These involve software tools, e.g. for computer-aided planning and control of transportation processes as well as fleet management systems used in the road (freight) transport [68-70], for instance, the system Fleet Board [71].

In order to ensure an adequate performance of the computer-aided systems used on different levels, there is an absolute necessity to link these particular systems based on clearly defined interfaces with corresponding protocols. Therefore, only a precisely timed and media-break free design of all information flows can meet the requirements on the (internal and external) information management within the logistical monitoring which are increasingly growing due to work-sharing structures.

2.5 Design Framework

(Technical) principles on the efficient management and the customer-oriented implementation of (transport) logistical tasks discussed in the previous four sections have to be understood as a long-term objective. In order to implement this objective through appropriate measures it is essential to ensure the consistent development of existing transport infrastructure and logistics facilities as well as of the administrative and legislative framework in particular. Only if these conditions are achieved timely and spatially adjusted on the European and national level, particular prerequisites are satisfied enabling to form a suitable (largely meshed) network structure which makes it possible to determine efficient connections in the multimodal transport.

Beyond that, different objective functions are considered to be essential too, also with regard to the issue of sustainability in transport processes. In addition to the three classic criteria, transport distances, transport times and transport costs, the issue of modal-related pollution subject to often debates needs to be involved into consideration as well, especially in terms of CO_2 emissions. The problematic nature of the issue concerned became increasingly dealt with in the traffic-policy discussions in recent years as well by analyzing practical applications, primarily associated with the objective to develop and implement the concepts of a Green Logistics [72]. However, in practice, it can be seen again and again that the cost aspect continues to dominate the logistical planning, unless a customer, for example, in case of taking appropriate decisions on energy procurement, consciously accepts higher transport costs with the clear purpose to convey a positive image of the company to the public. For such primarily marketing-based decisions, it has been often ignored that an efficient logistics per se involves both economic and ecological aspects. For example, a reduction in mileage needed to handle a given order volume does not only save money but, at the same time, implies a lower resource consumption thus reducing traffic-related emissions.

Based on the selected examples, the next chapter presents and compares possibilities of multimodal transport in the North and Baltic Sea Region by taking into account the Central Eastern and Eastern European Region as well. The focus of the following discussion is the problematic nature of multi-criteria objective structures and how do they result in the course of the implementation of transport-logistic tasks. Starting from a (meshed) network structure, possible links between the locations of shippers and customers are considered which involve different transport modes and in different combinations. The objective here is not to analyze and evaluate different transport processes from general aspects [73], but, in turn, to scrutinize specific transport demands in terms of operational planning by bearing on existing infrastructure. However, it cannot be excluded that inefficiencies observed are not discussed in detail due to structural shortcomings and no measures adopted.

3. Multimodal Transport Chains on the Basis of Corridors

Within the European transport policy, as discussed above, the development of transport corridors along with multimodal transport chains is of great importance, especially with regard to the integration of TEN-T structures as well as Pan-European corridors. This is particularly the case in the North Sea and the Baltic Sea regions and the neighboring Central Eastern and Eastern European and Scandinavian hinterland transport processes. This also concerns the railway projects going beyond these regions, such as the connection between the Baltic and the Black Sea (Viking Train Project) [74] or the direction towards Moscow (Mercury Train Project) and further into the Asian region [75, 76]. Intensively discussed approaches concerning the realization of a shift from time-consuming sea transports due to a direct European-Asian rail link appear to be irrelevant in respective discussions, since in terms of low capacities these have (and will have in the future) a comparatively poor impact [3]. Currently, a capacity of up to 300,000 TEUs has been recorded which can be expanded to 1,000,000 TEUs in the medium term. Despite this fact it does only constitute a small fraction of the most important SCT container throughput on the Northern Range [31].

The core element of the corridor formation is therefore the maritime transport [4, 77], including some areas of the TEN-T Priority Projects No. 21 (Motorways of the Sea) [78] and the SCT of the Northern Range which are seen as inter- and transcontinental gateways to the Baltic Sea. Additionally, terrestrial TEN-T projects (No. 11, 12, 20, 23, 25, and 27) and Pan-European corridors (No. I-III, VI, and IX) which are relevant to the hinterland of the Baltic Sea Region need to be considered.

As a starting point in these particular studies [79] serves a basic structure with ten port regions or locations and logistics facilities in the eight hinterland corridors (Fig. 4), logistics facilities and (modal-related) infrastructure available constitute the foundation for a cross-border network structure within the area inquestion. In order to plan the transport processes the core element has been expanded by relevant locations of shippers and customers. Consequently, the potential transport routes between the point of origin and the destination can be described in order to undertake their analysis and evaluation. This is done (in a coarse structure) based on the criteria already mentioned: distance, time and costs as well as the CO_2 emissions as a result of transport execution. A central question here is that to what extent a varying choice of transport is possible depending on various criteria. Besides, the analysis deals with the extent to which diverse transport chains differ in terms of individual criteria.

To investigate the performance of diverse transport chains, the following two examples from Leeds (GB) to Jonava (LT) and from Neumarkt/Upper Palatinate

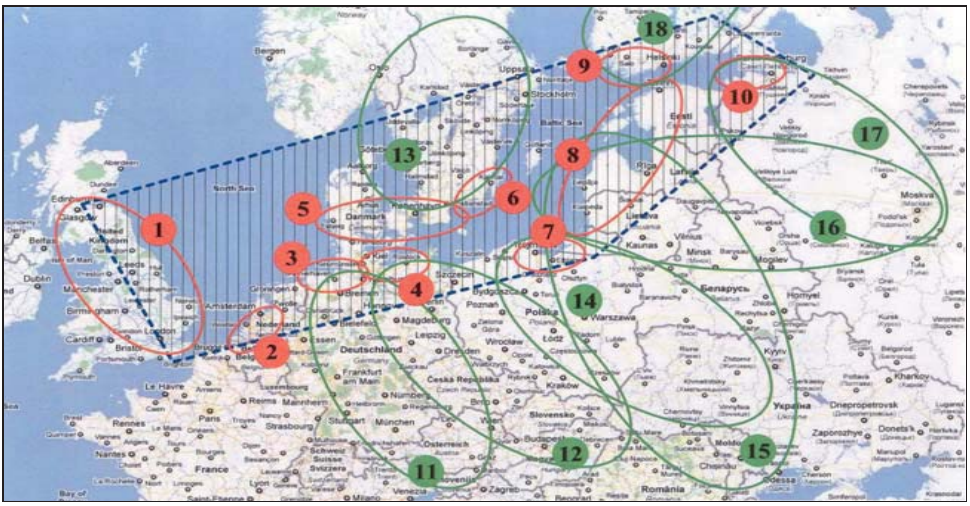

Fig. 4 Basic structure of multimodal networks in north and Baltic sea region.

(D) to Tampere (SF) are analyzed. According to the available transport modes and logistics facilities, the different multimodal transport chains can be designed (Figs. 5 and 6 as well as Tables 2 and 3). The calculation is made for the transport of a 40-feet standard container.

In order to compare the diverse multimodal routes for the considered examples, first, particular distances have to be determined based on distance data in the existing network structures. Consequently, on the basis of these data (by taking into account infrastructure-based restrictions and legal conditions, for instance, permitted work time, driving and rest times) transport times have been determined in terms of the distance-dependent average speed (based on information gathered from transport companies and forwarders), as long as there no precise timetable data are available. Cost factors used for calculations are likewise based on requests and constitute average values. In addition to these ones, times and costs of operations within the transshipment nodes are included as well, where a period of 24 hours and costs of € 150.00 have been applied. An exception applies in case of rail/road transshipment with six hours and € 25.00 is used.

Regarding the discussion about the (negative) environmental impacts of (freight) transport a CO_2 emission factor is calculated for the diverse transport chains, provided that the road freight transport accounts for 0.065 kg/t·km, the rail freight transport for 0.023 kg/t·km, the transport on inland waterways for 0.015 kg/t·km and the SSS for 0.018 kg/t·km. These particular values are referred to as average values, since a precise calculation of energy consumption [80, 81] depends on diverse influencing factors. Primarily these are topography of routes, status

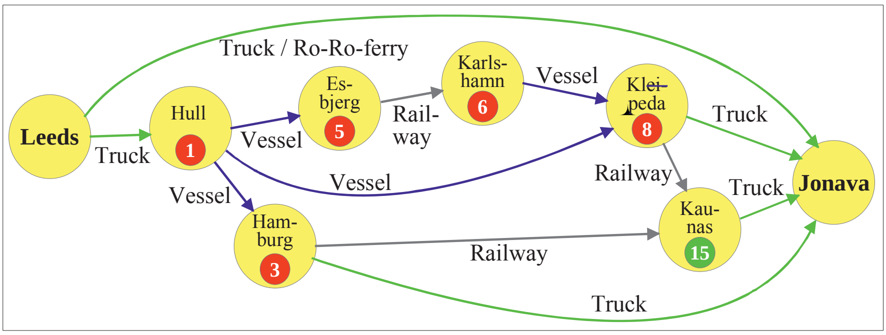

Fig. 5 Network of example 1 (Leeds (GB)-Jonava (LT)).

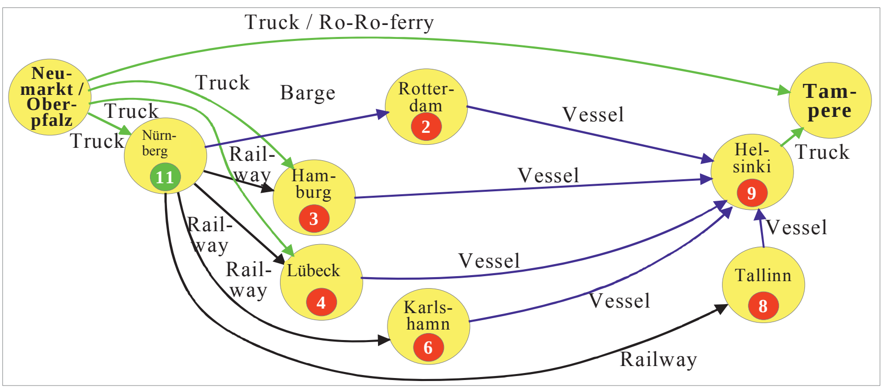

Fig. 6 Network of example 2 (Neumarkt (D)-Tampere (SF)).

Table 2 Transport chains of example 1 (Leeds (GB)-Jonava (LT)).

	Multimodal transportation chains
(1.1)	Leeds-(Truck/Ro-Ro-ferry)-Jonava
(1.2)	Leeds-(Truck)-Hull-(Sea going vessel)-Hamburg-(Truck)-Jonava
(1.3)	Leeds-(Truck)-Hull-(Sea going vessel)-Hamburg-(Railway)-Kaunas-(Truck)-Jonava
(1.4)	Leeds-(Truck)-Hull-(Sea going vessel)-Klaipeda-(Truck)-Jonava
(1.5)	Leeds-(Truck)-Hull-(Sea going vessel)-Klaipeda-(Railway)-Kaunas-(Truck)-Jonava
(1.6)	Leeds-(Truck)-Hull-(Sea going vessel)-Esbjerg-(Railway)-Karlshamn-(Sea going vessel)-Klaipeda-(Truck)-Jonava
(1.7)	Leeds-(Truck)-Hull-(Sea going vessel)-Esbjerg-(Railway)-Karlshamn-(Sea going vessel)-Klaipeda-(Railway)-Kaunas-(Truck)-Jonava

Table 3 Transport chains of example 2 (Neumarkt (D)-Tampere (SF)).

	Multimodal transportation chains
(2.1)	Neumarkt-(Truck/Ro-Ro-ferry)-Tampere
(2.2)	Neumarkt-(Truck)-Hamburg-(Sea going vessel)-Helsinki-(Truck)-Tampere
(2.3)	Neumarkt-(Truck)-Lübeck-(Sea going vessel)-Helsinki-(Truck)-Tampere
(2.4)	Neumarkt-(Truck)-Nürnberg-(Barge)-Rotterdam-(Sea going vessel)-Helsinki-(Truck)-Tampere
(2.5)	Neumarkt-(Truck)-Nürnberg-(Railway)-Hamburg-(Sea going vessel)-Helsinki-(Truck)-Tampere
(2.6)	Neumarkt-(Truck)-Nürnberg-(Railway)-Lübeck-(Sea going vessel)-Helsinki-(Truck)-Tampere
(2.7)	Neumarkt-(Truck)-Nürnberg-(Railway)-Karlshamn-(Sea going vessel)-Helsinki-(Truck)-Tampere
(2.8)	Neumarkt-(Truck)-Nürnberg-(Railway)-Tallinn-(Sea going vessel)-Helsinki-(Truck)-Tampere

of infrastructural development, vehicles used and cargo that, in turn, may vary within the transport process. The values employed are based on data published by [80-82]. The results of calculations are presented in Tables 4 and 5. It should be mentioned that the results for total distances, duration, and costs are calculated in total for the route, whereas the value for CO_2 emissions is dependent on the transported tons.

The calculations are undertaken based on average values as well as in terms of time and cost of the transport modes. Respective values might be lower in case of an appropriate synchronization of the processes (for example, by coordinating the arrival and departure times in schedule-based transshipment terminals). In unfavorable constellations, however, there can be observed the rise of transport duration. Additionally, the arising actual costs of transportation and handling have to be considered as well, since these are dependent on the extent of services requested and are widely treated as the result of (bilateral) negotiations.

The results gathered imply that in both cases there is no clear best solution having generated the lowest values regarding the essential criteria of transportation time, transportation costs and CO_2 emissions. In detail, the following picture has been observed.

Costs: the lowest cost constellations emerge in case of a high proportion of the SSS, whereas the transport by road (and rail) tends to result in higher costs. The reason behind this result is the bundling effect in the SSS as well as the disadvantages of road and rail freight transport inherent in the particular system.

Transport duration: a high proportion of transportation services by truck lead to the most favorable solution, while the rail freight appears to generate significant disadvantages. The performance indicators of these two transport modes comply with this result as well. A very good infrastructure for a (mono-modal) road transport is available and allows a high flexibility in operations, whereas the rail system is more fixed and therefore unveils some inefficiency, especially in single wagonload transport.

CO_2 emissions: A large proportion of the SSS in the transport execution also compared to the rail freight transport (apart from the version 2.4 which shows unfavorable values deriving from the total length of

Table 4 Results of example 1 (Leeds (GB)-Jonava (LT)).

	Distances (km)					Duration (h)	Costs (€)	CO_2 emissions[1]
	Truck	Railway	Barge	Sea going vessel	Total			
1.1	2,270			150	2,420	110	3,320	150.25
1.2	1,410			710	2,120	137	1,880	104.43
1.3	130	1,320		710	2,160	205	2,200	51.59
1.4	340			1,710	2,050	119	1,130	52.88
1.5	130	320		1,710	2,160	136	1,250	46.59
1.6	340	500		1,020	1,860	168	1,870	51.96
1.7	130	820		1,020	1,970	185	1,990	45.67

[1] kg/t·km

Table 5 Results of example 2 (Neumarkt (D)-Tampere (SF)).

	Distances (km)					Duration (h)	Costs (€)	CO_2 emissions[1]
	Truck	Railway	Barge	Sea going vessel	Total			
2.1	1,880			90	1,970	110	2,600	123.82
2.2	810			1,395	2,205	113	1,820	77.76
2.3	900			1,150	2,050	106	1,840	79.20
2.4	220		960	2,145	3,325	252	1,700	67.31
2.5	220	600		1,395	2,215	138	1,465	53.21
2.6	220	650		1,150	2,020	131	1,445	49.95
2.7	220	1,250		830	2,300	141	2,365	57.99
2.8	220	2,050		90	2,360	202	2,535	63.07

[1] kg/t·km

transportation distance) is considered as an advantageous one. A proportionate increase of the road freight transport operations, however, yields clearly less favorable values (as to be seen in solutions 1.1, 1.2 and 2.1). Nevertheless, new regulations like the EURO-VI-norm for diesel engines will lead to significant changes regarding pollution emissions thus changing the prevailing relations.

In general, it becomes obvious that the rail freight possesses only comparatively little favorable values, although, by taking into account the performance characteristics, quite different results should be expected. Besides the lack of (technical) interoperability [5, 62, 59] in the cross-border traffic, the reason behind this statement can be traced back to different gauge sizes, different voltage of the power supply systems and not or only partially compatible signaling and control technologies. In addition, there are (still existing) inefficiencies in the organizational processes [58] along with the lack of or an underdeveloped competition derived from the not consistently enforced deregulation. One important aspect in this respect is the missing (or only partially realized) separation of responsibilities for the rail network infrastructure and operational services.

