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# SUPPLY CHAIN RESILIENCE: NEW SOURCE OF COMPETITIVE ADVANTAGE

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***Abstract:*** *Supply chain assumes a unique business process without inter-company boundaries. Each supply chain partner is important for achievement of customer requirements. On one hand, supply chain is an inexhaustible source of competitive advantage, created by the companies, which constitute it. However, on the other hand, due to its complexness, supply chain is easy target of numerous factors, which jeopardize its competitiveness. Some of those factors are: turbulence, deliberate threats, external pressures, resource limits, sensitivity, and supplier / customer disruptions. Successful dealing with those factors assumes establishment of mechanisms for increasing supply chain resilience. Many researches indicate that some factors have greater influence on supply chain disruption and discontinuance. If those factors can be isolated, it will be easier to manage them or to avoid their influence. Therefore, the objective of the research presented in this paper is identification of the most frequent causes of supply chain disturbances, as a first step for developing supply chain resilience. According to the research results, authors suggest what should be primary focus of supply chain management, dealing with issues of resilience. Also, authors indicate which characteristics (capability factors) supply chains have to have in order to be considered resistant.*

***Keywords****: supply chain, competitive advantage, resilience, factors*

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## 1. Introduction

Frequent changes in the environment are the cause of increasing uncertainty in the market place. Importance of supply chain management is more pronounced at highly competitive markets. According to Ketchen and Hult situation of highly competitive markets could be describe like rivalry among supply chains instead individual firms (Kopecka, J., Penners, G., Santema, S., 2010, 513). This is the reason why agility of supply chain becomes more and more important. Supply chains become vulnerable in an uncertain environment. Global sourcing, Just in time manufacturing, increasing market requirements and shorter product life cycle are caused a need for more resilient supply chain. Supply chain managers are increasingly concerned for managing a variety of risks. They have aim to increase reliability of delivery and achievable value. However, supply chain managers must be proactive. They are must identify and take actions for elimination or mitigation disturbances effect (Craighead, C., Blackhurst, B., Rungtusanatham, M. & Handfield, R., 2007, 136). The most important characteristics of supply chain resilience are flexibility, agility, velocity, and visibility. Some authors have given explanation for these characteristics. Sheffi explains flexibility like help to companies in correctly answering to markets' variability (Sheffi, Y., 2006, 13). He considers that flexibility can be achieved by using some strategies as concurrent processes, final goods completing postponement inside the supply chain, sharing with suppliers (Sheffi, Y., 2006, 13). Hewlett-Packard company is a good example. In this company, the assembly of parts in final product is delayed until the reception of requires coming from different markets.

Authors Christopher and Rutherford at the paper "Creating a Resilient Supply Chains: A Practical Guide" give definition and description of the supply chain agility, velocity, and visibility (Longo, Ören, 2008, 528). According to these authors agility is ability of a company to quickly respond to unforeseen and unpredictable demand/supply markets changes (Longo, Ören, 2008, 528). However, agility of a company depends on agility of the other supply chain participants. Supply chain velocity is an attribute which is explained as time required for moving goods along the supply chain. Sometimes velocity is explained in terms of lead time. Visibility is compatibility of the company to see all information about the flow of products, information and finances in both directions (downstream and upstream along the supply chain).

## 2. Understanding Supply Chain Resilience

The concept of resilience is present in many different fields, not just in business and management. Resilience concept is found application in engineering, ecological sciences and organizational research and all of which were good base for creating a conceptual framework for supply chain resilience (Eltantawy, 2011, 403). Definition of resilience in engineering field is one of the basic: "the tendency of a material to return to its original shape after the removal of a stress" (Pettit, Fiksel, Croxton, 2010, 4). This definition could be applied in the context of supply chain. Supply chain partners must learn everything about reason disturbance and adapt into a new configuration. Authors Ponomarov and Holcomb explains resilient supply chain like "ability to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations" (Ponomarov, S., Holcomb, M., 2009, 126). President and CEO of Adaptive Learning Systems Dean Becker says "More than education, more than experience, more than

training, a person's level of resilience will determine who succeeds and who fails" (Coutu, 2002, 47). Resilient supply chains have ability to resist at all disruptions and on that way provide its competitive advantage (Sheffi, 2005, 4). According to Cristopher Martin resilient supply chains are have ability to change quickly (Christopher, 2000, 38). The best way for ensuring organization or whole supply chain in chaotic and uncertain future is development resilient leaders or organizations. Some definitions of supply chain resilience are shown in Table 1.

