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**Article**

## Approaching risk management: An overview on critical success factors and challenges

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## **Approaching Risk Management:**

an Overview on Critical Success Factors and Challenges

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## **ABSTRACT**

Business organizations have recently experimented an increasing risk exposure due to several exogenous factors (e.g. the legal and regulatory framework, the technological innovation and the volatility of financial markets and commodities), actually exacerbated by the current economic crisis affecting all sectors and companies. In addition, the new risk configurations refer more closely to networks or supply chains, in which individual organizations operate in order to achieve their business objectives.

Thus, in a supply chain context, a structured, effective and efficient risk management process becomes a fundamental tool for organizations and their governing bodies in particular, in order to develop economic balances, to support long-term value creation and to protect the entrepreneurial assets.

This paper provides some useful insights on critical success factors and challenges encountered by organizations approaching risk management initiatives. The discussion is centered about network risk, in order to emphasize the negative potential of criticalities and threats arising from the competitive environment. Starting from the interpretive review proposed, through the analysis of the main risk-facing strategies, it will be clear how companies are trying to overcome the traditional model focused on the primary activities of the value chain and supply chain processes, in order to adopt a risk management approach.

## **KEYWORDS**

Organizational Risk, Network Risk, Supply Chain Risk Management, Risk Management Strategies, Operations Risk, Risk Challenges

## **INTRODUCTION**

In the last century, the conceptualization of Risk and Risk Management has become a part of the management science research, in areas such as environmental protection, insurance practice, and psychological studies. The focus is direct to emphasize some specific features of those theoretical areas. Therefore, the conceptualization of Risk is always strongly related to a context of decision making, involving individual or organizations.

Moreover, in those propositions, some commonalities can be found about the definition of Risk that binds to the dimensions of unpredictability, decision making and potential losses (Brindley, 2004). In addition, the composition of the decision-making unit is relevant in defining Risk.

More recently, the study of Risk moves to the logistics area, but without reflect a Supply Chain Orientation (Mentzer et al., 2001), it still remains at a “single company” view (Jüttner, 2005).

As organizations increasingly use their supply chain to compete and gain a market advantage (Christopher, 1992), a further step forward in the conceptualization of Supply Chain Risk is needed, which fosters the achievement of the overall business strategy objectives.

A key feature of Supply Chain Management is the coordination of interdependent activities between organizations. Therefore, it can be defined as: “the management of upstream and downstream relationships with suppliers and customers in order to create enhanced value in the final market place at less cost to the supply chain as a whole” (Christopher, 1992).

In the coordination between the supply and demand side of the chain, the Information Technology (IT) is widely recognized as an area playing the major role (Johnson, 2001).

Furthermore, Sadgrove (1996) advances some problems can be related to supply and suppliers: a non optimal planning and an extended chain could cause increasing risks in keeping delivery promises. In addition, the widespread tendency to supplier reduction makes the supply chain more vulnerable to supply disruptions as long as the sourcing in emerging markets, which adds to the distance and the potential problems, some external troubles, such as political and cultural threats.

Zsidisin (2003a) recognizes that the risk is a multidimensional construct. Indeed, many authors apply a general definition of Supply Chain Risk, in terms of: Risk = Probability (of a given event) x Severity (negative impact on business). Therefore, Jüttner et al. (2003), promote the formulation of Risk already provided by March and Shapira (1987), with some resonances in the decision theory. According to them, “Risk” is referred as “the variation in the distribution of possible supply chain outcomes, their likelihood, and their subjective values”. While discussing about the risk in an end-to-end supply chain, the authors regard those uncertain variations or disruptions which affect “the information, material and product flows from original supplier to

the delivery of the final product for the end user". This is also confirmed in terms of "possibility and effect of a mismatch between supply and demand" (Gaonkar et al., 2007).

This definition overcomes the traditional variance-based formulation by March and Shapira (1987) and fills the gap between the measurement, hazard perceived and consequences.

Nevertheless, it doesn't deal with nor resolve the question about the multiple unit of analysis.

Based on a multi-organizational perspective the variance is not the variance in the results due to a single decision, but it becomes the variance in the cumulative result of several sequential and/or concurrent, even competitive and interdependent decisions, actions and activities.

Peck (2005, 2006) provides a multi-level approach to Supply Chain Risk, identifying four areas of analysis (e.g the value stream or process, the infrastructure or asset dependence, the organizational or inter-organizational network, the environment). Those areas are interdependent and intersect in various ways. The interdependence is certainly a result of networking (Juttner et al., 2003). For instance, some networking-related risks take the form of barriers and resistance to change within the network (Brindley, 2004).

Finally, Hallikas et al., (2004) assert that the Risk in network organizations is a concept dynamic in nature - interconnected - organizational - multi-faceted. These are all attributes which synthesize some individual aspect of the complexity inherent in the construct.

An updated review of the most relevant definitions of Supply Chain Risk proposed by scholars, with regard to its management within networks and business organizations, can be found in Rao and Goldsby (2009). In the view of the authors, the Supply Chain Risk Management (SCRM) substantially is an extension of Risk Management discipline, as already applied within borders of the individual organization.

Consistently with the main area of Supply Chain Management, and according to Kouvelis et al. (2006), understanding and reducing vulnerability is more crucial for the production and delivery network as a whole, than at a local level of individual firms.

