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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, CO₂ 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.

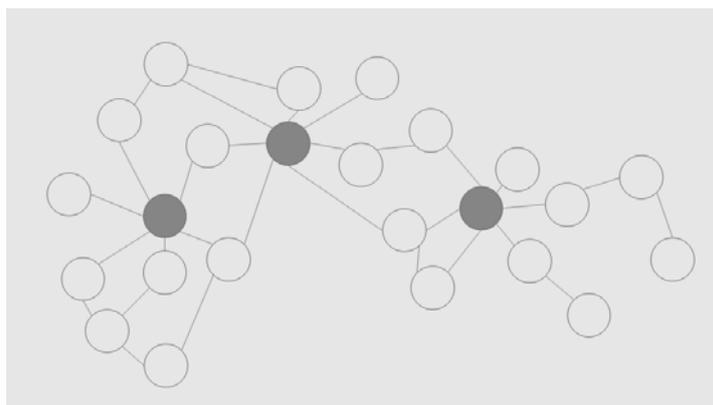


Figure 1. Transport corridor in social network theory

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 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. [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 SO₂, 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.

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