**Table 1. Definitions of resilience**

| Source | Definition | Field of study |
|---|---|---|
| Merriam-Webster (2007) | Capability of a body to recover its size and shape after deformation | Engineering |
| Folke (2004) | Ability to rebound from a disturbance while maintaining diversity, integrity and ecological processes | Ecology |
| Gorman (2005) | Ability to bounce back from adversity | Psychology |
| Stoltz (2004) | Ability to bounce back from adversity and move forward stronger than ever | Leadership |
| Rice and Caniato (2003) | Ability to react to and unexpected disruption and restore normal operations | Supply chain |
| Sheffi (2005) | Containment of disruption and recovery from it | Supply chain |
| Christopher and Peck (2004) | Ability of a system to return to its original state or move to a new, more desirable state after being disturbed | Supply chain |
| Fiksel (2006) | Capacity for complex industrial systems to survive, adopt and grow in the face of turbulent change | Supply chain |

*Source:* Pettit, T. (2008) Supply Chain Resilience: Development of a Conceptual Framework, an Assessment Tool and an Implementation Process, PhD thesis, The Ohio State University, p. 14.

The cost of rising petrol and Diesel fuel prices for road vehicle use in the United Kingdom coming up to fuel protests and it causes transportation disruptions 2000. The second reason for analyzes supply chain resilience is the outbreak of the Foot and Mouth Disease in early 2001. This two situations are caused the first widespread study on supply chain resilience began in the United Kingdom. The basic conclusion of study explored the UK's industrial are: 1) supply chain vulnerability is an important business issue, 2) little research exists into supply chain vulnerability, 3) awareness of the subject is poor and 4) a methodology is needed for managing supply chain vulnerability (Peck, 2003). "Some of business innovations and trends have succeeded for reducing higher probability, profit-sapping risks, like (World Economic Forum):

- Lean supply chains, by design, lay bare the causes of frequent failures, forcing organizations to learn and design reliability into their processes;
- Globalization provides opportunities for diversification of supply;
- Specialized production and scale accelerate learning and the ironing-out of risks;
- IT-enabled visibility gives advance warning of problems and enables decentralized solutions."

These innovations in some cases can cause risks. For example, Lean supply chains can cause delays in production due to bottlenecks and thus endanger the entire supply chain. Supply concentration and IT reliance cause disorder if critical nodes fail (World

Economic Forum). Christopher and Peck (Christopher, Peck, 2004, 13) were developed framework of supply chain resilience. According to them the key elements for achieving resilient supply chain are the following:

1) Resilience can be built into a system in advance of a disruption (i.e. re-engineering),
2) High level of collaboration is required to identify and manage risks,
3) Agility is essential to react quickly to unforeseen events and
4) The culture of risk management is a necessity.

Supply chain capabilities could be defined as: "attributes that enable an enterprise to anticipate and overcome disruptions." These capabilities are essential in modern conditions to ensure survival of the global supply chains and they represent source of competitive advantage to chains that have them. In this connection the resilience of the supply chain is a priority in the fight against disturbances from the environment. Developing capabilities in order to overcome the supply chain's vulnerabilities requires the establishment of balance between investment and risk. Some of capabilities and vulnerability are shown in the following table.

