

The Impact and Role of Transportation on the Construction and Operations of the Green Supply Chain

Blanka Tundys

Abstract The supply chain management strategy evolves increasingly and includes new areas and issues. The requirements of the sustainable development and its principles are also present in this field. The practical reflection of these ideas in the supply chain is the creation of sustainable and green supply chains. This task includes many activities at both the operational and strategic level. Also in the coordination and implementation of ideas on the level of the whole chain and in participating units which determine a challenge for the managers. The legal, organizational, social, environmental, and economic requirements in the field of sustainability have a huge impact on the supply chains. One of the fundamental processes in the chain is the transportation. It is therefore important to research the role of transport, above all, because of the cost of the construction and operation of the green supply chains. The attention was focused primarily on aspects of cost and organizational activities in the field of the transportation in the green supply chain.

Keywords Transport • Green supply chain

Introduction

Changes on the international markets of the exchange of goods, especially mass consumption and market development of client, economies of scale of production, specialization of labor, and the increasing importance and the use of outsourcing make the place of manufacture of products not coincide with places where is reported the demand. Therefore, the organization of the supply chain requires additional action. This situation is particularly seen in transport processes, which are beginning to play a significant role and function in the supply chain management. Transport is necessary to eliminate the gap between the buyer and the seller,

B. Tundys (✉)

Department of Logistics, Faculty of Management and Economics of Services,
University of Szczecin, Szczecin, Poland
e-mail: blanka.tundys@usz.edu.pl

and lengthening the supply chain means that suppliers and customers can share large distances. This situation causes a significant increase in transport costs, as well as other elements of the global logistics costs (including the costs of storage and a higher level of inventory). In addition, a growing interest in the new direction of development of the supply chain strategy, which is green and sustainable supply chains, entails redesigning and adapted to the new requirements, in the context of the particularly negative impact on the environment transport processes.

From a scientific point of view, it is interesting to see an indication of how transport processes affect the creation of green supply chains. Are there adequate determinants of the procedures of implementation of sustainable transport solutions for supply chain strategy?

It is also important to indicate who the initiator of the change is, and what level (operational and strategic) are introduced, and how they have the character (organizational, economic, legal, and administrative).

The considerations have to give an answer to the question to what extent, and what elements have an influence of the changes in transport processes taking place in the green supply chains. Are they a determinant, and may spur the development of new business concepts, or are they only a part of the whole, which is necessary and imposed by the leader of the chain. The requirements of the sustainable development, including in particular, economic aspects and cost have an influence of the changes in the organization and execution of transport processes, so that they are more environmentally friendly. The change is accompanied by the legal and organizational regulations.

The increasingly important role is played by the social aspects, and it is also affected by the creation of the green supply chains.

The article has an epistemological, as well as an empirical character. In the theoretical part will be aspects of the structure and requirements for green supply chain addressed, particularly focusing on a process approach in the management of the transport. It will be the role of selection of the sector and the mode of transportation in shaping of the effective and ecological supply chains explained.

In the empirical part will be the results of the research carried out on a sample of more than 500 companies operating in Poland and representing the three branches of the economy. The research was concentrated on the role of transport costs in the creation and operation of green supply chain.

Relevant Literature

Supply Chain—Sustainable Supply Chain—Green Supply Chain

An efficient supply chain is in many cases a guarantee of the success. Synchronized flow streams between cooperators allow adapting to a specific, required market demand. Such an understanding of the issue points out the crucial role of transport in the supply chain.

In addition, a new trend and direction of the development of the supply chain strategy, which is the balance and closing the loop, contributes to the redesign of the activities related to transport (including optimization) in order to introduce the most efficient and environmentally friendly transport throughout the chain.

Transport is an essential and integral part of the chain, which means that the green supply chain will require a green and sustainable transport process. As a part of creating a sustainable and green supply chain, it is necessary to meet three requirements, economic: relating not only to optimize the cost, but also fair conditions of contracts, timely adjustment of receivables, not to use the economic advantage to negotiate the inadequate conditions of contracts, transparency in establishing business contacts, prevention corruption; social: pertaining to fair labor practices, and practices aimed at cooperation with the local communities; environment: related to the impact on the environment, relating to the whole life cycle of the product design, material handling, use of raw materials for production and disposal.

The most important from the point of view of considerations definitions can be presented as: the strategic, transparent integration, and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key interorganizational business processes for improving the long-term economic performance of the individual company and its supply chains [1].

