

Major Features Of Adaptive Supply Chains – Literature Review¹

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Adaptiveness is one of the most significant features of the supply chain that affects the results of its functioning. The capability of the supply chain to adapt to all, more and more demanding conditions is one of the main factors that guarantee long-term competitiveness and success. R. Kalakota, M. Robinson and P. Gundepudi consider inventory visibility, fulfilment velocity and coordination versatility as three fundamental pillars of adaptive supply chains, also termed as 3V in the literature. The chief objective of this paper is the identification of features that a supply chain should have in order to be called adaptive, as well as the verification of their compliance with the 3V principle. The review of the available literature sources that focus on the subject of the major features of adaptive supply chains (in particular having a decisive effect on their adaptive capabilities) has resulted in certain common elements. The authors of all the described approaches emphasise the two features: visibility and velocity. The third, frequently indicated, feature is also versatility or variety (that can be treated as one of the elements of the versatility of the supply chain). Visibility involves ensuring access to the information for all participants in the supply chain, also customers. Velocity, in turn, refers to the reaction time of the supply chain to all sorts of events and the time of implementing necessary changes. The third element is versatility. It primarily involves balancing the operational capability of a supply chain with market requirements, in particular delivering suitable products and services of the required quality and in the ordered volume. It is also vital to adjust the offer to the individual needs of customers.

Keywords: adaptability, supply chain management, 3V, visibility, velocity, versatility

1. INTRODUCTION

The development of the concept of a supply chain in response to the market changes of the recent years has prompted managers to more frequently focus not only on internal issues of their organisations, but also on dependencies that take place between partners in the supply chain. This is because enterprises no longer compete as single entities but as a part of a larger, complex network. As R. Tarasewicz² observes, there is a need for new configurations of supply chains that account for such aspects as: optimisation, rationalisation, globalisation and adjustment to the changeable environment. Such a trend leads to the creation of new concepts of supply chain management in order to develop e.g. the capacity of a quick reaction to the customer's need, cost optimisation, a production system adjustable to the current needs, synchronisation of the planning process with

¹ The study was funded by the National Science Centre, Poland (grant no. 2014/13/B/HS4/03293).

² Tarasewicz R., *Jak mierzyć efektywność łańcuchów dostaw?*, Oficyna Wydawnicza Szkoły Głównej Handlowej, Warszawa 2014, p. 120.

the real demand, as well as the use of the possibilities that e-business offers. One of the concepts, also called the main megatrend in the development of supply chains³, is adaptability.

2. THE CORE OF ADAPTIVE SUPPLY CHAINS

The first uses of the term “Adaptive Supply Chain Management” (A-SCM) in literature took place in the years 2001-2002, mainly in the context of the development of information and communication technologies. Since then there have appeared many concepts that assumed that a supply chain should be more flexible and reactive, as well as able to comply with the requirements of velocity and agility⁴. The approach of the SAP enterprise⁵ to adaptive supply chains may be considered as one of the first steps in supply chain automation with the use of new technologies, including agent technologies, RFID, and Web services.

Supply chain adaptability can be defined as its capacity for changes that leads to preventing from the occurrence of undesired events, improving the functioning or acquiring new skills, in order to achieve the objective of the supply chain in specific environmental conditions (that are changeable) and in the light of incomplete information on their dynamics⁶. Participants in the adaptive supply chain get the ability to recognise the changing operational conditions in a period that allows them to evaluate alternative corrective measures, as well as to react in order to alleviate their impact on the company’s operation. This is particularly significant in the light of uncertainty currently faced by the enterprises (associated with such events as terrorist attacks, employee protests, force majeure etc.)⁷.