By reason of indifferent structures of the attained solutions resulting from the lack of comparability of the various criteria, it makes sense to apply a modified rating process. Here starting from the results regarding three criteria: duration of transportation processes, transportation costs and transport-related CO_2 emissions. The calculated values are set in relation to the accordingly best result of each criterion (basic value). Subsequently, the percentage deviation from this basic value was calculated for each alternative (in accordance with the Savage-Niehans rule [83] in order to get a standardized basis for the all three criteria concerned. By applying this particular scaling the diverse dimensions of the criteria are neutralized allowing a comparison. The objective to apply this procedure is to find sufficient results in the sense of Pareto-optimal solutions to provide a better support for decision makers. The Tables 6 and 7 present the results for both examples.

Five solutions in the first example yield very bad results and are therefore not recommended for application. Only solution 1.4 and 1.5 should be realized. Although solution 1.4 appears to be the best result in this context, solution 1.5 is worth to be discussed. Nevertheless, solution 1.4 has significant advantages with regard to transport duration and transport costs but, in turn, yields bad values regarding emissions. Since the only disadvantage of the solution 1.5 is the transport duration, it can be considered to improve the transport processes and handling times due to better planning in advance. Therefore, if only the transportation costs and the emissions are taken into account, there cannot be any definite decision. The second example, on the contrary, delivers a very clear result. Solution 2.6 generated for this example seems to be not the best one only in terms of the transport duration, whereas regarding the transportation costs and emissions it definitely proves to be the best alternative. Here as well, a possible improvement of transport processes would compensate the disadvantage concerned.

Table 6 Assessment of the results for example 1 (Leeds (GB)-Jonava (LT)).

	Duration	Costs	CO_2-emissions	Score
1.1	0.000	1.938	2.290	4.228
1.2	0.245	0.664	1.287	2.196
1.3	0.864	0.9	0.130	1.941
1.4	0.082	0.000	0.158	0.240
1.5	0.236	0.106	0.020	0.362
1.6	0.527	0.655	0.138	1.320
1.7	0.682	0.761	0.000	1.443

Table 7 Assessment of the results for example 2 (Neumarkt (D)-Tampere (SF)).

	Duration	Costs	CO_2-emissions	Score
2.1	0.038	0.799	1.479	2.316
2.2	0.066	0.260	0.557	0.883
2.3	0.000	0.273	0.586	0.859
2.4	1.377	0.176	0.348	1.901
2.5	0.302	0.014	0.065	0.381
2.6	0.236	0.000	0.000	0.236
2.7	0.330	0.637	0.161	1.128
2.8	0.906	0.754	0.263	1.923

4. Conclusions and Outlook

The design of multimodal transport chains within the freight transport does not yield any (in a mathematical sense) optimal solution, since the cases examined imply multi-criteria decision problems that always result in compromise solutions. Crucial in this light is the transport-technical and administrative framework on the one hand and the time- and quality-related requirements on the part of the shippers on the other. In addition, traffic and environmental issues play an increasing role which under the aspects of competition (that means in terms of cost situation) appears to be rather of secondary importance. These ones will remain, unless any other aspects will change these priorities, as e.g. by legal requirements or image profiling measures of a company.

The implementation of the politically desired prioritization of multimodal transport presupposes the use of appropriate measures taken by the responsible (political and public-law) institutions as well as by the providers of logistics services. In addition to the targeted (and to the corridor structures oriented) development of transport infrastructure, the transshipment facilities (as intermodal links) must be covered to a sufficient extent as well. This applies mainly to the rail transport. Accordingly, significant improvement potential was created for the rail transport by implementing respective measures (e.g. the creation of MegaHubs) [37, 59]. Restructuring and expanding initiatives as well as development activities within the field of infrastructure are the most important steps in order to achieve a supply-oriented design of transport chains thus ensuring sustainable development of logistics structures.

As the results of the two examples examined indicate, solutions can be achieved due to suitable infrastructural requirements (and associated service offerings), where the criteria for solutions are not considered to be totally opposite. In other words, there are acceptable compromise solutions, especially with respect to transport costs and CO_2 emissions. However, these results must always be understood as a decision option, that means, which transport process is being executed is an operational decision considering the case-specific requirements. The information about available alternatives may influence decisions, even with a view to better integration of environmental aspects (at a corresponding cost situation).

References

[1] U.C. Ewert, S. Selzer, Network organization in long-distance retail trade in the Middle Ages—Competitive advantages or hinderance to growth, in: H. Berghoff, J. Sydow (Eds.), Business Networks—A Historical form of Organization for the Future, Kohlhammer, Stuttgart, 2007, pp. 45-70. (in German)

[2] HB-Verkehrsconsult GmbH/VTT Technical Research Center of Finland, Pan-European transport corridors and areas status report, Project N° TREN/B2/26/2004 European Commission DG Energy & Transport (Final Report), Belgium, 2005.

[3] E. Vinokurov, M. Dzhaddraliyev, Y. Shcherbanin, The EurAsEC transport corridors, MPRA-Paper No. 20908, 2009, http://mpra.ub-uni-muenchen.de/20908 (accessed Nov. 14, 2012).

[4] A.J. Baird, The economics of motorways of the sea, Maritime Policies & Management 34 (2007) 287-310.

[5] G. de Ceuster, T. Voge, M. Chen, M. de Kievit, J. Laird, A. Koh et al., Trans-European transport network planning methodology—Final report, Report for European Commission DG MOVE, TREN/R1/350-2008 lot2, Belgium, 2010.

[6] C. Dionelis, M. Giaoutzi, The enlargement of the European Union and the emerging new TEN transport patterns, in: M. Giaoutzi, P. Nijkamp (Eds.), Network Strategies in Europe—Developing the Future for Transport and ICT, Ashgate, Aldershot, Burlington, 2008, pp. 119-132.

[7] A. Stratigea, M. Giaoutzi, C. Koutsopoulos, European policy aspects of network integration in the TEN transport, in: M. Giaoutzi, P. Nijkamp (Eds.), Network Strategies in Europe—Developing the Future for Transport and ICT, Ashgate, Aldershot, Burlington, 2008, pp. 169-187.

[8] T.E. Notteboom, Inland waterway transport of containerised cargo—From infancy to a fully-fledged transport mode, Journal of Maritime Research 4 (2) (2007) 63-80.

[9] J. Rohács, G. Simongáti, The role of inland waterway navigation in a sustainable transport system, Transport 22 (2007) 148-153.

[10] J.R. Daduna, Short sea shipping and river-sea shipping in the multi-modal transport of containers, International Journal of Industrial Engineering—Theory, Applications and Practice, 2011.

[11] A.K.Y. Ng, Competitiveness of short sea shipping and the role of port—The case of North Europe, Maritime Policies & Management 36 (2009) 337-352.

[12] A.C. Paixão Casaca, P.B. Marlow, Logistics strategies for short sea shipping operating as part of multimodal transport chains, Maritime Policy & Management 36 (2009) 1-19.

[13] L. Styhre, Strategies for capacity utilization in short sea shipping, Maritime Economics & Logistics 11 (2009) 418-437.

[14] M. Kaup, Functional model of river-sea ships operating in European system of transport corridors—Part II, Polish Maritime Research 15 (4) (2008) 3-11.

[15] Z. Radmilović, R. Zobenica, V. Maraš, River-sea shipping—Competitiveness of various transport technologies, Journal of Transport Geography, article in press 19 (6) (2011) 1509-1516.

[16] G. Aberle, Transport Economics, 5th ed., Oldenbourg, München/Wien, 2009. (in German)

[17] A. Knorr, Public weal and service provision of elementary requirements for the infrastructure, in: K.H. Hartwig, A. Knorr (Eds.), New Developments in Infrastructure Policy, Vandenhoeck & Ruprecht, Göttingen, 2005, pp. 31-53. (in German)

[18] A. Eisenkopf, Public private partnerships—About the role of public-private cooperation for providing traffic infrastructure in Germany, in: K.H. Hartwig, A. Knorr (Eds.), New Developments in Infrastructure Policy, Vandenhoeck & Ruprecht, Göttingen, 2005, pp. 155-173. (in German)

[19] J. Gutiérrez, A.C. Melhorado, E. López, A. Monzón, Evaluating the European added value of TEN-T projects—A methodological proposal based on spatial spillovers, accessibility and GIS, Journal of Transport Geography 19 (2011) 840-850.

[20] C. Reynaud, The concept of corridors and networks in developing Pan-European infrastructure, in: The seminar Transport Infrastructure Development for a Wider Europe, Paris, Nov. 27-28, 2003, http://unpan1.un.org/intradoc/groups/public/documents/untc/unpan013027.pdf (accessed Sep. 19, 2011).

[21] S. Proost, F. Dunkerley, B. de Borger, A. Gühnemann, P. Koskenoja, P. Mackie et al., When are subsidies to trans-European network projects justified?, Transportation Research (Part A) 45 (2011) 161-170.

[22] D. Peters, Cohesion, policentricity, missing links and bottlenecks—Conflicting spatial storylines for Pan-European transport investments, European Planning Studies 11 (2003) 317-339.

[23] K. Hayashi, T. Nemoto, Intermodal freight transport, in: D.W. Song, P.M. Panayides (Eds), Maritime Logistics, KoganPage, London et al., 2012, pp. 45-58.

[24] P.M. Panayides, D.W. Song, Evaluating the integration of seaport container terminals in supply chains, International Journal of Physical Distribution and Logistics Management 38 (2008) 562-584.

[25] J.P. Rodrigue, J. Debrie, A. Fremont, E. Gouvernal, Functions and actors of inland ports—European and North American dynamics, Journal of Transport Geography 18 (2010) 519-529.

[26] J.P. Rodrigue, T. Notteboom, The terminalization of supply chains—Reassessing the role of terminals in port/hinterland logistical relationships, Maritime Policy & Management 36 (2009) 165-183.

[27] J.P. Rodrigue, T. Notteboom, Comparative North American and European gateway logistics—The regionalism of freight distribution, Journal of Transport Geography 18 (2010) 497-507.

[28] D. Grundey, K. Rimiené, Logistic centre concept through evolution and definition, Engineering Economics 54 (4) (2007) 87-95. (in German)

[29] A. Jaržemskis, Research on public logistics centre as a tool for cooperation, Transport 23 (3) (2007) 202-207.

[30] L.M. van der Lugt, P.W. de Langen, The changing role of ports as locations for logistics activities, Journal of International Logistics and Trade 3 (2005) 59-72.

[31] J.R. Daduna, Importance of hinterland transport networks for operational efficiency in seaport container terminals, in: J.W. Böse (Ed.), Handbook of Terminal Planning, Springer, New York et al., 2011, pp. 38-397.

[32] H.S. Nam, D.W. Song, Defining logistics hub and its application for ports, in: D.W. Song, P.M. Panayides (Eds.), Maritime Logistics, KoganPage, London et al., 2012, pp. 195-209.

[33] T. Notteboom, Bundling of freight flows and hinterland network developments, in: R. Konings, H. Priemus, P. Nijkamp (Eds.), The Future of Intermodal Freight Transport—Operations, Design and Policy, Elgar, Cheltenham, Northhampton, MA, 2008, pp. 66-88.

[34] V. Roso, A. Rosa, Dry port concept and practice, in: D.W. Song, P.M. Panayides (Eds.), Maritime Logistics, KoganPage, London et al., 2012, pp. 179-193.

[35] V. Roso, J. Woxenius, K. Lumsden, The dry port concept—Connecting container seaports with the hinterland, Journal of Transport Geography 17 (2009) 338-345.

[36] K. Alicke, Modelling and optimization of the intermodal terminal Mega Hub, in: OR Spectrum 24, Berlin, 2002, pp. 1-17.

[37] S. Limbourg, B. Jourquin, Optimal rail-road container terminal locations on the European network, Transportation Research (Part E) 45 (2009) 551-563.

[38] J.P. Rodrigue, The Thruport concept and transmodal rail freight distribution in North America, Journal of Transport Geography 16 (2008) 233-246.

[39] J. Woxenius, Alternative transport network designs and their implications for intermodal transhipment technologies, European Transport 35 (2007) 27-45.

[40] T. Becker, S. Dünnbier, Cargo domino— Efficient rail freight transport with and without railroad siding, ZEVrail Glasers Annalen 126 (2002) 168-175. (in German)

[41] D. Bruckmann, Containerization of wagonload transport—Development of a method for estimation of containerisable amount in wagonload transport and optimization of process structure, Ph.D. Thesis, University of Duisburg-Essen, 2006. (in German)

[42] B. Dalla Chiara, F.P. Deflorio, D. Spione, The rolling road between the Italian and the French Alps—Modelling the modal split, Transportation Research (Part E) 44 (2008) 1162-1174.

[43] A. Deutsch, ModaLohr—A new alternative in multimodal transport?, Internationales Verkehrswesen 59 (2007) 284-287. (in German)

[44] E. Nathanail, Developing an integrated logistics terminal network in the CADES, Transition Studies Review 14 (2007) 125-146.

[45] T. Nobel, Development of freight villages in Germany, Ph.D. thesis, Institute of shipping economics and logistics (ISL), Bremen, 2004. (in German)

[46] M. Wermuth, R. Wirth, Models and strategies of freight transport, in: G. Steierwald, H.D. Künne, W. Vogt (Eds.), Urban Traffic Planning—Principles, Methodes, Objectives, 2nd new and improved edition, Springer, Berlin et al., 2005, pp. 296-326. (in German)

[47] A. Ballis, G. Mavrotas, Freight villages design using the multicriteria method Promethee, Operational Research 17 (2007) 213-232.

[48] B. Rall, Freight villages, in: D. Arnold, H. Isermann, A. Kuhn, H. Tempelmeier, K. Furmans (Eds.), Handbook Logistics, 3rd new improved ed., Springer, Berlin et al., 2008, pp. 778-781. (in German)

[49] E. Taniguchi, M. Noritake, T. Yamada, T. Izumitani, Optimal size and location planning of public logistics terminals, Transportation Research (Part E) 35 (1999)

207-222.

[50] J. Allen, M. Browne, Sustainable strategies for city logistics, in: A. McKinnon, S. Cullinana, M. Browne, A. Whiteing (Eds.), Green Logistics—Improving the Environmental Sustainability of Logistics, London et al., 2010, pp. 282-305.

[51] H.J. Quak, L.A. Tavasszy, Customized solutions for sustainable city logistics—The viability of urban freight consolidation centres, in: J.A.E.E. van Nunen, P. Huijbregts, P. Rietveld (Eds.), Transitions Towards Sustainable Mobility—New Solutions and Approaches for Sustainable Transport Systems, Springer, Heidelberg et al., 2011, pp. 213-233.

[52] J.H.R. van Duin, H. Quack, J. Muñuzuri, New challenges for urban consolidation centers—A case study in the Hague, Procedia Social and Behavioral Sciences 2 (2010) 6177-6188.

[53] Z. Yang, C. Liu, X. Song, Optimizing the scale and spatial location of city logistics terminals, Journal of the Eastern Asia Society for Transportation Studies 6 (2005) 2937-2946.

[54] E. Gouvernal, V.L. Letilleul, B. Slack, Transport and logistics hubs—Separating fact from fiction, in: P. Hall, R.J. McCalla, C. Comtois, B. Slack (Eds.), Integrating Seaports and Trade Corridors, Ashgate, Farnham, Burlington, 2011.

[55] L.M. van der Lugt, M. Nijdam, B. Dumay, Distriparks in Seaports—Case studies on logistics centres in Rotterdam, Paper EC Interreg IIIB North Sea Programme/SUTRANET project, Work Package 3: Transport and Logistics Centres, 2007.

[56] J.R. Daduna, Mode selection in freight transport—A pseudo debate?, in: S. Voss, J. Pahl, S. Schwarze (Eds.), Logistik Management—Systems, Methods, Integration, Physica/Springer, Berlin, Heidelberg, 2009, pp. 247-260. (in German)

[57] A. Eisenkopf, C. Hahn, C. Schnöbel, Intermodal competition in transport and distortion of competition, in: A. Eisenkopf, A. Knorr (Eds.), New developments in railway policy, Duncker & Humblot, Berlin, 2008, pp. 9-138. (in German)

[58] E. Schnieder, Modal split management, in: E. Schnieder (Ed.), Traffic management technology—Automatisation of Road and Rail Transport, Springer, Berlin, Heidelberg, 2007, pp. 439-469. (in German)

[59] D. Tsamboulas, Development strategies for intermodal transport in Europe, in: R. Konings, H. Priemus, P. Nijkamp (Eds.), The Future of Intermodal Freight Transport, Elgar, Cheltenham, Northhampto, MA, 2008, pp. 271-301.

[60] M. den Hengst, Interorganizational coordination—The role of information technology, in: R. Konings, H. Priemus, P. Nijkamp (Eds.), The Future of Intermodal Freight Transport, Elgar, Cheltenham/Northhampto, MA, 2008, pp. 252-270.