Carter and Rogers identify four supporting facets, or facilitations of the sustainable supply chain management (SSCM) (Fig. 1),

- strategy—holistically and purposefully identifying individual SSCM initiatives which align with and support the organization's overall sustainability strategy;
- risk management, including contingency planning for both the upstream and the downstream supply chain;
- an organizational culture which is deeply ingrained and encompasses organizational citizenship, and which includes high ethical standards and expectations

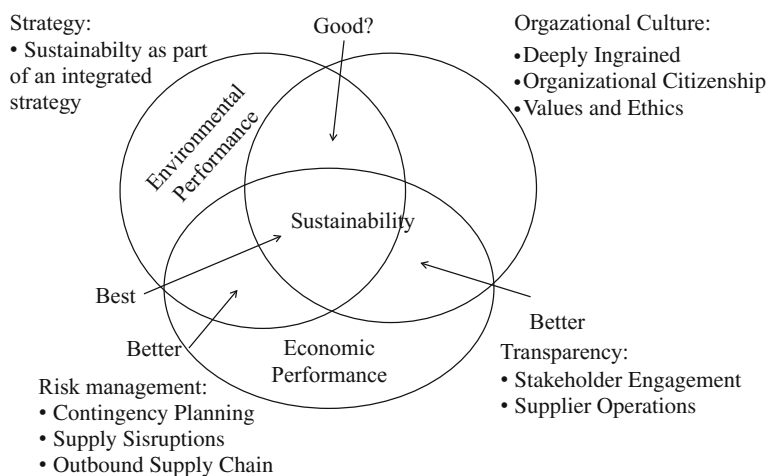


Fig. 1 Sustainable supply chain management. *Source* 1

(a building block for SSCM) along with a respect for society (both within and outside of the organization) and the natural environment; and

- transparency in terms of proactively engaging and communicating with key stakeholders and having traceability and visibility into upstream and downstream supply chain operations.

The problems they have to face to implement the sustainable supply chain refer to the first in 3 areas:

- economic—supporting SMEs, local producer, reducing barriers to entry, job creation, achieving value, fair supplier agreements, and business viability;
- social—base of competitive suppliers, fair employment practices, promoting workforce welfare, supporting skilling and development, community benefits, fair trade, and ethical sourcing practices;
- environment—reducing emission to air, releases to water and land, water and energy management, sustainable use of resources, using of renewable energy, minimization of waste and environmental impact

The tasks, problems, and objectives of sustainable supply chain can be related to the theoretical basis of the creation of green supply chain. In this case, attention and concentration is focused not only on aspects of sustainable development, but also more in terms of operational and also at this level, referring to the various phases and processes taking place within the chain. Theoretical basis can be found in the following publications covering various aspects of the green supply chain management [2–7]. Green supply chain management recognizes the disproportionate environmental impact of supply chain processes in an organization.

The analysis of the case studies related to the implementation of the green supply chain and indicate that business results must be directed to: combining the objectives of the green chain with the objectives of the individual and of the whole chain, analysis of the GSC can become a catalyst for the innovation, focus on reducing the use of natural resources and production of waste, and assessment of the supply chain as a single system life cycle. The implementation of the green chain allows reviewing processes, materials, and operational concepts. A very large role in implementing the concept of systems is played in the processes of ordering, negotiating, and vendor selection, also in the field of transport.

One of the elements of the strategic tools used in the construction of the GSCM is pollution prevention hierarchy (Fig. 2). These elements show the value of environmental programs.

GSCM must be linked to the life cycle thinking, combining the processes in the supply chain from strategy (green) flow of materials, manufacturing, transportation, retail/use, disposal, recycling, and re-return at least as a spare parts for the recycling. Green supply chains cover green thinking in the implementation of all processes taking place in the chains and which are needed for several reasons: the environment (global warming), the need to apply the principles of CSR, the benefits for participating organizations (including economic, e.g., by reducing costs)

eco-friendly, increasing environmental awareness in stakeholders, evolving consumer demand, and response to increasing fuel prices.

In the context of the consideration about green supply chain the framework should be indicated on the 3 major components forming a unified system: elements, contents, and key factors (Fig. 3).

