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Basic Determinants in Integrated Supply Chains

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An integrated supply chain is currently a decisive factor when it comes to remaining on increasingly demanding markets. Optimal organization of the supply chain is often a serious challenge for businesses that need to function in a more efficient way, and to provide products tailored to individual customers' needs. The accuracy and precision at every stage are crucial, as well as shorter response time to changes in demand, customer tastes and economic conditions.

Keywords: supply chain, customer service

1. INTRODUCTION

A supply chain covers mining, manufacturing, trade, services operating in different functional areas, as well as their customers, among whom products, information and financial resources flow in streams [21]. Role of supply chain management became prominent in 1990's and since then it became an important part of any industry [18]. All companies operating on the market, production, trade and services enterprises, seek opportunities for reducing prime costs, to attain the best competitive position, as customers seek for cheap goods and services which at the same time are of good quality. Consequently, companies must look for new methods in order to rationalize their costs, for example they undertake joint partnership-based activities, within an extended company which is an integrated supply chain.

The factor that decides of the success on the market is the ability to handle individual problems occurring in the supply chain, such as:

- realization of strategies which ensure the highest perceived value for a customer;
- understanding how costs are shaped, and how they are interconnected, as well as using potential sources of diversification;
- reaction to demand changes without the necessity of accumulating excessive stocks;
- organization of cooperation with suppliers in case of a sudden change of plans;
- the use of resources, capital and means of transport in order to improve service,
- the speed of introducing new products into the market, and preparing an enterprise in order to satisfy the increasing demand,
- supply chain efficiency, ensuring a wide selection of products to customers, and delivering faster than competitors,
- satisfying customer requirements in cases when the given order cannot be completed by the preferred supplier.

In order to meet the above listed conditions it is necessary to leave the framework of a traditional supply chain, such as sequential, linear transfer of information, from one partner to another, as it is too slow, inaccurate and expensive. This is especially

true considering the fact that multi-organizational setting raises the costs of the implementation, because of the lack of unified IT infrastructure and additional cost of implementing secure channels of communication [23]. Thus IT integration is an important part of integrated supply chain as it can suppress the inefficiencies caused by poor supplier performance, unpredictable customer demand, and uncertain business environment [12].

Establishing communities of cooperation, combined into a supply chain system, where suppliers, manufacturers, distributors and customers share information, is a way of overcoming the above listed problems, as in the contemporary economy it is not enterprises that compete against one another, but rather the supply chains whose part they are. Thus, one can summarize that over the years the competition has shifted from intercompany level to inter-supply chain level [10,13].

2. CUSTOMER SERVICE IN AN INTEGRATED SUPPLY CHAIN

A characteristic feature of the market economy developing in many countries is meeting ever more sophisticated customers' expectations and requirements, constantly raising the level of service.

Customer service is also considered in terms of the potential source of diversity because technological differences among products are less and less noticeable. Technologies used in the production of competing products are becoming more and more commonly unified and a client, who is not an expert in a given field, finds it difficult to capture differences among them. It is also becoming increasingly difficult to maintain a competitive edge with products offered as such, and moreover, customers increasingly buy unbranded substitutes. The broadly understood customer service is thus the most important and differentiating element, in relation to the competitors' offer, and it can be assessed on the basis of the following criteria [21]:

- timeliness of delivery - the degree of probability of keeping the agreed delivery deadline;
- quality of delivery - the ratio of the amount of delivery without natural losses, transport damage to the total volume of deliveries;
- delivery speed - the period between the acceptance of the order and the delivery;
- reliability of delivery - compliance of the delivery received with the assortment and time specification;
- adequacy of delivery - participation of the advertised assortment in the entire ordered delivery;
- delivery flexibility - susceptibility to changes in customer requirements (technological, seasonal and assortment);
- serviceability of the delivery - the scope of sales and after-sales services provided;
- readiness for dispatch - the percentage of goods ordered which can be immediately released;
- openness of delivery – ratio of satisfied customer information, about the status of the order, to all information;
- reliability of delivery - the ratio of positively settled returns to all returns;
- environmental performance of delivery - participation in the supply of environmentally friendly goods (especially their packaging);
- delivery rhythm - the ratio of the total number of days in the examined period to the number of deliveries;
- standard of delivery - the level of the new product offer in the current offer;
- supply reactivity - the number of delivery elements delivered in advance to the total number of items;
- the formalism of delivery - the adopted procedure for accepting complaints;
- convenience of delivery - convenience of the form of ordering delivery by customers.