D. Ivanov, B. Sokolov and J. Kaeschel⁸ claim that a supply chain can be called adaptive if it is capable of adapting to:

- changes in the market environment and the functioning in conditions of uncertainty,
- changes in the executive environment of specific measures,
- internal changes in the supply chain itself

by means of using structural and functional reserves, as well as better coordination that results from the application of information and computer technologies, in particular the Internet. Under the influence of long-term and strong changes in the environment, this type of a supply chain is able to reduce, suppress or eliminate disruptions and maintain, or even improve the operational efficiency through reconfiguring its elements (transition to a new state). Adaptability is crucial in the context of adjusting to global markets as a response to changes in the life cycle of a product and technology, as well as in reaction to the customers’ needs.

Adaptability allows partners in a supply chain to work in a dynamic environment so as to foster the achievement of greater effectiveness of operations⁹. A chain characterised by such a feature evolves together with

³ Szymczak M., *Elastyczność, wrażliwość i odporność jako cechy adaptacyjnych łańcuchów dostaw*, “Studia Oeconomica Posnaniensia”, 3 (2015)/6, p. 40.

⁴ Ivanov D., Sokolov B., *Adaptive Supply Chain Management*, Springer, London 2010, pp. 23-24.

⁵ SAP, *Adaptive Supply Chain Networks*, 2002.

⁶ Ivanov D., Sokolov B., *Adaptive Supply...*, p. 26.

⁷ Davidrajuh R., *Structures for Stepwise Development of Adaptive Supply Chains*, “Journal of Internet Commerce”, 5 (2006)/4, p. 55.

⁸ Ivanov D., Sokolov B., Kaeschel J., *A Multi-Structural Framework for Adaptive Supply Chain Planning and Operations Control with Structure Dynamics Considerations*, “European Journal of Operational Research”, 200 (2010)/2, p. 411.

⁹ Kramarz M., Kramarz W., *Determinanty i atrybuty adaptacyjnych łańcuchów dostaw drukarek przemysłowych*, “Studia

economic, political, demographic and technological transformations¹⁰. The adaptability capacity gives rise to three main directions of the evolution of supply chains: operational flexibility, sensitivity to the recipient's needs and resistance to disturbance. As M. Szymczak emphasises, "evolution is desired in each of these directions simultaneously [...] – only the distribution of the stresses allows for identifying the dominating direction"¹¹. Such development should be based on cooperation in a supply chain that involves four dimensions: data, people, tools and processes¹².

3. THE IMPACT OF ADAPTABILITY ON THE PERFORMANCE OF A SUPPLY CHAIN

Literature describes adaptability as one of the major factors that guarantee long-term competitiveness and success¹³. This is a vital feature that affects the effectiveness of supply chain operations. In a survey conducted in 2009 by the organisation PwC¹⁴, 65% of respondents¹⁵ considered the capacity to adapt to the changing environmental conditions as critical, and 30% – as an important source of gaining and maintaining a long-term competitive advantage¹⁶. Supply chain adaptability is mainly achieved by¹⁷:

- monitoring global economy in order to identify new sources of supply and new markets;
- spotting trends and observing market changes;
- using a network of intermediaries in order to acquire new suppliers and new logistics infrastructure;
- evaluating the needs of both direct customers and final consumers;
- ensuring full transparency of operations, resources and processes in the entire system in order to foster a quick reaction to the arising changes and problems;
- analysing the largest threats and limitations, creating plans of alternative deliveries and using the bases of trusted suppliers;
- dynamic resource allocation;
- applying flexible solutions, e.g. by means of using the postponement principle that allows for easier adaptation of products or components from one market onto the other;
- precise identification of the stages of the technological cycles and life cycles of the manufactured products.

While describing the most significant properties that have a fundamental impact on the effectiveness of supply chains on the contemporary market, R. Tarasewicz enumerates the capacity for adaptability apart from

Ekonomiczne. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach”, 217 (2015), p. 154; Whitten G. D., Green Jr K. W., Zelbst P. J., *Triple-A Supply Chain Performance*, “International Journal of Operations & Production Management”, 32 (2012)/1, p. 31.

¹⁰ Tarasewicz R., *Jak mierzyć efektywność...*, p. 57.

