MEASUREMENT OF SUPPLY CHAIN EFFICIENCY – SELECTED ISSUES FOR RESEARCH AND APPLICATIONS

Jędrzej Charłampowicz
Gdynia Maritime University, Faculty of Entrepreneurship and Quality Science, Department of Logistics and Transport Systems, Poland
E-mail: j.charlampowicz@wpit.am.gdynia.pl

Abstract

The increase in the share of maritime container traffic in the global structure of transport had caused dynamic development and strengthening of the market position of shipping companies, shipping alliances enhanced this effect. Container sea transport has become an integral part of global supply chains, in which the dominant position have been reserved for shipping companies. Crucial factor for the proper functioning of the supply chain is efficiency, which is also very extensive concept. This paper provides explanation and division of this idea on time efficiency, cost efficiency and spatial efficiency. The literature review has been made concerning various levels of efficiency and measuring of global supply chain efficiency in context of maritime container transportation. Due to strong position of shipping companies, supply chains need to adapt and reconfigure in the way of advancing competitive advantages in other fields than maritime transportation. Also based on the literature review an attempt is to made to determine the most suitable strategy for supply chain. Finally, the limitation of this paper and future research directions are presented.

Key words: container transport, supply chain management, measurement of efficiency, supply chain efficiency

1. INTRODUCTION

Introducing containers to global transportation was a revolutionary and innovative phenomenon that implied the need to change the then-existing transportation model. The possibility of utilizing intermodal transportation containers made it possible to use one means of transportation for transporting goods of different kinds. The maritime transport market had to adapt to the new conditions, such as through readjustment of vessels for shipping containers and later also through readjustment of ports for their handling. This type of adaptation significantly reduced transportation costs (Lee & Song, 2017, p. 442), thereby optimizing the cost efficiency of the supply chain passing through maritime container shipping markets. Reducing transportation costs also prompted further processes that helped liberalize global trade, as well as open up and develop new markets. Containerization is considered to be the main catalyst for globalization in the 20th century (Bernhoffen et al., 2016, p. 36). The dynamic growth of the new transportation branch strengthened the position of shipping companies which, in order to further increase their market share, started to establish strategic alliances that led to reduced costs and increased efficiency of the

service provided. Such agreements, based on the creation of a supply chain, allowed them to seek and gain sources of competitive advantage in other areas of business activity of both the transportation company and its customer.

The competitive advantage of the supply chain is expressed in the increased value delivered to the final customer. The way to achieve this objective is to improve the efficiency of the chain, e.g. by its readjusting, lowering its operating costs or limiting the duration of operations. The concepts of supply chain management (SCM), understood as various ideas combining supplier relationship management, production management and distribution management (Caniato et al., 2013, p. 286), will be helpful in achieving these goals.

The issue of supply chain efficiency is an area of interest for many researchers (Brandenburg, 2016; Beamon, 1998; Gunasekaran et al., 2004; Mathivathanan et al., 2017; Banaszewska et al., 2012). In spite of this, however, there has not been much space in the literature devoted to the discussion of the maritime container shipping markets with reference to supply chain efficiency.

The aim of this paper is to attempt to explore the efficiency of the supply chain operation on the maritime container shipping market and come up with an optimal supply chain management strategy based on the conducted literature research.

This paper is divided as follows:

- Section 2 reviews the literature on supply chain management strategies, chain efficiency and its performance, and then divides the performance into time, cost and spatial;
- Section 3 provides an overview of the literature on selected performance indicators taking into account the proposed efficiency breakdown;
- Section 4 discusses strategic alliances in the maritime container shipping market, including their impact on the supply chain, and then proposes an SCM strategy that optimizes the supply chain efficiency of the maritime container shipping market;
- Section 5 describes research limitations and further research perspectives;
- Section 6 presents final conclusions.