This is the subject of Supply Chain Risk, which has been increasingly investigated in recent years, both, in the scholarly and managerial literature. Nevertheless, despite the quantity and quality of those studies, a clear summary of definitions and approaches is still missing.

This work aims to depict the state of the art in the academic research on the SCRM field, with regard to some relevant risk-related issues in business network organizations. Consequently, the analysis will focus on the characterization of distinctive features of the Risk Management

process for the organizations approaching this area. For the purpose of this paper, we consider the set of organizational aspects (i.e. units, structures, mechanisms and tools), which address the systemic minimization of the Supply Chain Risk. While the external approach (e.g. towards the other partners in the supply network) is systemic, the inward actions performed by this set of organizational assets must pursue the alignment with the business strategy. Creating such a set, allowing for the management of both external and internal risks, becomes an important determinant for organizational success and value creation.

The paper is organized as follow. Through a selective literature review, in the next session we will organize the most relevant academic contributions, while indentifying two main approaches to the complex topic of Supply Chain Risk and providing some other key concepts. The writing will proceed through a focus on critical success factors that characterize the Risk Management approach from a Supply Chain perspective, and will arrive to illustrate some challenges and future opportunity in this field.

## **LITERATURE SELECTIVE REVIEW ON SUPPLY CHAIN RISK: SOME INTERPRETIVE GUIDELINES**

In order to investigate the grounds behind the increasing importance of risk in Supply Chain organizations, we will draw a picture as complete as possible of the knowledge developed in this field by a scholarly point of view. This section introduces the two consistent streams encompassing the most relevant studies on Supply Chain Risk Management area, which have been identified within the pertinent literature.

### **THE LOGISTICS-ORIENTED APPROACHES**

The relevance of risk issues in close relation to the SCM field emerges from many studies, primarily based on the empirical assessment of a wide-ranging set of effects initiated from a business interruption. Although the ability to effectively manage risk is critical to ensure a smoothly flow of products through the supply chain, this has only recently received attention by researchers (Juttner et al., 2003).

Traditionally, the appropriate policies for safety stock and buffer lead times were the most used strategy to protect against risks and uncertainties in the supply chain. However, in the

contemporary marketplace, such measures are less attractive than before, due to a more generalized focus on flexibility and responsiveness strategies (Zsidisin et al., 2005).

Consequently, it is crucial to achieve: “a new focus on managing and mitigating risk which extends beyond the four walls of a plant” (Christopher et al., 2004a).

In a supply chain organizations, the risk affects “the flow of information, material and products from the first original supplier to the realization of the ultimate product” (Christopher et al., 2004).

In addition, if we accept to bring the logistic risk to the possibility that at a given time and at some point in the supply network, supply does not meet demand, then regarding the consequences of this mismatch (Gaonkar et al., 2007), we identify at least three problem degrees, it may pose:

1) deviation: is the case where a change on one or more parameters of the flow occurs compared to the average or expected value, without leading to a distortion in the supply chain structure. Some examples are: changes in demand, supply, procurement or production cost, in shipping or production lead time;

2) disruption: is the case where the structure of the supply chain is radically modified by the lack of at least one storage or distribution facility for any transport channel or communication route, because of an unexpected event caused by a human or natural factor. Here we include the interruption of production, the blocking of supply and the closure of logistics channels;

3) disaster: where a temporary irrecoverable shutdown of the global network of companies occur, similar to a disruption of global proportions. The example universally cited is the terrorist action at the World Trade Center in 2001.

More frameworks, even at an operational level, are available in the SCRM literature. Cavinato (2004) argues that the identification and analysis of the risk types cannot be separated from an examination of the logistic flow components. In particular, he states that every supply chain is constituted by 5 consistent sub-systems:

1) physical flow: it includes real movement of materials or products within and between companies, such as transportation, shipping, warehousing and storage activities;

2) financial flow: it is the flow of money between different companies, the financial exposure, the use of financial instruments by all parties in the chain, the amount of cash currently available in the chain;

3) informational flow: it includes the processes and the electronic systems, the collection, the processing and the saving of data, their transfer, the qualification process, the access control, the market intelligence actions;

4) relational flow: it indicates the most appropriate links, which should be defined between the supplier, the company and the customers in order to maximize profit;

5) innovative flow: it is about the management of links between an individual enterprise and other resources of the Supply Chain, to design or discover new opportunities for products, services and processes.

In addition, Sheffi et al., (2003) through a research project carried out by the "Center for Transportation & Logistics at the Massachusetts Institute of Technology" (MIT) examined a sample of twenty medium-large sized American companies operating at different levels of the supply chain, revealed six types of failure modes that can cause a disruption in the logistics flow:

- supply failure;
- transport system failure;
- material flow failure;
- productive infrastructure failure;
- informational system failure;
- human resources failure.

According to those studies, which analyze the effects of the occurrence of a substantial risk, the aims of the SCRM will materialize in the need to ensure continuity of supply and availability of product, improving the ability of the supply chain to deal with sudden supply disruptions and restricting any "domino effect" throughout the chain (Artebrand et al., 2003).

The aim is therefore not to minimize the logistic risk exposure for all supply chain members, but to define for each of them an "efficient level of risk" (Norrman et al., 2004). In particular, if we consider the relationship between the resources devoted to risk management initiatives and the efficiency of the individual company (i.e. directly related to its level of profitability), it shows that an optimal cost area exists, in which the management of risk should be placed.

