COLLABORATING ON GREEN LOGISTICS IN CHEMICAL SUPPLY CHAINS: INSIGHTS FROM POLAND

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Abstract

Sustainable, safe, secure and efficient logistics is of great importance for chemical supply chains to operate successfully. However, as most logistics operations in this sector are outsourced to logistics service providers (LSPs), chemical companies have to rely on LSPs and collaborate with them when working on logistics eco-efficiency. This paper takes an LSP's perspective. It aims to investigate the vertical as well as horizontal collaboration needed in making chemical logistics greener and safer, by shifting chemical road freight to intermodal transport, combining modes, better transport planning, and energy and emission management. The research problem is analysed on the basis of a literature review and structured, in-depth interviews conducted with nine LSPs and twelve chemical companies operating in Poland.

The research is part of the "Promotion of Multimodal Transport in Chemical Logistics" project within INTERREG Central Europe Programme. The main findings from the research show that environmental regulations and targets in the EU Transport Whitepapers have resulted in LSPs' interest to work towards establishing more ecological strategies and operations, as well as new, greener services in response to the needs of chemical companies. There are many examples of vertical cooperation, even with elements of collaboration, among LSPs and their suppliers, and chemical customers in green logistics. However, this is not the case for horizontal cooperation among LSPs operating in Poland. They consider it to be very challenging and risky, and are reluctant to share their data with other LSPs. Nevertheless, environmental regulations, technological development and efficiency goals will soon force LSPs to consider working together with other LSPs, even competitors.

The research reported in this paper is limited in its scope. Even so, it does provide a platform from which more detailed research may be conducted. The managerial implications arising from the research suggest current practices in green logistics in general and green logistics in chemical industry in particular.

Key words: sustainability, multimodal transport, chemical freight, Logistics Service Providers (LSPs), vertical / horizontal cooperation

1. INTRODUCTION

Logistics within chemical supply chains is the integrated management of all the activities, such as freight transport, storage, inventory management, materials handling and the related information processing required to move products from a raw material source through the production and distribution system to the point of consumption and reverse direction (CSCMP, 2017). The main objective of logistics is to coordinate these activities in a way that meets customer requirements at minimum cost. In the past this cost had been defined in purely monetary terms. However, as concerns for the environment are rising, companies must now take into account the external costs of logistics associated mainly with climate change, air pollution, noise, vibration and accidents. In the European Union (EU) the negative effects of logistics have been estimated at more than 250 billion EUR annually (Woxenius and Barthel, 2013). A significant part of it comes from transport, in particular road freight transport.

This article concentrates on transport operations in chemical supply chains. The European Commission (EC) warns that transport represents almost a quarter of Europe's greenhouse gas emissions (GHG) and is the only major sector in the EU that has not seen the same gradual decline in emissions as other sectors. Within the transport sector, road transport is by far the biggest emitter, accounting for more than 70% of all GHG emissions from transport in 2014 (European Commission, 2016). It is also the main source of traffic congestion, noise, vibrations and accidents, which impacts not only environmental but also the social and economic performance of the EU.

Bearing this in mind, while designing the European transport policy for the 21st century, the EC aimed to "disconnect mobility from its adverse effects" (COM, 2001). In compliance with the Kyoto Protocol (EEA, 2005), the EC aimed to reduce GHG emissions by 20% below 1990 levels by 2020, and by 80-to-95% by 2050. In order to achieve these objectives, the EC wants to shift 30% of road freight, transported more than 300 kilometres, to multimodal by 2030 and to 50% by 2050, revitalize rail transport, and improve short-sea and inland waterways, among others (COM, 2011).

Transport and logistics industries are working on achieving these goals and making transport more sustainable with a strong commitment and contribution from chemical companies, who transport large volumes at long distances and recognize environmental and social sustainability as a strategic priority (WEF, 2009; Cefic, 2014). In regards to Central Europe, the chemical industry is an important economic sector with 117 billion EUR turnover and 340.000 employees.[1] However, as most logistics operations in the chemical sector are outsourced to logistics service providers (LSPs) (McKinnon & Piecyk, 2010, p. 14), chemical companies have to rely on LSPs and collaborate with them to improve the safety and environmental protection of chemical transports, while at the same time ensuring competitive and economically feasible solutions.

