International Journal of Industrial Engineering and Management (IJIEM), Vol. 4 No 4, 2013, pp. 229-236
Available online at www.iim.ftn.uns.ac.rs/ijiem_journal.php
ISSN 2217-2661

UDK:005.334

Assessing the trade-off between lean and resilience through supply chain risk management

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Received (25.10.2012); Revised (11.06.2013); Accepted (28.06.2013)

Abstract

In the run toward leaner supply chain, organisations have opted for new business paradigms which assume a strict selection between core and non-core activity, cutting costs and reducing waste in every supply chain processes. A number of research and case studies shows that the cost savings from these initiatives were admirable. However, this business ideology leads our supply chains to new extremes. Zero stock as an example of intense cost reduction policy and integrated supply chain management invariably comes with increased risks, related to raising vulnerability to delays and disruptions within supply chain. So the real picture is that lean strategy reduces costs and waste from supply chain, but also reduces supply chain resilience. Thus, creating and assessing the trade-off between cost savings (achieved through lean strategy) and resilience is rather than a necessary. This balance between efficiency and resilience could be reached through supply chain risk management concept. Hence, in this paper an attempt has been made to show how to use general supply chain risk management model to access appropriate balance between lean and resilience.

Key words: *lean, resilience, supply chain risk management, trade-off*

1. INTRODUCTION

According to [1] the overall aim of logistics is to manage the flow of materials through the supply chain, helping to achieve high customer satisfaction and using resources efficiently to give low costs. In other words, the main goal of logistics is to get the right goods or service to the right place, at the right time, and in the desired condition and quantity in relation to customers order. Logistics as a science seeks to identify the least cost way of achieving a given level of availability of goods or service to customers. It is nothing more than analysis of the trade-offs between different logistics functions in achieving the requisite availability or service that shows the way to the least cost solution within each cycle (such as the trade-off between cost and revenue, inventory costs trade-off, etc.). In order to decrease costs, and to make their supply chain leaner, a number of new business models were introduced by companies, which assumes a strict selection between core and non-core activity, cutting costs and reducing waste in every supply chain processes. Although many case studies shows that the cost savings from these initiatives were admirable, those new business models are more complex, more dynamic, more stochastic, and often totally unpredictable. This unpredictability, characterised by increased uncertainty exposes companies across the world to new challenges in achieving their competitiveness. In other words, implementations of those new business initiatives sacrificed control of some critical logistics operations and on that way the supply chain vulnerability increases, and it will increase even more if companies have become dependent on other organisations [2]. Should one consider the snow storms that affected Europe in December 2010, airports were paralysed by a lack of glycol, making the defreezing of aircraft wings impossible and sticking them to the grounds for days [3]. So the real picture is that lean strategy reduces costs and waste from supply chain, but also reduces supply chain resilience. Thus, creating and assessing the trade-off between cost savings principles (lean) and

resilience is rather than a necessary. This balance between efficiency and resilience could be reached through supply chain risk management concept. Hence, in this paper an attempt has been made to show how to access appropriate balance between lean and resilience. The remainder of the paper is structured as follows. First, basic definitions related to logistics and supply chain management will be summarised in chapter two. Next, the concepts of lean strategy and lean logistics are introduced in chapter three. Chapter four describes meanings of resilience, supply chain risk and necessity for developing of new form of logistics trade-off. Chapter five presents the role of supply chain risk management in this new form of logistics trade-off, and finally the paper ends with a brief conclusion.

2. LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Logistics is the management function responsible for all movements of materials within an organisation. But organisations do not work in isolation, and each act as a customer or as a supplier of some other organisations. This chain of linked organisations and activities forms one supply chain [1]. As have already noted in [4], the main difficulties related to term 'supply chain' are a number of different definitions which are not inconsistent with each other. However, most of those definitions point out the existence of many different members and activities or operations within the supply chain.