Among the above listed assessment criteria, the readiness of delivery, i.e. the ability to meet demand, deserves special attention. Unavailability of a given product or service at a time when the customer is willing to purchase it may result in them turning to competition. There is no doubt, therefore, how important the role of efficiently organized distribution as part of supply chain management is.

Among the activities related to customer service, logistics activities become of key importance. Logistics customer service consists of [15]:

- elements relating to the product, e.g.:
  - ✓ availability of goods in a warehouse,
  - ✓ compliance with the order regarding the quantity and assortment of goods,
  - ✓ flexibility regarding the size of orders;

- time-related elements, e.g.:
  - ✓ time of the customer order cycle,
  - ✓ punctuality, the smallest deviations possible off the actual delivery time from the planned one, agreed with the customer,
  - ✓ readiness to deliver at an unusual time,
  - ✓ flexibility, e.g. readiness to change the agreed delivery time,
- elements related to the place, e.g. the number of sales points and their availability;
- other elements, e.g. service or payment terms.

Elements of logistic customer service can also be divided into pre-trade, transactional and post-trade elements [11].

From the logistics point of view, customer service consists of providing the right product or service in the right place, time, quantity, quality, with the right service and at the right price. This means "the ability of the company's logistics system to meet the needs of customers in terms of: time, reliability, communication and convenience." [5]. In order to meet these requirements and take into account all customer service criteria, the logistics system must demonstrate flexibility in a broad sense. Undoubtedly, the Efficient Consumer Response strategy (ECR) can be perceived as such a system.

One of the most popular strategies of improving supply chains is the new logistics concept, created in the 1990s, called the Efficient Consumer Response (ECR). The basis of formation of the ECR was the rapid development of information technologies, the ever growing competition, the formation and development of international trade organizations, as well as consumers' need for more qualitative, safer, fresher product with better service and broad assortment [9]. The concept is often defined as: "a supply chain management strategy, based on synchronized supply and demand management, with the use of assistive technologies, to increase the competitiveness of the entire supply chain (maximizing the benefits of all participants of the chain)" [3]. Therefore, it means an effective reaction to the customers' needs on the part of all supply chain participants, starting with raw materials and packaging suppliers, through manufacturers, 3PLs, and ending with trading companies. The ECR idea is based on "interdependent optimization of value creation chains, between the participants of entire chains, penetrating the industries, and with their participation" [6]. In this way ECR encourages information sharing, trust and supply chain efficiency [20]. This can be further complemented by supply chain flexibility considered as the capability of supply chains to sustain and provide an optimal level of performance through quickly migrating to an alternate configuration [22, 14].

The behaviour of customers is the focus of the ECR strategy. Participants in the supply chain strive both to precisely identify the needs of customers, and to satisfy them completely. At the same time, appropriate processes must be started, conditioning the implementation of accelerated and individualized activities for customers, whose realisation is beneficial from the point of view of costs.

As part of the processes that make up the ECR strategy, two dimensions of management can be distinguished - logistics and marketing. The logistics dimension refers to supply chain management, and the marketing one - to the management of commodity categories. Effective chain management should ensure cooperation among all links, in order to exhaust the hidden potential for the increase in efficiency, while better cooperation in the field of marketing, due to the use of comprehensive category management, is the key to the growth of market efficiency.

The subject literature often mentions another area of efficient customer response, namely efficient support technologies. The technologies in question include the following processes: electronic data exchange, electronic funds transfer, product coding, computerization of points of sale, database management and costs account for processes j. [6].

The ECR concept uniqueness proves that well-known and long-recognized processes, as a result of integration, create new quality in the form of management innovations and efficiency potentials, which contributes to the supply chain partners' market success.

The ECR strategy is connected with cooperation of all links in the supply chain (info partnering), information exchange and its rapid flow, which has a significant impact on overcoming systemic barriers among the supply chain participants. Integration of the information chain is based on organizational changes, and on the structure of unified communication and data storage standards. It also conditions information exchange in order

to effectively manage the transfer of goods and marketing activities.