2. SUPPLY CHAIN MANAGEMENT (SCM) – OVERVIEW OF SELECTED LITERATURE

2.1. SCM strategies – *lean, agile, resilience*

SCM was a response to changing market conditions, market liberalization and growing customer expectations. Based on the above definitions, it can be said that the primary task of SCM is to integrate and coordinate processes and relationships occurring inside and outside the supply chain in the context of maximizing added value, which translates into surplus values throughout the supply chain. The fulfillment of the above tasks should account for the supply chain strategy, determined in terms of market conditions and the specificity of goods, by implementing a specific SCM paradigm. The most popular SCM strategies should include *lean* (Kisperska-Moroń & De Haan, 2011; Charłampowicz, 2016; Stratton & Warburton, 2013;

Nieuwenhuis & Katsifou, 2015), *agile* (Purvis et al., 2014; Christopher, 2000; Stratton & Warburton, 2013; Kisperska-Moroń & De Haan, 2011; Charłampowicz, 2016; Nieuwenhuis & Katsifou, 2015) and *resilience* (Kamalahmadi & Parast, 2016; Carvalho et al., 2012; Kristiano et al., 2017).

The concept of Lean Supply Chain (LSC) derives from the *Toyota Manufacturing System*, introduced in Toyota to – simply put - improve performance with lesser effort (Nieuwenhuis & Katsifou, 2015, p. 234) by introducing the "*Just-in-time"* system and automation (Waqas Azfar et al., 2014, p. 805). None the less, the implementation of the above concept is possible provide that there is stable and predictable demand. The main objective of the lean strategy is cost reduction, implemented via reducing and eliminating waste (*Muda*). The cost-based approach found in this concept makes it possible to maintain the cost efficiency of the chain operation (Stratton & Warburton, 2003, p. 184).

The Agile Supply Chain (ASC) strategy is associated with a rapid response to unpredictable changes in demand (Kim & Chai, 2017, p.44; Gligor et al., 2015, p. 71). (Christopher, 2000, p. 38-40) identifies 4 characteristics to be had by a truly agile supply network: market sensitivity, virtualization, process alignment, networkability. (Agarwal et al., 2007, pp. 444-448), meanwhile, speak of a total of 15 variables contributing to the improvement of agility of the chain. The results of the study outline 7 factors that influence the agility of the supply chain (Agarwal et al., 2007, p. 453). These are: customer satisfaction, quality improvements, costs reduction, delivery times, new product launches, customer service improvements and lead-time reduction. The principal objective of the ASC is to meet the customer's expectations in the context of a faster delivery time thanks to permanent willingness to respond to demand changes. The answer to the change may assume the form of a chain readjustment (Charlampowicz, 2016, p. 243).

The concept of resilience, meanwhile, has to do with the ability (possibility) to operate free of errors in a situation full of disruptions and to return to the initial state after the disruptions disappear (Elleuch et al., 2016, p. 1449). (Brusset & Teller, 2017, p. 60) believe that truly Resilient Supply Chain (RSC) is a chain in which, despite disruptions and unpredictable changes, the supply chain still manages to fulfill its tasks and deliver its products or services. (Soni et al., 2014, pp. 13-15) identify 10 RSC enablers based on surveys and the literature. These are: agility, collaboration among players, information-sharing, sustainability in supply chain, risk and revenue sharing, trust among players, supply chain visibility, risk management culture, adaptive capability, and supply chain structure. Then, (Liu et al., 2017) propose the following RSC components: risk management, agility, integration and SC (re-)engineering. (Kamalahmadi, M. & Parast, M., 2016, p. 121-122), meanwhile, distinguish factors such as: adaptability, flexibility and agility as key elements of a RSC.

Choosing the right SCM strategy is related to the characteristics of the supply chain and the market through which it operates. The main purpose of implementing a specific SCM strategy should be to improve the efficiency of the supply chain, which can be manifested e.g. in the form of cost reductions (cost efficiency) or time reductions (time efficiency). (Swink et al., 2014, p. 9) are of the opinion that the

highest level of efficiency and performance is achieved through the use of lean operations.