Formation of the supply chain and its efficient coordination with objective of customer satisfaction and sustaining competency are the key issues of supply chain management [5]. The objective of supply chain management (SCM) is to provide a high velocity flow of high quality, relevant information that enables suppliers to provide for the uninterrupted and precisely timed flow of materials to customers [6]. According to [7], SCM "*represents the process of planning, implementing and controlling the efficient, cost effective flow and storage of raw materials, in-process inventory, finished goods, and related information from the point of origin to the point of consumption for the purpose of meeting customer requirements*". The term 'supply chain management' appeared at the beginning of the eighties ([8], [1]) and it "*has been used increasingly by people who argue that logistics does not give a broad enough feel for the subject*" [1]. There are number of papers related to relationship between terms logistics and SCM indeed. But, as [1] concluded, the choice of terms is largely matter of semantics because these two terms refer to the same function. This statement is supported by several others researchers, such as [7] and [9].

Number of linked organisations and different operations within supply chain involve many opportunities to gain the benefits. But they also involve risks, which appearing to one organisations or single activity can be transferred to all other part of the supply chain. In case when some of logistics function is disrupted, there can be serious problems for the supply chain members. This vulnerability to disruptions is increased during the last two decades due to new trends in logistics (introduction of new methods and procedures) aimed to create a more efficient, cost-conscious supply chain environment. One of those new trends in SCM is lean logistics or lean supply chain.

3. LEAN MANAGEMENT

At the beginning, lean management tools and techniques were developed to reduce waste in manufacturing facilities. Over time, lean thinking has also proven effective in various settings other than just manufacturing [10].

3.1 Basic principles of lean management

Lean is management paradigm developed at Toyota Motor Corporation, and it is widely known as the Toyota Production Systems (TPS). TPS has continuously evolved and became known in the West, initially as just-in-time (JIT) production, and was subsequently popularised as lean production or lean thinking [11]. The 'lean production' concept was first introduced by Krafcik [12] and Womack [13], who used this term for comparative study in the automobile industry from Japanese and other part of the world. According to them, there are five basic principles of lean thinking:

- Value - specify what creates value from the customer's perspectives,
- The value stream – identify all the steps along the process chain,
- Flow – make the value process flow,
- Pull – make only what is needed by the customers, and
- Perfection – strive for perfection by continually attempting to produce exactly what the customer wants.

The main goal of lean production is to eliminate waste (the word 'lean' means 'capable of operating without waste'), which is anything other than minimum amount of equipment, materials, parts, and working time that are absolutely essential to production. There are seven types of waste (*muda* in Japanese):

- Waste from overproduction,
- Waste of waiting time,
- Transportation waste,
- Inventory waste,
- Processing waste,
- Waste of motion, and
- Waste from product defect.

Efforts focused on the reduction of waste are pursued through continuous improvement or *kaizen* events (such as 5 S's), as well as radical improvement activities [14].

3.2 Lean thinking in logistics and SCM

Although the origins of lean thinking is principally associated with manufacturing industries, lean can be equally applicable to other processes, such as logistic processes. Even more, applicability of lean thinking to other processes than manufacturing is strongly recommended in order to fully realise the benefits of lean manufacturing. It has become clear that there is the need for lean interfaces between all members and

all functions within whole supply chain, and need for establishing *lean logistics* or *lean supply chain*.
As the focus of lean management is on cost reduction by eliminating non-value-added activities, than lean logistics or lean supply chain could be defined as minimising waste and costs in all logistics operations within supply chain. As it has been already mentioned, not only production processes have to be lean, but all flows between supply chain members. Only in situation of creating lean flows throughout the supply chain, supply chain managers can achieve shorter lead times, lower costs and higher levels of customer satisfaction. According to [15] lean supply chain represent: "*A set of organisations directly linked by upstream and downstream flows of products, services, finances, and information that collaboratively work to reduce cost and waste by efficiently pulling what is needed to meet the needs of the individual customer*". As supply chains contain three types of flows: material flow, information flow, and financial flow, to build a lean supply chain, wastes associated with all flows need to be identified and eliminated. As have been stated in [10], pressures for a supply chain to be lean come from two sources. First, supply chain members, who are not yet lean, are urged by lean partners. Second, supply chain managers who see the power of lean thinking urge all members to build lean relationships for overall leanness. There are many logistics approaches developed on the basis of lean relationships, such as JIT delivery, Cross Docking, Vendor Managed Inventory, Milk Runs, 3PL, Supplier Parks, etc.