This paper takes an LSP's perspective. It aims to investigate the vertical as well as horizontal collaboration in making chemical logistics greener and safer by shifting chemical road freight to multimodal transport, greater use of intermodality when

[1] http://www.interregcentral.eu/Content.Node/ChemMultimodal.html

transporting chemical products to and from manufacturing plants, better transport planning, and energy and emission management in chemical supply chains.

The remainder of this paper is organised as follows. It starts with the introduction, which is followed in section 2 by a literature review, where two main topics are covered: green and sustainable logistics concepts, as well as supply chain collaboration on green logistics and transportation. This section provides the theoretical basis of the work. In section 3, the ChemMultimodal project and research methodology are presented. In section 4, the findings are presented and a discussion is organised around three topics: CO2 emission management, road freight transport shift to multimodality and collaboration on multimodal transport. The paper ends with conclusions and suggestions for future research.

2. LITERATURE REVIEW

The literature review is used to frame the analysis. It focuses on two main topics: (1) green logistics presented firstly as a function, next as a part of corporate strategy and finally from the supply chain perspective, and (2) LSPs' collaboration on making logistics greener and more sustainable.

2.1. Green logistics and sustainability

Green logistics is related to reducing environmental impact from different logistics operations, i.e. mainly freight transport, but also storage, inventory management, materials handling, or reverse logistics. While green logistics encompasses a wide variety of dimensions and initiatives, companies that focus only on one specific dimension (e.g. freight transport) could still be seen as implementing green logistics.

In the 21st century, interest in environmentally responsible logistics operations has increased. This has been a result of governmental regulations, economic considerations, and increasingly strong market signals from environmentally conscious consumers (Goldsby & Stank, 2000; Scholtens & Kleinsmann, 2011; Tacken et al., 2014). However, it should be recognized that the motivation towards greener logistics operations have been also found by companies internally. Rossi et al. (2013) have pointed out the growing role of cost reduction, quality improvement, and the personal commitment of a leader, as well as middle management involvement, as main drivers of green logistics. Evangelista et al. (2017) have expanded the list with, broadly discussed in literature, the willingness to improve corporate image.

After the stage of focusing on green logistics as a function and ad hoc reactive eco initiative, the environmental sustainability of logistics has become the new priority for logistics managers and part of corporate strategy (McKinnon, 2015). Managers have aimed at making logistics more sustainable, i.e. organizing it in the way that allows for meeting the needs and goals of the present, without compromising the ability of future generations to meet their own needs and goals (Brundtland Commission, 1987). It should be stressed that green logistics as a part of corporate sustainable strategy is not limited just to an environmental dimension. Sustainability means the reconciliation of environmental, economic and social objectives at the same time. It is about eco-efficiency and social responsibility of logistics. In literature the term eco-efficiency is defined as the "reduction of resource intensity and minimisation of environmental impacts (…) with value creation" (Rossie et al., 2013). In other words, it is doing more with fewer resources, and saving CO2 and money.

To improve corporate logistics performance, a large portion of companies, whose core competencies focus on functions other than logistics, have decided to outsource their logistics operations to LSPs (Selviaridis & Spring, 2007) what is also the case for the chemical industry (McKinnon & Piecyk, 2010, p. 14). Increase in the outsourcing of logistics services and intense competition in the 3PL market has led to a broadened scope of services offered by LSPs, aiming to satisfy the requirements of a wide range of customers (Busse & Wallenburg, 2011, Cichosz et al., 2017), including environmentally conscious customers. According to Martinsen & Huge-Brodin (2010), the development of green logistics services is an active interface between the demand and supply side, where both sides place pressure on, and respond to, each other. Research conducted in the European chemical industry by Leppelt et al. (2011) shows that the influence of a purchasing company (shipper) on logistical variables related to sustainability is significant. Sustainability leaders intensely invest in sustainable supplier relationship management practices, such as code of ethics, in order to manage sustainability even beyond their corporate boundaries. Research conducted by Rogerson (2017) proves these findings and presents three causes of influence on the shippers' purchasing processes based on logistical variables: specific requirements, network structure of transport providers, and scope of contract. Specifications by purchasers, especially time requirements, influence several logistical variables defined earlier by Piecyk & McKinnon (2010) such as 'mode used', 'length of haul', 'load factor', 'empty running', and 'fuel efficiency', which are, in turn, related to CO2 emissions.