In addition, several actors in the same chain can be characterized by different loss endurance level, depending on their size, their power, their degree of technological innovation, etc. The identification of this threshold, in the light of a deep understanding of the mechanisms and dynamics of individual organizations, could thereby serve as the basis for the allocation of risk

along the supply chain. It drives the differentiation of the overall SCRM strategy in specific sub-strategies, according to some local economy goals.

### **THE CONTRACT-ORIENTED APPROACHES**

Some authors investigate the Supply Chain Risk in relation with the problem of coordination and information asymmetry between parties in a supply chain. Among the coordination mechanisms, certainly the contract management is an interesting issue. Therefore, the strategies for information management and sharing aim to solve various degrees of asymmetry.

Schneeweiss et al. (2004), place the coordination issues at a tactical and operational level. In particular, they distinguish between the two extreme representations explained below.

- On the one hand, we can identify a logic deeply rooted in the logistics field which stylizes network decision as a centralized structure, where a single organization aims at the total cost minimizing, through its decisions. Much of the literature on SCM hypothesizes the favorable position of an actor within the network, and numerous software tools keep that setting. Naturally, this class could include the works already examined in the previous paragraph, which build up on Supply Chain Risk starting from the logistic process components;

- On the other hand, we can identify a logic that approach the supply chain as an aggregation of distributed decision-making units. While every actor keeps private and confidential information, all subjects involved will act in an antagonistic manner. In such a scheme, while considering only a limited number of logistical constraints, the decisions are relative to the definition of a purchase price and a material quantity to be delivered over a period of time, without any operational details. Usually, the works which deal with the risk from first-tier suppliers are hereby included (Zsidisin et al., 2005).

In general, when the supply chain partners belong to different organizations or business divisions, they tend to focus on their goals and make their own decisions independently. Consequently, locally optimal decisions may result in operational inefficiencies and situations sub-optimal as regard to the whole supply chain. Scholarly literature provides at least two contributions in this direction.

Lee et al. (1997) have shown that if the partners in a network of organizations place their orders independently, under an auto-regressive consumer demand, these sub-optimal policy

decisions create the "bullwhip" effect, causing information distortion and inefficiency. Furthermore, if each partner makes maximal profit ordering decisions, in the presence of a deterministic consumer demand, decreasing with the price, then the locally optimal decisions will produce a lower total profit for the supply chain (Tang, 2006a).

The problem of risk in business networks has stimulated a new interest in the research stream of supply chain contracts, with the aim of understanding the mechanisms to facilitate coordination and improve operational efficiency.

The contract models typically consider a supply chain consisting of a producer (supplier) and a retailer (buyer), which face a defined demand of final consumer. Cachon (2003) examined how the supply contracts can be used for the channel coordination, e.g. through the alignment of each individual partners goals to others.

Tang (2006a), while providing a selection of the academic literature on contracts with a specific focus on those that conceal various forms of uncertainty, classifies the retrieved contributions according to different risk factors for the financial and material flow. He also considers both directions in the flows.

One source of uncertainty is demand, in this context a SCRM approach regards at the links and balance between price and goods quantity supplied, on the one hand, and marginal costs of producers, on the other. We will illustrate some examples of such contracts classes.

- Wholesale price contract: fixed the selling price  $p$ , and the order quantity  $Q$  in a period, we can assume to follow the newsvendor problem, the problem is characterized in setting the wholesale price  $W$ , which allows the producer to cover its fixed costs  $F(Q) = 0$  and which gives a margin equal to  $W(Q) = W$ . The supplier determines the wholesale price that maximizes its net profit. Further conditions are that the dealer retains the revenue  $p$ , and the exceeding stock. Depending on different patterns of coordination (i.e. they reflect various contingent factors, such as the seasonality effects, the ability to split the order and sharing information about the storage costs or marginal costs of domestic sales, etc.),  $F(Q)$  and  $W(Q)$  may take different functional expressions.

- Buy Back Contracts: in a one time period, for the retailer the optimal solution is an order according to the solution of the newsvendor problem. In retail, however, a problem of stock outs can have relevant consequence on the profit of the seller and not only for him. To avoid this possibility and to induce the retailer to order more, it is quite common that a manufacturer



offers a return policy (through the buy-back contracts). By this option, he undertakes to withdraw a proportion  $R$  of the inventory excess of the retailers, whilst paying a price  $b < W$  ( $W$  = wholesale price). Every buy back problem is completely defined by the two parameters  $(R, b)$ . Based on the different buy-back policies, the properties of the profit for both, the producer and the seller, can be evaluated, by assessing the risk factors which threat it.

- Revenue Sharing Contracts: With respect to some products and distribution chains, it is not practical for the retailer to return the exceeding part of inventory goods. In these cases, a risk sharing scheme can be preferable, formalized through a revenue sharing agreement. A revenue sharing problem is identified by the wholesale price “ $W$ ” and by the portion of revenue that can be shared “ $a$ ”. In practice, the retailer can buy at a lower price, but he must remit to the producer a proportion “ $ap$ ” for each unit of goods sold. An example is taken from the video-rental industry.