3.3 Lean logistics and uncertainty

For years, cost savings has had the upper hand, and lean strategy which assumes zero inventories, was most promising management paradigm. However, due to the scale and complexity of supply chains, applying lean principles to the overall supply chain may not be an easy task. Also, there is an increasing uncertainty as another factor that affects the application of lean logistics. Therefore, some companies and researchers started questioning lean strategy in the mean of its applicability within 'uncertainty framework'.
Generally, there are two types of uncertainty related to demand and supply side of supply chain [16]. The nature of the demand could be divided into two categories:

- Predictable (low uncertainty) – for so-called 'functional products' which satisfying basic needs, and with high level of competition resulting in low profit margins.
- Unpredictable (high uncertainty) – for so-called 'innovative products' with higher profit margins and higher levels of product variety.

On other hand, supply uncertainty could be divided into two categories too:

- Low uncertainty – stable supply processes characterised by more supply sources, reliable sources, less process changes and generally short lead time.
- High uncertainty - evolving supply processes characterised by limited supply sources, unreliable sources and generally long lead time.

According to this, it could be defined the four areas (which correspond with the four cells in Fig 1.) that are more or less suitable for the application of the lean logistics depending on uncertainty level.

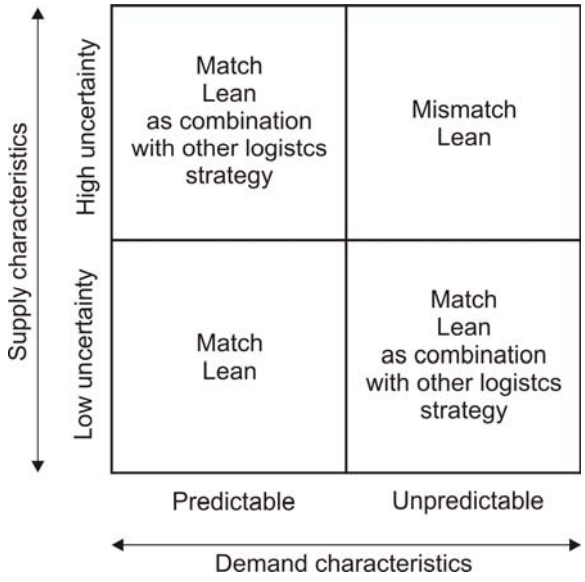

Figure 1. Lean logistics applicability in relationship with uncertainty

The area shown in the lower left corner in the figure above, which assumes low demand and supply uncertainty is most suitable for lean application. Low costs could be realised by eliminating non-value-added activities, striving to scale economies and optimising of techniques and production [16]. The area from the upper left corner in the figure above assumes supply chains which should follow combination of lean with some other logistics strategy such as inventory pooling. In this case, supply chains assume safety stocks but as lowest as possible which could be realised through their sharing between comparable companies in supply chain. The lower right corner represents the supply chains which focuses on balancing flexibility and lean through postponement strategy. And finally, the upper right corner assumes supply chains which strategy should not be based on lean strategy due to high demand and supply uncertainty.
After making this relationship between levels of lean applicability and uncertainty and defining areas (types of supply chain) which are more suitable for lean principle application, further question is how much such defined supply chain should be lean? This question has gained more importance after many examples of disruptions that have occurred in global supply chains.

4. SUPPLY CHAIN RISK AND RESILIENCE

There are many different definitions of risk in the literature, and we will not attempt to list them but only to give some general assessment. Risk is generally viewed as the possibility that an unexpected event can

harm an organisation [1], and it is a function of the level of uncertainty (represented by probability or frequency) and the severity of impact of an event. So, from a technical perspective risk (R) could be defined as:

$$\text{Risk (R)} = \text{Probability (P)} \times \text{Severity (S)}$$

Also, risk can be defined as the potential negative impact that may arise from an adverse situation. In context of supply chain, those adverse situations are interruption to logistics operations [18]. Risks arise from the uncertainty of future events, and all operations involve some kind of risks which have to be managed. This is the function of risk management.