Some can ask the question if further efficiencies in green logistics are possible. McKinnon et al. (2015), analysing improvements that have been made, admit "the potential still exists to cut the other environmental costs of logistics by a significant margin." Lieb & Lieb (2010) in their study of LSPs' CEO foresee that "green management and integrating green issues into logistics service offerings has involved more and more LSPs and will probably attract even more managerial attention in the logistics industry in the future." However, to achieve further efficiencies, a broader perspective on environmentally responsible logistics is required. Companies have to realize that an individual firm's environmental impact extends well beyond its corporate boundaries, and collaboration on green logistics becomes a must.

The thesis that supply chain partners' collaboration on green logistics can help to address the challenges related to modal shift, was formulated on the base of Resource Based View (RBV) and Social Exchange Theory.

2.2. LSPs' collaboration on green logistics

The fundamental rationale behind collaboration is that a single company cannot successfully compete by itself as customers are more demanding, less loyal, and competition is escalating. Thus, the ability to compete has been directly linked to the ability to collaborate with supply chain partners. Firms enter into interfirm collaborative arrangements in order to share risks and rewards. The objective is to secure higher performance than would be achieved by operating individually (Lambert et al., 1999).

When designing supply chain collaboration on green logistics, three elements are playing key role: the appropriate partner you collaborate with (i.e. customer, supplier, competitor, etc.), the plethora of green logistics activities constituting the 'width' of green logistics collaboration, and the level of supply chain collaboration referred as the 'depth' of the relationship.

2.2.1. The concept and directions of supply chain collaboration

In this paper supply chain collaboration is understood, according to Soosay and Hyland (2015), as: "two or more companies working together to create a competitive advantage and higher profits than can be achieved by operating alone". However, not all cooperation is collaboration. Świtała (2015) grades inter-firm relationships on a scale from cooperation (the basic level of supply chain integration), through to coordination (with a higher level of integration), up to collaboration (when companies treat each other as an "extension" of their organization).

It is widely accepted today that supply chain collaboration enables superior performance in firms due to the capitalization on resources, capabilities, processes and routines residing in their partners' firms (Fawcett et al., 2012). Among the main benefits companies name efficiency (e.g. cost reduction, reduced inventory, shortened lead-time, streamlining supply chain process, etc.), effectiveness (improved customer service and customer satisfaction, increased market share, increased sales, new product development, etc.), and profitability (Min et al., 2006; Kohli & Jensen, 2010).

The competences of LSPs make them an attractive partner for logistics collaboration. Collaboration with LSPs has a positive effect on the efficiency of logistics performance, which translates into the increased competitiveness of the supply chain. The LSPs and chemical companies collaboration within the supply chain was investigated during studies commissioned by Cefic and EPCA (chemical industry associations) (Cefic, 2004 & 2005). The main conclusion from the studies was that there is a need for increased collaboration to eliminate waste and create value. Working groups emphasised that "shippers (chemical companies) must understand their core role in logistics processes and cannot just expect providers to take the initiative from their current position. (..) The industry should develop new capabilities and working methods to collaborate with LSPs" (Braithwaite (ed.), 2005, p.3).

The supply chain collaboration of LSPs and their partners may have two directions, i.e. vertical and horizontal. **Vertical collaboration** refers to collaboration between adjoining businesses i.e. the LSP and customers (shippers) on the demand side, as well as suppliers, rail and port operators on the supply side. **Horizontal collaboration** refers to partners with a similar business profile, which operate at the same tier of the supply chain and very often decide to share logistics capacity. According to Barratt (2004), they could be competitors or non-competitors. This form of relationship is often called coopetition (cooperation plus competition). Coopetition is especially beneficial if cooperation takes place for non-core activities such as transport and logistics (Cruijssen, 2012). Soosay et al. (2008) refers to reduced logistics and administration costs for individual organizations, improved procurement terms, and lowered fixed costs of indirect labour as main incentives for integrating horizontally. Wallenburg and Schafller (2016) admit that horizontal collaboration is a common practice among LSPs who form partnerships to increase the productivity of their assets or extend their geographical coverage by combining a network of LSPs.