- Quantity-Based Contract: The Quantity Flexibility (QF) contracts will meet the diverse needs of supplier and retailer about the time when it is preferable to release the order. A QF contract is described by the wholesale price “ $W$ ” and by two corrective parameters  $(d, u)$ , so that an initial order  $x$  could be corrected until the quantity  $Q$ , paying a price equal to “ $W$ ” as long as  $(1-d)x < Q < (1+u)x$ . This formulation also includes the buy-back contract. When increasing the production capacity is very expensive for the manufacturer, he can develop a supply contract in order to commit each retailer in ordering a minimum quantity in advance, such as a fixed amount. In turn, the supplier undertakes to provide discounts based on the amount pre-ordered.

A further source of uncertainty can also be the purchase price (Tang, 2006a). In this case a risk sharing strategy can be undertaken through the Flexibility Time contracts, whereby the retailer follows the changes in the price and decides the best time suitable for placing the order.

Another source of uncertainty is related to the choices for managing information in a network of organizations. In particular, especially in the presence of risk, different strategies are needed depending on the type of product, demand and distribution network. Reducing the standard deviation of demand during the replenishment lead time results in a reduction of inventory throughout the supply chain. With regard to innovative products with a short life cycle (Fisher, 1997), making feasible a reduced replenishment time could allow a retailer to put more than one order during the selling season. Such logic is implemented by the Quick Response strategy in the

apparel industry, which allows the orders corrections, by reviewing the forecasts, as it is known the actual date of the first sales.

In the case of functional products with a longer life cycle (Fisher, 1997), the market information are critical to generate accurate forecasts. Thereby, the so-called upstream supply chain partners often base their forecasts on data about the confirmed orders from their party immediately downstream. This may trigger the bullwhip effect, or amplify the variability of orders which in turn can lead to higher inventory levels, lower levels of service, inefficient use of production and transportation capacity. To mitigate these effects related to the access and availability of information, Lee et al. (1997) suggest some strategies, such as information sharing, Vendor Managed Inventory (VMI) and Collaborative Planning Forecasting and Replenishment (CPFR).

### **THE “RISK SPIRAL” AND THE CONCEPT OF “CONFIDENCE”**

From the considerations presented above, we have shown that there is some focus difference between academic studies about the unit of analysis, because every approach aims to emphasize certain unique characteristics in the materialization of Supply Chain Risk. The financial risk may be costly and take the form of inventory obsolescence or stock-outs, but also the form of reworking and of penalty for failure to deliver. The complexity and uncertainty in a supply chain can also increase the risk of "chaos", which results in excessive reactions, unnecessary interventions, distrust, and distortion of information along the chain (Childerhouse et al., 2003). The existence of nervousness and chaos also means that it is difficult to make optimal decisions at each stage of the Supply Chain. Moreover, the so-called "decision risk" intensifies, i.e. the risk of taking wrong or ineffective decisions. For instance, the optimal production schedules cannot be realized, if there is uncertainty about when the materials or components will be available. A supply chain cannot respond to changing market trends and consumer preferences, if it is unable to properly capture the signals from the market. For example, a network cannot support the launch of a new product if in its plants manufactured products cannot be changed, or if the chain is unable to fill customer orders in a short lead time.

In a network of organizations in addition to the processes variability, there are tangible risks that lower the performance, making less reliable forecasts and planning. In fact, the exposure to Supply Chain Risk always results in a potential inefficiency.

This loss of confidence can occur through many elements inherent in the processes operability and functioning; they are:

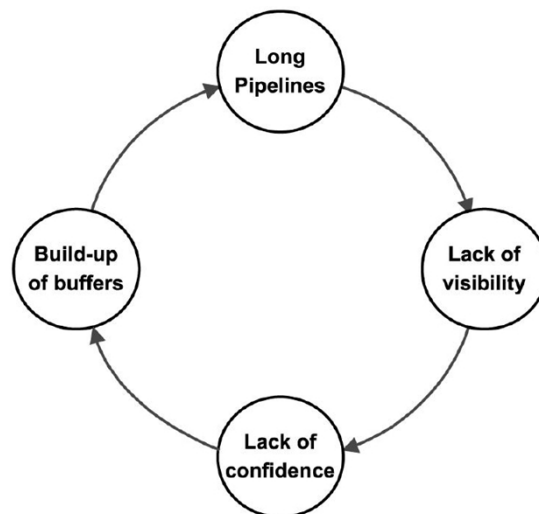
- Order cycle time;
- Current state of the order;
- Demand forecast obtained;
- Suppliers capacity;
- Production capacity;
- Products quality;
- Transport reliability;
- Service level delivered.

In addition to the tangible risks (i.e. including the risk of disruption), there are many intangible elements that lead to a loss of confidence about the parameters governing the Supply Chain. For example, an organization should ensure the preparation and the perception of individual members in making risky decisions. Moreover, in some cases, the actions undertaken can lead to an increased exposure to risk at the whole and a further decline in confidence levels.

In addition, informal procedures and behavior of employees can make an additional contribution to risk, beyond that of sub-supplies and supplies offshore.

The mechanism behind this phenomenon is explained by Christopher and Lee (2004), through the formalization of the Risk Spiral concept (see Figure 1).

Figure 1 The Risk Spiral (Christopher et al., 2004)



A single organization often can't access to what happens in other parts of the network: so that, the Risk Spiral mechanism exists and can trigger anywhere in the chain. It is a mechanism self-sustaining, which can only be mitigated with the restoration of appropriate levels of confidence in the parameters of supply chain, through the increasing of visibility and control.