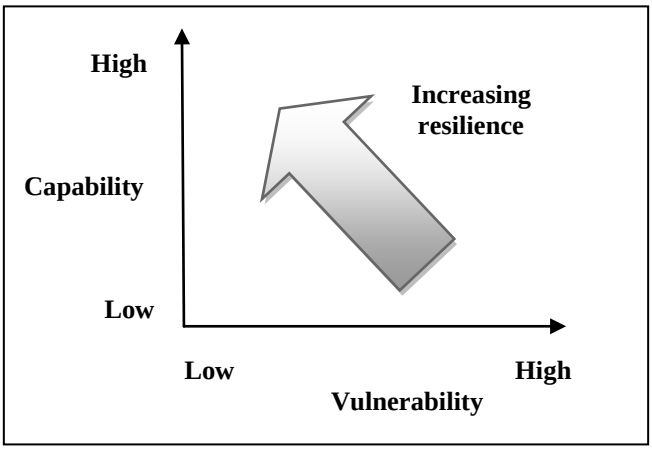
**Table 2. Vulnerability and capability factors**

| Vulnerability Factor | Definition | Capability Factor | Definition |
|---|---|---|---|
| **Turbulence** | Environment characterized by frequent changes in external factors beyond your control | **Flexibility in sourcing** | Ability to quickly change inputs or the mode of receiving inputs |
| **Deliberate threats** | Intentional attacks aimed at disrupting operations or causing human or financial harm | **Flexibility in order fulfillment** | Ability to quickly change outputs or the mode of delivering outputs |
| **External pressures** | Influences, not specifically targeting the firm, that create business constraints or barriers | **Capacity** | Availability of assets to enable sustained production levels |
| **Resource limits** | Constraints on output based on availability of the factors of production | **Efficiency** | Capability to produce outputs with minimum resource requirements |
| **Sensitivity** | Importance of carefully controlled conditions for product and process Integrity | **Visibility** | Knowledge of the status of operating assets and the environment |
| **Connectivity** | Degree of interdependence and reliance on outside entities | **Adaptability** | Ability to modify operations in response to challenges or opportunities |
| **Supplier/ Customer disruptions** | Susceptibility of suppliers and customers to external forces or disruptions | **Anticipation** | Ability to discern potential future events or situations |

*Source*: Pettit, T. (2008) Supply Chain Resilience: Development of a Conceptual Framework, an Assessment Tool and an Implementation Process, PhD thesis, The Ohio State University, p. 26-28.

Linkages exist between each vulnerability factor and a specific set of capabilities that can directly improve balanced resilience (Pettit, Fiksel, Croxton, 2010, 4). Essence of resilience is presented at Figure 1. Supply chain resilience increases as capabilities increase and vulnerabilities decrease. Supply chains with great resilience have ability to gain advantage from disruptions (Sheffi, 2005, 1).

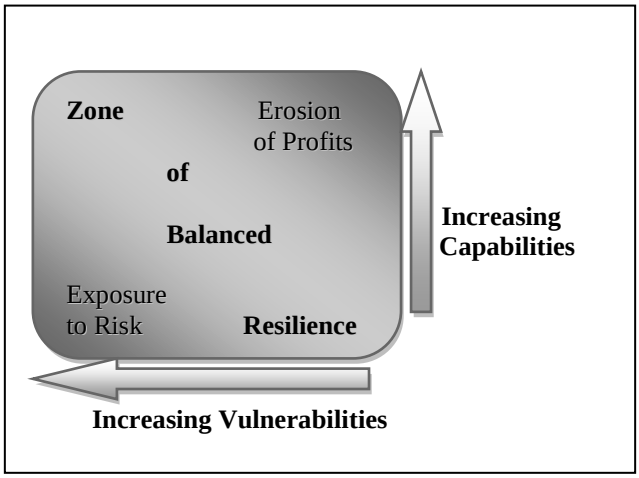
**Figure 1. Measurement of Resilience**




*Source:* Pettit, T. (2008)

In situation when supply chain cannot develop capabilities to offset high levels of vulnerabilities they will be overly exposed to risks. In case that supply chain may over-invest in capabilities relative to its vulnerabilities and therefore erode profits. The best solution for supply chain is when capabilities and vulnerabilities are more balanced. A great number of authors define this as "balanced resilience".