[61] J.R. Daduna, S. Voss, Information management in traffic and transport, in: J.R. Daduna, S. Voss (Eds.), Information Management in Traffic and Transport, Physika, Heidelberg, 2000, pp. 1-21. (in German)

[62] M. Hauner, E. Jänsch, Interoperability of the Trans-European railway system, in: M. Hecht, E. Jänsch, H.P. Lang, D. Lübke, J. Mayer, W. Mittmann et al. (Eds.), The railway system, EurailPress, Hamburg, 2008, pp. 557-592. (in German)

[63] N. Kühltreiber, M. Jandrisits, R. Pfliegl, B. Hofmann-Wellendorf, Value-added services for river information systems, Vermessung & Geoinformation 95 (2007) 186-194.

[64] ZKR, Guidelines and recommendations for inland waterway information services, European Union, 2004. (in German)

[65] DAKOSY AG, PCS—Port Communication System, 2010, ttp://www.dakosy.de/loesungen/pcs-seehafen/ (accessed Nov. 16, 2012).

[66] The International Air Transport Association (IATA), Cargo Accounts Settlement Systems (CASS), 2012, http://www.iata.org/ps/financial_services/pages/cass.aspx (accessed Nov. 16, 2012).

[67] Wasser-und Schifffahrts verwaltung des Bundes (WSV), Electronic inland waterway system (ELWIS), 2010, http://www.wsv.de/service/elwis/index.html (accessed Nov. 16, 2012).

[68] T.G. Crainic, M. Gendreau, J.Y. Potvin, Intelligent freight-transportation systems—Assessment and the contribution of operations research, Transportation Research (Part C) 17 (2009) 541-557.

[69] J.R. Daduna, Application of fleet management systems for monitoring and control of logistic processes, Logistik Management 7 (4) (2005) 45-63. (in German)

[70] A. Goel, Fleet Telematics—Real-time Management and Planning of Commercial Vehicle Operations, Springer, New York, 2008.

[71] Daimler FleetBoard GmbH, FleetBoard—Awarded telematics solutions, 2012, http://www.fleetboard.com/info/en/products.html (accessed Nov. 16, 2012).

[72] A. Woodburn, A. Whiteing, Transferring freight to “greener” transport modes, in: A. McKinnon, S. Cullinana, M. Browne, A. Whiteing (Eds.), Green Logistics—Improving the Environmental Sustainability of Logistics, KoganPage, London et al., 2010, pp. 124-139.

[73] J.J. Winebrake, J.J. Corbett, A. Falzarano, J.S. Hawker, K. Korfmacher, S. Ketha et al., Assessing energy, environmental, and economic tradeoffs in intermodal

freight transportation, Journal of the Air & Waste Management Association 58 (2008) 1004-1013.

[74] A. Beifert, G. Prause, Logistic innovation networks in South Baltic Sea region. in: G. Prause (Ed.), Baltic Business and Socio Economic Development, Berliner Wissenschafts-Verlag, Berlin, 2011, pp. 3-17.

[75] M. Emerson, E. Vinokurov, Optimisation of Central Asian and Eurasian Trans-continental Land Transport Corridors, EU-Central Asia Monitoring (EUCAM) Working Paper 07, 2009.

[76] G. Prause, A. Beifert, Logistics in the Baltic Sea region, in: W. Kersten, T.H. Blecker, C. Herstatt (Eds.), Innovative Logistics Management, Erich Schmidt, Göttingen, 2007, pp. 327-342.

[77] V. Paulauskas, K. Bentzen, Sea motorways as a part of the logistics chain, Transport 23 (3) (2008) 202-207.

[78] J. Parantainen, A. Meriläinen, The Baltic sea motorway—Recent developments and outlook for the future, Journal of Maritime Research 4 (2007) 21-30.

[79] J.R. Daduna, G. Prause, Corridor design as a basis of efficient transport chains in multi-modal transport, in: D. Ivanov, H. Kopfer, H.D. Haasis, J. Schönberger (Eds.), Dynamics and Sustainability in International Logistics and Supply Chain Management, Cuvillier, Göttingen, 2011, pp. 28-40. (in German)

[80] A. Kranke, M. Schmied, D.A. Schön, CO_2-calculation in logistics—Data Sources, Formulas, Standards, Vogel, München, 2011.

[81] A. Lortz, A. Rausch, D. Rogge, T. Spahl, CO_2-balancing for the design of climate-friendly transport chains at BASF, in: R. Schönberger, R. Elbert (Eds.), Dimensions of Logistics—Functions, Institutions and Levels of Actions, Gabler, Wiesbaden, 2010, pp. 211-243. (in German)

[82] PLANCO Consulting GmbH/Federal Institute of Hydrology, Transport economic and ecological comparison of the transport modes road, rail and waterway (Part A: Comparison of transport modes), Expertise for the Water and Shipping Administration of Federal/WSD East, 2007. (in German)

[83] R. Klein, A. Scholl, Planning and decision, Vahlen, München, 2004. (in German)

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SUSTAINABLE ENTREPRENEURSHIP ALONG GREEN CORRIDORS

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Abstract. The research in this paper highlights the interaction and development of sustainable entrepreneurship activities in the environment of Green Transport Corridors. The objective is to show how the concept of Green Transport Corridors, initiated by the European Commission, comprises the framework for an entrepreneurial ecosystem bearing the potential to deploy sustainable entrepreneurship activities to the benefit of new start-ups as well as already existing small and medium sized companies (SMEs). The methods used are to analyse the existing green corridor initiatives together with their economic growth strategies and their impact on the surrounding entrepreneurial ecosystems. The results will be discussed in the context of network and cluster theories and evaluated by previously made studies and cases from SME sector in regard to logistics and networking. Additionally, with focus group meetings core requirements for green corridors together with a set of key performance indicators (KPI) are elaborated. The results are that Green Transport Corridors set the frame for sustainable development and foster a coherent entrepreneurial ecosystem especially for start-ups and existing SMEs in the logistics sector.

Keywords: Sustainability, transport corridors, entrepreneurial ecosystem, logistics networks.

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1. Introduction

Since the appearance of the first Transport White Paper (COM 2001: 370 final) of the European Commission in 2001 the necessity of shifting volumes of the dominant road traffic to other more efficient transport modes is being expressed constantly. The goal was linked to the preparation of an environmental friendly transport sector, and at the same time to provide safer and efficient transportation by reducing accidents, congestions and negative impacts through emissions, i.e. noise, light and pollution. After the revision of the EU Transport White paper (COM 2006: 314 final) in 2006, the concept of green corridors was introduced as an initiative of the European Commission in the Freight Transport Logistics Action Plan (FTLAP 2007). According to FTLAP, green corridors will “reflect an integrated transport concept where short sea shipping, rail, inland waterways and road complement each other to enable the choice of environmentally friendly transport”. In recent years, on European and also on national level an increasing number of initiatives have been taken to speed up the shift towards greener and more efficient logistic solutions in Europe. Important steps on EU level in this development process have been the Green Paper on TEN-T from 2009, as well as the TEN-T Policy Review 2011 and the EC White Paper on “A Sustainable Future of Transport”. The current situation shows that the main characteristics of a green corridor and conditions that make a transport corridor actually green are varying but it is already visible that there are also common topics, which are recognised by all green corridor initiatives. Most important common factors in all green corridor projects are trans-nationality and co-modality, which enables the choice of environmentally friendly transport along a usually international transport route. Furthermore, all initiatives agree that for green transport adequate trans-shipment facilities, innovative transport technology, and advanced ITS applications are compulsory to achieve environmentally friendly transport solutions.

Beside these more technical oriented topics also a set of requirements and key performance indicators (KPI) for green corridors are developed in order to describe a framework for the corridor governance and to safeguard a sustainable corridor management. This framework influences the economic environment of the corridor and impacts the entrepreneurial ecosystem directly. The implementation of a green corridor concept lies still mainly on the involved stakeholders, but the corridor framework fosters a coherent guideline for sustainable entrepreneurial activities. This paper focuses on the benefits for entrepreneurial activities and especially small and medium sized enterprises (SME) as being part of a Green Transport Corridor. The research question is how and to which extend can SMEs benefit from being part of the Green Transport Corridor and how do the frame conditions of green corridors impact entrepreneurship and the business environment around corridors.

2. Theoretical frame

The theoretical frame describes Green Transport Corridors, their business environment and their impact on the entrepreneurial ecosystem and the integrated SME sector. SMEs are not necessarily responsible for supply chain management in the whole but are due to their size and specialized service they offer stakeholders of the supply chains of larger manufacturers and industry players. In the following the growing importance of the Green Transport Corridor concept is presented. Furthermore, the role of SME as stakeholders in this development is explained by allocating the corridor in the context of cluster and network theories.

2.1. Green Corridor initiatives

In the realisation of green corridor concept the Baltic Sea Region (BSR), being one of the most innovative and ecological oriented regions in Europe, enjoys a vanguard position in the development of green transport concepts. The authors took part in some important green transport corridor initiatives around the BSR e.g. the East-West-Transport-Corridor, linking Denmark and Sweden via the Baltic Sea and Lithuania with Belarus and Ukraine. In the follow some important initiatives together with their current status and their main results shall be highlighted. It should be mentioned that this list is not complete, since in the following years and also in upcoming periods more project initiatives will be established to promote green transportation.

- EWTC II – The East-West-Transport-Corridor II corridor links Denmark, Sweden, Northern Germany, Lithuania and Russia together in a network. The defined corridor runs from Esbjerg in the Western part of Denmark across the Great Belt bridge and from North Eastern part of Germany across the Baltic Sea further on to Karlshamn in Sweden, and from here on, via the Baltic Sea to Klaipėda in Lithuania and further on to Moscow or Belarus to Central Asia. The corridor is mainly land-based, based on intermodal train solutions and sea-based solutions (short sea shipping) across the Baltic Sea.
- Scandria – The Scandria corridor covers the area from the South Western part of Norway and South Eastern part of Finland via Sweden (Region Halland and Region Skåne) and further on via Zealand to Berlin/Brandenburg in Germany. At present, the corridor is mainly a road-based corridor supplemented with ferries/bridge when crossing the Øresund and Femern, but with a possibility of introducing more intermodal rail, especially on the German part.
- TransBaltic – The TransBaltic initiative has its focus on improving the transport system around the Baltic Sea and core partners from Norway, Sweden, Denmark, Germany, Poland, the Baltic States and Finland.

- NECL II – The North East Cargo Link II project tries to develop and promote a Midnordic Green Transport Corridor as a cost-effective and environmentally friendly transport route with partners from Norway, Sweden, Finland and Russia.

Meanwhile the BSR Transport Cluster Project for sustainable, multimodal and green transport corridors has been approved by the BSR Programme and launched in 2012 (BSR Transportcluster 2012). The BSR Transport Cluster includes among others all four previously described green transport initiatives and it acts as an umbrella platform for the whole Baltic Sea Region by joining forces and knowledge of the BSR transport projects of the period 2007-2013. The main objective of the BSR Transport Cluster is to connect all transport modes and to strive towards a green BSR transport network in order to develop a coherent concept and a common standpoint for sustainable macro-regional transport and regional growth policies for the BSR on European level. In addition to the above mentioned BSR Programme cooperation projects, the research project SuperGreen was launched in the 7th Framework Programme and supported by the European Commission (DG-TREN).

- SuperGreen –The purpose of SuperGreen is to promote the development of European freight logistics in an environmentally friendly manner and evaluate a series of green corridors covering representative regions and main transport routes throughout Europe (SuperGreen 2010).

Finally, the Nordic green corridor initiative, launched in 2008 and managed by the Swedish Logistics Forum, has to be mentioned due to its strong impact on the BSR.

- Green Corridor – in the green corridor initiative of the Nordic States the government offices in Denmark, Finland and Norway, as well as the European Union's research consortium SuperGreen cooperate in order to define and implement green corridor concepts for Northern Europe. More than 30 local projects were identified as part of the Swedish initiative (Green Corridor 2010).

These goals and the overall strategy for a single European transport area are dominated by the implementation and development of environmentally friendly transportation, i.e. by reducing emissions, particularly greenhouse gases (GHG), developing intermodal transport systems with the exploitation of the individual benefits of each system (co-modality), and supporting innovative intelligent transport systems (ITS) for all transport modes (Hunke, Prause 2012). However, environmentally friendly transport is only one interesting aspect of green corridors. Due to the transnational character of a corridor network, the companies of different sizes and with different cultural and business background are working together to organise and realise the corridor services. The companies are embedded in transnational supply chains which are part of the corridor and they are contributing to the corridor performance. So the question arises how and with which principles the entrepreneurial activities within a corridor are organised and coordinated.

2.2. Frame requirements for Green Corridors

Starting point for all green corridor initiatives in the BSR was the logistics status after the EU enlargement in 2004 which was realised by the project "LogOn Baltic – Developing Regions through Spatial Planning and Logistics & ICT Competence" under the BSR Programme between 2006 and 2007. The empirical activities of LogOn Baltic showed that the landscape of inter-company logistics was dominated by larger production companies and logistics service providers together with their closed and company oriented ICT-systems in order to safeguard the control of their individual supply chains and to realise dedicated platforms for sourcing of transport services mainly from regional SME (Kersten *et al.* 2007; Kron, Prause 2008; Prause 2010a; Prause 2010b). The results lead the Swedish Logistics Forum to the formulation of six requirements on green corridors targeting to overcome the dominating hierarchical logistics landscape described in the LogOn Baltic project and to be able to implement environmentally friendly, efficient and sustainable logistics solutions (Green Corridor 2010):

- Sustainable logistics solutions with documented reductions of environmental and climate impact, high safety, high quality and strong efficiency,
- Integrated logistics concepts with optimal utilization of all transport modes, so called co-modality,
- Harmonized regulations with openness for all actors,
- A concentration of national and international freight traffic on relatively long transport routes,

- Efficient and strategically placed trans-shipment points, as well as an adapted, supportive infrastructure, and
- A platform for development and demonstration of innovative logistics solutions, including information systems, collaborative models and technology.

Of special importance for the SME sector is the demand of "openness and harmonisation for all actors" as well as "collaborative models ad technology" stressing a more balanced and cooperative work of all kind of suppliers, manufactures, forwarders, customers and disposal companies which are involved in the green corridor supply chain activities. However, the requirements of the Swedish Logistics Forum have to be completed by a quantitative instrument to be able to evaluate the green supply chain management performance, i.e. to monitor and control the performance in the Green Transport Corridor development. In recent years, the EU forces the development of guidelines on specific criteria how to monitor and assess the overall green logistics actions. In the European funded project East-West-Transport-Corridor (EWTC) a "Green Corridor Manual" was developed for the first time. It tries to give a holistic and consistent monitoring concept for multi-modal sustainable transport (Fastén, Clemedtson 2012). The green corridor manual consists of a set of recommendations and guidelines on how to implement the green corridor concept according to the EU freight agenda and as promoted by the EU Baltic Sea Strategy.

2.3. Key performance indicators

The green corridor manual focusses on the definition of a set of key performance indicators (KPI) and incentives and regulations for more efficient, high quality, safe, secure and environmentally friendly transport facilities and services. Such a manual can list indicators and measures with their potential impacts, together with a governance model for the development of a stepwise deployment of this concept. The manual can be read by all stakeholders of the corridor. This applies also for each SME in the network to evaluate their own potential and measure their own performance. It is also possible to look into and elaborate different options for the certification of green transports, which is of great economic interest for the single company who is awarded as well as the whole transport market.

There are different aspects which will influence the performance of each stakeholder in the transport corridor. One approach to evaluate the performance is by defining criteria. These criteria are separated into enabling and operational criteria. Enabling criteria describe the settings of the transport chain in regard to the hard infrastructure, meaning roads, railways, terminals, ports etc. The soft infrastructure includes the information and communication systems which support the transport logistics services offered along the defined transport route or a set of factors. Another aspect of enabling the performance of a transport chain are the different regional, national and international policies and regulations which apply to all stakeholders. Operational aspects describe the geographical settings as such, the transport and logistics solutions by involving new and innovative business models. The implementation of transport techniques will have also a direct impact on the performance of a transport corridor measured by given KPIs. The overall performance of a transport corridor is measured by summing up the performance of its stakeholders. This means for specific standards appearing in the KPIs that these standards have to be implemented especially on company level otherwise this standard cannot be realised on corridor level. Therefore, corridor standards represent minimum criteria for the corridor stakeholders. The following table gives an overview about the KPIs which were selected from the EWTC project and were also tested during the project duration.