¹¹ Szymczak M., *Ewolucja łańcuchów dostaw*, Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu, Poznań 2015, p. 73.

¹² Szymczak M., *Elastyczność, wrażliwość i odporność...*, p. 41.

¹³ Ahimbisibwe A., Ssebulime R., Tumuhairwe R., Tusiime W., *Supply Chain Visibility, Supply Chain Velocity, Supply Chain Alignment and Humanitarian Supply Chain Relief Agility*, “European Journal of Logistics, Purchasing and Supply Chain Management”, 4 (2016)/2, p. 38.

¹⁴ PwC is a global network of enterprises that provide accounting, auditing and consulting services.

¹⁵ The research sample included 1,124 general directors, i.e. persons holding the highest executive power in enterprises, in over 50 countries.

¹⁶ PwC, *12th Annual Global CEO Survey*, 2009, p. 24.

¹⁷ Antonowicz M., *Wyzwania logistyczne firm – elastyczne łańcuchy dostaw*, “Studia Ekonomiczne. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach”, 255 (2016), p. 221; Lee H. L., *The Triple-A Supply Chain*, “Harvard Business Review”, 82 (2004)/10, p. 105; Whitten G. D., Green Jr K. W., Zelbst P. J., *Triple-A Supply Chain...*, pp. 30-31.

flexibility, responsiveness, or alignment¹⁸. On the other hand, based on the analysis of 60 leading enterprises, H. Lee proposes a concept of Triple-A Supply Chains¹⁹, which assumes that a successful supply chain should be characterised by three features²⁰:

- agility – react quickly to rapid changes in supply and demand;
- adaptability – adjust quickly to the evolving structures and market strategies;
- alignment – thanks to which enterprises, acting to the advantage of their own interests, at the same time improve the functioning of the entire supply chain.

D. Ivanov and B. Sokolov introduce a different character of dependencies between the described features than the one within the “Triple-A” concept²¹. They developed a framework of adaptive supply chain management (Fig. 1).

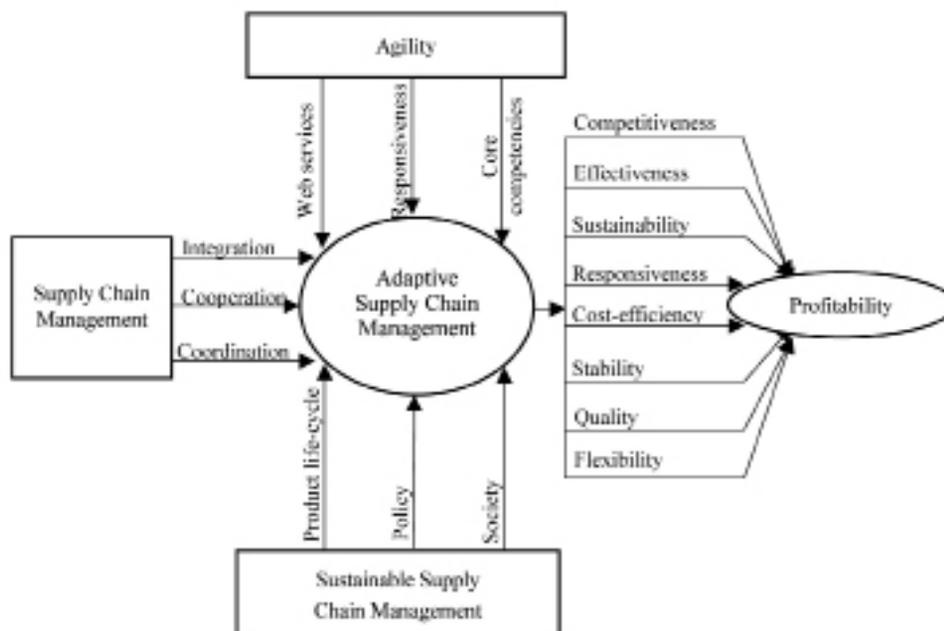


Fig. 1. Framework of Adaptive supply chain management

Source: D. Ivanov, B. Sokolov, *Adaptive Supply Chain Management*, Springer, London 2010, p. 27.