The concept of confidence underpins the prevalent perception about the reliability of performances in every stage of the supply chain, i.e. the degree of confidence that an actor or an organization in the fact could keep what it promises to the next partner in the chain.

For example, if the confidence increases, it also increases the propensity “to replace inventory with information” (Christopher et al., 2004).

Indeed, the components of confidence are visibility and control. A visibility end-to-end would allow the information to be available for the right subject on time, while the enabling of appropriate control leverages allows for timely intervention.

They both are essential elements to facilitate a risk management approach, although they can be equal or in some cases one can dominate the other.

## **THE CRITICAL SUCCESS FACTORS FOR THE RISK APPROACHING ORGANIZATIONS**

The literature review reports some introductory notes. Therefore, it only partially contributes to explain why many research streams are sometimes related to SCRM discipline, because of some forms of scientific contiguity. For example, adopting an analytical-descriptive approach, the SCRM area seems to have some conceptual affinities to other relevant research streams, such as Supply Chain Vulnerability Management, Business Continuity Management, Supply Chain Event Management, Crisis Management, Disaster Recovery, Security and Safety Management, Reliability Management.

Almost all works cited in the previous sessions, could be classified with respect to some of these macro areas, since the academic studies specifically analyze risk events, risk sources and precursors. A common element between them, is an essentially static approach, although many recent contributions seem to consider the risk impact in relation to the possibility that risky events propagate within a network of organizations. The scholarly literature as well as the business practice reports that “Recent events have vividly demonstrated that a disruption affecting an entity anywhere in the supply chain can have a direct effect on a corporation’s

ability to continue operations, get finished goods to market or provide critical services to customers” (Juttner et al., 2005).

Thus, in a strategic-operational perspective, it seems that issues and problems about Supply Chain Risk are tackled in the academic works examining some global properties of network systems. Usually, in those studies, as the focus is on a primary feature of supply networks, the others are treated as complementary characteristics. Therefore, although it would be unrealistic to suppose that subsequent attributes are mutually exclusive properties in modern supply chain organizations, they will be analyzed separately below.

**Resilience:** A widely accepted definition of resilience property in the production systems can be found in Asbjørnslett and Rausand (1997): “A strong and resilient system is able to support without perturbation or absorb a catastrophic failure and persist”. While the resistance to disruptions emphasizes the importance of pre-disruption mitigation activities, the concept of resilience extends those ideas in order to also include improvements in the capability and performance of a system both during and after a disruption. Based on those ideas, we therefore can define supply chain resilience as the ability of a supply chain system to reduce the probabilities of a disruption, to reduce the consequences of those disruptions once they occur, and to reduce the time to recover normal or acceptable performance. Further adjustments to this definition are present in Svensson (2002), which specifically investigates vulnerability in the supply chains context. In his view, vulnerability originates from the time and functional dependencies between firms’ activities and resources. His conceptualization is followed by Christopher et al. (2004a), which propose a framework to build a resilient Supply Chain through four key principles: (1) resilience can be built into a system in advance of a disruption (i.e. through re-engineering), (2) a 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.

In parallel to the Cranfield studies, researchers at the Massachusetts Institute of Technology (MIT) explore many case studies of supply chain disruptions, in order to highlight the most effective management responses to vulnerability, such as flexibility, redundancy, security, and collaboration. In particular, Sheffi (2005) investigates also the relationship between resilience and resources redundancy. The standard use of redundancy leads an organization to maintain safety stock of material and finished goods along the supply chain, a low exploitation capacity,

many alternative suppliers, etc. Therefore, transitioning to lean and agile operations is generally based on the assumption that redundancy can result in increased costs and reduced quality, but these redundant measures can actually give a company time to plan its recovery after a disruption. Typically, resources redundancy is expensive to hold, and it constitutes a temporary measure. Ponomarov et al. (2009) state that “the dynamic integration of logistics capabilities enables supply chain resilience that leads to sustainable competitive advantage”. In their writing, they primary refer to “capabilities” as the strategic management attribute in “adapting, integrating, and reconfiguring resources, organizational skills and functional competencies to respond to the challenges of the external environment”. In the Ponomarov’s model, capabilities (e.g. flexibility, agility, visibility, and responsiveness) have to be properly combined in order to improve supply chain performances such as readiness, response, recovery, etc., which they are strictly related to. These capabilities result in a more adaptive supply chain, in order to face with unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations.

Finally, getting to the research by Pettit (2010) which performs many focus groups and shows that resilience is inherent to those organizational capabilities that a supply chain as a whole can develop. Pettit includes agility, availability, efficiency, flexibility, redundancy, velocity, visibility and many others. His research aims to provide management insight into linkages between each vulnerability derived from empirical studies, and a set of successfully employed capabilities to face off this vulnerability.

From the examples and citations here reported, we derive that in the literature stream dealing with resilience, Supply Chain Risk is assimilated to the paradigm of vulnerability for the networks.

**Flexibility:** Production systems today face situations of demand uncertainty, as regards both to the quantity and variety of product required by the customers. Flexibility is seen as a reactive capability to market changes and as a strategic approach to cope with uncertainty.