Simatupang & Sridharan (2002) have observed that while aiming at gaining more flexibility, LSPs combine both vertical and horizontal collaboration. This kind of thought-process and action is referred as **lateral collaboration**. The logistics examples of lateral collaboration are integrated logistics and multimodal/intermodal transport, aiming at synchronizing the carriers and shippers of different firms in a seamless and effective freight transport network when at the same time cooperating with other LSPs to improve efficiency of logistics.

When the parties involved in the logistics collaboration are located in close proximity, we talk about **logistics clusters**. According to Sheffi (2012) they embrace: (i) logistics service companies or (ii) companies with logistics-intensive operations who compete based on their logistics prowess, and (iii) the customers of logistics services i.e. chemical companies. Naturally, many logistics clusters develop around transportation hubs, such as mode-changing terminals.

2.2.2. Framework for green logistics collaboration

Green logistics initiatives, which are the subject of green collaboration, may be defined as “the set of actions and decisions necessary to mitigate the negative impact on the environment derived from activities carried by company” (Klassen & McLaughlin, 1996). Nowadays, they are more often taken into account when purchasing logistics services (Martinsen & Bjorklund, 2012).

Evangelista et al. (2017) propose taxonomy, distinguishing two different types of environmental initiatives. On one hand, there are initiatives mainly focused on green solutions that are predominantly effective within the boundaries of an LSP company (called ‘point’ initiatives), related to e.g. the vehicle, its age, engine type, fuel, eco driving, loading factor, use of IT, etc. On the other hand, there are green actions that extend their impact beyond the boundaries of LSP (called ‘supply chain’ initiatives), which demand partners’ collaboration on planning, organizing and controlling. They include among others:

- shifting road freight transport to a **multimodal transport** – understood here as the carriage of goods by at least two different modes of transport when the main part of products journey is done by an environmentally friendly mode on the basis of a multimodal transport contract (Cichosz et al., 2017),
- greater use of **intermodality** (the usage of one loading unit during the whole journey of freight what demands infrastructure planning, and coordinating leasing of equipment, inspections, cleaning, mending and empty stacking of intermodal loading units among others),
- **collaborative transport planning** for routes and fill-rates optimization, and

- **energy and emission management** by introduction of environmental management systems (e.g. ISO 14001), emission off-set programmes, using lower energy transport modes, renewable energy etc.

Some of these initiatives are managed in dyadic relationships (LSP vs. supplier or LSP vs. customer), while the others need multi-partner collaboration. The latter were found to be more demanding and underdeveloped (Evangelista et al., 2017), and thus offering higher potential for efficiency, including eco-efficiency.

2.2.3. Intensity of supply chain collaboration

Collaboration is challenging and costly, which means that it is not for all supply chain members. Lambert et al. (1999), Barratt (2004), Soosay et al. (2008), Cruijssen (2012) and many others suggest that segmentation is needed for selecting a small number of strategically important customers and suppliers worth collaborating with.

Lambert et al. (1999) have identified three types of cooperation (the model was adopted by Cruijssen in 2012 with three types of collaboration specifically in transport services) depending on the level of integration between partners. According to Cruijssen (2012) **type I** consists of mutually recognized partners that cooperate to a limited degree within a short time horizon. **Type II** – participants that do not merely coordinate, but also integrate part of their business planning. The horizon is longer, and multiple divisions or functions of the companies are involved. **Type III** is when participants have integrated their operations to a significant level and each company regards the other(s) as an extension of itself. This business relation is based on mutual trust, openness, shared risk and shared rewards. Typically, there is no fixed end date for such collaboration. This spectrum of relationships is completed on the left side by an arm's length (transactional) relationship and on the right side by full integration.