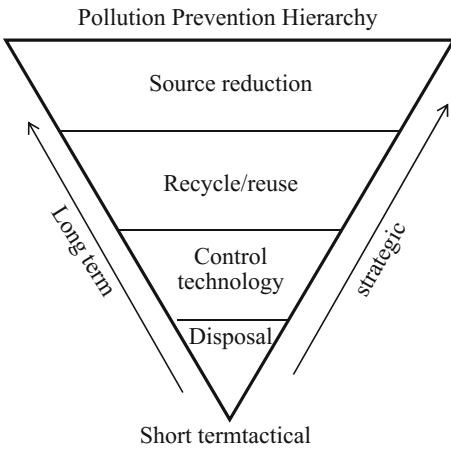


Fig. 2 Pollution prevention hierarchy. Source 1

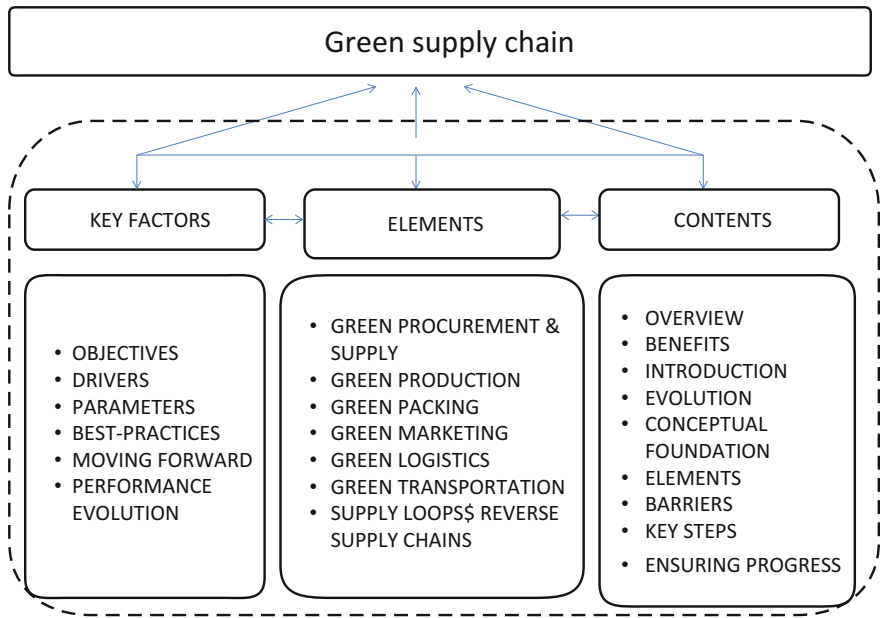


Fig. 3 Elements of the Green supply chain. Source Own elaboration on the basis on Ref. [8] [11.02.2016]

Sustainable and Green Transportation

The changes in the development of the supply chain strategy (in the direction of green supply chain) are uniquely associated with the changes in the implementation of the transport processes. The movement of goods must take place smoothly, without interference, and high efficiency of a well-organized transport ensures the smooth functioning of the supply chain as a whole depending on the business.

An efficient and effective processes related to handling transport provide delivery of goods to the customers on time and in good condition. In broad terms, the process has also to rationalize the cost of supplies or precise linking of the supply the needs of the recipient. The more complex the relationship between individual recipients, the greater the importance of the transport processes.

In the context of the considerations, it is important to indicate the nature and characteristics of the sustainable transport. Most often they talk about a sustainable transport system that is efficient, meets the expectations of society, economic, and above all minimize the harmful effects of transport on the environment. Generalizing these are the implemented solutions that have a positive impact on all areas of the sustainable development: society (enabling the fulfillment of basic needs access to the transport system by individuals and society in a safe manner and consistent with the needs of human health and ecosystems), the economy (affordable, efficient, supporting developing economies) and ecological (reduces emissions and waste, minimizes consumption of non-renewable resources in the long term will be based on the use of vehicles to supply renewable energy, reducing the scale of the destruction, and reduces the noise level) (own elaboration based on Ref. [9]). As the main features of the development in these areas should be considered [10]:

- social features: availability, liquidity, security, social cohesion, and the integrity of the transport system;
- the economic characteristics: competitiveness, working conditions in the sector, intensity, infrastructure (development, modernization, investing, capacity, quantity, and quality of the transport network) modality, and development of the market of transport services;
- environmental features: environmental friendliness of transport, minimizing environmental impacts, and prevention and liquidation of the consequences of the transport of environmental hazards.