4.1 Supply chain risk

Supply chain risk can be conceptualized as an event that adversely affects supply chain operations and hence its desired performance measures, such as chain-wide service levels and responsiveness, as well as costs [17]. There are wide ranges of events that can affect supply chain operations, from environmental, and intra-organisational to inter-organisational. Their impact could be divided from short-term to long-term, as they are highlighted in literature by practical examples. From logistics point of view, supply chain member's interaction become very complex, especially in the context of growing uncertainty, where the main drivers of uncertainty are new business models that were applied in order to increase both the logistics efficiency and competitiveness. Hence, as the main risk sources in supply chain it could be identified both interaction between members in supply chain, and interaction between members of supply chain and its environment.
As have already been stated, present risk to supply chain range from short delays to catastrophic disasters, and one of the key phases in proactively managing them is to imagine and understand these various types of risks. In attempting to differentiate supply chain risks, 'many scholars have proposed typologies and/or taxonomies or risks' [19]. Literature review performed in [20] has found more than 30 categories or types of risk, used by different authors. However, many of those supply chain risk types have a similar or identical meanings and their difference is only in different taxonomies.

4.2 Supply chain resilience

As stated in [11], when risk events occur, supply chains tend to break down and take a longer time to recover. This ability of the companies to resists a serious damaging event and to return to the previous state is called resilience (Fig 2.).
Supply chain resilience is an emerging term that relates to the amount of risk and the vulnerability of a company. Hence, supply chain resilience can be defined as the ability to recover from or adjusted easily to adversity of change, i.e. supply chain disruptions caused by disturbance [21]. Also, resilience can be defined as the supply chain's ability to react to the negative effects caused by disruptions that occur at a given moment in order to maintain the supply chain's objectives [22]. In such a context, companies must be able to respond to the supply chain risks and vulnerabilities through building in resilience.

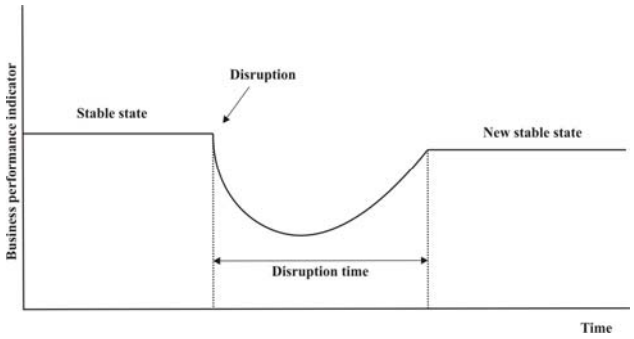

Figure 2. System resilience (adopted from [23])

In [24] are described three main ways through which companies can develop resilience: increasing redundancy, building flexibility and changing the corporate culture. While other concepts are also discussed in academic articles, most of the topics discussed typically belong to one of these three strategies. The most convenient way to increase supply chain resilience is by increasing redundancy across the entire supply chain which assumes keeping some additional resources (inventory) in reserve to be used in case of disruption. However, this is in stark contrast with the notion of lean thinking that advocate to reduce wastage and to operate with zero inventories. Hence, the necessity for balance between resilience and lean arises as a new form of trade-off in the supply chain management (Fig 3.).

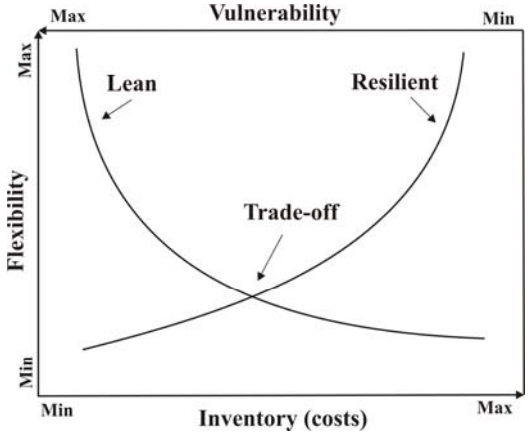

Figure 3. A new form of logistics trade-off

4.3 A new form of trade-off

Many practical examples show that the cost savings from lean initiatives were impressive. Vast amounts of capital have been released from supply chains by requiring suppliers to stock their own components in just-in-time warehouses next to their customers. Everything seemed "just right", but then nature took its course, and the catastrophic events have shown how the global and leaned supply chains are vulnerable to unexpected events. However, some organisations overcome these contingencies better than others, and

they all share one critical feature: resilience. But, as already noted, lean logistics means nearly zero inventories and on other hand resilient company must have enough inventories to react to the effect of disruptions that may occur in a supply chain. Although these concepts seem to be contradictory, it would be ideal to have both systems working together in a company [11]. Due to stated fact, there is a need to develop a new trade-off for companies to assure that their supply chains are less vulnerable to risks and that it continues to maintaining its lean benefits.