2.2. Supply chain efficiency

The literature on the subject fails to distinct between concepts and indicators of efficiency and performance, which are conceptualized the same (Ganga & Carpinetti, 2011; Shafiee et al., 2014; Estampe et al., 2013). Then again, some authors (Chopra & Meindl, 2016, p. 26) define efficiency as one of the components of performance, understood as inverse of the cost of manufacturing and delivering the goods to the customer. The above definition is in line with the economic take, but it does not match the logistical aspect that can be expressed by the timing of the operations in question. (Roh et al., 2014, p. 201) considers an efficient supply chain to be one that aims to achieve cost efficiency by eliminating waste and processes not generating any added value. It follows from it that an efficient supply chain strategy should be implemented through the implementation of the LSC. However, in considering the chain efficiency with respect to factors such as time of order fulfillment, it appears that - due to its characteristic - the ASC-based approach would prove a better solution. For this reason, the author believes it is necessary to divide efficiency (as a component of the chain efficiency) into time-related, cost-related and spatial, in order to better identify an appropriate strategy for the chain examined.

2.2.1. Time efficiency of the supply chain

In spite of the large emphasis placed costs in the supply chain, their reduction will not always prove consistent with the overall strategy. Whenever a supply chain is passing through a highly uncertain and volatile market, it may be that reducing delivery time, capacity to making rapid changes and readjustments will be more important than cost reduction in either achieving or increasing competitive advantage. Such characteristics are typical to the ASC, whose main objective is to provide value as quickly as possible.

Operating a supply chain on a competitive market also entails the opportunity, and the need, to continually seek advantage in costs, space or service quality. The latter is very often associated with the time fulfillment of individual operations. Supply chain time efficiency is a feature of the supply chain that assumes the ability to meet customer expectations in the context of lead-time reduction. Other factors affecting time efficiency are: rapidness of information exchange, duration of physical operations, production time, delivery time.

2.2.2. Cost efficiency of the supply chain

A supply chain geared toward costs reduction is a characteristic feature of the LSC. The cost-cutting strategy is implemented by eliminating non-value-added processes and waste. The cost of the supply chain is defined as all significant costs present in the chain (Pettersson & Segerstedt, 2013, p. 358). It is necessary to define and determine costs at each stage of the supply chain in order to achieve cost

efficiency. (Gunasekaran et al., 2004, p. 338) note that supply chain efficiency is achievable through the use of a total logistics cost. In addition, they highlight the impact of cost-reducing activities in one area in terms of their impact on the costs of other areas (Gunasekaran et al., 2004, p. 338). Applying this to container shipping, this means that, for instance, an increase in a shipping batch to benefit from a lower unit rate would result in an increase in the cost of storage.

2.2.3. Spatial efficiency of the supply chain

Geographic distribution of the centers of individual links and their network partners has an impact on the supply chain readjustment and transport organization, being also an important determinant of competitiveness (Arnold et al., 2004, p. 256). The spatial layout of the network should be determined taking into account the shortening of the path that must be covered between the centers. This means that when forming the supply chain, the sum of total savings generated by individual network participants constitutes an important aspect. With that being said, factors such as reduction of transportation congestion should also be considered (Weisbrod et al., 2016, p. 460). Spatial efficiency of the chain is related to the mutual relations between time and cost.

When setting up a supply chain, in the context of maximizing spatial efficiency, the following elements will be worth analyzing: physical location of individual links and partner, state and characteristics of the infrastructure linking the individual centers, and local regulations. The liberalization of regulations and the improvement of the condition and availability of infrastructure will affect the distribution of supply chain participants in terms of gaining competitive advantage. Such advantage will be achieved by obtaining a high level of spatial efficiency expressed in the form of optimization of the relationship between costs and time as in delivery time.

3. SELECTED INDICATORS OF EFFICIENCY AND PERFORMANCE OF THE SUPPLY CHAIN

Proper indicators need to be used in order to determine the efficiency of the supply chain. Beamon (1998, p. 287-288) proposes a total of 17 performance indicators, which are either qualitative or quantitative. Among the qualitative indicators, there are: customer satisfaction, flexibility, information and material flow integration, efficient risk management and supplier performance. Quantitative indicators, meanwhile, are distinguished between those directly related to cost or profit and those that rely on customer responsiveness (e.g. lead-time reduction). The proposed indicators include some related to the time efficiency of the supply chain (e.g. lead-time reduction), cost efficiency (e.g. cost reduction) and spatial efficiency (information and material flow integration).