3. QUALITATIVE DETERMINANTS OF THE INTEGRATED SUPPLY CHAIN

The turn of the 20th and 21st centuries is a period of sudden transformations, being a cause of increasingly demanding requirements, which enterprises face. It is, on the one hand, related to globalization trends, resulting in an ongoing increase in competition, complexity of systems and rate of innovation, on the other hand, to customer expectations growing as the demands for production individualisation were becoming more and more common. One must not also disregard the cyclic decline of activeness of enterprises due to the economic crisis.

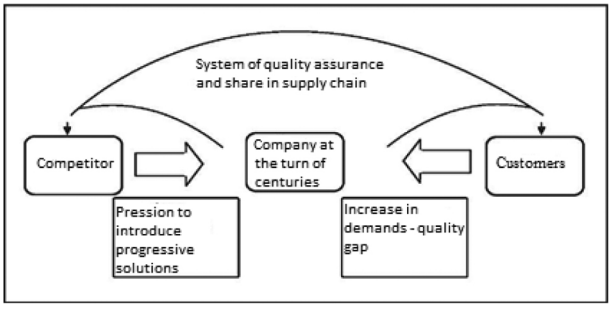

Fig. 1. The company's response to the challenges of the 21st century [8]

Therefore, the market situation forces businesses to shorten times of response to changes in the environment, and to display more and more flexibility in operations. Enterprises willing to hold their position in the market must face multifaceted challenges and newly emerging trends oriented toward quality, time and flexibility. The universal concepts being most suitable for solving the aforementioned problems are logistics and quality management (TQM).

Interpretation of the concept of comprehensive quality management can be considered in the aspect of the three components of the TQM concept [1]. The term "Total" refers to the integration of all partners in the supply chain, and all structures and levels and processes of managing the chain are a source of quality development. The concept of "Quality" is customer oriented. Products delivered to a customer must not only meet certain quality requirements, but the quality of these goods must take into account the constantly growing expectations of buyers. The final term, i.e. "Management" highlights the very nature of TQM as a managerial concept which may be implemented in the supply chain by developing subsystems of the quality sphere management, i.e. functional subsystems for policy making, planning, controlling, organisation and development of all supply chain links.

Offering products of high quality features, extended with logistic advantages from the customer service area, creates opportunities for the supply chain participants to behave in a strategic and competitive manner in the market. Not only does it enable them to win over the competition, but also satisfy or even exceed customer expectations.

It is commonly assumed that the prerequisite of the supply chain creation and growth is partnership, which should be interpreted as the way to manage economic relationships among the chain links on the grounds of mutual trust, division of risk and benefits, triggering additional effects of synergy and competitive advantage. There should be no doubt that for a sustainable growth, organizations need to use other organizations' resources and cannot work in isolation from other members [19].

Bearing the time criterion in mind, partnership may be divided into a short-term (operational) one, and a long-term (strategic) one. Short-term partnership occurs when in the course of repeatable transactions concluded between enterprises; contacts are established between employees responsible for sales and distribution, and those employed in the recipients' purchasing departments. In time, these relationships also begin to cover functions related to product design and manufacture. In the case when long-term (multiannual) partnership exerts significant impact on the content of, and the manner in which the partners pursue their objectives, it is recommended that it should be referred to as strategic partnership. Trust is the key, as a pre-condition in Inter-organizational strategic partnerships [7]. Consequently, strategic partnership in a supply chain should be understood as important and long-lasting collaboration among its participants, based on mutual trust, sharing risk and benefits, which consists in undertaking joint investment and organisational projects in the pursuit of reaching various individual objectives, serving the purposes of common goals oriented at winning competitive advantage and creating value. Strategic alliance creation requires a commitment to investing in relation-specific assets

having the potential of collectively increasing the competitiveness of alliance partners through lower total value-chain costs, fewer defects and faster product development cycles [4].

When not only time but also intensity and scope of economic interconnections among the supply chain links are taken into account, one may distinguish three types of partnership (see Fig. 2) [11, pp. 2–3], [21]:

- type one - usually short-term and limited cooperation in the scope of coordination of activities and planning, undertaken only at a single facility or the partners' functional area;
- type two - transition from coordination to integration of activities among multiple facilities and the partners' functional areas in a long, but typically strictly defined time horizon;
- type three - operational integration which leads to perceiving a partner as an "extension" of one's own organisation, without strictly defined time limits for the cooperation completion.