**Figure 2. Resilience Fitness Space**




*Source:* Pettit, T. (2008)

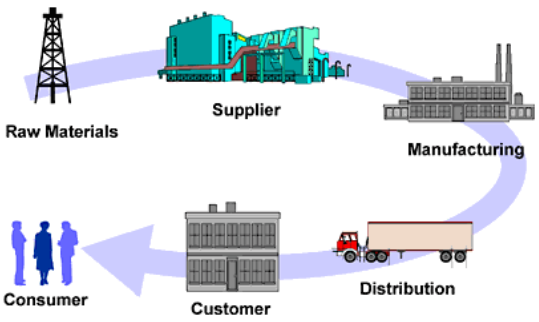
## 3. Levels of Uncertainty

Supply chain vulnerabilities are a result of many drivers of risk. Great exposure to a number of risk drivers' influence reducing resilience of the entire supply chain. Disturbances could seriously threaten flows of operation in supply chain (Zsidisin, G., Panelli, A., Upon, R, 2000, 189). If supply chain have ability to overcame or adapt disturbances, the confidence in supply chain will be greater (Holcomb, M., Ponomarov, S., Manrodt, K., 201, 40). In this sense, each supply chain must continuously increase resilience or improve competences which increase resilience of the whole supply chain. All drivers of risk could be defined at four levels (Peck, 2003, 15):

- Level 1 - Process/Value Stream,
- Level 2 - Assets and Infrastructure Dependencies,
- Level 3 - Organisations and inter-organisational networks and
- Level 4 - The Environment

Level 1 - The supply chain could be describe as "pipeline" flowing through and between companies in the network (see Figure 3). Aim of this complex structure is to provide efficient, value-based, management of individual flows of material/products, information and finance. "Supply chains carry one or more of these Value Streams" (Peck, H. 2003, 16). Credible and reliable information flow depend on the willingness of supply chain partners to share that information. High level of trust, coordination and collaboration are some of the conditions to achieve the information flow between partners. At this level risks, supply chain is affected by risks which coming from poor quality, demand volatility, changeable requirements of marketplace.

**Figure 3. Partners of supply chain**




Source: PE-Energy (http://pe-energy.com/the-oilrig-supply-chain/)

The entire supply chain is composed of fixed points or facilities (e.g. factories, distribution centres, retails). The functioning of these points needs adequate IT assets (hardware, processing, and communications/service centres), which are in some way internal and inter-organisational communications networks. Networking fixed points in the supply chain system needs adequate national and international communications infrastructure and transportation/distribution infrastructure.

Inadequate assets and infrastructure could cause disruptions of supply chain. Using assets and infrastructure for exchange information or business process could result in increase of the level of supply chain resilience.

Networking through supply chain is not based just on the adequate assets and infrastructure, but also on the relationships between the partners. Inadequate relationships and lack of trust among partners is one of the most common factors that cause interruptions and disruptions in the supply chain. Nevertheless, one of the most important principles of supply chain concept is that powerful partners do not abuse their position. Relations based on trust are necessary condition of development of resilient supply chain.

In some cases supply chain managers may work to achieve other commercial interests through competitive pressures and divergent strategic goals. This situation is one that causes increasing of supply chain vulnerability.

The fourth level of uncertainty in supply chain proceeds from external environment of supply chain. Factors which effect supply chain from external environment are political, economic, social, and technological. The sources of risks at this level are likely to be beyond the direct control of supply chain managers, nevertheless the vulnerability of supply chain can often be assessed in advance.

## 4. Conclusion: Recommendations to Build a More Resilient Supply Chain

Many authors dealt with this problem and tried to devise ways for increasing the resilience of supply chains. Based on the research and analysis authors are provided some of the recommendations that could be used in the process of increasing resilience (Pochard, S. 2003, 67):

- Build a Risk Awareness Culture,
- Find a trade-off between recent practices such as Lean Manufacturing or JIT and Risk Management,
- Revisit single sourcing strategies,
- Introduce flexibility to enhance resilience,
- Quantifying the rewards of risk management can help to justify risk management investments.