Table 1. Performance areas of green supply chains

Performance areas	**Operational indicators**	**Enabling indicators**
Economic efficiency	Total cargo volumes On time delivery	Corridor capacity
Environmental efficiency	Total energy use Greenhouse gases, Co2e Engine standards ISO 9001 dangerous goods	Alternative fuels filling stations
Social efficiency	ISO 31 000 ISO 39 000	Safe truck parking Common safety rating Fenced terminals

Source: Fastén, Clemedtson (2012)

The KPIs are covering the economic, environmental and social aspects. Whereas the economic and environmental indicators are more focussing on physical and quantitative aspects, i.e. stressing efficiency and service quality, the referred standards about dangerous goods (ISO 9001 dangerous goods) as well as the ISO norms for risk management (ISO 31 000 and ISO 39 000) are laying emphasis on safety and road traffic security aspects. Another popular indicator for social performance measured the sick leave rates of companies, fluctuation by employee turnover, the number of temporary employees and workers and the average salary level and salary differences between the stakeholders of the transport corridor. These indicators express how the sustainable performance is developed in the corridor and due to the composition of the corridor indicators as the amalgam of all corridor stakeholder indicators the KPIs together with other corridor requirements, stressing openness, collaboration and harmonisation, forming the entrepreneurial environment of the green corridor by supporting networking and sustainable development of the corridor stakeholders. First test results from the EWTC project show that more detailed aspects must be considered like age, gender, level of education, and experiences of the employees (Fastén, Clemedtson 2012). Finally, the enhanced corridor requirements together with the set of KPIs will act as a corridor mission formulating the framework for the sustainable corridor development and shaping the business environment for sustainable development.

2.3. Corridors, networks and entrepreneurship

The concept of a transport corridor consists of physical logistics flows connecting the main hubs in shape of a tubular transport system leading to the perception of a transport corridor as a tubular logistics cluster. Those systems realise a high complexity of interactions among their actors along the supply chains within the corridor so that a network perspective may better explain the emergence of collaborative practices and integrative behaviours in logistics in general and supply chain management from organisation's point of view (Lee 2005). Researchers have begun to suggest the need for a network-based view of supply chains, recognizing that the interactions between organisations in a supply chain are rarely as sequential as a chain structure would suggest (Bovel, Martha 2000). As a whole, studies acknowledge the importance of a network structure for the effective diffusion of supply chain-related practices (Roy *et al.* 2006), as well as for efficiency and flexibility of the responses of the supply chain to customer expectations (Wathne, Heide 2004). Due to natural reasons transport and logistics activities have often close relations to strategic alliances, cooperation and collaboration agreements which can result in cluster activities. Arising from the social network theory a transport corridor can be seen as a scale free network. It started from dyadic relationships between two stakeholders and grew to a broader network. Specific characteristics of scale-free networks vary with the theories and analytical tools used to create them, however, in general, scale-free networks have some common characteristics. One notable characteristic is the relative high number of nodes with relations to other nodes which greatly exceeds the average. The nodes with most of the relations are often called "hubs", and may serve specific purposes in their networks. Thus, hubs are both strength and weakness of scale-free networks. These properties have been studied analytically using percolation theory by Cohen *et al.* (2000) and by Callaway *et al.* (2000).

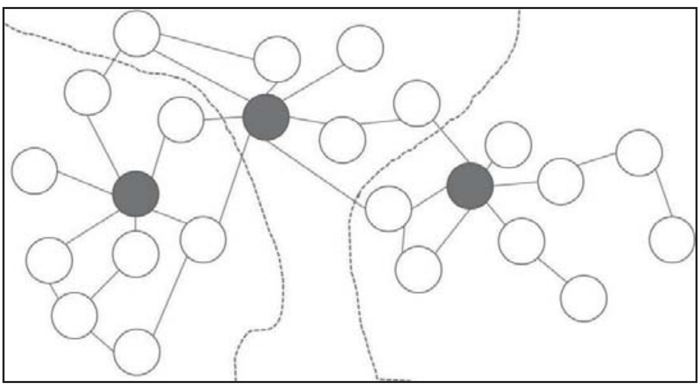

Fig.1. Transport corridor in social network theory

Source: developed by authors

By applying the network theory to the tested green corridor (EWTC) even more characteristic of this tubular logistics cluster are demonstrated. Due to the transnational dimension of the green transport corridor the hubs and stakeholders along the corridor are artificially separated more than an absolute free network would allow (dotted lines). For each geographical region hubs can be defined, e.g. because of the location it might be sea ports which offer best places for co-modality and entry processes for cross-border transportation. These hubs are surrounded by other nodes which have a close relation and alliance to this specific hub but can also have other relations to any other smaller node originally located around another hub.

When it comes to the study or establishment of logistics cluster initiatives the Baltic Sea Region is one important area inside Europe. A study of the project "LogOn Baltic" revealed big differences in the level of the regional networking activities around the Baltic Sea Region. The development of cluster structures in the logistical sector were remarkably underdeveloped, especially in the regions located in the former UDSSR countries, so that there are no regional offers for logistics services in these regions (Kersten *et al.* 2007). This structural weakness is linked with a general lack in language skills and intercultural experience of the people working for the SMEs which was subsumed under a weakness of logistic service providers in "soft factors". These observations have a direct impact on the development of green transport corridors because the majority of them are linking regions in Western and Eastern countries like EWTC or Scandria. Consequence of these lacks in soft factors in Eastern European regions, especially in relationship with networking and cluster building activities, have been discussed in several studies in the academic literature not only in the context of logistics (Wölf, Ragnitz 2001; Prause 2010a; Prause 2010b; Kron *et al.* 2007). The studies revealed that knowledge spill-over effects inside the cluster have been regarded as relatively unimportant by the managers of the cluster companies. The perception of the interviewed managers was more focused on operational topics like cheap labour and land prices than on strategic soft topics like innovation and networking. As a result the authors proposed that initiatives for establishing green corridors should rather concentrate on the development of logistics soft factors than on pure investments in infrastructure. Meaning, the underestimation of the soft dimensions is indicating a strategic weakness of the cluster and a threat for the future networking activities and cluster development (Prause 2010a).

A special importance for networking and cluster building plays trust. So, for example, in transaction costs theory a direct explanation is given how to understand the linkage between organisational structures stating that the lesser the trust in a socio-economic system, the more formal structures are required in organisation and cooperation. Also, game theory is leading to the conclusion that on the long run all parties' interests are best achieved by a social environment which is as transparent as possible and favours cooperation, reciprocity and trust (Katajamäki 2006).

3. Green Transport Corridors and the entrepreneurial environment

Previous theory analysis describes the concept of green transport corridor as a tubular logistics cluster. Furthermore, there is a large variety of possible factors influencing the performance of these clusters. Additionally, the performance of companies inside a cluster can only be understood when their integration is taken into account. The most complete measure for the performance of clusters is the value added generated in the cluster. The value added generated in the cluster is the sum of the value added generated by the members of the population. In practice, the measurement of the performance of clusters is a very complicated task because the necessary data for the analysis of the various variables influencing the performance of a cluster are not available. In his PhD thesis Peter de Langen (2004) developed a framework for the assessment of the performance of seaport clusters and considered a set of variables influencing the performance of a seaport cluster. He proposed four variables describing the cluster structure. As a consequence, he was able to provide a basis for an assessment of strengths and weaknesses of the structure of the considered seaport clusters and derived from their strengths and weaknesses recommendations for improving the performance of these clusters.

3.1. Case study: Rostock Seaport Cluster

Rostock is located in North – Eastern Germany and it was the largest port in GDR till 1990. Rostock seaport is still an important German port at Baltic Sea and it represents an important hub in the green corridor project Scandria. Like in all seaports also in Rostock all basic activities are related to handling and transfer functions of cargo and passenger. The generic work in a seaport cluster is based on logistics and service activities. A closer view at the companies integrated in the Rostock seaport cluster reveals that nearly all of them belong to the logistics-related sector, outlining that the seaport cluster can be considered as a service cluster. All companies at Rostock seaport are part in at least one of the seven sectors of seaport handling, transportation, logistics, seaport administration, services of sea pilots and experts, and ferry companies. In a performance study, senior managers of the seaport cluster have been interviewed according to the underlying concept of De Langen (Prause 2010a). The relative low number of interviewees does not give a representative image of the situation inside the cluster but it indicates a trend which could be strengthened by results of other empiric activities.

A first result of the study revealed that the intensity of integration of the different service sectors into the seaport cluster differed heavily and those sectors which are related to passengers like travel agencies and cruise and ferry companies are not well integrated into the existing seaport cluster at all. Furthermore, more hardware-oriented services like repair and maintenance are sharing a similar situation. So as a first result it can be stated that the kernel of the Rostock seaport cluster is represented by cargo-related logistical service providers and navigation-related services.

In accordance with the analytical framework of De Langen, an analysis of the eight structural variables of the Rostock seaport cluster was realized, ordered in the two categories "cluster structure" and "cluster governance". Surprisingly, the study brought to light that knowledge spill-over effects inside the cluster have been regarded as relatively unimportant by the interviewees. This shows together with the weaknesses in the variety of goods and in the cluster population a strategic disadvantage in the area of innovations of the cluster. The high ranking of the available working power, the high transportation volumes and the low land prices are revealing an emphasis on operating topics in the perception of the cluster companies.

The stated strengths in the Rostock Seaport Cluster are focusing on freight forwarders and brokers who are generating and distributing the service tasks among the cluster companies. These intermediaries are competent and there is a high quality in problem solving inside the cluster. But again, these mentioned strengths are emphasising more the operative level of business activities. When it comes to the weaknesses inside the cluster, the existing level of trust is low revealing again a strategic problem for the future cluster development. Concerning the topic of trust it was assessed that the actually level of trust inside the cluster was very low and additionally the importance of trust for the cluster development was regarded as low. This weak perception for trust as an important cluster dimension is also expressed in the second weak point concerning the existence of central actors. Central actors like the port administration are acting as a moderator between the different cluster companies and laying the basis for common cluster activities. This leads to an increase in the trust level among the cluster population. As a result, the neglect of the soft dimensions is indicated as a strategic weakness of the cluster and a threat for the future cluster development.
In further interviews in the Rostock region with experts from public authorities, associations of enterprises, logistics service providers and trading companies it turned out that the actual situation in Rostock region can be characterised by a weak industrial density and a lack of skilled workers due to the migration to the economically more developed regions of Germany, especially to the Hamburg region (Prause 2010b). Most of the complaints about the weakness of region were related to soft factors. The experts are regarding the lack of a regional logistics strategy for Mecklenburg-Vorpommern as a strategic problem for the whole logistics sector. Additionally, the level of the regional networking activities and the development of cluster structures in the logistical sector are remarkably underdeveloped so that there are no regional offers for logistics services in Rostock region. This structural weakness of the region is linked with a general lack in language skill and intercultural experience of the companies and an underdeveloped educational sector for the field of logistics.

3.2. Case study: Logistics Networking in Hamburg

Hamburg is representing the German logistics capital with more than 5,000 classical logistics companies and approximately 150,000 employees in the logistics sector. By taking into account also the employees in the logistics service sector like consultation, IT services and transport assurances, the number of employees in the larger metropolitan region of Hamburg even exceeds the number of 230,000 employees. This phenomenon is heavily driven by the development of Hamburg seaport enjoying a growth rate despite recession years.

In order to strengthen the development of the logistics cluster in Hamburg region, the logistics initiative for Hamburg was founded in 2005 with the target to establish additional 14,000 new jobs in Hamburg and to generate an additional value added in Hamburg of approx. 6 billion Euro. The forecast for the effects of the activities of the logistics initiative was based on the Regionomica study (Regionomica 2005).
Three topics have been identified as main success factors for the further logistical development of Hamburg:

1. free land for logistical operations
2. technical innovation projects in logistics
3. education and qualification in logistics

As an important bottleneck for the further development in the logistics sector, the study identified a lack of educational capacity in the Hamburg region since the increasing need of skilled workers and employees in logistics was threatening the whole logistics sector in Hamburg. So the logistics initiative stressed heavily the expansion of logistical education and qualification in Hamburg. One important factor for the Hamburg region is the development of free land for logistical purposes since the high density in the Hamburg region leads to a permanent shortage of space. Under the precondition that the space problem will be solved in the next 10 years, the study is estimating the creation of approx. 700 new logistical jobs in the first year, and up to 8,500 new logistics jobs till 2015. With an average gross value added per employee in logistics of approx. 55,000 Euro for the next 10 years, the total additional value added from new jobs in logistics was calculated to approx. 3 billion Euro.

The indirect effects of the logistical initiative have been estimated to be 3 % considering the following three topics:

1. Effects from technology and innovation
   Estimated effect: 1 % per year
   New jobs: approx. 500

2. Effects from education and qualification
   Estimated effect: 0.5 % per year
   New jobs: approx. 500
   Additional value added: 80 million Euro

3. Effects from cooperation
   Estimated effect: 1.5 % per year
   New jobs: approx. 750
   Additional value added: 230 million Euro

The most interesting result of this analysis is the relative high value of 1.5 % due to cooperation yielding in the same total effect like innovation and education together. The study contained the important statement that the estimated effects of cooperation have been detected already empirically during the writing of the study. Altogether, the study estimated the total effect of the logistics initiative of Hamburg with 14,000 new jobs in direct and indirect logistical sectors and an additional value added for Hamburg of approx. 6 billion Euro.

Conclusions

The concept of Green Transport Corridor is highly ranked on the political agenda however the question still remains if and how the private business sector, mainly SMEs in logistic sector can benefit from these attempts. This research shows an approach to provide a framework for sustainable development by applying the Green Transport Corridor concept in the entrepreneurial environment. SMEs are seen as the main stakeholders and also the main beneficiaries in this process.

Former studies analysing the potential benefits for regions and private enterprises from being part in cluster structures demonstrated consentaneously that cooperation and network activities among cluster stakeholders are the way to achieve most efficient operations. To measure the cluster performance and to monitor the activities of the SMEs involved in the green corridors there are also theoretical and rather practical approaches described. From an EU funded project a so called “Green Corridor Manual” can be used as well as results and requirements from other green corridor initiatives. According to that manual the performance of these tubular logistics clusters is influenced by enabling and operational factors, trying to represent and connect the hard and soft infrastructure as well as operational aspects.

The answer of the research question is that SME by their operational nature are heavily integrated in the development of green transport corridor concepts. SME cover the highest amount of logistic activities in a supply chain; this applies to traditional view as well as the green supply chain management. However, the green corridor approach emphasizes the integration of SME into green transport corridors by stressing the requirement of “harmonized regulations with openness for all actors” enhancing the position of SME sector as stakeholders in the green corridors. This will give a perfect frame condition for the development of SME performance and also the economy of regions and markets they operate in. Since the implementation of green corridor concepts is still in the test phase the final business structures are still unknown but in any case it is crucial to involve the SMEs into the process of the development right from the start and in further development.

References

Bovel, D.; Martha, J. 2000. From Supply Chain to Value Net, *The Journal of Business Strategy* 21(4): 24–28.

BSR Transportcluster. 2012. Available on the internet: <http://transportcluster.eu/>

Callaway, D. S.; Newman, M. E. J.; Strogatz, S. H.; Watts, D. J. 2000. Network Robustness and Fragility: Percolation on Random Graphs, *Physical Review Letters* 85(25): 5468–5471.

Cohen, R.; Erez, K.; Ben-Avraham, D.; Havlin, S. 2000. Resilience of the Internet to Random Breakdowns, *Physical Review Letters* 85(21): 4626–4628.

COM. 2001. White Paper: European transport policy for 2010: time to decide. Commission of the European Communities. Brussels.

COM. 2006. Keep Europe moving - Sustainable mobility for our continent, Mid-term review of the European Commission’s 2001 Transport White Paper. Commission of European Communities. Brussels.

De Langen, P. W. 2004. The Performance of Seaport Clusters. *TRAIL Thesis Series*, No. T2004/1. ISBN 90-5892-056-9.

Fastén, G.; Clemedtson, P. 2012. EWTC II Green Corridor Manual. Green Corridor Manual – Task 3B of the EWTC II project. NetPort.Karlshamn.

FTLAP. 2007. Communication from the Commission: Freight Transport Logistics Action Plan. Commission of European Communities. Brussels, 18.10.2007.

Green Corridor. 2010. Regeringskansliet – Government Offices of Sweden. Green Corridors.

Hunke, K.; Prause G. 2012. Hub Development along Green Transport Corridors in Baltic Sea Region, in Blecker, T.; Kersten, W.; Ringle, Ch. M. (Eds.). *Pioneering Supply Chain Design - A comprehensive Insight into emerging Trends, Technologies and Applications*. Josef-Eul-Verlag, Lohmar-Köln, 265–282.