In order for the integrated supply chain and the system functioning under its framework to perform

continuity		
low	**Type II** Routine, simple supplier swapping, if needed	**Type III** Efficiency improvement through continuous mutual adjustment, leading to benefits attained in terms of both costs and revenues.
high	**Market Exchange** Efficiency increase through price pressure, Limited requirements in terms of continuity and commitment.	**Type I** Occurring when purchasing complex systems and installations
	Low High commitment	

Fig. 2. Commitment and continuity of cooperation versus partnership types depending on the situation in the sphere of purchasing [21, p. 43]

their functions properly, one should design a product made of raw materials and prefabricated units of suitable quality, and envisage highly advanced level of information flow and customer service.

Both the aforementioned types of activity are closely interlinked and interdependent. A high-quality product will not deliver the expected benefits without being effectively introduced into the market, and even the best organised logistic service will not improve the quality of products. Therefore, it is important that understanding of quality should be uniform. Any potential discrepancies in the understanding of quality-related problems among the supply chain participants may cause numerous perturbations in the flow of goods, consequently leading to deterioration of logistic integration. In order to ensure compatibility among quality-promoting activities of enterprises and quality-related demands of their customers, the International Standardisation Organisation proposed and developed the ISO standards. In 1986, ISO 8402 standards were introduced, providing quality-related terms and definitions, whereas in 1987, a series of ISO 9000 standards pertaining to quality management was deployed. The ISO 9000 system does not define technical parameters of a product or a service, but rather the manner in which enterprises operate, owing to which they are capable of providing their customers with products or services of specific quality.

Enterprises conforming to the requirements of the ISO10005 (guidelines for the quality) and ISO 100011 (guidelines for quality system auditing) standards are awarded the ISO certificate which ensures them a high competitive position, an increase in reliability and an opportunity to reach the network of suppliers for well-known manufacturers.

Quality may affect the manner in which a supply chain functions in three ways: activity-related, subject-related and procedural.

The activity-related effect pertains to the influence of the concept of total quality management on the improvement of all processes, and consequently also the activities exerting decisive impact on the efficient functioning of the supply chain, such as packing, reloading, transportation, storage etc.

The subject-related impact of total quality management on the supply chain efficiency consists in the activities undertaken in the sphere of quality and logistics being focused on the same raw materials, materials, semi-finished products and ready-made products, the only difference being that TQM determines these features, whereas logistics coordinates their flow.

Therefore, at a certain level, quality is an absolute prerequisite of an operationally effective supply chain.

The procedural dimension pertains to the fact that logistic processes should be subject to streamlining activities, undertaken as a part of quality management (procedures, methods, tools, documentation)

With convenient conditions, enterprises are able to function in the market by selling products of very

