

Radim LENORT\*, Pavel WICHER\*\*

## NEW TRENDS IN SUPPLY CHAIN MANAGEMENT AND THEIR COMPARISON & INTEGRATION

### Abstract

This article examines, describes and compares new trends in strategic supply chain management of industrial companies. The increasing globalization and increased uncertainty and risks in the business environment gave birth to new approaches intended to protect the supply chain and to exploit new market opportunities. The basic trends include agile and resilient supply chains. Both of these concepts are trying to complement and enhance the heavily used approach of lean supply chain that starts facing problems in the above described conditions.

**Keywords:** lean, agile, resilient, LAR, supply chain

### 1. INTRODUCTION

Supply chain management has recently been a very hot logistics topic [10]. Both theorists and practitioners have been dealing with this issue. The opportunities and threats occurring in the unstable business environment of the 21st century are the main reason behind this interest. Typical characteristics of this business environment include globalization, change and risk. Strategies that are to be successful in such conditions must be fast, flexible, but also cost effective. At the same time, the variable and complex business environment is very competitive. It is no longer efficient for an industrial company to compete by itself, but it is necessary for the supply chain to act as an integral unit [4].

The article has two primary objectives. The first one is to characterize the key features of the individual approaches in supply chain management and to show the principles used in application of these approaches in practice. The second objective is to compare the individual approaches and to find the possibilities of joining them together.

The structure of the article is adapted to fit its objectives. The first three chapters gradually describe the basic principles of lean, agile and resilient supply chains. They are followed by a comparison of the characteristics of the individual approaches and recommendations regarding the possibility of their integration into a compact unit – LAR supply chain.

### 2. LEAN SUPPLY CHAIN

The term lean is generally characterized as elimination of waste ("muda" in Japanese). It was developed in the 80s in the automobile company TOYOTA, where it was named TPS – Toyota Production System. It soon spread to manufacturing plants around the world and it still remains one of the cornerstones of most successful manufacturing and logistics strategies. The basic principle of the lean approach is the removal of everything that does not bring added value. A typical example might be the elimination of excess inventory, defects or waiting [18, 20].

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\* AGH University of Science and Technology, Faculty of Management

\*\* VŠB – Technical University of Ostrava, Faculty of Metallurgy and Materials Engineering

Over time, lean has become a fundamental approach not only within the company, but throughout the supply chain. A new concept of lean supply chain, which is based on the same idea – to eliminate waste in all parts of the value flow (suppliers, sub-suppliers, manufacturers, distribution elements and customers), was created. There are five basic principles providing a vision of how to achieve this goal [2]:

1. Specify what creates value from the customers perspective
2. Identify all steps across the whole value stream
3. Make those actions that create value flow
4. Only make what is pulled by the customer just-in-time
5. Strive for perfection by continually removing successive layers of waste

The lean concept saves a large amount of logistics costs. It works very well in a stable environment which, however, is not achievable in the 21 century [5]. This fact has raised the need to search for new approaches in logistics followed by the emergence of the agile concept and, later, of the resilient supply chain as well.

### 3. AGILE SUPPLY CHAIN

Rather different definition of the term agility can be found in the scholar literature. Rimienė suggests combining the individual definitions using the following way: “Agility is an ability of a company (supply chain) in a changing market environment profitably exploit market opportunities, quickly and flexibly respond to the customers’ needs, and qualitatively, suffering minimum cost, satisfy them by using innovative solutions and partnership cooperation.” [15]. It is not important whether the definition includes quality [14] or innovative solutions [21]. The most important factor is the ability of elegant reaction to large and unpredictable changes that would have meant substantial troubles for lean supply chain. Elegance in this context is understood as the ability of the supply chain to react quickly, with minimum expenditure of costs and in a robust way. There are many changes that may occur in the business environment, they occur with constantly increasing speed, unpredictability and the rate of impact on the supply chain. The main areas where changes occur are:

- Customers – changes in their requirements, stability of demand
- Competition – not only the existing but also potential and substitution
- Suppliers – instability of supplies, financial problems of the suppliers
- Politics and law – changes in legislation, way of market protection and support of business in each country
- Economics – changes in macroeconomic development of countries
- Society – changes in habits and preferences of inhabitants, social problems
- Technology – development of new technologies, short product life cycles

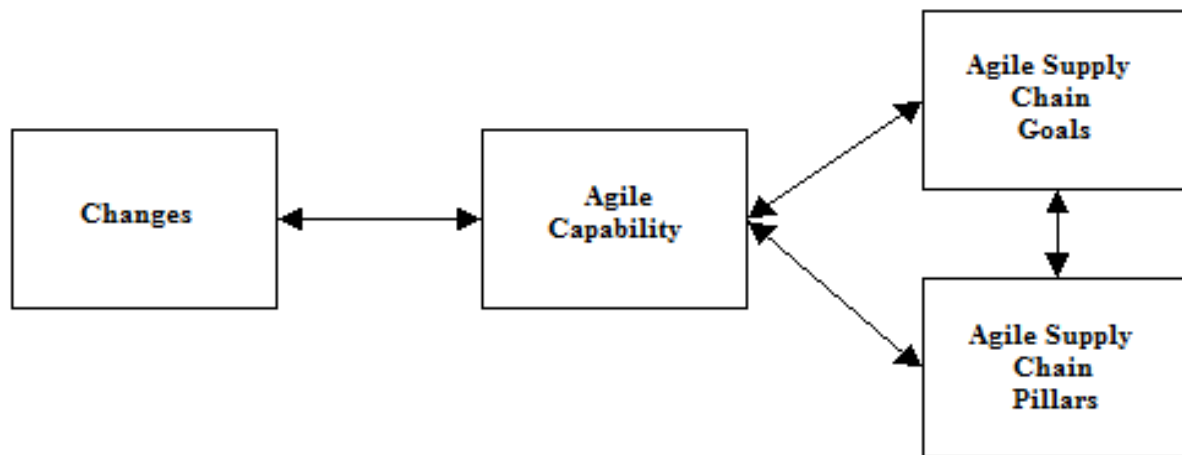
To describe a supply chain as agile, it must have certain capabilities that will allow it to cope with these changes. The most frequently presented ones are [16]:

1. Responsiveness – the key to achieving agility is the ability to identify the change correctly and in time
2. Competency – the ability to effectively realize the goals in the area of agility
3. Flexibility – the ability to use different procedures and tools to achieve the given objectives
4. Quickness – the ability to perform all activities as quickly as possible

The supply chain can acquire these skills only if it is well designed and controlled. The basis is the maximum sharing of information throughout the supply chain, which should be completely open and should be done in real time [5]. Sharing information is an important, but not the only corner-stone of agility. Other means include [12]:

- Collaborative relationship – creating a cooperation within the supply chain on such a level so that the suppliers and customers develop new products together
- Process integration – supply chain is understood as a single unit with integrated processes
- Customer/market sensitivity – supply chain is able to quickly and well read the market changes and customers' needs

Summary of the concept of agility is shown in Figure 1. At the beginning, there are changes in the business environment which affect or may affect the supply chain. According to their quantity and scope, it is necessary to determine the range of the required agile capabilities of the supply chain. The supply chain will acquire these capabilities if it consistently respects the goals of agility and if it applies the designed basic procedures.