Katajamäki, A. 2006. Inter-organisational networking capability in Finland, in Batog, J. (Ed.). *Baltic Business Development - Regional Development, SME Management and Entrepreneurship***.** Szczecin, 127–141.

Kersten, W.; Boeger, M.; Schroeder, M.; Singer, C. 2007. *Developing Regions through Spatial Planning and Logistics & ICT competence – final report***.** As part of the publication series of the EU project LogOn Baltic, Turku School of Economics, report No. 1:2007, Turku.

Kron, E.; Prause, G. 2008. *LogOn Baltic aggregated ICT Survey Report*. Turku School of Economics, Turku.

Kron, E.; Prause, G.; Klinkenberg, G. 2007. Expert Interviews in Mecklenburg-Vorpommern - Results and analysis of the intersectoral expert interviews in the field of logistics and ICT (LogOn Baltic Regional Report). Turku School of Economics, Turku.

Lee, P. D. 2005. Measuring Supply Chain Integration: A Social Network Approach, *Supply Chain Forum: An International Journal* 6(2): 58–67.

Prause, G. 2010a. SME in Service Cluster - A regional Study, in: Kramer, J.; Prause, G.; Sepp, J. (Eds.) *Baltic Business and Socio-Economic Development 2007: 3rd International Conference,* Tallinn, Estonia, June 17-19, 2007. Berlin: Berliner Wissenschafts-Verlag, 349–360.

Prause, G. 2010b. Logistics-related Entrepreneurship and Regional Development - An empiric Study, in: Kramer, J..; Prause, G.; Sepp, J. (Eds.). *Baltic Business and Socio-Economic Development 2007: 3rd International Conference,* Tallinn, Estonia, June 17-19, 2007. Berlin: Berliner Wissenschafts-Verlag, 329–348

Regionomica. 2005. *Wirtschaftliche Effekte der Logistikinitiative Hamburg.* Hamburg.

Roy, J.; Nollet, J.; Beaulieu, M. 2006. Reverse Logistics Network and Governance Structures, *Supply Chain Forum: An International Journal* 7(2): 58–67.

SuperGreen. 2010. Available on the internet: <http://www.supergreenproject.eu/>.

Wathne, K. H.; Heide, J. B. 2004. Relationship Governance in a Supply Chain Network, *Journal of Marketing* 68(1): 73–89.

Wölfl, A.; Ragnitz, J. 2001. Netzwerkaktivitäten und Produktivitätslücke Ostdeutschlands, *Wirtschaft im Wandel* 13: 315–319.

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MANAGEMENT OF GREEN CORRIDOR PERFORMANCE

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In the context of a harmonized transnational transport system the green corridor concept represents a cornerstone in the development and implementation of integrated and sustainable transport solutions. Important properties of green corridors are their transnational character and their high involvement of public and private stakeholders, including political level, requiring new governance models for the management of green corridors.

Stakeholder governance models and instruments for green corridor governance are going to be developed and tested in different regional development projects in order to safeguard a better alignment of transport policies at various administrative levels and a strengthening of the business perspective. A crucial role in this context belongs to involvement of public and private stakeholders in order to safeguard efficient corridor performance.

The paper presents recent research results about green supply chain management in the frame of network and stakeholder model theory and its application to the stakeholders of green transport corridors.

Keywords: green supply chain management, green transport corridors, stakeholder governance

1. Introduction

Due to globalisation today's industry is not dependent solely on location of resources and raw materials but is present all around the globe and decision makers having chosen their locations more in consideration of cost factors like labour costs, real estate prices and tax regulations but not on geographically close location to the markets and low transportation costs. Therefore, one of the main challenges connected to energy provision and use in a green logistics perspective is the energy consumption during transportation of goods. In a supply chain, CO_2 emissions related transportation accounts for 14% of the total emissions according to [1].

When it comes to growth on the one hand and sustainable development on the other hand, the responsibility lies mainly on the companies' shoulders as the supply chains can be seen as the key factors in creating a sustainable supply to the customers [2]. The growth rate of trade volumes is expected to continue in the future increasing the demands in the performance of logistics networks. The current estimations for Europe are predicting a 50% increase in passenger and freight transport within the next 20 years [3]. The emphasis of the European Union is laid on green transport corridors, i.e., European trans-shipment routes with concentration of freight traffic between major hubs and by relatively long distances of transport marked by reduced environmental and climate impact while increasing safety and efficiency with application of sustainable logistics solutions, inter-modality, ICT infrastructure, common and open legal regulations and strategically placed trans-shipment nodes [4].

2. Theoretical Background

A. Supply Chain Management

Green supply chain management is based on the principle of supply chain management with an extra add-on on green impacts, meaning environmental friendly and efficient aspects. Supply chain management aims at providing the logistic aspects of the production process in the company in the most efficient way. That means that also suppliers, manufactures, customers and disposal companies are involved in the supply chain activities. In the context of green supply chain management, there exists interdependency between conventional supply chain management and eco-programs [5]. This includes the approach on how ecological aspects can be considered in the whole business processes in the most effectively way. The work [6] proposed that green supply chain management practices, which include green purchasing, green manufacturing, materials management, green distribution/marketing and reverse logistics, refer to the involvement of environmental thinking into the supply chain management from the extraction of raw materials to product design, manufacturing processes, delivery of the final products to the consumers and end-of-life management [7]. Therefore, it can be assumed that the involvement of green aspects in the supply chain of a company also involves changes in the supply chain itself. Of course, this will then also have an impact on the cooperative alliances with suppliers, manufactures and the customer at the end of the logistics chain.

However, there have been few studies exploring the issue of green supply chain management in the network approach. The performance evaluation of the supply chain management is one aspect of managing the transport corridor performance as an alliance and interdependence of stakeholders in the transport corridor. Hence, applying green supply chain concepts is essential in order to reduce environmental impacts, enhance market competition, and ensure regulation compliance.

The challenge within each supply chain is to choose the right mode of transportation, to use the right equipment, and to use the right fuel [8]. Among the modes of transportation we find plane, ship, truck, rail, barge and pipelines, all with different attributes when considering costs, lead time, environmental performance and availability. However, the reality is that it rarely happens that all modes of transportation are realistic options when shipping goods. The reason is that the goods might set limitations on which modes that can be used. The customers will also be very influential when choosing mode of transportation as they might be demanding a very high service level with quick delivery. When shipping goods over long distances, the alternatives are normally transport by air or ship. However, when distances are short, truck, airplane, train, or short sea ships are used [8].

Another important factor that has great impact on the environmental performance is the type of fuel that is used. Today the main categories of fuel are gasoline, biofuels, and electricity. Modern gasoline is much cleaner than it used to be. Biofuel can be mixed with regular gasoline, but if biofuel is used extensively, then the engine will have to go through some costly adoptions. Biofuel is fuel based on organic waste, and in that sense it is environmental friendly, but the problem is that it takes a lot of gasoline to make biofuel, which makes the total environmental performance of biofuel quite pure. However, if the technology and methods that are used for making biofuel are improved in the future, the environmental performance might raise significantly. Electric vehicles are clearly environmental friendly as they have very low levels of emissions, and the production of electricity can be controlled in order to calculate the emissions. The most important restriction for electrical vehicles is their range, which is too limited in order to be fully competitive with the combustion engine. This limitation might be eliminated in the future if the technology on battery capacity moves forward [8].

Finally, there is also a possibility for a development and use of other types of equipment. This might for instance be to use Giga-liners (long trucks), to use extra-long trains, and larger vessels at sea. These are all improvements that could decrease the emissions per kilo transported. However, if then the load factor drops, then the environmental performance might get lower than it originally was. Another method that already is used extensively is to lower the speed; this is for instance used in the shipping industry when the rates are low. A bi-effect is that the environmental performance rises.

Additionally, [8] proposed that Operations Research (OR) leads to a more efficient use of resources, which is not only cost attractive, but also tends to create less emissions of greenhouse gases. Therefore, with new methodologies in OR these savings and reduction of emissions can be considered as one solution to the challenge of high energy consumption in the transport and logistics sector. Furthermore, OR helps to identify transport solutions, especially with multi-criteria decision analysis, when it comes to multi-modal choice and alternative route optimisations. One key aspect of new solutions is the exploration of new and innovative transport connections by using multi-modal transport chains. The method of multimodal transports allows cargo to be transported faster with lower environmental impact. One attempt, mainly in the European aspect, is to consider transport chains as transport clusters along certain routes, the so-called transport corridors.

B. Network approach

In order to understand what a transport corridor means by theoretical backgrounds it can be helpful to see the corridor as a conglomeration of different stakeholders which act along a defined geographical area in order to achieve different goals but with the same objective not only to minimize the environmental impact but also to reduce costs, increase efficiency, and create sustainable logistics solutions. Realization of the increasing complexity of the interactions among actors along their supply chains suggests that a network perspective may better explain the emergence of collaborative practices and integrative behaviours in logistics in general and supply chain management from organization's point of view [9]. Researchers have begun to suggest the need for a network-based view of supply chains, recognizing that the interactions between organizations in a supply chain are rarely as sequential as a chain structure would suggest [10]. As a whole, studies acknowledge the importance of a network structure for the effective diffusion of supply chain-related practices [11], as well as for efficiency and flexibility of the responses of the supply chain to customer expectations [12].

As the stakeholders act in a coherent sense and are located in a certain geographical area such a transport corridor can be described as a tubular cluster performance. Due to natural reasons transport and logistics activities have often close relations to strategic alliances, cooperation and collaboration agreements which can result in cluster activities. Arising from the social network theory a transport corridor can be seen as a scale free network. It started from dyadic relationships between two stakeholders and grew to a broader network. Specific characteristics of scale-free networks vary with the theories and analytical tools used to create them, however, in general, scale-free networks have some common characteristics. One notable characteristic is the relative high number of nodes with relations to other nodes which greatly exceeds the average. The nodes with most of the relations are often called "hubs", and may serve specific purposes in their networks. It turns out that the major hubs are closely followed by smaller ones. These ones, in turn, are followed by other nodes with an even smaller number of degrees and so on. This hierarchy allows for a fault tolerant behaviour. If failures occur at random, which, in the case of transport corridors, means the drop out of a stakeholder and the vast majority of nodes are those with small degree, the likelihood that a hub would be affected is almost negligible. Even if a hub-failure occurs, the network will generally not lose its connectedness, due to the remaining hubs. On the other hand, if a few major hubs are taken out of the network, the network is turned into a set of rather isolated graphs.

Figure 1. Transport corridor in social network theory

Thus, hubs are both strength and weakness of scale-free networks. These properties have been studied analytically using percolation theory by [13] and by [14].

In the work [15] such a social network perspective to the stakeholder theory of the firm has been applied. Accordingly, research has started to address systems of dyadic interactions and stakeholder multiplicity, which can be also of importance for the understanding of a transport corridor concept. Opportunities for organizational resistance or adaptations to stakeholder expectations [16], [17] and [18] can be investigated. In the work [19] the predictors for stakeholder networks for value chains have been investigated. The identified two structural features of such stakeholder networks: Firstly, network density, defined as the degree of completeness of the ties between the actors in a network, has been identified as a likely determinant of corporate responsiveness in that it affects the ease of communication and efficiency of information flow across actors in the network [20], [17], and [21]. The second predictor, the degree of centrality in the network, that is, the extent to which an organization occupies a central position in the network, has been suggested as a further influence on the attentiveness of companies to stakeholder concerns and their willingness to accommodate their requests [15]. How different stakeholders with different typologies can cooperate efficiently and how they might be managed can be described with the stakeholder model theory.

C. Stakeholder model theory

In contrary to the shareholder model theory which says that in an organization or a firm only the shareholders have an interest in creating value for themselves and serving the interest of the other direct shareholders, the stakeholder model theory assumes that the firm has to serve several stakeholders. These can be not only direct involved interest groups but also the society, employees or suppliers of third party organizations or public institutions or political stakeholders. The stakeholder approach was initiated by [22] but was constantly developed during the last decades (see [23], [24], [25] and [26]) as in capitalistic markets the importance of the decision-making by stakeholders is increasing. Decisions do not only have an impact on the organization itself but also to society and a wider group of stakeholders, mainly when it comes to environmental effects and public serving obligations like it can be assumed for the green transport corridors.

When it comes to governance structure of an organization like a green transport corridor also the question of property rights arises. Property rights theory has mainly been developed by [27], [28] and [29]. The party that possesses the rights to an asset can decide the use of it and is entitled to receive the income from it. Unfortunately, this is not obvious to distinguish in the case of transport corridor as the rights of the available assets, i.e., roads, terminals, railways, land, infrastructure, etc. belongs to different stakeholders. Mainly these assets belong to public institutions which by their nature have no interest in earning income form their assets but serving the society and ensuring economic freedom. Next to the question of the property rights there are also other opinions when it comes to assets of the organization. [30], [31], [32] and [23] argue that the assets of the firm do not only consist of physical assets but also the skills of its employees, the expectations of customers and suppliers, and its reputation in the community. This is not only applicable to the transport corridor concept in general but to every participating company on lower level as well.

One crucial aspect of governance of a transport corridor is still how the decision making process can be solved with such a big group of different stakeholders. In the work [33] already have been stated that "the more groups of stakeholders there are, the more complicated it will be to reach a decision, especially as the stakeholders often have different goals".

In order to analyse the possibilities of introducing the stakeholder model in governance of transport corridors it is important to have a clear idea of what is meant by stakeholders respectively owners. It can be assumed that stakeholders by nature are also owners of the corridor structure. Therefore we further define stakeholders as these parties which have a stake on the corridor and are part of the governance structure of the same, as [22] definition states that stakeholders are: ''…any group or individual, who can affect or is affected by the achievement of organisation's objectives''. The work [34] defines stakeholders as ''…persons or groups that have, or claim ownership, rights, or interests in a corporation and its activities, past, present, or future.'' He further differentiates between primary and secondary stakeholders. The first group includes stakeholders, like shareholders, employees, customers, suppliers, government and communities, without their participation the organization cannot exist. The secondary stakeholders are ''…those who influence or affect, or are influenced or affected by, the organisation, but they are not engaged in transactions and are not essential for its existence.'' Examples of secondary stakeholders are the media and competing companies. Other researchers [25] differentiate between "social" and "non-social" stakeholders. Furthermore there are direct and indirect stakeholders. Examples of direct social stakeholders are customers, employees and investors and examples of indirect non-social stakeholders are the natural environment and future generations which applies very much to the concept of green transport corridors. As the concept for a transnational governance model, the management of a green transport corridor, is new and not completely investigated it might be useful to assume the group of stakeholders and try to define their expectations and intentions.

According to the network theory the stakeholders can be divided into smaller nodes and actors which function as hubs along the corridor. What makes a transport corridor also specific and more complex than a logistics network is the geographical and political scope? The transport corridor covers several countries, regions and terrestrial and maritime areas as well as national, regional and transnational political bodies. One could assume that the highest political institution is automatically considered as the institution with the highest degree respectively highest decision making power in the network. However, by looking deeper to the actual performance of a transport corridor and the role the individual stakeholders play it becomes obvious that the hubs are rather represented by other institutions.

1) Ports and logistic centres

Ports and also strategically planned logistic centres are considered as hubs due to their location. Because of the connection to many transport modes (sea, inland waterway, road and railway) the cargo is shifted or stored for a certain time period. When looking at the ideal transport chain along the corridor, every cargo has to pass the main hubs at least twice during their entry and exit points. This simple fact makes the ports or logistic centres to a very crucial part of the transport corridor. Owners of hubs and logistics centres can be private but also public bodies. But anyhow they aim to cover their running costs and earn additional income for their offered activities.

2) Logistic forwarders

Logistic forwarders, like rail companies, international courier services, and ferry lines, are not dependent on one geographical location. Upon the company size they are rather considered as a hub due to their close and manifold relations to other stakeholders in the corridor. They provide large portions of equipment (containers, trucks, ferries, rail wagons) and also professional knowledge and skills of their employees. Therefore they are a very crucial part of the performance of the corridor.

Logistic forwarders are almost 100% owned by private companies respectively represent a stakeholder group which is very much interested in generating value and income for their own shareholders. They will only act as stakeholders of a common transport corridor if the savings through cooperation are higher than the losses.

3) Political institutions on several levels

Political institutions of all levels in all countries represent the national or regional governments. Governments are not mainly interested in earning income for themselves from establishing a transport corridor. However, they are obliged to represent the local market economy and ensure the best framework condition so that private companies can perform well. This includes also equal access to all transport corridor activities. From that point of view they have more like a representing function. Additionally as the governments support the corridor activities with public funds the whole society is interested in the investments. Therefore the political institutions act also agents for the general society.