Gunasekaran et al. (2004, p. 336-339) came up with 46 indicators including the strategic, tactical and operational levels, divided into 4 activities: plan, source, make/assembly and deliver. Some of the indicators presented refer to time efficiency (e.g. efficiency of purchase order cycle time) and cost efficiency (e.g. cost per

operations hour). They points out, however, that due to the diversity of the supply chain, depending on the industry, not all indicators will be correct, which is why new, more desirable ones need to be developed. Researchers also discusses the Performance Based System (PBS) (Gunasekaran et al., 2005, p. 527) whose main tasks are: identifying business areas that create value and accurately estimate costs.

Kolinski and Sliwczynski (2016) highlighted the problem of transposing strategic objectives to the operational level. They proposed a system of indicators and metrics of evaluation of the efficiency of supply processes on operational level. Researchers presented seven calculation formulas related with supply efficiency in enterprises. Some of them are corresponding to time efficiency (e.g. the ratio of delivery timelineness).

Otto and Kotzab (2003) propose considering supply chain performance through a perspective-based approach. There are, according to them, six different ways to look at SCM: System Dynamics (SD), Operations Research and Information Technology (OT), Logistics (L), Marketing (M), Organization (O) and Strategy (S). Some of the perspectives (namely SD, OT, L, O) present performance indicators related to time efficiency. Characteristics of individual perspectives with respect to their goals under SCM prevents the development of time, cost and spatial efficiency indicators in each case. (Balfaqih et al., 2016) reviewed supply chain performance measurement systems in terms of approaches and techniques applied. The most popular approach is perspective-based, followed by process-based and hierarchical-based approaches. He also discussed the use of particular techniques for measuring chain performance. Among the most popular are: survey/Delphi and uncertainty-based techniques (Balfaqih et al., 2016, p. 144).

Chopra & Meindl (2016, p. 44-59) identify 6 drivers of supply chain performance, including: facilities, inventory, transportation, information, sourcing, pricing. They also present a total of 48 indicators for all the factors, among which are those related to time, costs and space efficiency. Additionally, they emphasize that achieving competitive advantage depends on the relationship between logistic and functional performance indicators of the supply chain.

Carvalho et al. (2012, p. 337-338) defines two indicators related, respectively, to the field of logistics and costs, which were used to evaluate the SC so as to improve its resilience. The proposed indicators are associated with the previously defined chain efficiency dimensions. Lead Time Ratio expresses time efficiency, whereas Total Cost demonstrates cost efficiency.

Shafiee et al. (2014) examined the efficiency of the food industries supply chain in Iran, assuming a total of 15 efficiency criteria (e.g. customer response time, learning cost). They developed a DEA network model based on the BSC approach with a 4-segment supply chain (financial perspective, customer perspective, internal process perspective, learning and growth perspective).

The basic criterion for selecting specific indicators will be the scope and nature of the information one has regarding the supply chain. Knowing the objectives of the supply chain allows for implementing measures that focus and control a particular link. It may often prove impossible assuming a holistic approach, understood as the implementation of indicators measuring the entire supply chain.

4. SUPPLY CHAIN EFFICIENCY ON MARITIME CONTAINER SHIPPING MARKETS

4.1. Strategic alliances

Grzelakowski (2013, p. 122) notes that the maritime container shipping market (MCSM) is currently a strongly integrated market. Responsible for this state of affairs are the operators of global supply chains and the cause of this phenomenon is, among others, increasing transportation capacity and increased share of high-value goods in transported cargoes. Testament to it is the fact that over the last two decades (1990-2009) total port handling increased more than five-fold (Notteboom, 2012, p. 231). Despite the reduction in cargo flows on the main routes, the volume of transported containers amounted to 175 million TEU in 2015 (UNCTAD, 2016, p. 17). Over the past 12 years, meanwhile, the average size of a container ship more than doubled (2.5 times, to be exact) (UNCTAD, 2016, p. 42).