**Figure 1.** Concept of Agile Supply Chain

*Source: own*

#### 4. RESILIENT SUPPLY CHAIN

We can encounter two basic characteristics in the development of supply chains. On one hand, it is their growing complexity and global nature, and on the other hand, the increasing pressure on their leanness. The combination of these two opposing tendencies increases the risk of disruption of smooth material and information flow. Building a resilient supply chain can control and reduce these risks [7]. A risk may increase in case the supply chain reduces its inventory, uses single sourcing, has longer supply lines, more outsourcing or tightly meshed global communications network [9]. Both of the risks can be generally divided into the following categories [7, 13]:

1. Internal to firm – process and control
2. External to the firm but internal to the supply chain network – demand and supply
3. External to the network – environmental

Resilience is generally defined as "the ability of the supply chain to get back to its original or new, more suitable status in case of disruption." There are two basic features of resilient supply chain resulting from this definition – flexibility and adaptability. [8]

There is a long way to massive practical use of the concept of resilient supply chain. Currently, surveys are carried out to indicate the principles and methods of building resilient supply chains. The basic principles are, for instance, described by Christopher [7]:

- Supply chain (re)engineering – supply chain understanding, supply chain design principles, supply base strategy
- Supply chain collaboration – collaborative planning, supply chain intelligence
- Agility – visibility, velocity and acceleration
- Supply chain risk management culture – establish supply chain continuity teams, board-level responsibility and leadership, factor risk consideration into decision making

Sheffi recommends various ways of building a resilient supply chain [17]:

- Redundancy – includes measures such as excessive inventory, low capacity utilization or increased number of suppliers. However, such measures are usually very costly and they are very inefficient.
- Flexibility – is considered to be a far more efficient instrument for achieving a resilient supply chain. It means to use postponement, use concurrent instead of sequential process, align procurement strategy with supplier relationships.
- Cultural change – the fundamental characteristics of company culture helping to create a resilient supply chain include awareness and communication of key employees, well distributed powers, enthusiasm for work and conditioning for disruptions.

## 5. COMPARISON OF THE INDIVIDUAL APPROACHES

The individual approaches (lean, agile and resilient supply chain) are compared in Table 1. The selected comparison attributes include the main idea, market, production, creation of alliances, key indicator, inventory strategy and selection of suppliers. For some parameters, it is possible to find conformity or similarity between the concept of agile and resilient supply chain, because both had been created in response to the same situation – a turbulent business environment. Other attributes are generally considered as a sign of a well managed supply chain and that is why they are included in all the compared approaches (a good strategy for information can serve as a typical example [19]).

**Table 1.** Comparison of lean, agile and resilient supply chains

<b>Attributes/ Approaches</b>	<b>LEAN</b>	<b>AGILE</b>	<b>RESILIENT</b>
Main idea	Elimination of waste	Reaction to changes	Elimination of risk
Market	Stable	Unstable – uncertainty	Unstable – risks
Production/ products	Maximum performance with minimum costs	Great product customization	Postponement strategy
Creation of alliances	Classical alliances	Virtual organization	Integration of supply chain
Key indicator	Costs	Services	Risk
Inventory strategy	Minimum inventory	According to market needs	Safe inventory level
Selection of suppliers	High quality and low costs	Speed, flexibility and quality	More suppliers to eliminate risk

Source: *modified according to [3, 10]*

Despite all the differences mentioned above, the presented approaches still have the same purpose – to satisfy the customer at minimal costs [3]. Generally speaking, each of the approaches is suitable for a different extreme model situation in which it is going to achieve high customer satisfaction and minimum cost, compared to the remaining approaches. The real world is, however, a combination of these extremes, which is why there was an effort aimed at linking the individual concepts together.