The main challenge is how to rich proposed trade-off or how to increase resilience without affecting (or significantly reducing) the maintenance of a lean supply chain environment. The potential answer lies in developing a proactive supply chain risk management model (Fig 4.).

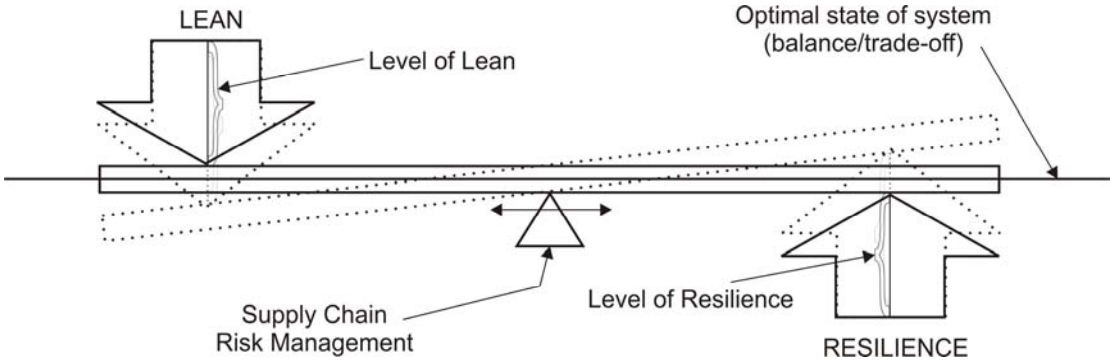

Figure 4. The role of SCRM in a trade-off between lean and resilience

5. THE ROLE OF SUPPLY CHAIN RISK MANAGEMENT

5.1 Basics of supply chain risk management

To survive in a risky business environment, it is imperative for companies to have a proper supply chain risk management (SCRM), because poorly handled disruptions in supply chain could result in costly delays causing poor service level and high cost [25]. SCRM is a new and novel methodology that captures both the operations as well as the financial aspects of decision making [26].

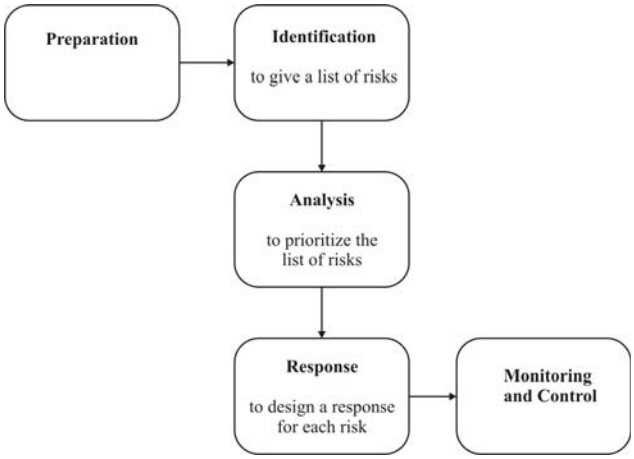

Figure 5. Core steps in SCRM [1]

SCRM as a product of supply chain management and risk management represents the management of supply chain risk using principles of risk management with the final aim to ensure continuity and efficiency of the supply chain. The core of SCRM rests on a timely reaction to changes. Company has to be able to look at all different impacts at different levels, and if they want to proactively handle those impacts, they have to look to the fundamental elements of prevention and response. In order to do prevention, a company needs to identify all kinds of potential risk, to assess it and to measure it. After that, they could at solutions, whether they are risk mitigation, insurance, or just monitoring, as shown in Figure 5.

One of the most popular concepts for supply chain risk analysis and prioritisation is the risk mapping (shown in Fig. 6).