The MCSM has to face very volatile and rapidly changing market realities (Notteboom, 2002, p. 102). The strong concentration of the market on the supply side is expressed in two ways: subjective capital integration, and organizational and functional form expressed through alliances established on the main routes of container transportation (Grzelakowski, 2013, p. 126). The reasons for these strategic agreements are: risk sharing, economies of scale, knowledge and technology exchange, vertical integration and strengthening of market position (Rau & Spinler, 2017, p. 157). Referring to the service characteristics where the main factors are port calls, average number of deployed vessels and average duration, there are minor differences among alliances (Panayides & Wiedmer, 2011, p. 36). Research conducted by (Rau & Spinler, 2017, p.170) confirms that the main drivers of change in the alliances are: competitive intensity, alliance complexity cost and freight rate volatility, while shorter lead times increase market concentration. Participation in the alliance has no influence on management, including sales and marketing, pricing or maintenance of vessel (Stopford, 2009, p. 534), and besides alliances compete with each other (Lee & Song, 2017, p. 445).

Widespread use of the slow-steaming strategy (Grzelakowski, 2013, p. 124) has negatively affected the time and cost efficiency of the supply chain by increasing the time it takes to transport goods. Lee and Sang (2017, p. 459-462) distinguish three types of slow-steaming (21 knots, 18 knots and 15 knots versus the design speed of 23-26 knots) and present two slow-steaming models. They also note that the above strategy is applied by practically all shipping lines to a very large extent.

The literature is lacking in research that would determine the impact of strategic alliances on supply chain efficiency in time, cost and spatial matter.

4.2. SCM strategy on the maritime container shipping market

In the event of a prolonged transportation time, caused by the implementation of a slow-steaming strategy, the main actions are to seek both time and cost savings in other links in the supply chain. The key to success, then, is supply chain integration. The immanent feature of the transportation industry is its vulnerability to integration

(Matczak, 2015, p. 232). The MCSMs have witnessed unique transformations unheard of in other transportation sectors. Through mergers & acquisitions (M&A), as well as formation of alliances, with reference to Icontainers data, in April 2017, the three major alliances controlled 80% of the market[23]. Some M&As require the alliance to be reorganized (Lee & Song, 2017, p. 445).

In speaking of the above characteristics, the supply chain's ability to integrate, react quickly and perform tasks under unpredictable circumstances are all extremely important. The RSC concept fits the bill, as it assumes the ability to deal with unpredictable disruptions (Lam & Bai, 2016, p. 18). One aspect of the RSC is agility. Yang (2014, p. 112) recognizes that agility is not a direct driver of supply chain performance, although it reinforces its performance through cost efficiency. The RSC concept assumes the chain operates in a highly unpredictable environment, where it must continually carry out tasks irrespectively of the disruptions. Operating under such conditions require the implementation of a risk management approach aimed at reducing both present and future risks to which the participants are exposed (Yang, 2011, p. 392). Liu et al. (2017) also stress the need to establish a risk management structure as a key to improving the RSC performance.

Within the framework of the proposed definition of the RSC, Kamalahmadi and Parast (2016, p. 121-122) present three RSC phases: anticipation, resistance, recovery and responses. Additionally, they point out that agility is one of the most important aspects of the resilience-based management strategy. This is an immanent feature of the RSC, which forms part of the context of the maritime container shipping market (MCSM) operation. The cost associated with the RSC is high, resulting among others from the need to implement technology in order to better deal with the variability of demand in terms of type and quantity.

Seeking time and cost efficiency in a situation of high demand uncertainty is characteristic of the RSC. The area of knowledge connected with the relationship between the RSC and the MCSM is prospective, with high growth potential.

5. RESEARCH LIMITATIONS AND FURTHER RESEARCH

5.1. Research limitations

The ability to utilize and have full access to *Science Direct* journals made it possible to review the literature in interesting areas. None the less, the fact of relying on only one database greatly limited the possibility of conducting a more extensive literature research. No access to the base *Emerald Insight* impeded carrying out a fuller investigation and presentation of the phenomena of measuring performance and efficiency in the supply chain.

Another research limitation is the lack of research on the impact of the MCSM characteristics and readjustments on supply chain performance with respect to time, cost and space.

[23] http://www.icontainers.com/us/2017/03/21/new-shipping-alliances-what-you-need-to-know/ - access 11.05.2017

One other significant research limitation is the lack of a broader possibility to verify the relationship between the selected SCM strategy for the transport services market (here, the MCSM) and time, cost and space efficiency. These relationships are treated by transportation companies as an element of commercial secrecy and thus access to them is limited.