According to the concept developed by D. Ivanov and B. Sokolov, supply chain management constitutes a basis for integration (organisational: of suppliers and customers; functional: of common business processes; managerial: of the strategic, tactical and operational level of decision making), cooperation and coordination. Agility strategies enrich supply chain management by means of exchanging information with the use of Internet services, as well as greater flexibility and sensitivity through the concentration on key competences and creating virtual alliances.

Sustainable supply chain management is focused on a product's life cycle, as well as accounts for issues connected with political and social conditions. A proper combination of the enumerated elements provides for the

¹⁸ Tarasewicz R., *Jak mierzyć efektywność...*, pp. 54-59.

¹⁹ The name of the concept originates from the first letters of three attributes of the supply chain: Agility, Adaptability, and Alignment.

²⁰ Lee H. L., *The Triple-A...*, p. 105.

²¹ Ivanov D., Sokolov B., *Adaptive Supply Chain...*, p. 27.

basis for adaptive supply chain management. Adaptive supply chain management leads to achieving a number of features that shape profitability and in effect – long-term competitiveness, sustainable growth and survival.

4. MAJOR FEATURES OF ADAPTIVE SUPPLY CHAINS

Adaptability capacity is an effect of developing a certain set of features in a supply chain. T. Ross, M. Holcomb and B. Fugate²² list six key elements crucial for achieving perfection in the area of management by means of creating an adaptive supply chain:

- collaboration, i.e. sharing information in real time with key customers, suppliers and partners, standardising processes and measures;
- optimisation, i.e. the application of novel tools for optimisation and process development, elimination of ineffective measures;
- connectivity, i.e. standardising applications and platforms; supporting the many-to-many relationship, trade development;
- execution, i.e. developing areas of transport, distribution, warehousing and order management, developing financial settlements, measuring the results of efficiency;
- speed, i.e. increasing the sensitivity of the supply chain, access to information in real time;
- visibility, i.e. tracking the flow of resources, updating the status of an order in real time.

On the basis of the conducted research, the authors claim that two elements: execution and speed form a synergic effect that could be defined as operations excellence. T. Ross, M. Holcomb and B. Fugate also indicate that the basis for visibility is collaboration that is vital for integrating information communicated by various partners in the supply chain. Ensuring updated information (provided in real time or time close to the real time) supports the process of delivering the proper product at the right place in adequate time. Collaboration primarily depends on the capacity of full IT integration (e.g. of the equipment, software, systems architecture, data distribution etc.)²³.

Still, D. Ivanov and B. Sokolov enumerate the following features of adaptive supply chains (as an effect of applying innovative concepts and technologies): stability, effectiveness, responsiveness, flexibility, robustness, cost-effectiveness and competitiveness²⁴. Achieving these features ensures the stability of the functioning of the supply chain, contributes to the growth of customer satisfaction as well as leads to lower costs and improved profitability.

According to the theory presented by the SAP enterprise, the transition from the traditional to the adaptive supply chain takes place at three stages²⁵:

- Integration. This stage involves the integration of applications used by the cooperating partners. Its scope directly determines the level of visibility. The visibility of the information originating from the organisation as well as outside it (e.g. on orders, plans, stocks, deliveries etc.) is critical for making a quick reaction to the changing market conditions, coordination of events in the entire supply chain as well as monitoring the situation and undertaking preventive measures. Thus, visibility provides a basis for adaptive supply chains.

²² Ross T. J., Holcomb M. C., Fugate B. S., *Connectivity. Enabling Visibility in the Adaptive Supply Chain*, Capgemini LCC, Boston 2004, p. 5.