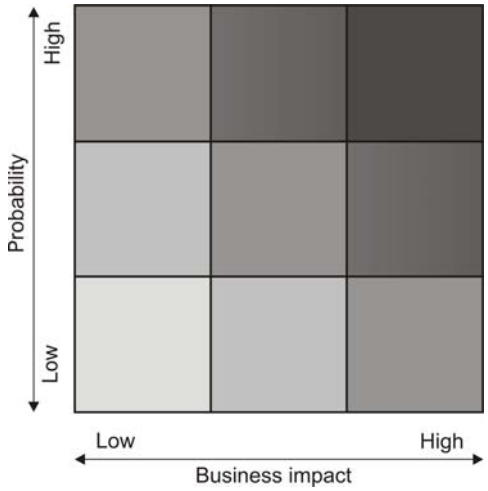

Figure 6. Supply chain risk mapping

Before using this simple matrix, we need to identify type of risk related to our supply chain. After that, we need to determine the priority of each type of risk based on business impact and probability. Most dark zone is very clear; we need to mitigate risks in this quadrant. Brightest zone can wait for reaction, and all others zones need plan what to do with them.

5.2 SCRM as a framework for assessing the trade-off between lean and resilience

In order to investigate relevant literature sources on trade-off between lean and resiliency, within area of SCRM, the short literature review has been conducted. The tools for collecting these papers were the Internet searches and searches through the library services at the University of Novi Sad. The research revealed that about 300 papers were addressing SCRM. Also a great number of paper addressing the lean and resilience paradigms, but trade-off between these two is not researched at all (except in [11]). According to these findings it is clear that a framework for addressing this trade-off is missing. The idea of this paper is to integrate matrix which represents dependency between lean application and level uncertainty (shown in Fig 1.) with matrix for supply chain risk mapping (shown in Fig 6.). This integration is presented in Fig 7. On that way, before we make a decision whether to apply lean principles or not in some logistics system, it should be considered the type and the level of risk. So, this framework for assessing the trade-off between lean and resilient should be integrated into SCRM model (Fig 8.). Proposed frameworks consider the need to characterise in detail both paradigms (lean and resilience), defining its performance measurement systems and attributes before implementation of selected response. As a result, balanced trade-off between efficiency and resilience is received.