5.2 Further research directions

Balfaqih et al. (2016, p. 145) point out that the area for measuring supply chain efficiency is still very fertile. Undoubtedly, further action is required in order to develop tools that will account for the market and commodity characteristics with respect to time-related, cost-related and spatial efficiency. Apart from that, to better manage the global SC, it seems necessary to develop efficiency measures on the MCSM.

It is necessary to conduct two-directional research to be able to gain a better understanding of the impact of strategic alliances on the efficiency of the supply chain, as well as to better understand the measures that take into account time, cost and spatial efficiency of the supply chain. The above indicators should be confronted with empirical data to determine their suitability. Carvalho (2012, p. 340) argues that further research on the relationship between the RSC strategy design and the SC performance is needed.

Determining the impact of strategic alliances on supply chain efficiency will enable developing more efficient performance measures, which translates into having more complete information about the supply chain and thus gain competitive advantage.

6. CONCLUSIONS

The changing market conditions and strong market concentration in the container shipping branch imply the need for continuous adaptation of the supply chain. This readjustment must be in line with the adopted strategy as well as market and commodity characteristics. The strong position of the MCSM's supply side, resulting from M&A practices and strategic alliances, along with the slow-steaming strategy they have adopted, necessitates seeking savings in both time and cost, as well as in other areas of the chain than the maritime shipping market. The resilient concept practically the only one SCM strategy that corresponds to the MCSM market characteristics, related with the MCSM's impact on reducing the efficiency of the supply chain, forcing the operators to implement a strategy for normal operation in the event of disruptions. The RSC fits the bill it promotes timely fulfillment of entrusted tasks in spite of disruptions, which translates into gaining competitive advantage.

The aim of this paper was to attempt to explore the efficiency of the supply chain operation on the maritime container shipping market with respect to time, cost and space, and to come up with an optimal SCM strategy. The supply chain performance measures were discussed in the context of their fit for performance in all these three

dimensions. The literature on establishing strategic alliances on the MCSM and their impact on chain efficiency were also reviewed. Moreover, the usefulness of the RSC adaptation to the supply chain passing through the MCSM was discussed in order to maximize efficiency (or minimize its losses).

The main conclusions of this paper are: (i) the RSC proves an efficient SCM strategy for the SC passing through the MCSM; (ii) the need to develop SC performance measures with regard to link characteristics in the context of the MCSM; and (iii) empirically determine the impact of strategic alliances on supply chain efficiency with respect to time, cost and space.

7. REFERENCES

Agarwal, A., Shankar, R. & Tiwari, M. K. (2007). Modeling agility of supply chain. *Industrial Marketing Management* 36, p. 443-457.

Arnold, P., Peeters, D. & Thomas, I. (2004). Modelling a rail/road intermodal transportation system. *Transport Research Part E*, 40, p. 255-270.

Balfaqih, H., Nopiah, Z. M., Saibani, N. & Al.-Nory, M. T. (2016). Review of supply chain performance measurement systems: 1998-2015., *Computres in Industry*, 82, p. 135-150.

Banaszewska, A., Cruijssen, F., Dullaert, W. & Gerdessen, J.C. (2012). A framework for measuring efficiency levels – The case of express depot. *International Journal of Production Economics*, 139, p. 484-495.

Beamon, B. M. (1998). Supply chain design and analysis: Models and methods. *International Journal of Production Economics*, 55, p. 281-294.

Bernhoffen, D. M., El-Sahli Z. & Kneller R. (2016). Estimating the effects of the container revolution on world trade. *Journal of International Economics*, 98, p. 36-50.

Brandenburg, M. (2016). Supply chain efficiency, value creation and the economic crisic – An empirical assessment of the European Automotive industry 2002 – 2010., *International Journal of Production Economics*, 171, p. 321-335.

Brusset, X. & Teller, C. (2017). Supply chain capabilities, risks, and resilience. *Internarional Journal of Production Economics*, 184, p. 59-68.

Caniato, F., Golini, R. & Kalchschmidt, M. (2013). The effect of global supply chain configuration on the relationship between supply chain improvement programs and performance. *International Journal of Production Economics*, 146, p. 285-293.