The sustainable transport must reflect a steady disparate aims: economic, social, and environmental. This means that the construction of relations and links in the sustainable and green supply chain should definitely be taken into account. It is not without significance that the relationship with the clients and the measurement chain takes sustainability and green transport into account.

Transport as a Part of the Green Supply Chain

The success of the processes in the chain decided to shorten the time flow of goods and information, cost reduction, higher levels of customer service, and increased environmental processes. Modern business strategies are aimed at managing the entire supply chain and the primary role of time, as well as increasing the role of sustainable development.

The transport processes play an extremely important role in the supply chain. On the way to their realization, they affect both the logistics strategy and organizational solutions occurring in the individual chain links, and they are related to the elimination of ineffective solutions and the desire to reduce the cost of their own business. The actions taken within the supply chain and related to the implementation of the transport processes include the following:

- support of various types and forms of cargo,
- optimization of the using of means of transport,
- optimization of the unit load,
- optimization of routes,
- provide timely delivery,
- locations transshipment points,
- organizational, functional, and technical specifications in the movement, handling, and storage,
- the legal and financial, and
- rotation packaging and recycling.

It is also important that actions taken in the process of transport and modern application are often held at the legal level (e.g., by the need for appropriate standards for emissions), organizational (by optimizing and modeling of routes), economic (economic benefits achieved through the use of modern technology, including new contracts, have the ability to reduce operating costs). Definition of the green transportation in the framework of the green chain requires a statement of its most important features desired. It should start from the means of transport, which should meet the requirements of the low-carbon transport. Another element is the proper integration and optimization of the transport, and it is also related to its cost-effectiveness and efficiency. Another element is the implementation of IT systems, the use of which will allow for eliminating the negative impact of transport on the environment. They allow, inter alia, for the monitoring of the vehicles, and pollution.

These elements are a part of the green supply chain. In practical solutions, its essence and objectives are hidden under the concept of green logistics, which also includes the green storage processes. The elements that define green transport are as follows: electric vehicles, fuel cells, and bio-diesel efficiency, use hybrid vehicles for distribution and delivery, proper planning of shipment.

An important factor is the use of monitoring and evaluation of the activities of transport, including the efficiency and environmental performance, sustainable

measurement of sustainability in transport, both in terms of macro and micro area. Referring both to the level of the whole economy and the assessment processes in individual companies. In this regard, it is about the growing importance of sustainable transport [more: 10].

The transportation is one of the most cost-intensive elements of the supply chain, while being one of the most negatively influencing on the environment. Therefore, process approach indicates the need to link with the objectives of the green supply chain. Firstly, using appropriate planning tools to optimize its use, and secondly using appropriate (environmentally neutral) means of transport, and thirdly using and applying appropriate indicators and gauges measuring of the sustainable transport as part of the assessment and measurement of the green supply chain.

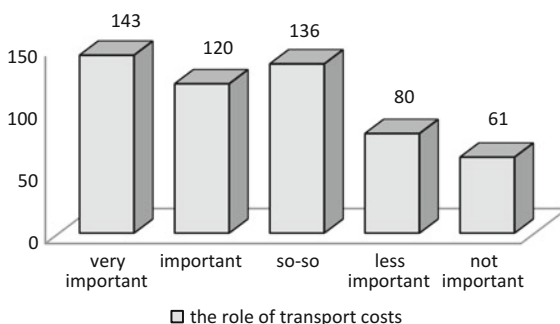
Research and Questionnaire Design

As a part of the research on the green supply chain, there were choosing companies representing the three sectors of the economy, they are functioning in Poland. In this research, it was referred to the transport issues. The issues referred were considering to the aspect of cost and environmental aspects in general using to choose a supplier (including whether one of the criteria is “clean” transport). The samples were subjected to the food industry (manufacturers and dealers), clothing (manufacturers and sales network) as well as manufacturers and distributors of household appliances. The study involved 549 enterprises, drawn on the basis of the specific research sample, determined in proportion to the number of economic entities operating on Polish territory. Selected test results and their interpretation are the following figures.

The first important question referred to the role of transport costs (general) in the functioning of the green supply chain. Of 549 respondents answered the question 540. Detailed data are presented in Fig. 4.