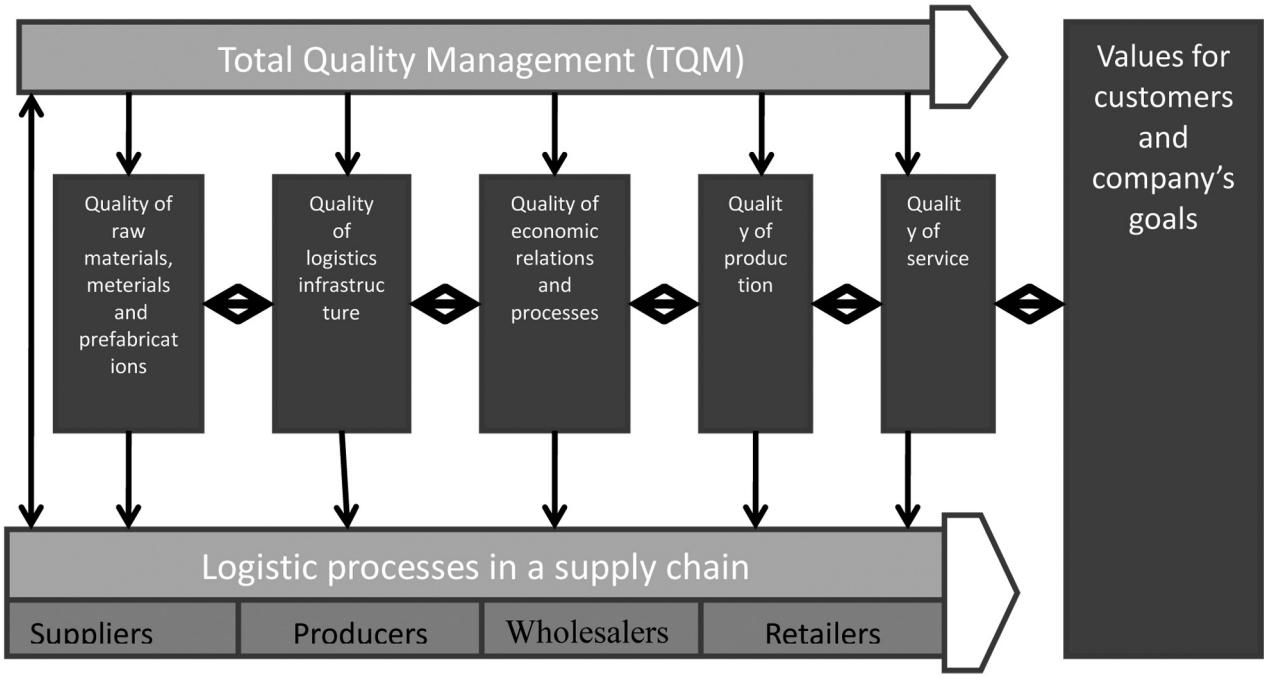

Fig. 3. Impact of TQM on the supply chain [8, p. 14]

poor quality which, however, it is impossible in the supply chain as it causes numerous conflicts as well as loss of mutual trust among partners, which precludes efficient cooperation between individual chain links and intensification of integration.

Implementing the concept of Total Quality Management (TQM) in an integrated supply chain is connected with the pursuit of what is referred to as logistics excellence. This notion was coined by the American A.T. Kearney's Logistics Agency, while conducting a survey aimed at assessment of the quality level in the field of logistics sphere of logistics [1, p. 239]. A supply chain is logistically excellent when it entails all elements of this quality assessment concept. Implementation of the logistic quality concept is preceded by identification of comprehensive and solid relationships between supply chain partners and customers, ones which simplify defining shared goals owing to understanding of mutual needs. Then, through planning, integration of all the supply chain participants' activities, technological progress, staff motivation and stimulation to pursue the common goal, the integrated information system as well as implementation of criteria and indicators for measurement and assessment of logistic quality, the supply chain may attain logistics excellence.

4. TIME RELATED DETERMINANTS IN INTEGRATED SUPPLY CHAINS

Yet another overriding indicator that determines supply chain competitive capacity is the time factor. Under current market conditions, business that are incapable of adapting to the changes taking place in the environment, not only cannot count on achieving success, but even on survival.

The importance of the time factor stems from the function it performs while innovative products and customer service strategies are prepared. Compression of time in the sphere of research and development enables companies to enter the market with a new product, while in the sphere of supply and distribution, it ensures rapid response to market demands and makes it possible to deliver products, for which the demand is currently at its peak.

Therefore, time is a factor of strategic relevance, decisive of the success of operations, both with regard to flexibility and promptness of decision making, which implicates the enterprise's high market share

Growing importance of time perceived as one of crucial factors in the struggle against the competition has contributed to the emergence of a new managerial Qualitative and Temporal Determinants concept, namely Time Based Management (TBM).

This concept is characterised by more efficient use of time, which decides of the improvement of the process implementation efficiency and relationships among partners and with customers, since rapid responding to the signals incoming from the market exerts crucial effect on the features which cause diversification of the competitive level, such as: customer service quality, cost level, quality of the products manufactured and the way in which the entire supply chain of enterprises is perceived, this being decisive of market success.

Companies aspiring to join the group of enterprises achieving market success as a result of their quick response to customer needs should follow the following rules [1, p. 242]:

- time expenditure (time consumption) is considered to be the basic strategic and managerial factor;
- ability to respond to customers' demands determines both the level and the efficiency with \which customer loyalty towards the enterprise is triggered;
- promptness in the innovation process constitutes the target criterion of efficient allocation of new products on the market, ahead of the competition,
- capability and promptness of response make it possible to constantly adapt the benefit schemes functioning in the enterprise to the customer groups perceived as the most attractive ones from the market perspectives.