**Build a Risk Awareness Culture -** Supply chain managers and all employees must be aware that supply chain is exposed to risks. All employees must have appropriate role in the risk management process. This should lead to organizational changes and the risk aware supply chain design (Pochard, S. 2003, 68). Supply chain risk management is not the first priority of a firm but it is one of the most important part of supply chain management.

**Find a trade-off between recent practices such as Lean Manufacturing or JIT and Risk Management -** With implementation of Just in time strategy and Lean manufacturing companies in supply chain have tried to eliminate all the wastes in supply chain, and focus on cost reduction. However, apart positive results of implementation of these strategies, there are consequences expressed as an increase in supply chain vulnerability. Therefore, companies in supply chain should create a balance between these strategies and supply chain risk management. Companies must consider some of the alternatives: single vs. multiple sourcing, zero stock vs. safety stock, and centralization vs. dispersion.

**Revisit single sourcing strategies -** Positive effects of single sourcing are cost-effectiveness, higher quality, relationship based on trust. When supplier goes out of

business or produce lower quality product that can cause greater exposure of supply chain to risk this becomes great problem. For solving this problem there are two solutions:

- Development of strong relationship with supplier and continuously monitoring the health of the concerning supplier,
- Partner in supply chain can consider more flexible strategies and contract with back-up suppliers; This involves signing long-term contracts, option contracts with various suppliers, creating a local supply source or creating multiple supply sources.

**Introduce flexibility to enhance resilience -** Flexibility of supply chain is its ability to respond to numerous changes in the environment. Companies in flexible supply chain can use availability of resources and take corrective actions to minimize the impact of unexpected disruptions. Therefore, companies have to build organisation and operating links through supply chain which facilitate a rapid changeover when needed.

**Quantifying the rewards of risk management can help to justify risk management investments -** Positive results of implementation of Just in time strategy reflect in important savings. Supply chain risk management also has important benefits. Those benefits are reflected in the avoidance of big losses, but the quantification is not as obvious as for Just in time implementation. Managers usually are focused on costs and are tempted not to undertake any measure of risk management.

Disturbances in supply chain have cascade effect because a huge dependencies between partners in supply chain (Svensson, 2004, 732). Each disturbance may cause negative effects not only to individual partners but also to whole supply chain (Barroso, A. P., Machado V. H., Cruz Machado V., 2011, 164). This is the reason because one of the key challenges of global supply chains in modern conditions is high level of resilience.

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## OTPORNOST LANCA SNABDEVANJA: NOVI IZVOR KONKURENTSKE PREDNOSTI

***Rezime:*** *Lanac snabdevanja predstavlja jedinstven poslovni proces bez među-kompanijskih granica. Svaki partner lanaca snabdevanja važan je za ostvarivanje zahteva korisnika. S jedne strane, lanac snabdevanja je neiscrpan izvor konkurentske prednosti, stvorene od strane kompanija koje ga čine. Međutim, s druge strane, zbog svoje kompleksnosti, lanac snabdevanja je laka meta brojnih faktora koji ugrožavaju njegovu konkurentnost. Neki od tih faktora su: turbulencije, namerne pretnje, spoljni pritisci, ograničenje resursa, osetljivost, poremećaji kod dobavljača/kupca. Uspešno upravljanje tim faktorima pretpostavlja uspostavljanje mehanizama za povećanje otpornosti lanca snabdevanja. Mnoga istraživanja pokazuju da neki faktori imaju veći uticaj na poremećaje i prekide u lancu snabdevanja. Ako se ovi faktori mogu izolovati, biće lakše upravljati njima ili izbeći njihov uticaj. Dakle, cilj istraživanja u ovom radu je identifikacija nekih najčešćih uzroka poremećaja u lancu snabdevanja, kao prvi korak za razvoj otpornih lanca snabdevanja. Na osnovu istraživanja, autori ukazuju na to šta bi trebalo da bude fokus menadžmenta lanca snabdevanja, koji se bavi pitanjem otpornosti. Takođe, autori ukazuju na karakteristike koje lanci snabdevanja moraju imati kako bi se smatrali otpornim.*

***Ključne reči:*** *lanac snabdevanja, konkurentska prednost, otpornost, faktori*