3. Monitoring of Green Transport Corridors

When it comes to the issue of monitoring and controlling green transport corridors there are many attempts from the individual companies and industry representatives but also from international government level. The EU forces in the recent years the development of guidelines on criteria how to monitor and assess the green logistics actions. The authors participated in the European funded project East-West-Transport-Corridor under the Baltic Sea Region Programme 2007-2013, where for the first time a “Green Corridor Manual” based on the green East-West-Transport-Corridor was developed trying to give a holistic and consistent monitoring concept for multi-modal sustainable transport [35]. The green corridor manual consists of a set of recommendations and guidelines on how to implement a green multi-modal transport chain according to the EU freight agenda and as promoted by the EU Baltic Sea Strategy. It also proposes a set of Key Performance Indicators (KPI) and incentives and regulations for more efficient, high quality, safe, secure and environmental friendly transport facilities and services. Such a manual can list indicators and measures with their potential impacts, together with a governance model for the development of a stepwise deployment of a green transport corridor. It is also possible to look into and elaborate on different options for the certification of green transports, which is of great economic interest for the whole transport market.

There are different aspects, which will influence the performance of transport chains. One approach is to separate them into enabling and operational criteria. Enabling criteria describe the settings of the transport chain in regard to the hard infrastructure, meaning roads, railways, terminals, ports, etc. The soft infrastructure includes the information and communication systems which supports the transport logistics services offered in the defined transport route or set of factors. Other aspects of enabling the performance of a transport chain are regional, national and international policies and regulations which apply to all stakeholders. Operational aspects describe the geographical settings as such, the transport and logistics solution by involving new and innovative business models. The implementation of transport techniques will have also a direct impact on the performance of a transport chain measured by given KPIs.

Table 1. Performance indicators

Performance areas	Operational indicators	Enabling indicators
Economic efficiency	Total cargo volumes On time delivery	Corridor capacity
Environmental efficiency	Total energy use Greenhouse gases, Co2e Engine standards ISO 9001 dangerous goods	Alternative fuels filling stations
Social efficiency	ISO 31 000 ISO 39 000	Safe truck parking Common safety rating Fenced terminals

Table 1 gives an overview about the KPIs, which were selected from the East-West-Transport-Corridor project and were also tested during the project duration. Additionally to the table of performance indicators often the enabling factors are described by a corridor dashboard aiming to connect the short-term KPIs and the enabling KPIs by visualizing capacity, accessibility and performance. So the dashboard stimulates improvements of the corridor infrastructure and facilitates the cooperation of all stakeholders along the corridor in order to improve total performance [35].

Economic efficiency and service quality performance of a transport corridor can be demonstrated by the total cargo volumes. Large cargo volumes increase the attractiveness of a transport corridor as it might influence decisions from potential stakeholders whether to accept the transport corridor or not. Furthermore, efficiency and service quality is reflected by the ability of the transport chain stakeholders to provide on time delivery. It is measured by the arrival time in relation to transport timetables. A key element with regard to on-time delivery is a uniform provider and shipper entity for measuring lead times and its arrival time with relevant precision. The enabling performance under this area is the transport chain capacity, which is set by the enabling criteria of hard and soft infrastructure and policies.

Total energy use aims at describing the general environmental efficiency. Indirectly it also describes, to which extend the traffic flow is efficient, when, e.g., idle times, empty returns and long-waiting times are reduced. In addition, operational performance in regard to the environmental efficiency can be measured on fuel consumption, as it enables the calculation (if needed) of SO_2, given the legal fuel conditions or the actual quality used. In case renewable energy resources are used, the emitted Greenhouse gases (carbon dioxide, methane and nitrous oxide) can describe the impact on climate affecting emissions of the transport corridor. As an enabling indicator the availability of the corresponding fuel stations must be measured by assessing the numbers of traditional fuel stations and alternative fuel stations. The more alternative fuel stations are available the more environmental efficiency can be assumed.

Engine standards (also includes after treatment devices), which are regulated for all stakeholders of a certain transport corridor, can also be used as a performance indicator as they indirectly describe the emissions related to impact on health and nature. Further indicators are related to dangerous goods, which are already regulated quite strictly by international standards (e.g., ISO 9001 dangerous goods) and are, therefore, quite known to measure the safety aspects of the transport corridor.

Social efficiency can be also measured by operational performance of the transport corridor. Indicators and common standards are already precisely stated in the ISO norms for risk management (ISO 31 000 and ISO 39 000). In these norms the cargo security aspects are regulated as well as the traffic safety aspects firstly meant for organizations but can be also transferred to the monitoring of a transport corridor (e.g., road traffic accidents). Another indicator for social performance can be measured with the sick leave rates of companies, fluctuation by employee turnover, the number of temporary employees and workers and the average salary level and salary differences between the stakeholders of the transport corridor. These indicators will give an indication on how the social performance is developed in the corridor today but they do not reflect in the indicator in regard to sustainability of the corridor. First test results from the East-West-Transport-Corridor project show that more detailed aspects must be considered. These could be age, gender, level of education, and experiences of the employees. Indicators, which enable social performance in regard to cargo security and safety, are the consistent usage of fenced terminal areas with access controls and safe truck parking systems along the transport corridor [35].

4. Conclusions

Sustainable logistics solutions are high ranked on the political agenda and first results in the implementation of green transport solutions have been generated paving the way to general sustainable logistics. The results from green corridor projects on European level like the East-West-Transport-

Corridor lead to holistic and consistent green monitoring concepts for multi-modal transport solutions, which can be expressed in KPIs, in its turn, which are applicable for green supply chain management.

The performance of transport chains is influenced by enabling and operational factors, trying to representing and connects the corridor's hard and soft infrastructure as well as operational aspects. But the first experiences of green corridors on European level are showing that beyond the development of appropriate KPIs the success and performance of corridors heavily depend on the commitment and cooperation of the involved stakeholders. So governance models and cultural aspects are representing important success factors of green corridors.

Even due to the fact that companies are aware of environmental issues they are still lacking behind the realization of the full potential of green supply chain management. Most businesses need additional incentives to realize environmental investments, either by law or by economic motivations. First test results of KPI application in the East-West-Transport-Corridor showed also that organizations and corridor stakeholders were not willing to publish their performance indicators by fearing to lose their competitive advantages despite the fact that green and sustainable supply chain management within organizations could result in cost reductions and better business performance. Further research work has to be realized in order to tackle these strategic bottlenecks of green corridors.

REFERENCES

1. Stern, N. (2006). *The Stern Review: The Economics of Climate Change.* HM Treasury, London. Retrieved October 29, 2012, from http://siteresources.worldbank.org/INTINDONESIA/Resources/226271-1170911056314/3428109-174614780539/SternReviewEng.pdf
2. Seuring, S. (2004). Integrated chain management and supply chain management comparative analysis and illustrative cases. *Journal of Cleaner Production,* 12, 1059-1071.
3. Tetraplan (2009). *TRANSvisions: Report on Transport Scenarios with a 20 and 40 Year Horizon*. (Final Report EC DG TREN 2009).
4. COM (2011). *Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system.* Brussels: Commission of European Communities. 28.03.2011.
5. Sarkis, J. (2001). Introduction. *Greener Management International,* 35(3), 21-25.
6. Hervani, A.A., Helms, M.M., Sarkis, J. (2005). Performance measurement for green supply chain management. *Benchmarking: An International Journal*, 12(4), 330–353.
7. Srivastava, S.K. (2007). Green supply-chain management: a state- of- the- art literature review. *International Journal of Management Review*, 9(1), 53–80.
8. Dekker, R., Bloemhof, J.; Mallidis, I. (2012). Operations Research for green logistics – An overview of aspects, issues, contributions and challenges. *European Journal of Operational Research,* 219, 671–679.
9. Lee, P.D. (2005). Measuring Supply Chain Integration: A Social Network Approach. *Supply Chain Forum: An International Journal* 6(2), 58–67.
10. Bovel, D. & Martha, J. (2000). From Supply Chain to Value Net. *The Journal of Business Strategy*, 21(4), 24–28.
11. Roy, J., Nollet, J. & Beaulieu, M. (2006). Reverse Logistics Network and Governance Structures. *Supply Chain Forum: An International Journal,* 7(2), 58–67.
12. Wathne, K.H. & Heide, J.B. (2004). Relationship Governance in a Supply Chain Network. *Journal of Marketing*, 68(1), 73–89.
13. Cohen, R., Erez, K., Ben-Avraham, D. & Havlin, S. (2000). Resilience of the Internet to Random Breakdowns. *Physical Review Letters,* 85(21), 4626–4628.
14. Callaway, D.S., Newman, M.E.J., Strogatz, S.H. & Watts, D.J. (2000). Network Robustness and Fragility: Percolation on Random Graphs. *Physical Review Letters*, 85(25), 5468–5471.
15. Rowley, T.J. (1997). Moving Beyond Dyadic Ties: A Network Theory of Stakeholder Influences. *Academy of Management Journal*, 22(4), 887–910.
16. Neville, B.A. & Menguc, B. (2006). Stakeholder Multiplicity: Toward an Understanding of the Interactions between Stakeholders. *Journal of Business Ethics*, 66(4), 377–391.
17. Oliver, C. (1991). Strategic Responses to Institutional Processes. *Academy of Management Review*, 16(1), 405–425.
18. Wolfe, R.A. & Putler, D.S. (2002). How Tight are the Ties that Bind Stakeholder Groups? *Organization Science*, 13(1), 64–80.
19. Vurro, C., Russo, A. & Perrini, F. (2009). Shaping Sustainable Value Chains: Network Determinants of Supply Chain Governance Models. *Journal of Business Ethics*, 90(4), 607-621.

20. Meyer, J.W. & Rowan, B. (1977). Institutionalized Organizations: Formal Structure as Myth and Ceremony. *American Journal of Sociology*, 83(2), 340–363.
21. Pfeffer, J. & Salancik, G.R. (1978). *The External Control of Organizations: A Resource Dependence Perspective*. New York: Harper and Row.
22. Freeman, R.E. (1984). *Strategic management: A stakeholder approach*. Boston: Pitman.
23. Donaldson, T. & Preston, L. (1995). The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications. *Academy of Management Review*, 20(1), 65–91.
24. Campell, A. (1997). Stakeholders: The Case in Favour. *Long Range Planning*, 30(3), 446–449.
25. Wheeler, D. & Sillanpää, M. (1998). Including the Stakeholders: the Business Case. *Long Range Planning*, 31(2), 201–210.
26. Spurgin, E.W. (2001). Do Shareholders Have Obligations to Stakeholders? *Journal of Business Ethics*, 33, 287–297.
27. Coase, R.H. (1960). The Problem of Social Cost. *Journal of Law and Economics*, 3, 1–44.
28. Grossman, S.J. & Hart, O.D. (1986). The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. *Journal of Political Economy*, 94(4), 691–719.
29. Hart, O. (1995). *Firms, Contracts and Financial Structure*. London: Oxford University Press.
30. Kay, J. (1996). *The Business of Economics is Business*. London: Oxford University Press.
31. Blair, M. (1996). *Ownership and Control*. Washington: Brookings Institution.
32. Blair, M.M. & Stout, L.A. (1999). *A Team Production Theory of Corporate Law*.
33. Hansmann, H. (1996). *The Ownership of Enterprise*. Cambridge, MA: Harvard University Press.
34. Clarkson, M.B.E. (1995). A Stakeholder Framework for Analyzing and Evaluating Corporate Social Performance. *Academy of Management Review,* 20(1), 92–117.
35. EWTC II Green Corridor Manual. (2012). *Green Corridor Manual – Task 3B of the EWTC II project*. (To appear).

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SUSTAINABLE SUPPLY CHAIN MANAGEMENT IN GERMAN AUTOMOTIVE INDUSTRY: EXPERIENCES AND SUCCESS FACTORS

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Abstract. Climate change and environmental aspects are key issues on public agenda. Governments and politicians try to implement new regulations and limits to reduce the environmental burden of the industries around the globe. However, success can be seen only to a limited extend in many areas. On the other hand some industrial sectors themselves start to think about solutions to handle the big impacts. Some pioneers in this field discovered already also the competitive and economic advantage of implementing so called green and sustainable solutions in their business. This includes production, manufacturing and transport activities but also ways how to manage and monitor such activities from an eco-friendly perspective. This paper will give an overview of the implication of green logistics along the supply chain in regard to the automotive industry including supply companies from SME sector and will demonstrate the application of this issue. For that an example of the European market leader Volkswagen AG in Germany is chosen and analyzed in the case description.

Keywords: Supply Chain Management, sustainability, green logistics, automotive industry.

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1. Introduction

Global warming is the rise in the average temperature of Earth's atmosphere and oceans that it is primarily caused by increasing concentrations of greenhouse gases produced by human activities such as the burning of fossil fuels and deforestation. The Intergovernmental Panel on Climate Change (IPCC 2007) report claimed global warming as the most important environmental problem of today's society and industries. Due to globalization, today's industry is not dependent solely on location of resources and raw materials but is present all around the globe and decision makers chose their locations more in consideration of cost factors like labor costs, real estate prices and tax regulations, but not on geographically close location to the markets and low transportation costs. Therefore, one of the main challenges connected to energy provision and use in a green logistics perspective is the energy consumption during transportation of goods. In a supply chain, CO2 emissions related transportation accounts for 14% of the total emissions according to Stern (2006). Transportation of goods usually also involves emissions of NOX, SOX and PM.

The challenge of today's society is how industrial development can exist symbiotically next to the environmental concerns in a long-term perspective (Beamon 2005). When it comes to growth on the one hand and sustainable development on the other hand, the responsibility lies mainly on the companies' shoulders as the supply chains can be seen as the key factors in creating a sustainable supply to the customers (Seuring 2004). In order to increase the acceptance of this ecological responsibility many governments introduced laws and regulations to the industry. These are for example the packaging and waste directive of the European Union since 1994 or the German Act on closed-loop resource management (1996). The aim is to provide a legal frame to force companies to reduce waste and to protect natural resources in the production process and the life cycle of the product. One of the major difficulties in implementing green logistics in most companies is the high cost investments that often have to be done long in advance of any returns. To do investments without return is not a normal thing to do for a business, at least not in the private sector. The fact that the problem of environmental problems is something that applies to everyone also makes it a problem that applies to no one. The thought of something serving the greater good can be used for a charity investment, but not for a business philosophy. Many companies are facing the issue that they try to balance between being environmental friendly and saving the nature on one hand and pleasing profit-hungry shareholders on the other side (Gifford 1997). Nevertheless newer studies are showing that sustainable and green business strategies have a positive impact on the performance of a company (AT Kearney 2011; WiWo 2012).

2. Green supply chain management

Green and sustainable supply chain management is based on the principle of supply chain management with an extra add-on on green impacts, meaning environmental friendly and efficient aspects. Supply chain management aims at providing the logistic aspects of the production process in the company in the most efficient way. That means that also suppliers, manufactures, customers and disposal companies are involved in the supply chain activities including the involved SME sector. In the context of green supply chain management, there exists interdependency between conventional supply chain management and eco-programs (Sarkis 2001). This includes the approach on how ecological aspects can be considered in the whole business processes in the most effectively way. It can be assumed that the involvement of green aspects in the supply chain of a company also initiates changes in the supply chain itself. Of course, this will then also have an impact on the cooperative alliances with suppliers, manufactures and the customer at the end of the logistics chain. By integrating these ecological aspects of the product's entire life cycle into the overall closed-loop system, the extraction of raw materials is already taken into account, as well as processes after the useful life of a product, e.g. collection, transportation and inspection, until the product is finally disassembled, remanufactured or disposed (Trowbridge 2001).

The challenge within each supply chain is to choose the right mode of transportation, to use the right equipment, and to use the right fuel (Dekker *et al.* 2012). Among the modes of transportation we find plane, ship, truck, rail, barge and pipelines, all with different attributes when considering costs, lead time, environmental performance and availability. However, the reality is that it rarely happens that all modes of transportation are realistic options when shipping goods. The reason is that the goods might set limitations on which modes that can be used. The customers will also be very influential when choosing mode of transportation as they might be demanding a very high service level with quick delivery. When shipping goods over long distances, the alternatives are normally transport by air or ship. However, when distances are short, truck, airplane, train, or short sea ships are used (Dekker *et al.* 2012). Dekker *et al.* (2012) present a table which shows how the different modes of transportation performs up against another taking into consideration their emissions and kW h/t/km. The water- based modes can in general carry much higher weights than the land- based modes. Larger loads give better CO2 –efficiency. However, the diesel train and heavy truck is superior when measuring NOx- efficiency, while ships emit high levels of NOx. When comparing PM, there are not any significant differences between the modes. One of the modes, the Boing 747-400, is clearly the least environmental friendly of them all. It is not possible to prefer one of the modes in front of the other, as there are many variables to take into account when choosing the transportation mode. Presently, road transport contributes to the largest share of the emissions, but because of the strict limitations that the EU has set for emissions for trucks, they are closing in on the other transport modes. This is much thanks to the fact that trucks are only used for 3–5 years, which means that new technology gets implemented swiftly.