Close integration of the supply chain and the concept of time management results from the same objectives of the supply chain integration with the aims of strategy of competing with times, such as [5, p. 150]: lower costs, better quality, larger diversity of a product, higher flexibility and sensitivity to customer needs, as well as shorter response time.

Due to the chain concept it is possible to attain the synergy effect, and as result implementation of time based strategies delivers better results, compared to their implementation in individual enterprises. It is about such systems of quick reaction, also referred to as quick customer service systems, as QR (Quick Response), ECR (Efficient Consumer Response) and VMI (Vendor Managed Inventory). The systems in question considerably decrease to a large degree the time of material, as well as information and money flow in the integrated supply chain. The original condition for the logistics of quick response in terms of commercial activities has been competition.

The QR system assumes that there is an information network which interconnects enterprises from the supply chain, and the way in which this system functions is as follows [5, p. 91]:

- selling goods at a supermarket and scanning a product,
- sending information about sales of an article to the store computer,
- sending information about the volume of daily sales of individual products to the manufacturer,
- placing an order with the manufacturer using the JIT (*Just-in-Time*) system,
- replenishing the range of products by manufacturers via the JIT system,
- confirming the receipt of the shipment by the store in a computer system.

Companies operating in the QR system have to meet many requirements. One of them is the need to establish partnership relations among enterprises, which is connected with overcoming mutual distrust in relation to the exchange of information. In addition, it is necessary to reconfigure logistics systems, implement an efficient IT system and technology and production systems that guarantee quick changes and product improvements, in accordance with the requirements of customers. The tasks in question can be performed by well-trained and flexible staff. Quick response strategies are known to yield significant value to firms by better matching supply and demand [2]

According to M. Chaberek [3, p. 68] and many other authors, the strategy of effective customer service ECR is based on solutions resulting from the combination of QR strategy and the JIT system. Similarly to QR and JIT, ECR requires the implementation of electronic data processing. It is due to the fact that the efficient flow of information, up and down the supply chain, is a priority. It translates into a more efficient flow of products among units.

Vendor managed inventory (VMI) consist of planning material flows by the supplier. In this system, the customer does not place orders, but exchanges, with the supplier, information on the actual sale of their products, the current state of inventories and promotional campaigns. Constant insight into the level of customer inventory is possible due to the continuous flow of information,

from electronic points of sale (*EPOS*), through which the supplier is able to better forecast the demand, and optimize the use of production and logistics capacity.

5. SUMMARY

Application of quality standards is associated with numerous benefits for the participants in the supply chain. Relations among companies deepen since the cooperation is better. Probability of production disruption, due to material defects, and the need to handle returns is lower. Better quality of goods is the reason of the higher economic transport susceptibility, which in turn favours using better technological solutions in transport process. This is reflected by the fact that fast transport reduces the level of frozen funds, punctual transport - less delays, certain transport - reduces stocks, rhythmic transport - reduces storage space and related storage costs, and flexible transport allows quick adaptation of the chain to changing market conditions. It is possible, therefore, to obtain synergy effects: lowering costs, shortening delivery times, increasing the level of customer service, as well as creating more advantageous market offers, gaining a competitive advantage, increasing market share, technological development of the chain, and many other objectives, crucial from the point of view of mutual cooperation.

The introduction of the QR strategy creates opportunity of shortening replenishing time to a significant degree, which reduces the level of inventory, which, in turn, reduces costs, incurred by the participants of the supply chain, and finally is the reason of faster response to the customer's order. It also makes products that are currently in demand available.

In order to effectively implement the time competition strategy, full engagement and close cooperate among partners within the supply chain is necessary, by entrusting each other with information. This interaction of the supply chain participants provides the opportunity to identify, much faster, and to eliminate, much easier, reasons of too high inventory levels, too long reaction time in the entire chain and to reduce significantly the enterprise expenses. The control of the whole process is the real scope of logistic management of the order delivery time [17, p.16].

The experience of companies in the application of quality strategies and time management proves that the speed of enterprise reactions and the optimization of value in the entire logistics chain are more and more often a factor determining their survival on the market. Even when companies use a separate strategy to compete against time, efforts to compress time are increasingly being made. Only the companies, that master the art of rapid response and include time compression in their strategies will survive in the demanding and highly volatile economic reality.

REFERENCES

[1] Blaik, P. *Logistyka – koncepcja zintegrowanego zarządzania*. Warszawa: PWE. 2001.