When interpreting the presented data, it should be pointed out that more than the half of the respondent’s transport costs play a very important or important role. Surprisingly, despite everything, it seems that managers of the supply chains,

Fig. 4 What role in the functioning of the green supply chain plays a transportation costs



who were responsive to the questions, in 141 cases responded that transportation costs do not actually play a significant role in the functioning of the green supply chain. The term “so-so” means that managers are aware of the existence of such costs, but there are other elements that play a more important role than transportation. This means that the Polish enterprises, in terms of the need to build a green supply chain, including the use of green transport, have less knowledge of the subject.

Another question was concerning the determination of the overall “greening” their supply chain, in the context of greening of the transport processes (Fig. 5). The sample was 549 respondents, of whom it is interesting that 64 replied that they had no knowledge on the subject. Unfortunately, as other answers indicate awareness of the need for greening, including the balancing of transport processes, it is small, because the 207 respondents were in favor of rather small involvement in this type of processes and an indication that the degree of greening of these processes is small and very small. In addition, taking into account even those who have no knowledge about, it should be noted that the level of awareness and implementation of sustainable transport in these chains is small.

In the context of questions about the sustainability criteria for the suppliers selection, relating to the selection of suppliers using “clean” transportation the answers were not clear. The question answered 494 respondents (Fig. 6), which accounted for 90% of all respondents. Of which only 121 answered that this criterion is used very often or often. “Sometimes” indicated 136 respondents, which accounted for 27.5% of the responses. And in this case, it should be noted the fact that making a vendor selection takes these aspects into account. This is important in the context of the whole green supply chain management, since it indicates that at one of the most important decisions concerning the selection criteria on the supplier associated with a pure transport are starting to be taken into account, although unfortunately in Polish realities do not play a significant role.

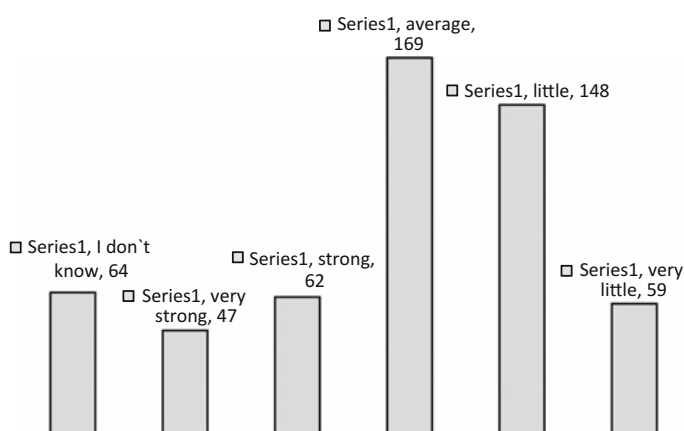
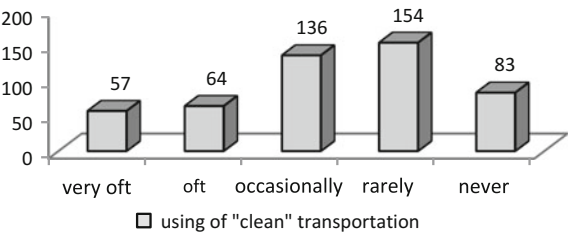


Fig. 5 How would you evaluate the general “greening” yours supply chain (in the context of transport processes)

Fig. 6 Elements which are taken into account by sustainable selecting criteria of suppliers



Another question is related to the role of ecological transport in the functioning of the green supply chain answered 537 respondents. In this regard, it should be noted a large variety of answers. In fact, almost the same number of questions played a large and a small role (Fig. 7).

The responders were also asked about the evaluation of “greening” supply chain processes and/or use the meters and indicators of the sustainable transportation. In this regard, there is more “no” answer in the area of the companies. Regarding the assessment of the whole supply chain, it is a difference occurred in only one answer (1 affirmative answer more). Lack of the dominant response and hesitancy of respondents (managers) points to the lack of knowledge or skills to using it to evaluate the enterprise or an entire of the supply chain (Fig. 8).

Interpreting the test results, it should be noted that in the polish reality (at least in the range tested and surveyed industries) subject, the use of “clean” transport is generally unknown but to a small extent used.