However, it generally requires a strong commitment and a long-term perspective, in order to support organizations to effectively compete. Supply chain flexibility is a really interesting and timely topic for practitioners, which evolved from manufacturing literature, since it is widely recognized that “it is now important to look beyond the flexible factory to the flexible supply chain” (Slack, 2005).

The value of flexibility in meeting customer demands and improving responsiveness, is supported by authors such as Fisher (1997), Lambert et al. (1998), Christopher et al. (2004b), and many others. In particular, flexible supply chains are able to adapt effectively to disruptions in supply and changes in demand whilst maintaining customer service levels.

Christopher et al. (2004b) state that a deep understanding of supply chain structure, which connect an organization to its suppliers and their suppliers in the upstream, and to its customers in the downstream, is an essential pre-requisite for every strategic re-engineering activity. Moreover, some careful considerations about uncertainty, as introduced above, should primary influence the design of supply chains.

According to Christopher et al. (2004a), more attention has to be paid on avoiding disruption at the bottleneck of the network and the programs of improvement must focus on maximizing capacity and flexibility at the bottleneck. These measures can be built only through the identification and prioritization of critical paths in the chain, as will be explained later in the text in correspondence to the introduction of mapping tools.

A valuable contribution proposed by Stevenson et al. (2007) investigates how a strategic design program aimed to reduce unwanted uncertainty, could influence flexibility in supply chains. In a brief section of their paper, the authors recognize three strategic means or leverages, which may help understanding the inevitable trade-off between uncertainty and flexibility. In particular, the analysis is focused on the relative roles of supply chain design, supply chain collaboration and inter-organizational information systems, respectively. The measures included in the model, which are fundamental for the supply chains development and survival, cover components of flexibility playing both at the inter-firm level and at the intra-firm level.

Therefore, the former is clearly the most relevant in a supply chain perspective. In particular, Stevenson et al. (2007), in examining specific supply chain design issues, criticized the positioning of the customer order decoupling point: it still represent the point in the chain at which the customer demand-driven information is received and processed. On the one hand, if placed in the upstream of the chain sufficiently, it may increase flexibility, whilst reducing uncertainty.

On the other hand, moving the decoupling point upstream may impact on the responsiveness of the network, both in terms of speed and efficiency and also uncertainty is affected, as a second-order effect. Sometimes, the strategic decision of this positioning is not even allowed to

the management. Otherwise, it can be induced by product characteristics or by some other exogenous conditions. From the above, we can derive that those supply chain management techniques included in the scope of flexibility, can be considered as strategies to mitigate uncertainty in business networks.

An interesting classification of these methods and tools is proposed in the study provided by Tang and Tomlin (2008a), which also provides an estimate of the degree of flexibility needed by organizations, referring to a set of enablers so as to reduce the negative implications of the occurrence of certain events associated with supply, process, and demand risks.

In the research stream relative to flexibility, Supply Chain Risk is correlated to the uncertainty paradigm. A strategy of increasing flexibility is aimed also to reducing uncertainty; in that sense, achieving a greater supply chain flexibility may result for an organization to mitigate its risk exposure.

**Agility:** Success in a volatile market is realized by the ability to respond to demand changes, or even anticipate changes and respond to uncertainties and opportunities that may emerge. This overcomes several types of flexibility, and includes the ability to create new unplanned activities in response to some unforeseen shifts in market demand or to unique customer's requirements (Narasimhan et al., 2006).

From practice, it could be observed that some organizations create Supply Chains which are able to respond to sudden changes in the markets. Moreover, in business networks, agility is a critical requirement, because in some industries, both supply and demand suffer from variations more rapid and large than those fluctuations predictable from historical data.

In other industries, such as fashion markets (Christopher et al., 2004b), products demand simply cannot be forecast. In these contexts, it is advisable to explore strategies which allow to create, manufacture and deliver products on the real-time demand basis.

Therefore, the growing tendency to source products and materials in the low cost countries, while seeks to establish substantial cost advantage toward competitors, is a further element of increasing complexity and has resulted in longer lead times and pipelines.

New risks, in the global environment, arise from neither the length of replenishment time nor the geographic distance, but are driven by the delays and variability caused by internal processes at both ends of the chain as well as the import/export procedures.



Thus, Cavinato (2004) argues that the agile logistics addresses supply chain risk, due to its scope, generally pertinent to customer demand and matching manufacturing and logistics capacity and capabilities to it.

Lee (2004) formulates the Triple-A Supply Chain model, in which the synergistic dimensions of agility, adaptability and alignment have to be integrated. Essentially, these features connote short, medium, and long term perspectives, respectively.

Khan et al. (2008) propose an evidence-based framework for risk management, supported by an actual implementation to a business case in the textile industry. They noted how an organization can improve the agility of its supply network through the development of a product design capability, both in-house and through close collaboration with suppliers. In their study, products design emerges as a time consuming activity, while taking control of the design function may really improve agility, in order to mitigate the risks of operate with long lead times.

The generalizability of this result can be drawn from Christopher et al. (2004a), which break down the lead time managed by individual organizations into three critical components: the time-to-market, the time-to serve and the time-to-react. Shorten each of these summands, and therefore their sum, leads to enhanced agility and responsiveness for the whole network.

Thus, an organization, which seeks for improve supply chain agility, must reconsider the time needed in translating a market opportunity into a product or service, in delivering it to the customer with the service level required, in adjusting the output of the business in response to a volatile demand.