Another important factor that has great impact on the environmental performance is the type of fuel that is used. Today the main categories of fuel are gasoline, biofuels, and electricity. Modern gasoline is much cleaner than it used to be. Biofuel can be mixed with regular gasoline, but if biofuel is used extensively, then the engine will have to go through some costly adaption. Biofuel is fuel based on organic waste, and in that sense it is environmental friendly, but the problem is that it takes a lot of gasoline to make biofuel, which makes the total environmental performance of biofuel quite pure. However, if the technology and methods that are used for making biofuel are improved in the future, the environmental performance might raise significantly. Electric vehicles are clearly environmental friendly as they have very low levels of emissions, and the production of electricity can be controlled in order to calculate the emissions. The most important restriction for electrical vehicles is their range, which is too limited in order to be fully competitive with the combustion engine. This limitation might be eliminated in the future if the technology on battery capacity moves forward (Dekker *et al.* 2012).

Finally, there is also a possibility for a development and use of other types of equipment. This might for instance be to use Giga-liners (long trucks), to use extra-long trains, and larger vessels at sea. These are all improvements that could decrease the emissions per kilo transported. However, if then the load factor drops, then the environmental performance might get lower than it originally was. Another method that already is used extensively is to lower the speed; this is for instance used in the shipping industry when the rates are low. A bi-effect is that the environmental performance rises. Additionally, Dekker *et al.* (2012) proposed that Operations Research (OR) leads to a more efficient use of resources, which is not only cost attractive, but also tends to create less emissions of greenhouse gases. Therefore, with new methodologies in OR these savings and reduction of emissions can be considered as one solution to the challenge of high energy consumption in the transport and logistics sector. Furthermore, OR helps to identify transport solutions, especially with multi-criteria decision analysis, when it comes to multi-modal choice and alternative route optimizations. One key aspect of new solutions is the exploration of new and innovative transport connections by using multi-modal transport chains. The method of multimodal transports allows cargo to be transported faster with lower environmental impact. One attempt, mainly in the European aspect, is to consider transport chains as transport clusters along certain routes, the so called transport corridors. The emphasis is laid on green transport corridors, i.e. transshipment routes with concentration of freight traffic between major hubs and by relatively long distances of transport marked by reduced environmental and climate impact while increasing safety and efficiency with application of sustainable logistics solutions (COM 2011). Already in 2001, the Transport White Paper (COM 2001) of European Commission expressed the necessity of shifting some volumes of the dominant road traffic to other efficient transport modes. The goal was to prepare for an environmental friendly transport sector and at the same time to provide safer and efficient transportation by reducing accidents, congestions and negative impacts through emissions, i.e. noise and pollution.

3. Investments for sustainable supply chain management

One of the major difficulties in implementing green logistics in most organizations is the high cost investments that often have to be done long in advance of any results. Recent results of Global Supply Chain Survey 2013 revealed that sustainability aspects in supply chain management are considered by about 60% companies but concrete investment measures are still very rare (PwC 2012). Only 42% of the participants of the PwC survey think that sustainable supply chain management is an important management issue at all. The crucial question asked before an investment from a company is who is paying for the investment and how does the society benefit from this investment. The three different options for who will be left with the bill are the company itself, the consumer or the society. In some areas the society pays for upgrades through handouts or tax-cuts to companies that operate more environmentally friendly. An example of this is the Norwegian shipping industry, where the government, through special taxes, pays for up to 80 percent of the costs of installing environmental friendly equipment (NHO 2011). In other businesses the customers pays more for a certain product because it is made in an environmentally friendly manner. This strategy is most often used for food and groceries and will for some customers add a feeling of superior quality as well. This is impossible in many industries as customers are less aware of the environmental part of different products. For companies not covered by either of these two, it is important that the changes in themselves are economically defendable and that it gives them lower costs or higher profits. There have been few empirical studies on the impact of green investments, but a study done by Rao and Holt (2005) reveals some interesting findings. They have separated the logistics in to three different areas:

- Inbound logistic
- Production
- Outbound logistics

In the inbound logistics there was huge savings by having green suppliers. The savings came in waste reduction, compliance with regulations and resource utilization. The greening of production led to savings in raw materials because of re-use, and water and energy usage. The lowering of costs in the supply-chain led to greater competitiveness and a better opportunity to steal market shares from competitors, through efficiency.

The problem for these industries is to see the opportunities and get over the initial large investments. If the investments needed to become greener are too great, there should be possibilities for tax cuts or other carrots to help them overcome this obstacle. It is also a problem with an uneven playing field. In an international marketplace there need to be common rules that applies to everyone, by forcing every actor to do the heavy investments it will get easier for everyone.

4. Sustainability improves the business performance

But there exist also other investigations about sustainable supply chain management which give a more positive picture by pointing out that green supply chain management has a positive impact on the business performance. A couple of recent studies revealed that sustainability pays offs for companies (AT Kearny 2011; WiWo 2012). These results are not restricted to logistics sector but they bear a special relevance for the supply chain management. The largest global study on CO2 – reduction, the Carbon Disclosure Project (CDP), brought to light that sustainability in supply chains leads to a better company performance and a higher Return on Investments (AT Kearny 2011). The reason for that is that the cooperation of sustainable supply companies and the optimization of supply chains according to CO2 – aspects represent a powerful tool for cost cuttings. CDP explored that more than half of all larger companies and about a quarter of all suppliers experienced significant cost reduction by sustainable supply chain activities. The results of the CDP project are based on a survey of more than 1000 leading, globally operating companies and they are fixed in the Supply Chain Report 2011.

Whereas the results of the CDP project are stressing more the cost reduction possibilities of green and sustainable business activities the results of two studies of the German business journal "Wirtschaftswoche" which were realized in cooperation with the two consulting companies "Serviceplan" and "Biesalski & Company" are pointing out a strong relationship between sustainable business strategies and demand and turnover (WiWo 2012). The studies focused on consumer behavior and are based on a sample of 7700 persons. Both studies were able to prove that those companies which were considered as sustainable in the client perception generated additional turnover due to a green company image. The additional turnover depends on the business sector and can yield up to 10% like the following figures show:

- Logistics & Travelling: 7.7 %
- Automotive: 7.0 %
- Energy: 5.2 %
- Telecommunication: 5.0 %

The second important outcome of the two studies is a sustainability ranking of 101 well known German companies where the 20 upper ranked companies are shown in the following picture including the four most important German car manufacturers (Table 1).

Table 1. Sustainability ranking of German companies

1	**Hipp**	**11**	Milupa
2	**Alete**	**12**	Bosh
3	**BMW**	**13**	Frosta
4	**Miele**	**14**	Toyota
5	**Bärenmarke**	**15**	Coppenrath & Wiese
6	Landliebe	**16**	Volkswagen
7	Audi	**17**	Storck
8	Otto	**18**	Iglo
9	Mercedes-Benz	**19**	Haribo
10	dm-Drogeriemarkt	**20**	ING-Diba

Source: WiWo (2012)

It is easy to see that the four big German automotive companies understood the lesson and worked on the development of strong green images in order strengthen their market position. All together it can be stated that green and sustainable business strategies improve the performance of a company.

5. Green supply chain management in automotive industry

The empirical study of Thun and Müller (2010) about the green supply chain management in the German automotive industry showed that the supply chain management has been applied for a longer period of time than green supply chain management. The majority of the participating companies in this study have implemented the latter only within the last years. Green supply chain management still seems to be a new concept which has just started to evolve over the last decades. According to the study the implementation of green supply chain management was only done to a satisfying extend when the companies were forced by law or legal regulation. Only economic benefits seem not to be the motivation.

However, the study among German players showed that the fulfillment of the legal requirements was even higher than requested as the competition is big and the customer demand even more than the laws require. While customers and competitors are mentioned as important drivers, government and management as internal drivers only play a secondary role (Thun, Müller 2010). Therefore, green supply chain management can be regarded as market driven. A reason for this is the fact that in terms of the automotive supply industry the customers are original equipment manufacturers which are forced by legislation to deal with environmental aspects (Crotty, Smith 2006). Accordingly, they demand eco-friendly products and processes from their suppliers. Hence, customers are a driving force and green supply chain management is a way for automotive suppliers to gain competitive advantage.

In the study also internal and external barriers were identified. The main internal barriers are the lack of acceptance in the company and the increased costs. As an external barrier, and this applies mainly to global companies with production facilities in different countries, was mentioned the number of different environmental acts and regulations which result in a high complexity. However, since the green supply chain management seems to be a new or at least unknown concept many companies fear the dependency from partners in their eco-oriented partnerships. They prefer an internal focus first before trying to integrate eco-programs externally with their partners. Nevertheless, the cooperation with partners and the establishment of functioning partnerships with suppliers is the key factor in successful green supply chain management in the automotive industry.

6. Case description

Volkswagen Group (parent company is the German Volkswagen Aktiengesellschaft) is a German multinational automotive manufacturing company headquartered in Wolfsburg, Germany. It designs, engineers, manufactures and distributes passenger cars, commercial vehicles, motorcycles, engines and turbo-machinery, and offers related services including financing, leasing and fleet management. It is the world's largest motor vehicle manufacturer by 2011 unit sales and has maintained the largest market share in Europe for over two decades. Volkswagen Group sells passenger cars under different brands like Audi, Bentley, Bugatti, Lamborghini, Porsche, SEAT, Škoda and Volkswagen marques. Motorcycles are offered under the Ducati brand; and commercial vehicles under the MAN, Scania and Volkswagen Commercial Vehicles marques. The Volkswagen Group is divided into two primary divisions, the Automotive Division and the Financial Services Division, and consists of approximately 340 subsidiary companies. The company has operations in approximately 150 countries worldwide and operates 94 production facilities across 24 countries. Volkswagen Aktiengesellschaft is a public company and has a primary listing on the Frankfurt Stock Exchange, where it is a constituent of the DAX index, and secondary listings on the London Stock Exchange, Luxembourg Stock Exchange, New York Stock Exchange and SIX Swiss Exchange. As of September 2012, 20% of the voting rights are owned by the State of Lower Saxony.

From the Sustainability Report 2012 (Volkswagen 2012) it can be read that Volkswagen aims to be the market leader by 2018. A logical consequence is that the production has to and will continue to grow. This means, also the resource and energy consumption will increase. Volkswagen intends to take also the ecological leadership. So already now, concrete measures for greater efficiency in the production must be taken to mitigate the increasing resource and energy requirements of the future growth. Therefore, under the program *think blue. Factory* the production will be more environmentally friendly by a total of 25% until 2018. This will apply to all Volkswagen plants in regard to energy consumption, waste generation, emissions of airborne emissions and water consumption which will be reduced by 25% (Figure 1). In 2011, Volkswagen has implemented many concrete steps in the production.

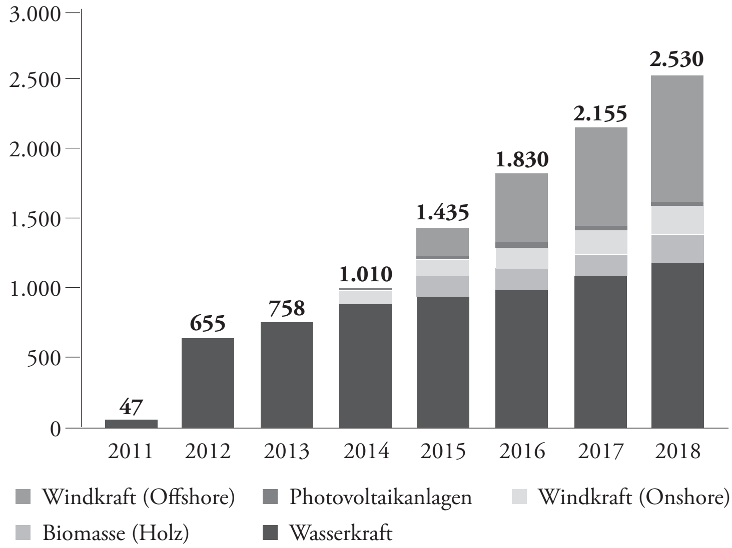

Fig.1. Renewable energy resources of Volkswagen [GWh]

Source: Volkswagen 2012

There is a new system responsible for the efficiency measurement of the production. Standards were developed which apply to the whole organization around the globe. For example, only very energy efficient machineries and equipment is allowed to be purchases for production. Internally, the Volkswagen organization promotes to transfer knowledge and exchange best practice examples of different production locations. The energy management in production locations of SEAT in Martorell and Barcelona (Zona Franca), Spain, are certified according to the ISO 50.001 and UNE 16.001standards. Thus, SEAT is the first Spanish company which is certified according to ISO 50.001 and can therefore testifies its position in the Spanish market when it comes to environmental protection.

Another tool in monitoring environmental efficiency is the so called energy consultant in the intranet of Volkswagen. All employees can see information and advises in order to save energy consumption and conscious usage of electricity. Typical users of energy are shown in the departments of management, production, planning and controlling who give exemplary advises how to save energy. Additionally, background information is given and the employees can learn about the standards and methods applied.

7. Volkswagen AG and green supply chain management

The sustainability efforts of the Volkswagen company are not only limited to the production of automobiles but also and especially to the logistics of the production and the product. In that respect it is paid attention to sustainability on the whole logistics process in all steps. The processes are analyzed and in cases where it is economically and ecologically necessary improvements were made. This applies to the internal logistic in the operation but also to the logistics of the suppliers of raw material and components as well the transport and shipment of the final products, the finished cars. This must be the responsibility of a global company especially when the complexity of the products and transshipments becomes bigger as the production grows worldwide. When it comes to Green Logistics Volkswagen aims at reducing the consumption of resources and water, reduction of emissions, particulate matter and waste. In the following some examples are shown how Volkswagen is taking these challenges of green logistics.

The transportation of components between the two locations in Spain, Martorell and Zona Franca, or the transportation of finished cars to the port of Barcelona, is only made with trains. SEAT, the local company, invested around 8.6 million € in building the appropriate infrastructure for that. But the savings are accounted significantly as more than 57.000 drives by truck each year can be circumvented.

At the main location in Wolfsburg, Germany, all short distance transshipments are made with bio-gas driven trucks. This pilot project was implemented by a research team of the Vienna University. This project resulted in the reduction of CO2 emissions of 20 %. The emissions of nitric oxide could be reduced by 30% whereas the noise emissions were reduced even with 50 %. Due to these positive effects this project will be also transferred to other locations in near future.

Another example of how also the single sub-brands handle the sustainability efforts in logistics is shown with the company Audi. Audi opened a new logistic centre at the location Neckarsulm, Germany. Because of the increasing number of new arrivals and model variations, the number of small part deliveries also increased. Small part deliveries are small transport boxes for components and small supplies. Since 2008 the number of these deliveries doubled. Traditionally these parts had to be sorted and distributed manually. However, with the new small part distribution center machines can now handle approx. 1,300 boxes each hour. Together with architectural improvements and energy saving measures only in the location Neckarsulm up to 500 tons of CO2 are saved every year. For this resource saving and partly CO2 emission free transport concept Audi was awarded already with the sustainability award of the Federal Association Logistic Austria and Germany (BVL 2012).

Audi also uses sustainable transport solutions for their finished cars. Since October this year, the DB Schenker Rail will transport the new manufactured cars of Audi from Neckarsulm to the port of Emden. And this transport will be totally CO2 neutral. This transport route is already the second one next to the transport between Ingolstadt and the port of Emden. The electricity which is used for running the train comes exclusively from renewable energy sources. This successful implementation of CO2 neutral transportation is another big step towards a total CO2 production of Audi, says the Audi- production director Dr. Frank Dreves (DB 2012).

Conclusions

As the case shows and also the results of the empirical survey of Thun and Müller (2010) green supply chain management is a hot topic in the German automotive industry however, some constraints still exists as the concept is fairly new and unknown. Volkswagen AG paid a lot of attention to implement the green logistics concept in the supply chains and until now can also report positive results in regard to their performance. They are the European market leader. And this is not solely because of their green logistics approach but this is for sure also a driver for business performance. One result of the study was also that green supply chain management leads to better performance in terms of indicators such as environmental protection and efficient usage of resources. Therefore, the attempt of green supply chain management should be promoted further. It can be stated that companies are aware of the environmental issues but still lacking behind realizing the full potential of green supply chain management. Most businesses need more incentives to do environmental investments, either by law or by economic motivations. But there are also positive signs that green and sustainable supply chain management leads to cost reductions and a better business performance. Especially the consumers appreciate green business strategies so the green image of a company helps to strengthen the market position.