[2] Caro, F., V. Martínez-de-Albéniz. *The impact of quick response in inventory-based competition*. Manufacturing Service Operations Management 12(3), 2010 p. 409–429.

[3] Chaberek, M. *Makro- i mikroekonomiczne aspekty wsparcia logistycznego*. Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego. 2002.

[4] Chen H., Chen T. *Asymmetric Strategic Alliances: A Network View*. Journal of Business Research, Volume 55, Number 12, 2002 p.1007

[5] Christopher, M. *Logistyka i zarządzanie łańcuchem dostaw*. Warszawa: Polskie Centrum Doradztwa Logistycznego. 2000.

[6] Ciesielski, M. *Logistyka w strategiach firm*. Warszawa–Poznań: Wydawnictwo Naukowe PWN. 1999.

[7] Delbufalo E. *Outcomes of Inter-Organizational Trust in Supply Chain Relationships: A Systematic Literature Review and a Meta-Analysis of the Empirical Evidence*. Supply Chain Management: An International Journal, Volume 17, Number 4, 2012 p. 377-402

[8] Długosz, J. *Jakościowe determinanty łańcucha dostaw*. Logistyka. No. 3, 2000.

[9] Kato Y.; Kiriyama R.; Takenaka T.; Kurisu Y.; Nozaki D.; Yano K.; Sato F.; Iida T. *Enhanced production of ECR plasma by using pulse mode microwaves on a large bore ECRIS with permanent magnets*. Source: 19. international conference on ion implantation technology, Valladolid (Spain), 25-29 Jun 2012 ISSN: 0094-243X

[10] Lambert, D. M. (2008) *Supply chain management: processes, partnerships,performance*, Sarasota, Fla., Supply Chain Management Institute.

[11] Lambert, D.M. & Emmel-Hainz, M.A. & Gardner, J.T. *Developing and Implementing Supply Chain Partnerships*. International Journal of Logistics Management. Vol. 7, No. 2,1996 p. 2-3.

[12] Lenny-Koh, S.C., Demirbag, M., Bayraktar, E., Tatoglu, E., & Zaim, S. *The impact of supply chain management practices on performance of SMEs*. Industrial Management & Data Systems, 107(1), 2007 p. 103-124

[13] Mentzer, J. T. *Fundamentals of Supply Chain Management: Twelve Drivers of Competitive Advantage*, 2004, SAGE

[14] Merschmann, U., & Thonemann, U. *W. Supply chain flexibility, uncertainty and firm performance: an empirical analysis of German manufacturing firms*. International Journal of Production Economics, 130(1), 2011 p. 43-53

[15] Milewska, B. & Dembińska-Cyran, I. & Jedliński, M. *Logistyka – wybrane zagadnienia do studiowania przedmiotu.* Szczecin: Wyd. Naukowe Uniwersytetu Szczecińskiego. 2001 p. 81

[16] Mindur, M. Zintegrowany łańcuch dostaw. In: Mindur, L. ed. *Technologie transportowe* Warszawa–Radom: Wydawnictwo Naukowe ITE-PIB. 2014.

[17] Piotrowski, M. *Najważniejszy jest sprawny łańcuch dostaw*. Logistyka. 2004. No. 6.

[18] Prasad, K. D., Subbaiah, K. V., & Rao, K. N. *Supply chain design through QFD-based optimization*. Journal of Manufacturing Technology Management, 25(5), 2014 p. 712–733

[19] Sarkis, J., Zhu, Q., & Lai, K. An organizational theoretic review of green supply chain management literature. International Journal of Production Economics, 130, 2011 p. 1-15

[20] Whipple, J. M., & Russell, D. *Building supply chain collaboration: a typology of collaborative approaches*. The International Journal of Logistics Management, 18(2), 2007 p. 174-196

[21] Witkowski, J. *Zarządzanie łańcuchem dostaw. Koncepcje, procedury, doświadczenia*. PWE. Warszawa 2010.

[22] Yu, K.. The effects of objective and perceived environmental uncertainty on supply chain flexibility. In Service Systems and Service Management (ICSSSM), 2013 10th International Conference p. 410-415.

[23] Zagorecki, A. & Ristvej, J. & Comfort, L.K. & Lovecek, T. Executive Dashboard Systems for Emergency Management. *Communications.* 2012.Vol. 14. No. 2.

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