In the stream reviewed at this point, the Supply Chain Risk problem seems generally to be studied in relation with the variability phenomena, which affect organizations competing in globalized networks in different forms. Hence, decreasing process variability may conduct to a reduced risk exposure.

**Robustness:** Robust are defined those Supply Chains that, even in the presence of disturbances, could continue to operate and satisfy their customers without fluctuations in the outputs delivered. The robustness strategies make Supply Chains more efficient to cope and manage the inherent fluctuations, and more resilient also in front of severe and unexpected disturbances (Tang, 2006b).

Christopher et al. (2004b) report a dictionary-based definition, in which “robustness” is strictly related to the physical strength of a system. While advocating for a greater specificity on

supply chains properties, which substantially stands in networking capabilities, they refer to the IT terminology: “robustness is the ability of a computer system to cope with errors during execution”.

Some similarities can be found here with the field of Supply Chain Event Management (SCEM), populated by some vendors which offer partial solutions, including track and trace, supply chain visibility and alert messaging solutions.

Unfortunately, the most part of those products merely notify the human operator of unexpected occurrences and leave him to resolve the issue (Gaonkar et al., 2007).

Hence, there is a critical need for suitable tools and solutions that would allow organizations to enhance their reliability or robustness under uncertainty.

Trkman et al. (2009) examine the features of turbulent environments in which most organizations are involved. In the authors view, suppliers’ turbulence has to be considered in addition to turbulent elements experimented by the focal firms, such as market turbulence, technology turbulence and exogenous turbulence.

Since suppliers (and suppliers’ suppliers) operate in different supply markets and environments, their turbulence varies and, therefore, the actual performance, a supplier can realize in the chain, also differ.

Consequently, an organization must adopt different strategies for various suppliers, according to their potential for a disruption, i.e. the degree of turbulence they face in the specific market segment, which the focal organization itself is included in.

Those measures (such as, at the opposite of the relations span, ordering large batches to decrease procurement costs or single-source suppliers with long contractual commitments, respectively), filtered by the dynamics of suppliers’ competitive environment, result in a greater robustness to the upstream variations and impacts for the firm and, in turn, for the whole supply chain.

Generally, considering supply and demand sides, robust strategies, implemented throughout business organizations in response to some turbulent and volatile variables, are studied by Tang (2006a, 2006b). Through the analysis of several real cases, published early in the scholarly literature, he identifies and discusses nine of such strategies (e.g. Postponement, Strategic stock, Flexible supply base, Make-and-buy, Economic supply incentives, Flexible transportation, Revenue management, Dynamic assortment planning, Silent product rollover).

Moreover, it is conceivable that those strategies may be effective even in the case when an organization is not able to accurately measure the probability of a major disruption occurrence and impact. While being considered as cost-effective and time-efficient generic strategies, those practices are acknowledged to improve supply chain robustness. Thus, they are a useful support for organizations in facing turbulence and reducing supply chain risk.

As it emerges from the core literature in the SCRM field, the risk construct is substantially employed as an axiomatic measure for some global attributes, usually referred to complex systems networks and to modern Supply Chains, in particular. That is, the mathematical modeling of risk is actually introduced in order to characterize, by analogy and / or diversity, some relevant phenomena which affect network organizations, such as uncertainty, variability, vulnerability and turbulence.

In spite of the increasing number of studies and contributions, this certainly allow to explain the lack of uniformity and the fragmentation of knowledge, which distinguish the Supply Chain Risk Management literature. Here, the systemic view of the business network is the unique allowable “trait d’union” between notions and approaches which differ substantially.

#### **CHALLENGES AND FUTURE OPPORTUNITIES OF THE RISK MANAGEMENT APPROACH**

In the previous sections, several definitions, issues and notions have been introduced, which are available to organizations facing and managing Risk. Looking to future developments, notice that the most critical challenges are still lying just in the Risk concept. Then, with regard to semantic of Risk and the practical implementation of Risk Management process, an interesting review has been published by Khan et al. (2008). In this work, the authors seek to orient the reader within the long debate between those who believe the risk is an objective construct and those who believe that is a subjective one.

Lupton (1999) noted that the different interpretations vary from the technical and scientific perspective, which hypothesizes the risks is objective and measurable, to the constructivist perspective of social sciences, which sees the risk as determined from the of social, political and historical concerns importance of the subjects involved. Yates and Stone (1992) adopt the latter approach, assuming that the risk is a subjective construct, because “it represents an interaction between the alternative and the risk taker”.

Over the years, a great number of proven tools have been developed in order to qualify and manage risk. Despite the broad acceptance among managers, some of these methods have been criticized for eliminating the human judgment from the decision-making process, leading to transform the basic assumptions in mathematical formulae.

Thus, according to Adams (1995): “Rarely are risk decisions made with information that can be reduced to quantifiable probabilities, yet decisions somehow get made”. Therefore, the scientific research has tried to balance this gap, by encouraging the development of new tools and models, as conceptual as operational for the management of the Supply Chain Risk. Without going into further detail, it is crucial to recognize that this debate exists, and it has significant implications on how and to what extent Risk is viewed and managed by organizations.