## 6. INTEGRATION OF APPROACHES

Hybrid approaches trying to use the advantages of all their parts represent the main contemporary trend. The first attempt tried to combine agility and leanness. These approaches were initially considered to be contradictory. New common elements and possibilities of interconnection were gradually discovered over time. This process gave birth to the term "leagile supply chain", which recommends combining leanness and agility on the basis of:

- Paret's principle (80/20) – it is becoming evident that approximately 20 percent of the key products make up eighty percent of production volume. This part of demand is often well predictable and stable, and that is why it can be created by applying the principles of leanness (especially in order to minimize costs). The remaining 80 percent of the products can be manufactured on the basis of the principle of agility (to achieve the desired flexibility). [6, 11]
- Postponement – by lifting the decoupling point towards the customer, we can see large part of the supply chain operating in compliance with the principle of leanness. The final part, based on the principle of agility, will allow high flexibility and it will be able to respond to unpredictable customer demands. [11]
- The division of demand to "base" and "surge" – leanness is used for base demand which is satisfied with the advantage of minimal costs. In the event of rapid increase of demand, agile techniques will be used for elastic response. Seasonal fluctuations can serve as a typical example of the application of this rule. [6, 11]

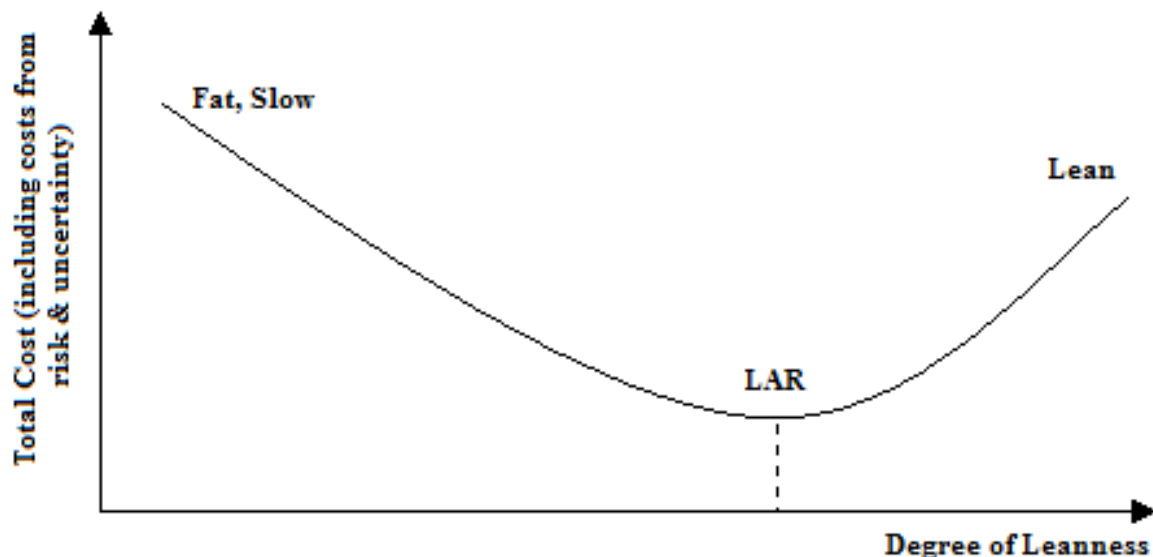
There are also the first approaches emerging in scholar literature trying to integrate leanness and resilience [8], or agility and resilience [1]. The next logical step is to create such a hybrid concept that will include the elements of all these approaches – Lean-Agile-Resilient (LAR) supply chain. The main challenge arising during the creation of this concept is the optimum balance and interconnection of the individual approaches. In order to achieve this goal, it is possible to recommend the distribution of attributes of the individual concepts into two groups:

1. Conformities – properties that are identical for all concepts (for ex. excellent information sharing and shortening of lead times) will be used by the entire supply chain.
2. Differences – complications occur in a situation where one part of the concept encourages a different or completely opposite strategy within a given attribute. For example, leanness recommends reduction of stock to a minimum in order to minimize costs. Agility suggests maintaining stock large enough to match the market conditions. On the other hand, resilience recommends safe amount of stock, which minimizes the possible risks of disruption of continuous material and information flow.