²³ Ross T. J., Holcomb M. C., Fugate B. S., *Connectivity. Enabling...*, pp. 8-9.

²⁴ Ivanov D., Sokolov B., *Adaptive Supply Chain...*, p. 26.

²⁵ SAP, *Adaptive Supply Chain...*, p. 10; Davidrajuh R., *Structures for Stepwise...*, pp. 57-58.

- Cooperation. This stage is focused on developing the capacity for information exchange in real time, which is a direct derivative of the cooperation stage. The velocity of response of the supply chain is determined by e.g. quick access to the required information and its distribution. The growth of the complexity of products and the need for delivering them in all the shorter time make product designing, their manufacturing and distribution become the result of joint efforts undertaken by all the enterprises in a supply chain. However, the effectiveness of cooperation and the resulting speed of planning and execution of intentions are seriously weakened if the cooperation takes place in an unintegrated environment.
- Adaptability. An adaptive supply chain is a group of organisations that cooperate together, release transactional, operational and financial data in order to boost competitiveness and profitability. Integration and cooperation within the network supported by a high level of specificity of provided information lead to improved management of variability in comparison to competitors. This is the last stage of strengthening the adaptability of a supply chain.

R. Kalakota, M. Robinson and P. Gundepudi name the inventory visibility, the fulfilment velocity, and the coordination versatility as the fundamental pillars of adaptive supply chains²⁶. These form the 3V principle, which sets directions of the development of supply chains connected with new criteria of effectiveness²⁷, i.e. capacity for a quick reaction, a skill of optimal use of resources as well as high operational flexibility. The 3V principle argues that supply chains should be created all the more consciously and their management should account for the added value for all stakeholders²⁸. Also U. Ruhi and O. Turel claim that 3V elements represent features characteristic of a proper supply chain²⁹. Numerous publications that describe the main elements that are vital for the proper functioning of a supply chain mention specific elements of the 3V principle. Their overview is presented in table 1.

Table 1. Elements of the 3V principle and the main features of the supply chain

Source	Elements of the 3V principle			Other features
	Visibility	Velocity	Versatility	
Ruhi, Turel, 2005, p. 95-117	X	X	X	
Szymczak, 2015, p. 71	X	X	X	
Kalakota et al., 2003, p. 300	X	X	X	
SAP, 2002, p. 7	X	X		variability
Hudnurkar, Rathod, 2012, p. 132	X	X		variability
PwC, 2012, p. 1	X	X		variability
Wilhjelm, 2013	X	X		variability
Ebadian, 2014	X	X		variability
Carvalho i in., 2012, p. 52	X	X		flexibility, collaboration, responsiveness
Scholten, Schilder, 2015, p. 472	X	X		flexibility, collaboration

²⁶ Kalakota R., Robinson M., Gundepudi P., *Mobile Applications for Adaptive Supply Chain: A Landscape Analysis*, [in:] Lim E. P., Siau K. (eds.), *Advances in Mobile Commerce Technologies*, Idea Group Inc., Hershey, USA 2003, p. 300.

²⁷ Classic indicators of operational effectiveness are the level of service, time and cost.

²⁸ Szymczak M., *Ewolucja...*, pp. 71-73.

²⁹ Ruhi U., Turel O., *Driving Visibility, Velocity and Versatility: The Role of Mobile Technologies in Supply Chain Management*, "Journal of Internet Commerce", 4 (2005)/3, pp. 95-117.

Jüttner, Maklan, 2011, p. 247	X	X		flexibility, collaboration
Iyer, Seshadri, Vasher, 2009, p. 2	X	X		variety, variability
Basu, Wright, 2008, p. 117-121	X	X		volume, variety, variation
Hines, 2013, p. 329	X	X		value, volume volatility, variety, variability, virtuality

Source: own elaboration.

M. Hudnurkar and U. Rathod describe visibility, velocity and variability as three fundamental problems of traditional supply chains³⁰. Focusing attention on these three features is a key factor in order to increase the operational efficiency of each supply chain³¹.