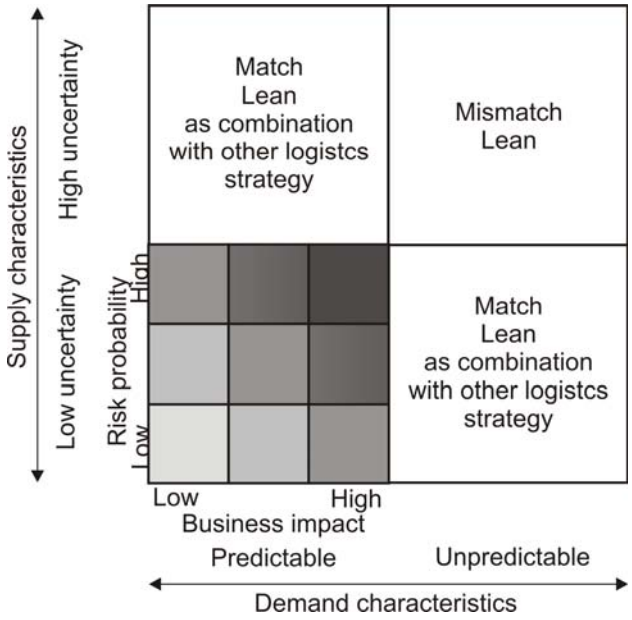

Figure 7. The integrated matrix

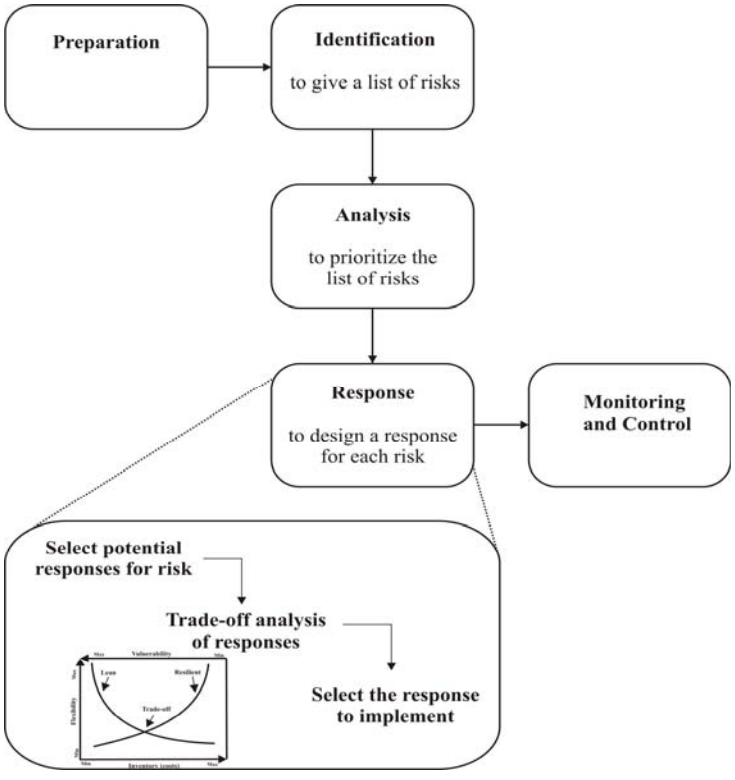

Figure 8. Framework for the trade-off between lean and resilience within SCRM model

6. CONCLUSION

We are witnessing how supply chain management and logistics are evolving quickly, with managers under continuing pressure to find better and efficient ways of organizing their business processes. These improvements assumed lower costs or better customer service. To achieve these goals, organisations are moving toward leaner and greater integration of their supply chains. This brings many benefits, but it also increases risks because an emphasis on cost reduction can remove all slack from the supply chain, increasing

vulnerability to unexpected events. Logistics managers start to be aware of this problem and they are start looking more seriously to risk, vulnerability and resilience in supply chains. Thus, creating the new trade-off between cost savings (lean principles) and robustness (resilient principles) is necessary. This paper shows how framework for creating efficient trade-off between lean and resilience could be designed within supply chain risk management model. Only full understanding of trade-off between lean and resilient may contribute for a more efficient and less vulnerable supply chains.

ACKNOWLEDGMENTS

This paper is a part of a research project entitled "Development and application of risk management models on corridors VII and X from the aspect of improvement of the transportation system of Serbia" (TR 36007), which is financed by The Ministry of education, science and technological development of the Republic of Serbia.

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Utvrđivanje kompromisa između lean i prilagodljivosti putem upravljanja rizikom kod lanca snabdevanja

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Primljen (25.10.2012.); Recenziran (11.06.2013.); Prihvaćen (28.06. 2013.)

Rezime

U trci prema lean lancu snabdevanja, organizacije su se odlučile za nove poslovne paradigme koje pretpostavljaju jasan odabir između osnovnih i ne-osnovnih aktivnosti, smanjujući troškove i redukujući gubitke u svim procesima lanca snabdevanja. Određeni broj istraživanja i studija slučaja pokazuje da su uštede usled eliminacije troškova u ovakvim inicijativama bile značajne. Međutim, ova poslovna ideologija vodi naše lance snabdevanja do novih ekstrema. Prazno skladište kao primer politike ekstremnog smanjenja troškova i menadžment integrisanog lanca snabdevanja bez izuzetka idu zajedno s povišenim rizicima, što je povezano s povišenom ranjivošću u vezi sa kašnjenjem i prekide u lancu snabdevanja. Prema tome, stvarna slika je da lean strategija smanjuje troškove i gubitke u lancu snabdevanja, ali takođe smanjuje i prilagodljivost lanca snabdevanja. Stoga, stvaranje i procena kompromisa između ušteda troškova (postignutih lean strategijom) i prilagodljivosti je više od potrebe. Ovaj balans između efikasnosti i prilagodljivosti može da se postigne putem koncepta menadžmenta rizika kod lanca snabdevanja. Iz tog razloga, u ovom radu je učinjen pokušaj da se pokaže kako koristiti opšti model menadžmenta rizika kod lanca snabdevanja da bi se pristupilo adekvatnom balansu između lean i prilagodljivosti.

Ključne reči: *lean, prilagodljivost, menadžment rizika kod lanca snabdevanja, kompromis*