However, in the SCRM literature, this debate is neither mentioned nor solved. Although most authors in this field use terms such as "perception" and "risk perceived" (Cousins et al., 2004, and many others), indicating a subjective rather than objective meaning, others use the concept of probability (Harland et al. 2003), in light of a more objective point of view.

A further challenge for risk management in network organizations is the environment, which seems to foster many uncontrollable forces. A fatalistic view, in terms of acceptance of this environmental complexity and the limitations of every managerial action, is in contradiction with the contingent need of organizations to address risk.

Nevertheless, the managers and the organizations that employ them are contractually, morally and often legally obliged to identify, manage or mitigate the effects of known or “knowable” risks (Peck, 2005).

After recognizing that the Risk Management process is dynamic in nature, in which it has to adapt to changes in market conditions and in firms characteristics as well, while managers take actions to reduce known risks, at the same time they are changing the risk profile for the organization and for others in the network.

These two considerations highlight the distance between the functional goals of Supply Chain Management and the changes in organizational structure and business strategy. Few organizations have SCM specialists in their boardrooms; consequently, the supply chain implications of strategic decisions are often not recognized until serious problems emerge.

As we observed in the previous section, the actions taken to mitigate risk have to balance the cost of intervention and the potential damage that risk could create. Those actions can be divided

(Paulsson, 2004) into two categories, actions linked to production and actions linked to protection. The decision makers must pay attention to support a balance between these two types of initiatives. On the one hand, if an organization exceeds in protecting itself, the production will worsen and the costs will increase, threatening the financial stability. On the other hand, if a company doesn't protect itself enough, it might be hit by a severe and unexpected disaster, even with consequence on its survival. Thus, the valuable risk managing actions have to be placed around a “parity zone”, where the cited balance could be guaranteed.

In the scholarly literature, there is a general agreement about the Risk Management initiatives should be implemented at a management function level, seeking to address the risks for the organization within the wider context of business objectives.

However, there is some controversy about whether Risk Management should be considered as an ordinary business function, or whether it should be isolated from the daily operations, and used only when needed.

According to the most popular professional organization dealing with Risk:

*“Risk management should be a continuous and developing process which runs throughout the organization’s strategy and the implementation of that strategy. (...) It must be integrated into the culture of the organization with an effective policy and a program led by the most senior management. It must translate the strategy into tactical and operational objectives, assigning responsibility throughout the organization with each manager and employee responsible for the management of risk as part of their job description.”* (IRM/AIRMIC/ALARM, 2002).

This scenario will realize only if an organization put the fostering the Risk culture at the center of its strategies. Christopher et al. (2004) argue that “this Risk Management culture should extend beyond the boundaries of corporate risk and business continuity management to become supply chain continuity management”.

In addition, the main challenge for the future remains the study and development of such tools and practices, leading an organization to respond in time and efficiently to the dynamics of environment and process activity.

One first general issue is the availability of Risk Management tools which drive the assessment stage, already considered as the most important phase in the entire process.

Sometimes the dimensions of probability and loss potential cannot be defined uniquely on a quantitative basis. It becomes crucial considering and modeling in the risk decision schemes also the judgments and risk attitude of the decision unit (Brindley, 2004).

A second one is the development of simulation tools, providing outcomes and results with a maturity and duration lower than the speed at which the core variables are changing, i.e. such instruments have to be performance-linked.

## CONCLUSIONS

This article has presented the state of the art on Risk Management, in particular discussing practices, tools and approaches available under a network perspective and formalized in the scholarly literature. In the last decade, Risk Management has emerged as one of the most critical issue that modern organizations face in their competitive environment, and probably will continue to be so in the beginning of 21st century. The focus provided on benefits and critical success factors of approaching Supply Chain Risk Management issues, facilitates a better, more effective understanding of organizational implications, requirements and practices to achieve an organization's goals.

In the first part of this paper, many key concepts and definitions are reported spanning in other scientific areas, while the focus has been in characterizing risk in network organizations through its dynamic, inter-connected and organizational nature. We built on the assumption that individual organizations today are competing, through the business network they operate in.

Thus, we presented a selective overview of the academic knowledge in this field, distinguishing two possible streams for the categorization and understanding of contributions. The first one which shows an affinity with the logistics discipline from a conceptual point of view, while the second one take in exam the coordination issues between different entities involved in supply chains.

However, risk situations are not the same for different organizations. The background of specific problems faced is described by the identification of the risk sources, the risk enablers, the factors of interaction between the organization and the environment or between different organizations.

In addition, since the Supply Chain Risk takes on multiple forms and dimensions, the technical tools which support the Risk Management activity should be consistently used. This

condition entails that the risk facing organizations should establish a formal and structured process for Risk Analysis and Management. The Critical Success Factors in those efforts are strongly related to the organization strategy. Hence, the overall business strategy must be broken down in a supply chain strategy consistently with the business objectives and also with the assets and resources available.

Furthermore, these initiatives have to be harmonized with the current supply chain practices, adopted throughout the network. We identify four perspectives such as resilience, flexibility, agility and robustness, which can help the organizations to draw their strategic endorsement on Supply Chain Risk Management.

We emphasized that risks seems to be a dynamic occurrence of consequential problems. Hence, those problems have no definitive solutions. By their nature, they are unknown before they emerge. Nevertheless, managers and organizations should strive to understand why and how problems might arise, and have tools and approaches which support them in the decision-making process.

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