Planning for environmental goals extending beyond single company boundaries and involving multiple supply chain partners needs intensive collaboration, as very often it results in supply chain reconfiguration.

3. RESEARCH ON GREENER TRANSPORT OF CHEMICAL COMPANIES

As freight transport represents the largest portion of costs and emissions within the framework of logistics operations, research on green logistics of chemical companies is focused on green transport operations.

3.1. Transport challenges in chemical supply chains

Describing chemical freight transport, it should be emphasized that it differs between upper and lower end of supply chain. In the upper section of supply chains, primary producers of base chemicals transport their products mainly in bulk volumes that can fill a full road vehicle, barge, ship, wagon and even a whole train. Thus, on the inbound logistics side, chemical companies make use of lower carbon modes such as pipeline, rail and water-bone services. Further down the supply chain, the nature of transport operations changes as the portion of packaged chemical products increases, average order size declines, and the average number of drops per delivery increases, which results in the growth of a significant use of road transport. Applying rail transport in the lower part of supply chain requires more planning, but it is still feasible as chemical packaged products are characterized by relatively high density.

The priority for transport operations in chemical supply chains is safety and security. Product safety refers to the reduction of the probability that use of it will result in negative consequences on customers (which are from a wide spectrum of sectors as chemicals are incorporated into a broad array of products). Product security refers to the delivery of a product that is uncompromised by intentional contamination, damage, or diversion within the supply chain (Marucheck et al., 2011). Safety and security are named as qualifying criteria when purchasing logistics services. Eco aspects are just now gaining attention from chemical companies (Evangelista et al., 2017; Martinsen & Bjorklund, 2012).

The challenge to arrange and coordinate multimodal transport with rail, water-bone or sea (where applicable) as main haulage is addressed to logistics providers, as almost all transport operations of chemical companies (except pipeline movement) are outsourced (McKinnon & Piecyk, 2010). Chemical companies employ a full range of logistics companies, with a full range of transport modes. The density of chemical products is relatively high and the chemical industry generates a high portion of full loads, which makes the chemical industry a perfect shipper for massive transport modes, and shift to multimodal.

3.2. ChemMultimodal project – response to environmental challenges

The ChemMultimodal project aims to promote the multimodal transport of chemical goods in Central Europe. Regional authorities, chemical industry associations and scientific institutions from seven regions in Central and Eastern Europe are working together to improve safety and environmental protection of chemical transports on the one hand, but also to ensure competitively and economically feasible solutions on the other.

The project partners want to support chemical and logistics companies in their ambitions to shift transport from road to multimodal. The chemical industry is an important stakeholder responsible for 8 percent of freight transport in Central Europe and significant user of multimodal.

The European Union has defined targets for the increase of multimodal transport in the upcoming years. Actions to reduce the CO2 footprint have a high political priority at global, European, and national levels. Multimodal transport is often cross-border transport – therefore harmonization challenges are very important to ensure sound framework conditions. Nevertheless, reality has shown insufficient progress for the modal shift, caused by infrastructure bottlenecks or high competition from road transport.

The project is running from June 1st 2016 to May 31st 2019. It is divided into six stages. The main objectives for the first two stages were: (1) analysis of the current situation of the intermodal transport of chemicals, and (2) development of a toolbox for chemical road freight transport shift to multimodal, in particular rail.

3.3. Research methodology

The research problem is analysed on the basis of a literature review and structured, in-depth interviews conducted in 2016 with twelve chemical companies operating in Poland and nine LSPs serving them.

3.3.1. Instrument development

A questionnaire for in-depth interviews was developed in English as a guide for the whole project and was later translated into Continental languages of project partners. The questionnaire included a mixture of open and multiple-choice questions. It comprised of the following sections:

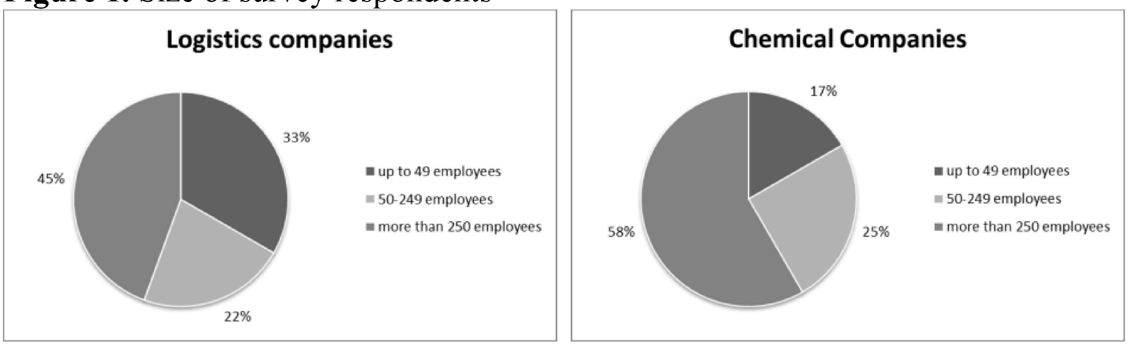
1. Relevance of CO2 measurement
2. Importance and main routes of multimodal transport
3. Potential for modal shift
4. Drivers (advantages) and barriers (disadvantages) of modal shift
5. Potential internal and external improvements in modal shift (with emphasis on vertical and horizontal collaboration with supply chain partners).

A pilot test was performed with an expert in the field of logistics and supply chain management in chemical company, before the full sample of respondents were interviewed. It allowed for the avoidance of misunderstandings.

3.3.2. Data gathering

The questionnaire was sent out to forty-nine companies across Poland. Logistics and supply chain managers were found as the most suitable informants. Twenty-one managers responded and interviews were performed by telephone and at-company sites from August to September 2016, and lasted approximately one hour each. Statistical data was completed by e-mail. Finally, 21 questionnaires were collected: nine from logistics companies (LSPs, carriers, rail and port operators) and 12 from chemical companies (producers and distributors as well). Both groups of respondents were rather diversified, 45% of logistics companies were big players with more than 250 employees, 22% were medium sized players, and 33% were considered as small logistics companies. The split of chemical companies was as follows: 58% - big, 25% - medium, and 17% - small players (Figure 1).

Figure 1. Size of survey respondents



Source: own elaboration on the base of conducted survey

4. FINDINGS AND DISCUSSION FROM POLAND

As generally most logistics operations within chemical supply chains are outsourced to logistics companies, the analysis of the results of the survey are performed from the perspective of LSPs (although in some aspects the other perspective is also included). The analysis is organized around three main topics: CO2 emission management, road freight transport shift to multimodality and collaboration on multimodal transport.

4.1. CO2 emission management in chemical transport

One of the main goals of ChemMultimodal project is to reduce CO2 emissions from European chemical transport and this way making it greener. Therefore, it was important to diagnose the current status of CO2 footprint measurement practices within chemical and logistics companies, and learn if there is willingness among partners in chemical supply chains to improve the situation.

The results of the survey show that in Poland **the interest in CO2 measurement is rather low among chemical and logistics companies**. The situation looks a little bit better among big logistics players, who introduced sustainable programmes and sustainable organisational culture, resulting in their employees being environmentally conscious while having the equipment and procedures to do it. These logistics providers measure and report on the CO2 footprint for different groups of their stakeholders, including their customers who can receive emission data on their invoices. To estimate CO2 emissions, logistics companies apply CO2 calculators, calculating emissions using energy consumption data. A very popular web-based CO2 calculator among big logistics players is EcoTransIT.

Medium and small logistics companies, as the reasons for low interest in emissions measurement, most frequently cite: ‘the lack of obligatory requirements for transport emission reporting’, and ‘no equipment and procedures for emissions’ measurement’. Respondents from chemical companies point out the other two aspects that cause their disinterest in measuring emissions. Firstly, most of their emissions come from the production process and their sustainability programmes are focused on reducing emissions from production. Secondly, they outsource transport and logistics to LSPs thus, in their opinion, emissions from transport and logistics are not their problem. They have already paid for it.