Fig. 7 What role in the functioning of the green supply chain plays environmentally friendly transport

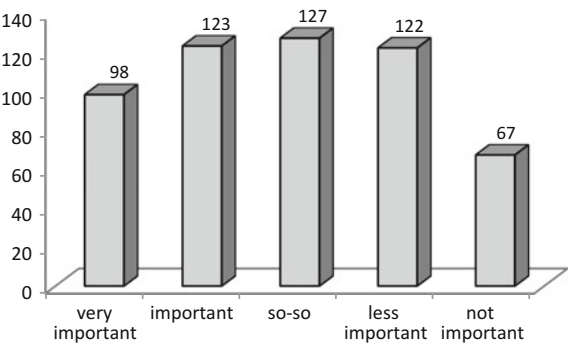
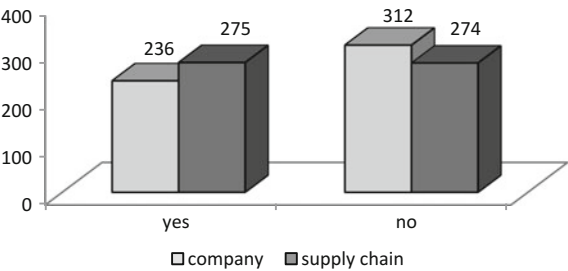


Fig. 8 To the evaluation of “greening” supply, chain processes are used the meters and indicators of the sustainable transportation



Discussion and Limitation of This Study

Elements of the discussion should be referred to the significance of transport costs in the creation and operation of the green supply chain and their role in the supply and generally using of “green” transport in the supply chains. The cited study did not refer to the significance of transport and their optimization. They were designed to identify, or during the implementation of the transport processes in the framework of the green supply chain, companies have pay attention to the need to use a green transportation.

The limit element of this development and the data is the fact; there were no studies closely related to the role of the transportation. Transport in this study is only a part of the functioning of the green supply chain. Another element is the limitation of industries. It seems reasonable to take a further extension of the research spectrum and scope associated with the areas of transport and its importance in the green supply chain. Importance in future studies is the expansion of the role of transport as one of the most important elements of the green supply chain.

Summary

Summing up the considerations, it should be noted that the subject matter is extremely important and present in the literature. Theoretical considerations indicate what elements should have a sustainable and green transportation, as well as a part of the process of green supply chains. Unfortunately, the practical reflection indicates that in the Polish reality, it is not yet subject raised and implemented in the supply chain. It reveals a lack of knowledge and awareness, and probably also the knowing of the specific elements and practical solutions which are already implemented in other organizations and supply chains. It can be concluded that in the current situation, only the elements required by law are implemented. Perceived are also those elements that bring economic benefits, but less attention is paid to those that are related to the social element.

Acknowledgements This paper is a part of a project financed by the National Science Centre granted on the basis of the decision DEC-2013/09/B/HS4/02707.

References

1. Carter, C.R., Rogers, D.S.: A framework of sustainable supply chain management: moving toward new theory. *Int. J. Phys. Distrib. Logistics Manag.* **38**(5), 360–387 (2008)
2. Beamon, B.M.: Designing the green supply chain. *Logistics Inf. Manag.* **12**(4), 332–342 (1999)
3. Srivastava, S.K.: Green supply-chain management: a state-of-the-art literature review. *Int. J. Manag. Rev.* **9**(1), 53–80 (2007)

4. Zhu, Q., Sarkis, J.: Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *J. Oper. Manag.* **22**(3), 265–289 (2004)
5. Zhu, Q., Sarkis, J., Geng, Y.: Green supply chain management in China: pressures, practices and performance. *Int. J. Oper. Prod. Manag.* **25**(5), 449–468 (2005)
6. Zhu, Q., Sarkis, J., Lai, K.H.: Confirmation of a measurement model for green supply chain management practices implementation. *Int. J. Prod. Econ.* **111**(2), 261–273 (2008)
7. Pagell, M., Wu, Z., Murthy, N.N.: The supply chain implications of recycling. *Bus. Horiz.* **50**(2), 133–143 (2007). globalscgroup.com [11.02.2016]
8. Assessment & decision making for sustainable transport, European Conference of Ministers of Transport, OECD (2004)
9. Borys, T. (ed.): *Wskaźniki zrównoważonego rozwoju. Ekonomia i Środowisko* (2005)
10. Tundys B.: Pomiar zrównoważonego transportu w ocenie zielonego łańcucha dostaw, *Logistyka* nr 3/2015, s. 5297–5306

Sustainable Transport Development, Innovation and
Technology

Proceedings of the 2016 TranSopot Conference

Suchanek, M. (Ed.)

2017, IX, 282 p. 68 illus., 25 illus. in color., Hardcover

ISBN: 978-3-319-51426-0