Carvalho, H., Barroso, A. P., Machado, V. H., Azevedo, S. & Cruz-Machado, V. (2012). Supply chain redesign for resilience using simulation. *Computers & Industrial Engineering*, 62, p. 329-341.

Chang, L., Ouzrout, Y., Nongaillard, A., Bouras, A. & Jiliu, Z. (2014). Multi-criteria decision making based on trust and reputation in supply chain. *International Journal of Production Economics*, 147, p. 362-372.

Charłampowicz, J. (2016). Tworzenie wartości przez łańcuch dostaw typu „leagile" – wybrane aspekty; *Studia i Materiały Instytutu Transportu i Handlu Morskiego*, 13, p. 238-246.

Chopra, S. & Meindl, P. (2016). *Supply Chain Management: Strategy, Planning and Operations*; Pearson, 6th Edition.

Christopher, M. (2000). The agile supply chain – competing in volatile markets. *Industrial Marketing Management*, 29, p. 37-44.

Elleuch, H., Dafaoui, E., Elmhamedi, A. & Chabchoub, H. (2016). Resilience and Vulnerability in Supply Chain: Literature review. *IFAC-PapersOnLine*, 49-12, p. 1448 – 1453.

Estampe, D., Lamouri, S., Paris, J.-L. & Brahim-Djelloul, S. (2013). A framework for analysing supply chain performance evaluation models. *International Journal of Production Economics*, 142, p. 247-258.

Ganga, G. M. D. & Carpinetti, L. C. R. (2011). A fuzzy logic approach to supply chain performance management. *International Journal of Production Economics*, 134, p. 177-187.

Gligor, D. M., Esmark, C. L. & Holcomb, M. C. (2015). Performance outcomes of supply chain agility: When should you be agile? *Journal of Operations Management*, 33-34, p. 71-82.

Grzelakowski, A. S. (2013). Rozwój globalnego handlu i systemu logistycznego i ich wpływ na rynek morskich przewozów kontenerowych., *Internatiolal Business and Global Economy*, 32, p. 114-133.

Gunasekaran, A., Patel, C. & McGaughey, R. E. (2004). A framework for supply chain performance measurement. *International Journal of Production Economics*, 87, p. 333-347.

Gunasekaran, A., Williams, H. J. & McGaughey, R. E. (2005). Performance measurement and costing system in new enterprises. *Technovation*, 25, p. 523-533.

Ivanov, D., Tsipoulanidis, A. & Schonberg, J. (2017). Global Supply Chain and Operations Management: A Decision-Oriented Introduction to the Creation of Value, Switzerland: Springer International Publishing

Kamalahmadi, M. & Parast, M. M. (2016). A review of the literature on the principles of enterprises and supply chain resilience: Major findings and directions for future research. *International Journal of Production Economics,* 17,p. 116-133.

Kim, M. & Chai, S. (2017). The impact of supplier innovativeness, information sharing and strategic sourcing on improving supply chain agility: Global supply chain perspective. *International Journal of Production Economics*, 187, p. 42-52.

Kisperska-Moroń, D. & De Haan, J. (2011). Improving suplly chain performance to satisfy final customers: „Leagile" experiences of polish distributor. *International Journal of Production Economics*, 133, p. 127-134.

Kolinski, A. & Sliwczynski, B. (2016). Impact of the transposing the strategic objectives on suppy chain efficiency. *Ekonomski Vjesnik/Econviews: Review of contemporary business, entrepreneurship and economic issues*, 29(S), p. 45-60.

Kristiano, Y., Gunasekaran, A. & Helo, P. (2017). Building the „Triple R" in global manufacturing. *International Journal of Production Economics*, 183, p. 607-619.

Lam, J., S., L. & Bai, X. (2016). A quality function deployment approach to improve maritime supply chain resilience. *Transportation Research Part E*, 92, p. 16-27.

Lee, C.-Y. & Song, P.-D. (2017). Ocean container transport in global supply chains: Overview and research opportunities. *Transport Research Part B*, 95, p. 442-474.