Concerning the change in the approach to CO2 and other emissions’ measurement, it is worth noticing that respondents admitted that as long as they would not see advantages or would not be obliged to measure and reduce emissions, they might not be particularly interested in changing their behaviour in this field. And according to the rule ‘if you do not measure it, you cannot manage it’, their interest in operations helping to reduce CO2 emission i.e. modal shift, more efficient planning of transport routes, backloads, and improvement of a fill-rate factor or efficiency of terminal operations, etc. would stay rather low.

4.2. Multimodal transport in chemical supply chains

The results of the survey show that multimodal transport is applied in chemical supply chains. However, it is considered more important for logistics companies than for chemical ones. These evaluations correspond with chemical companies' multimodal transport share, which is relatively low in relation to other modes of transport. The bad news is that, in general, respondents from chemical companies in Poland do not see a specific motivation to increase multimodal transport usage. They acknowledged that they organize transport on the base of cost and convenience. They are not interested in CO2 emissions. Shorter transit time and better cost are arguments that could motivate them to use multimodal transport more intensively. However, regarding transit time, in most cases logistics companies are not able to satisfy chemical companies' expectations with multimodal transport within the framework of contemporary European transport system with its low interconnectivity and interoperability (Cichosz et al, 2017). In this case **the real motivation to shift chemical road transport to multimodal is safety and security, as well as necessity to carry higher tonnages**.

Main routes for multimodal transport in Poland are hinterland connections from/to Polish ports Gdańsk/Gdynia, Szczecin/Świnoujście, as well as from European ports, such as ARA (Antwerp, Rotterdam, Amsterdam) and Hamburg, to central Poland and Upper Silesia. Respondents see the biggest potential to shift road transport to multimodal in hinterland connections from/to Polish ports and from their factories to Spain, Italy, Germany, Romania and Turkey.

Identifying essential factors which support the promotion of multimodal transport within the chemical industry, both chemical and logistics companies pointed out lower transit costs over long journeys and safer transit for dangerous, hazardous products. Logistics companies, analysing drivers of modal shift, paid more attention to environmental issues. They admitted that the usage of multimodal solutions supports their CSR strategies, as well as contributes to emission reduction of greenhouse gases, noise, fumes and vibrations. However, to be efficient, they see the need for close collaboration with other chemical supply chain partners.

4.3. Collaboration on multimodal transport in chemical supply chains

The results of the survey with a discussion regarding collaboration on greener freight transport in the chemical industry are presented from three perspectives: a vertical, a horizontal, and a lateral one.

4.3.1. Vertical collaboration

Regarding vertical collaboration, all respondents from logistics companies admitted that they cooperate with their customers, however the intensity of the cooperation between companies differs. Big logistics players have a few significant customers with whom they integrate selected logistics processes, work on new routes (including intermodal connections), new packaging or extra services tailored to their needs, e.g. terminal services related to cleaning railway cars. This cooperation has elements of collaboration. However, it is the minority. The logistics market in Poland is very fragmented and the majority of logistics companies are small players with very limited market power. That is why they generally cooperate with their customers at arm's length with very limited trust. In the case of arm's length cooperation, partners are not ready to allocate the risk related to a shift from road to multimodal transport. They instead focus on time and cost efficiencies.

Regarding chemical companies, two out of 12 respondents decided to outsource their freight operations to LSPs, three out of 12 prefer to organize freight transport on their own, three work in cooperation with LSPs, and the last four apply the mixed model with few routes managed by chemical companies' transport departments on their own, and the others are managed by LSPs. The share of operations managed independently against these managed by LSPs differs from company to company.

In regard to collaborating with suppliers with access to infrastructure, equipment and services (including IT services), LSPs see the potential in it and aim to further utilize these relationships. Information and Communication Technology (ICT) is seen as an enabler, which helps LSPs to cross organizational boundaries. In the beginning, ICT was mainly used to support existing inter-organizational processes (e.g. the exchange of documents) whereas now the trend is on the emergence of new ways to do business with supply chain partners (e.g. electronic auctions).