There are two ways to be used to address the differences. The first one is a compromise which, however, often fails to achieve any absolutely effective solution. The second option is based on splitting the supply chain into several parts using various key

parameters (volume of production, size, costs, degree of uncertainty within the sector, possible and anticipated risks, awareness, visibility) and on the adoption of different strategies for each of them. To create such a diversified and yet compactly functioning supply chain can be very complicated and time consuming. On the other hand, if the design and implementation of the LAR concept of supply chain is successful, it should yield better results.

From a practical point of view, it is necessary to change the attitude of the managers towards the costs associated with the supply chain management. Many managers believe that there is only one way of achieving the highest possible savings – permanent leanness. However, it is important to realize that costs must be understood as a whole. The classical logistics costs must also include the costs arising from the risks and changes that can not be completely eliminated in the current market environment. Then, it may be noted that the lowest (zero) total cost can not be achieved in the state of absolute leanness, but in the state of optimal leanness that will be suitably complemented by elements of the agile and resilient supply chain concept (see Figure 2). In other words, in a hybrid LAR supply chain, which will be tailor-made to a given supply chain, the individual elements of the original concepts will be appropriately combined.

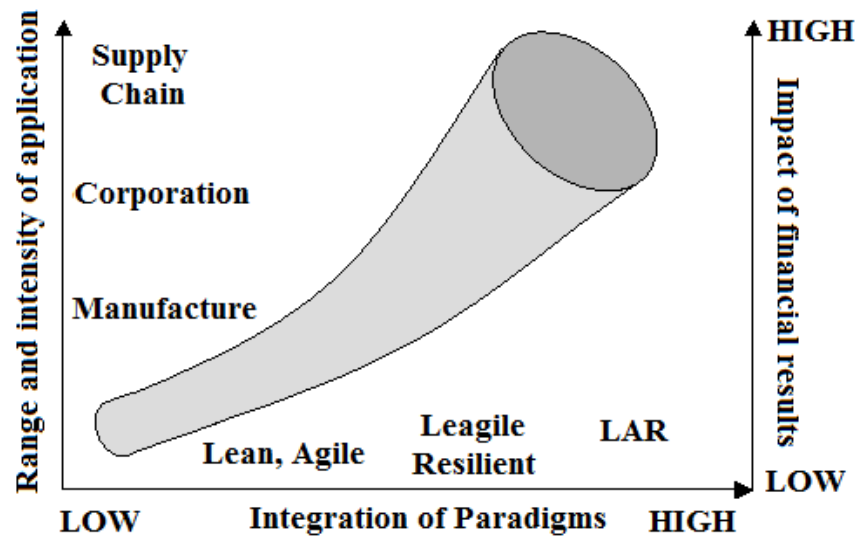


**Figure 2.** Searching for optimal leanness

*Source: modified according to [8]*

## 7. CONCLUSION AND FURTHER RESEARCH

The business environment in which the industrial companies currently find themselves is becoming more and more global and unstable. That is why it is also necessary to adapt the strategies the companies assert in the area of logistics management and supply chain management. Figure 3 shows two basic tendencies of these changes. The left vertical axis symbolizes the expansion of application of the individual approaches from production, through the company to the entire supply chain. The horizontal axis shows the historical development of approaches, beginning with the application of "simple" leanness and ending with the efforts to create a hybrid concept called the LAR supply chain. The image is also supplemented by the right vertical axis, which illustrates the growth of benefits as a result of shift from lean production to LAR concept of supply chain.



**Figure 3.** Development of supply chain management  
*Source: own*

However, the systematic knowledge, procedures and tools for successful implementation of LAR supply chain concepts in real business environment are still missing nowadays. Due to the complexity of the researched matters, the technique of modelling and dynamic simulation appears to be a suitable tool for researching the LAR supply chains. The dynamic model of global supply chain will make it possible to check the possible ways of building LAR supply chain for various changing business environments. Further scientific and research activity of the authors follows this direction.

#### ACKNOWLEDGEMENT

The work was supported by the specific university research of the Ministry of Education, Youth and Sports of the Czech Republic No. SP2011/85.

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