Liu, C.-L., Shang, K.-C., Lirn, T.-C., Lai, K.-H. & Lun, Y. H. V. (2017). Supply chain resilience, firm performance, and management policies in the liner shipping industry. *Transportation Research Part A*,

Matczak, M. (2015). *Procesy integracji w transporcie światowym oraz ich rynkowe implikacje*. Gdynia: Akademia Morska w Gdyni.

Mathivathanan, D., Govindan, K. & Noorul Haq, A. (2017). Exploring the impast of dynamic capabilities on sustainable supply chain firm's performance using Grey-Analytical Hierarchy Process., *Journal of Cleaner Production*, 147, p. 637-653.

Nieuwenhuis, P. & Katsifou, E. (2015). More sustainable Automotive production through under standing decoupling points in leagile manufacturing. *International Journal of Cleaner Production*, 95, p. 232-241.

Notteboom, T. E. (2002). Container Shipping And Ports: An Overview. *Review of Network Economics*, 3(2), p. 86-106.

Notteboom, T. E. (2012). *Container Shipping*. In Talley, W. K. (Ed.). *The Blackwell Companion to Maritime Economics*. Blackwell Publishing Ltd., pp. 230-262.

Otto, A. & Kotzab, H. (2003). Does supply chain management really pay? Six perspectives to measure the performance of managing a supply chain. *European Journal of Operational Research*, 144, p. 306-320.

Panayides, P. M. & Wiedmer, R. (2011). Strategic alliances in container liner shopping. *Research in Transport Economics*, 32, p. 25-38.

Pettersson, A. I. & Segerstedt, A. (2013). Measuring supply chain cost. *International Journal of Production Economics*, 143, p. 357-363.

Purvis, L., Gosling, J. & Naim, M. M. (2014). The development of lean, agile and leagile supply network taxonomy based on different types of flexibility. *International Journal of Production Economics*, 151, p. 100-111.

Rau, P. & Spinler, S. (2017). Alliance formation in a cooperative container shipping game: Performance of a real options investment approach. *Transport Research Part E*, 101, p. 155-175.

Roh, J., Hong, P. & Min, H. (2014). Implementation of a responsive supply chain strategy in global complexity: The case of manufacturing firms. *International Journal of Production Economics*, 147, p. 198-210.

Shafiee, M., Lotfi, F. H. & Saleh, H. (2014). Supply chain performance evaluation with data envelopment analysis and balanced scorecard approach. *Applied Mathematical Modelling*, 38, p. 5092-5112.

Soni, U., Jain, V. & Kumar, S. (2014). Measuring supply chain resilience using a deterministic modeling approach. *Computers & Industrial Engineering*, 74, p. 11-25.

Stopford, M. (2009). *Maritime Economics*, 3th Edition, London and New York, Taylor & Francis.

Straton, R. & Warburton, R. D. H. (2013). The strategic integration of agile and lean supply. *International Journal of Production Economics*, 85, p. 183-198.

Swink, M., Melnyk, S. A., Bixby Cooper, M. & Hartley, J. (2014). Managing Operations Across the Supply Chain, 2nd Edition, New York: McGraw-Hill/Irwin

UNCTAD (2016). Review of maritime transport 2016. Report by the UNCTAD Secretariat, Geneva.

Waqas Azfar, K. R., Khan, N. & Gabriel, H., F. (2014). Performance measurement: A Conceptual Framework for Supply Chain Practices., *10th International Strategic Management Conference, Procedia – Social and Behavioral Sciences*, 150, p. 803-812.

Weisbrod, G., Mulley, C. & Hensher, D. (2016). Recognising the complementary contributionas of cost benefit analysis and economic impast analysis to an under standing of the worth of public transport investment: A case study on rapid transit in Sydney, Australia., *Research in Transportation Economics*, 59, p. 450-461.

Yang, J. (2014). Supply chain agility: Securing performance for Chinese manufacturers. *Internatiol Journal of Production Economics*, 150, p. 104-113.

Yang, Y.-C. (2011). Risk management of Taiwan's maritime supply chain security. *Safety Science*, 49, p. 382-393.

http://www.icontainers.com/us/2017/03/21/new-shipping-alliances-what-you-need-to-know/ [access May 11, 2017]