Literature mentions various configurations of the features characterising supply chains that include certain elements of the 3V principle. Visibility and velocity, supported by flexibility and collaboration in the supply chain are indicated as the characteristics of resilient, or agile supply chains³². The formula can be also expanded by other features, leading to 4V, 5V, or even 7V concepts.

Supply chain management in the company Toyota is focused on the attempt to achieve balance within four key parameters – 4Vs: variety of products offered, velocity of product flow, variability of outcomes against forecast, visibility of processes to enable learning³³.

The objective of variety management is to balance the operational capacity of the supply chain with market needs. With regard to its impact on all partners in the supply chain it is vital that each of them takes part in making decisions on the scope of versatility. On the other hand, it is also advisable to analyse feedback from the market on whether the assumed diversification of the product offer corresponds with the current market conditions and needs. Flow velocity is expressed in each executed process and is closely connected with the synchronisation of planning processes within the entire supply chain. Another element that leads to maintained performance by means of interaction with variety and velocity is the changeability of orders and deliveries. Reducing variability through the proper execution of specific processes allows for their realisation with the minimum level of kept stocks, which leads to gradual cost reduction and improved quality of results. The fourth key feature of the supply chain is the visibility of all processes, achieved by e.g. the use of proper

³⁰ Hudnurkar M., Rathod U., *Collaborative Supply Chain: Insights from Simulation*, "International Journal of System Assurance Engineering and Management", 3 (2012)/2, p. 132.

³¹ Ebadian M., *3 Vs of Biomass Supply Chain: Variability, Visibility and Velocity*, 2014; PwC, *Supply Chain and Manufacturing: Focus on Three "Vs" to Improve Supply Chain Management*, 2012, p. 1; Wilhelm R., *Revisiting the 3Vs of Supply Chain: Visibility, Variation and Velocity*, 2013.

³² Carvalho H., Azevedo S. G., Cruz-Machado V., *Agile and Resilient Approaches to Supply Chain Management: Influence on Performance and Competitiveness*, "Logistics Research", 4 (2012)/1, p. 52; Jüttner U., Maklan U., *Supply Chain Resilience in the Global Financial Crisis: An Empirical Study*, "Supply Chain Management: An International Journal", 16 (2011)/4, p. 247; Scholten K., Schilder S., *The Role of Collaboration in Supply Chain Resilience*, "Supply Chain Management: An International Journal", 20 (2015)/4, p. 472.

³³ Iyer A., Seshadri S., Vasher R., *Toyota Supply Chain Management: A Strategic Approach to Toyota's Renowned System*, McGraw-Hill Education, USA 2009, p. 2.

measurers that provide necessary information in order to make decisions and revise plans. This exposes bottlenecks, which fosters immediate reaction and undertaking attempts to eliminate them. The main objective of managing 4V parameters is to maintain the adequate speed of operation, synchronisation of the offer's diversity with the current need expressed by the market, as well as reduction of variability. Visibility allows for continuous learning and – by means of providing feedback – for reaction in response to market reality³⁴.

Another concept that describes elements to be managed in order to create values in the supply chain is the 5V, described by R. Basu and J. Wright³⁵. The authors expand the 4V³⁶ model for process analysis, developed by N. Slack et al., which incorporates: volume, variety, variation and visibility by adding the fifth element – velocity.

Managing the first element is primarily connected with the characteristics of the demand for products and services. Large, regular demand leads to situations where the processes performed in the supply chain are characterised by considerable repetitiveness. In the context of operational management this means that specific tasks are frequently repeated, which justifies the need to train specialist employees in the execution of a limited number of operations. In this situation it is worth considering the standardisation of components as well as the use of the same parts for the production of various product models. Extensive demand also allows for executing regular deliveries, minimising the number of errors and reducing costs generated as a result of these errors.