References

AT Kearny. 2011. Supply Chain Report 2011 - Carbon Disclosure Project. London.

Beamon, B.M. 2005: Environmental and sustainability ethics in supply chain management, *Science and Engineering Ethics* (2): 221–234.

BVL (Bundesvereinigung Logistik). 2012. Sustainability award logistics. Available on the Internet: <http://www.bvl.de/presse/meldungen/nachhaltigkeitspreis-logistik-2013>.

COM. 2001. White Paper: European transport policy for 2010: time to decide. Commission of the European Communities. Brussels.

COM. 2011. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. Commission of European Communities. Brussels.

Crotty, J.; Smith, M. 2006. Strategic responses to environmental regulation in the U.K. automotive sector: the European Union End-of-Life Vehicle Directive and the Porter hypothesis, *Journal of Industrial Ecology* 10(4): 95–111.

Dekker, R.; Bloemhof, J.; Mallidis, I. 2012. Operations Research for green logistics – An overview of aspects, issues, contributions and challenges, *European Journal of Operational Research* 219: 671–679.

DB (Deutsche Bahn). 2012 Available on the Internet: <http://www.deutschebahn.com/de/konzern/im_blickpunkt/3000686/eco_rail_20120928.html>.

Gifford, D. Jr. 1997. The value of going green, *Harvard Business Review* 75(5): 11–12.

IPCC. 2007. Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

NHO (National Health Organization). 2011. Application for support. Available on the Internet: <http://www.nho.no/support-from-the-fund/category479.html>.

PwC. 2012. Global Supply Chain Survey 2013. PricewaterhouseCoopers.

Rao, P.; Holt, D. 2005. Do green supply chains lead to competitiveness and economic performance? *International Journal of Operations & Production Management* 25(9): 898–916.

Sarkis, J. 2001. Greening Supply Chain Management: Introduction, *Greener Management International* 35(3):21–25.

Seuring, S. 2004. Integrated chain management and supply chain management comparative analysis and illustrative cases, *Journal of Cleaner Production* 12: 1059–1071.

Stern, N., 2006. The Stern Review: The Economics of Climate Change. HM Treasury, London. Available on the Internet: < http://siteresources.worldbank.org/INTINDONESIA/Resources/226271-1170911056314/3428109-174614780539/SternReviewEng.pdf (29.10.2012)>.

Thun, J.-H.; Müller, A. 2010: An Empirical Analysis of Green Supply Chain Management in the German Automotive Industry, *Business Strategy and the Environment* 19(2): 119–132.

Trowbridge, P. 2001: A case study of green supply chain management at Advanced Micro Devices, *Greener Management International* 35(3): 21–135.

Volkswagen. 2012. Sustainability Report 2012. Available on the Internet: <http://www.volkswagenag.com/content/vwcorp/content/en/sustainability_and_responsibility/Sustainability_Report_.html>.

WiWo. 2012. Die Gut-Geschäftler [The good business makers], *Wirtschaftswoche* [Business Week] 23: 110–112.

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Tallinn,
February 2015

KOKKUVÕTE

Vaatamata hiljutisele turbulentsile globaalses majanduskeskkonnas, prognoositakse tulevikus kaubavahetuse mahtude kasvu, mis asetab logistilised võrgustikud senisest suurema surve alla. Euroopa Liidu tähtsaim transpordipoliitiline alusakt „Transpordi valge raamat“ (2011) on sõnastanud poliitiliste meetmete raamistiku, mille üheks keskseks eesmärgiks on järgnevatel aastakümnetel Euroopa üldise mobiilsuse jätkusuutlik kasv ning rea võtmepiirangute eemaldamine. Eesmärkide saavutamine ja visiooni elluviimine eeldab Euroopa Komisjoni ja erinevate logistikasektori huvigruppide omavahelist tihedat koostööd. Üheks paljulubavaks kontseptsiooniks selles osas on rohelised transpordikoridorid (Green Transport Corridors, GTC). GTC termin ja mõiste on tulnud kasutusse Euroopa Komisjoni initsiatiivil, aga detailide täpsustamine ja rakendusplaanid on delegeeritud mitmete kohaliku ulatusega projektide pädevusse ilma ühtse kooskõlastatud rakendusstrateegiata. See on kaasa toonud GTC mõiste hägustumise ning vastuolulised tõlgendused, mis tähendab, et erinevad huvigrupid mõtestavad seda kontseptsiooni erinevalt ja GTC ühtne elluviimine on raskendatud.

Käesolev väitekiri esitab üksikasjaliku GTC mõiste arendamise ja juhtimise raamistiku. Töö käsitleb erinevaid vaatenurki seoses keskse uurimisprobleemiga: kuidas rohelisi transpordikoridore kavandada ja juhtida. Väitekiri keskendub täpsemalt järgmistele uurimisküsimustele:

a) Millised on rohelistele transpordikoridoridele esitatavad raamtingimuste ja funktsioonide ootused ning kuidas rakendada sel otstarbel toetavaid IKT-lahendusi?
b) Kuidas saavad organisatsiooni- ja koostöömudelid panustada jätkusuutlike logistikasüsteemide arengusse ning kitsaskohtade ületamisse rohelistes transpordikoridorides?
c) Millised on multimodaalsetes transpordisüsteemides lühimerevedude ja erivedude marsruutide optimeerimise koosmõjud rohelistele transpordikoridoridele?
d) Mis on roheliste transpordikoridoride peamised tunnused ning milline on erinevate huvigruppide sidusus?
e) Kuidas rohelisi transpordikoridore juhtida vastavate tunnuste kaudu?
f) Millised on võimalikud edutegurid ja oodatavad mõjud ettevõtete majandustulemustele rohelistes transpordikoridorides?

Käesolev väitekiri kombineerib metoodiliselt esmaseid ja teiseseid andmeallikaid, kirjanduse analüüsi ning osalust uurimisprojektides. Autor kogus andmeid nii poolstruktureeritud ekspertintervjuude abil kui ka kvantitatiivsete küsitluste läbiviimisega mitmetes Euroopa Liidu finantseeritud regionaalsetes uuringuprojektides. Teisene andmeanalüüs tugineb Euroopa Komisjoni ja teiste rahvusvaheliste institutsioonide publikatsioonidele ning teadusallikatele. Töö hõlmab ulatuslikku kirjanduse ülevaadet ja integreerib käsitlusse ideid tarneahela juhtimise, sotsiaalvõrgustiku teooria ning sidusrühmade teooria valdkondadest. Autor käsitleb arenguid rohelise tarneahela juhtimise alal ning analüüsib mõjusid ettevõtetele ja majanduskeskkonnale.

Ühe tähtsaima teoreetiliste käsitluste ühisosana määratleb autor roheliste transpordikoridoride kontseptsiooni jätkuva sidusa rakendamise.

Teiseks väitekirja alusväiteks on lähenemine rohelistele transpordikoridoridele läbi sotsiaalvõrgustike teooria, mis määratleb sidusrühmad vastavate lülide ja sõlmede võrgustikuna.

Kolmanda osa töö teoreetilises raamistikus moodustab sidusrühmade teooria mudeli rakendamine roheliste transpordikoridoride kontekstis. Töös määratletud tunnused hõlmavad terviklikult huvigruppide omavahelist suhestumist. Need suhted võivad olla nii positiivsed, mis tähendab, et huvigruppidel on ühilduvad eesmärgid, kui negatiivsed, mis tähistab vastuolulisi taotlusi. Autor on rakendanud analüüsis organisatsiooniteooria meetodeid. Idee sidusrühmi kirjeldavatest tunnustest leiab käsitlust ka roheliste transpordikoridoride juhtimissüsteemide ja valitsusstruktuuride tasandil.

Autori lähenemine uurimisküsimustele on käsitletav kahel tasandil. Esimeseks sammuks on roheliste transpordikoridoride mõiste areng. Värsked võrdlevad rakendusuuringud esitlevad kontseptsiooni töölerakendumist ning käsitlevad toetavaid keskkonnatingimusi. Uuringud määratlevad roheliste transpordikoridoride eduka rakendamise edutegurid. Nendeks on eelkõige sobilike transiitkaupade käitlust võimaldav infrastruktuur ja regionaalsete ettevõtete koostöövõimekus, mis võimaldab mõjutada positiivselt logistilise võrgustiku riskikeskkonda.

Autor analüüsis uurimistöös roheliste tegurite mõju transpordis ning tõi esile hinnangud erinevate transpordiviiside kaasamiseks rohelises transpordivõrgustikus. Rakendusuuringute tasandil uuris autor marsruudi optimeerimise problemaatikat, käsitledes lühimerevedude rolli rohelistes transpordikoridorides. Optimeeritud marsruudid tähistavad kõige säästlikumat veolahendust detailselt määratletud keskkonnas. Võimalikku lahendust erivedude problemaatikale käsitles autor Läänemere regiooni ülegabariitsete veoste transpordistrateegia loomise kaudu.

Vastavalt roheliste transpordikoridoride juhtimise potentsiaalile on väitekirja autor demonstreerinud individuaalsete sidusrühmade tüpoloogiat. Need tegevused on hinnatavad projektipõhises uurimistegevuses määratletud näitajatega, mis leiavad rakendust sidusrühmadepõhise juhtimise teoreetilises raamistikus. Suur osa sidusrühmadest rohelistes transpordikoridorides on väikeettevõtted, mis tähendab, et transpordisüsteemide ja väikeettevõtluse omavaheliste mõjude teema leiab töös süvendatud käsitlust.

Autor käsitleb roheliste transpordikoridoride kontseptsiooni kui koostööd toetavat ja arendavat platvormi, millel kohtuvad erinevad strateegiad, taotlused, väärtused ja kultuurikeskkonnad ühiste huvide realiseerimisel. Taoline koostöö saab realiseeruda riskivabalt vaid siis, kui kõigi osapoolte vajadused saavad piisaval tasemel rahuldatud. Vastasel juhul tekib vajadus eraldiseisva neutraalse institutsiooni järele, mis võtab üle süsteemi ja koostööd juhtiva ja koordineeriva rolli. Käesolev väitekiri ühendab selles osas erinevaid vaatenurki ja täiendab seniseid väheseid süsteemseid teoreetilisi käsitlusi roheliste transpordikoridoride juhtimissüsteemidest.

Väitekirja autor leiab, et püstitatud uurimisküsimus on leidnud põhjalikku ja põhjendatud käsitlust. Uuenduslik metoodiline lähenemine ja analüütiline uuringutegevus võimaldasid luua unikaalset teadmist, mis hõlbustab Roheliste Transpordikoridoride kontseptsiooni rakendamist ning parendab tervikuna transpordi- ja logistikasüsteeme, pidades eelkõige silmas, et Euroopa logistikavõrgustikes on keskkonnasäästlike ja jätkusuutlike lahenduste arendamine võtmetähtsusega arengufaktor. Väitekirja autor toob esile praktilised järeldused erinevatele Roheliste Transpordikoridoride sidusrühmadele. Mitmete järelduste ja näpunäidete asjakohasus ja paikapidavus on end ka juba praktilises arendustegevuses tõestanud. Sellele vaatamata näeb autor ruumi edasisteks uuringuteks, mille potentsiaalselt viljakad suunad on samuti töö kokkuvõtvas osas käsitlust leidnud.

Tõlkinud Tarvo Niine

ABSTRACT

Despite recent turbulences in global economy the growth of global trade volumes is expected to continue in the future, thus increasing the demands on logistics networks. The political framework for EU Transport Policy Development is presented in the EU White Paper on Transport 2011 in order to build for the next decades a competitive European transport system that will increase mobility and remove major barriers in key areas. Logistics stakeholders need to find solutions for how to implement this vision held by the EU Commission. One way is to employ the concept of Green Transport Corridors (GTCs). The EU Commission developed the term GTC, however implementation and further investigations were forwarded to different EU funded regional development projects with no clear and coherent implementation strategy. Therefore, almost all projects and initiatives have a different understanding of this concept. So, not only the definition but also the realization is different with regard to the understanding of the involved stakeholders.

In order to provide a framework for development and management of GTCs this research focuses on the following central research question (CRQ):

CRQ: How can Green Transport Corridors be conceptualised and managed?

a) What framework conditions and functionalities should a GTC fulfil, especially how can IT solution support help to achieve this?
b) How can organizational models and cooperation contribute to sustainable hub development along a GTC by removing existing bottlenecks?
c) What are the impacts of including the concept of Short Sea Shipping and special transportation (oversize transport) in multimodal route choice optimization?
d) What are the characteristics of the GTC properties (stakeholders) and how do they interact?
e) How can these properties be managed and governed according to their characteristics in the GTC?
f) Which success factors and economic efficiency effects can be expected by private businesses when participating in the GTC?

Methodological choices of this research were based on primary data collection, second data assessment, literature reviews, and project participation. Primary data was collected with the help of semi-structured expert interviews and evaluation of quantitative web-based questionnaires in the frame of project participation of the author as a project manager of some EU-funded regional development projects. Second data assessment included the review and analysis of published information from the EU Commission, other development projects and international consortia. The literature review was extensive, as this thesis

includes theoretical aspects from different fields, mainly: supply chain management; social network theory; and stakeholder theory.

The author identified impacts of green supply chain management developments and the potential impact on businesses and economy. Resulting from the broad literature review and results available, the author could highlight the necessity of the further development and engagements in the implementation of the GTC approach.

The second assumption the author of this thesis made was that a GTC could be identified as a type of network with many different stakeholders, where basic theory, i.e. social network theory, can be applied. Network theory describes the stakeholders of a network as links and nodes. The same applies to GTCs.

The third fundamental basis of the framework for this thesis is the theory of the stakeholder model. Through the research and assessment of previous research and results, the author was able to apply common characteristics to the approach of GTCs. The identified characteristics show that each stakeholder, it might be a link or a node, has an interrelation with other stakeholders. These interrelations can be positive, meaning they strive for the same aims and objectives in the cooperation, or they might be negative, which would mean that they aim at more controversial objectives and act controversially accordingly. The author identified parallel assumptions and methods in organizational theory and corporate structure development which can also be applied to the GTC. The theory that stakeholders have common characteristics is also relevant for the development of management bodies and governmental structures in the construct of a GTC initiative.

The contribution of this research is based on the two-step approach towards solving the CRQ. The first step is the development of the GTC concept. New implemented comparative studies among leading research and development projects show the functionalities and frame conditions for the implementation of this concept. Another aspect of innovative research is the elaboration of other factors for successful implementation of the GTC concept. This is the establishment of adequate transhipment facilities and cooperative business structures among the logistics players, as they are quite crucial for the failure-free existence of such a network.

The author analysed the impact of green factors in transportation and provided an assessment of different transport modes in order to create a green transport network. The method applied showed a route optimization by applying Short Sea Shipping in the network of the transport modes. With this, the routes were optimized and can be considered as part of the GTC as they demonstrate the green solution for transportation along defined routes. A solution for the special cargo involvement was demonstrated by the implementation of the oversize transport strategy in the Baltic Sea Region which was developed by the author of this thesis.

According to the management potential of a GTC, the author of this thesis shows the typologies of the individual stakeholders of the GTC who represent the characteristics of such a network. This operation is evaluated by KPIs which are developed during project participation and are applied to the theoretical frame of stakeholder management.

One further impact assessment was made based on the fact that investigations showed that the main portion of stakeholders in the GTC is privately run small business or single entrepreneurs. Therefore, the advantages and disadvantages for small business were demonstrated when these companies become part of such a described logistics network. As the impact is not only on each single company but also on the economy of a nation or region, a question arises over whether there are measurable indicators for the efficiency of a GTC? Therefore, the advantages and disadvantages for small businesses were demonstrated when these companies become part of such a described logistics network.

Additionally, the author sees the GTC concept as a construct where different stakeholders with different business strategies, objectives and values and business cultures attempt to cooperate in order to all benefit from the joint agreement. Naturally such cooperation can only be failure-free if all stakeholders are satisfied in their needs to an acceptable extent. If this is not the case, or the (transnational) business environment requires that some neutral institution take over the management role, an additional artificial management body would need to be created. This thesis covers this evolving research gap when it comes to management of the GTC.

The author of this research was able to answer the central research question. Fundamental and innovative methodology and the application of research and analytical methods delivered unique research results, which could contribute to the concrete successful implementation of the GTC concept in the transport and logistics field. The development of sustainable and environmentally friendly solutions for transportation and logistics will be the most crucial factor when developing the economy, especially in the dense logistics network of the European Union. The author of this thesis provides hands-on results for private stakeholders as well as (trans-) national or regional governance institutions which might be responsible for the management of GTCs. Practical applicability for many of the research findings has already been approved during this research. However, in addition, the author of this thesis delivers proposals directions for further investigations in future research which lay beyond scope of this thesis.

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