4.3.2. Horizontal collaboration

On the other hand, LSPs' horizontal collaboration is very limited in Poland. Respondents from logistics companies admitted that their cooperation with competitors, and non-competitors operating at the same tier of the supply chain, is extremely difficult. The biggest challenge is openness and trust, and fair gain and risk sharing. Shortages in these aspects make transport services organized by several providers not transparent to customers. This type of cooperation needs improvement, as LSPs are aware of the advantages of horizontal collaborations in terms of cost, efficiency, customer service, market position and others. LSPs understand that, individually, it could be difficult for them to shift transport from road to rail but when consolidating shipments from different LSPs it could be feasible to fill the train. It should be emphasised that nowadays ICT enables inter-firm communication and facilitates the process of horizontal collaboration. Thanks to IT solutions logistics companies could develop knowledge and recognition of capacities and capabilities of fellow LSPs (e.g. specialised in other core areas than their own) and make use of it.

Horizontal cooperation, even with elements of collaboration, in the light of the European regulations, environmentally conscious customers' requirements and the eco-efficiency goals, could soon become a must solution allowing for an increased scale of operations.

4.3.3. Lateral collaboration

Consolidating shipments in order to achieve the volume of transport to qualify it for multimodal or intermodal shipments requires both types of collaboration i.e.

vertical (with customers, carriers, rail and terminal operators etc.) and horizontal (among LSPs) as well. This type of collaboration is referred to as a lateral one.

ICT solutions available on the market could facilitate the collaboration process. Many information tools such as rail maps, terminal maps, schedules with regular rail connections, etc. are already available free-of-charge. However, as the results of the survey show, logistics and supply chain managers of logistics and chemical companies do not know and use them. When planning transport, most of them uses information systems that are integrated just within their company what does not help them to collaborate on consolidating shipments across companies. Nevertheless, the results of the survey show, that situation is slowly changing. Several logistics companies (more often big players) are connected to their suppliers and/or customers, and very low proportion of LSPs is even connected to other LSPs. The results of the survey show that LSPs prefer to cooperate with other LSPs through fourth parties such as e.g. a railway operator who operates regular connections and consolidates shipments for them such as PCC Intermodal.

5. CONCLUSIONS

This paper addresses the topic of collaboration on green transportation with LSPs and chemical companies by using a sample of 21 in-depth interviews conducted in Poland.

From a theoretical perspective, this study enriches the existing body of knowledge by looking at the supply chain collaboration on green logistics through the perspective of an LSP, who is actually not a supply chain leader in chemical supply chains. However, as most logistics operations in the chemical industry are outsourced to logistics service providers, LSPs play core role in improving safety, competitiveness, as well as eco-efficiency of chemical transports and other logistics operations.

The discussion within the paper is focused on reducing the negative impact of chemical transport by introducing to the supply chain green initiatives extending beyond the boundaries of LSP, i.e. organising for multimodal transport, greater use of intermodal transport, and energy and emission management. Within the literature review the horizontal cooperation among adjoining LSPs is emphasised as one which is gaining more and more attention from academics and logistics practitioners as well, and which is giving opportunities for achieving further efficiencies.

This study makes a number of **contributions to practice**. It proves that the ability to compete in chemical transport has been directly linked to the ability to collaborate. It suggests that LSPs should focus not only on vertical but also horizontal collaboration. The study proves that to collaborate with other logistics companies, LSPs should develop a better knowledge and recognition of the capacities and capabilities of fellow LSPs, which could be easier with the support of industry-wide IT platforms.

Within the ChemMultimodal project, partners from seven regions across Central Europe are working on a tool which is aimed at facilitating chemical supply chain partners' collaboration. The tool embraces: (1) IT visualisation of multimodal transport infrastructure, (2) planning guidelines for increasing multimodal transport, (3) consulting services to improve multimodal transport, and (4) measuring the CO2 footprint. Tests of the tool with selected chemical companies in seven regions across Central Europe will start in mid-2017.

This study presents some limitations. The main one relates to the small number of investigated companies. To achieve empirical generalisation, it would be necessary to increase the number of case studies. Moreover, further research is needed on vertical collaboration in multimodal transport, within logistics clusters developed around inland logistics terminals and ports. It would be interesting to take a deeper look at the problem from the perspective of the process itself, and by using IT tools to support planning for multimodal transport collaboration.

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