Another two elements in the 5V model similarly affect the functioning of the supply chain. Both larger variety of the offered products or services and considerable variability of demand bring the necessity to maintain a proper level of safety stocks in many places of the supply chain. Such an operation is aimed at the preparation for rapid changes in the volume of demand as well as meeting specific customer requirements. Moreover, it results in the growth in process complexity that leads to satisfying the need for specific products and services.

A crucial element of the model is also the visibility of the processes executed within the supply chain. Insufficient exchange of information between its participants and especially limiting oneself to reporting the need for products or services solely to the closest business partners leads to constant increase in the levels of stocks kept. The authors also account for the fact that the processes that involve a direct contact with a customer require greater visibility than the other ones.

Velocity is the last significant aspect in supply chain management. It may be assessed on the basis of e.g.:

- time of order execution,
- time devoted to each process in the supply chain,
- share of deliveries executed on time,
- stock turnover ratio.

T. Hines offers a different approach to the issue of supply chain features. Based on requirements reported by the customers, T. Hines formulated seven major business challenges (7V) to which an organisation should respond while developing its strategy for a supply chain. These refer to the need of perfecting the capability to manage³⁷:

- value,

³⁴ Iyer A., Seshadri S., Vasher R., *Toyota Supply...*, pp. 3-4.

³⁵ Basu R., Wright J. N., *Total Supply Chain Management*, Elsevier, London 2008, pp. 117-118.

³⁶ The authors refer to the IPO model, which describes three areas: inputs, processes and outputs. The model's central element is comprised of the processes that transform inputs into outputs.

³⁷ Hines T., *Supply Chain Strategies: Demand Driven and Customer Focused*, Routledge, New York 2013, pp. 329-330.

- volume volatility,
- velocity,
- variety,
- variability,
- visibility,
- virtuality.

The basis for the functioning of a supply chain within the 7V model is identifying what a customer expects and providing the proper value (value). Mostly customers are not ready to purchase the volumes that the suppliers would wish to sell and in the time frame within which they would desire to do it. Another challenge is thus achieving the capacity to increase supplies when the demand is larger, as well as to limit them whenever the demand is lower, without incurring excessive costs (volume volatility). It is also recommended to strive to launch new products and services as well as adjust the offer to the individual requirements of the customers (variety) in such a manner that ensures proper quality while managing such variability (variability). Reaction velocity is also significant since it greatly affects the possibility to achieve competitive advantage (velocity). Visibility is another key capability in the management of the entire supply chain. The application of information and communication technologies, the integration of systems, policies and procedures, supported by the exchange of information between all partners allow for ensuring full transparency of all the events that take place in the supply chain (visibility and virtuality)³⁸.

5. SUMMARY

In order to summarise the presented analysis of publications on the major features of supply chains (in particular those that determine their adaptive capabilities), certain common elements can be identified. The authors of all the described approaches attach great significance to two features: visibility and velocity. The third, frequently indicated property is also versatility³⁹. This confirms the 3V principle, according to which these features are called the three fundamental pillars of adaptive supply chains.

Visibility involves ensuring access to information to all participants in the supply chain, including customers. Its range may also include the use of innovative technologies that support cooperation in the supply chain, coordination of material and non-material assets as well as replacement of resource relocation with information share. Velocity in turn refers to the reaction time of the supply chain to all events as well as the time of implementing necessary changes (this means flexibility in terms of time). The third element that connects the described models is widely understood versatility of operations. It mainly concerns balancing the operational agility of the supply chain with market needs, in particular delivering proper products and services at the required quality and in the required volume. It is also vital to adjust the offer to the individual needs of the customers. Versatility also requires undertaking cooperation with suppliers and recipients in the light of various conditions of order execution, which involves the need to ensure high operational flexibility of the supply chain so that it can handle the issue of variability.

³⁸ Ibid.

³⁹ Many authors perceive variety as an important feature as well. Variety can be treated as one of the elements of the versatility of the supply chain.

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