

Risk management and mitigation strategies in the supply chain: A case study in the aeronautical industry.

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Abstract

During the evolutionary process of the organizations, competitiveness became a preponderant factor, making each and every organizational initiative to be directed towards creating a differential that increases their competitiveness. The insertion and integration process of economies in international trade – more and more globalized - is fundamental for the economic growth strategy. There is a perceived tendency for international integration of the supply chain (SC), however, the greater it is global expansion the greater it is the likelihood of uncertainties and accidents – by disturbing on one of the chain links - affecting other parts of the chain. In the past years it has been widely discussed the concept of Supply Chain Risk Management (SCRM), tool that assists on the implementation of actions aimed at managing potential risks management, and actions aimed at minimizing the impact of external risks to ensure greater reliability throughout the supply chain. In this sense, the objective of this study is to provide empirical information of the risk management implementing process within an aeronautical industry supply chain.

Keywords: Supply chain; risk management, empirical research, SCRM implementation.

1 Introduction

In the current economic environment it is emphasized that the competition is shifting from a relationship between competing companies to a relationship between different organizational arrangements, among which the supply chain is highlighted. The notion of supply chain management (SCM) is a concept that has evolved in recent decades rising from the evolutionary movement that came of business logistics.

Notably, the growing concern in managing the supply chain is partly due to two major groups: on one hand, companies seeking to concentrate on core competencies and reduce costs, have begun to outsource major parts of their production to other companies other regions or countries, requiring a robust logistics management. On the other hand, the turbulence and chaos in the competitive environment triggered by environmental, political, socioeconomic, and other factors, that require businesses adaptation, flexibility and quick responses ahead to market changes often unpredictable.

Therefore, it becomes clear that after a period of production systems fragmentation seeking to reduce costs and focusing on core competencies, companies are faced with ruptures risks among the various links, from suppliers, transport, production, distribution to retail and consumer. The supply chain "in their simplest degree of complexity consists of three entities: the company, a supplier and a customer directly involved in upstream and downstream flows of products, services, finance and information", according to Jüttner (2005, p. 121). In this context, supply chain management "encompasses all stages involved" inside and within these companies in order to meet client expectations (CHOPRA & MEINDL, 2003, p. 3).

The issue of disruptions risk in the companies supply chain around the world has been the subject of recent studies, as companies are connected in global supply chains there is a real vulnerability condition in the operations flow. Following Jüttner, Peck and Christopher (2003, p. 3) "a disruption that affects an entity anywhere in the supply chain can have a direct effect on the ability of another company to continue operations [...]." The point is that is not enough for each link to worry about their risk management to

solve problems because, in the context of supply chain exposures, risk management requires solutions involving the entire chain.

2 Methodology

The theme of risks is not new but has been progressively more exploited in the field of supply chain management (LAVASTRE ET AL., 2012), consequently the demand for studies and results in the area is increasing. Khan and Burnes (2007) emphasize that research on SCRM need (a) be within a larger study on risk, yet, (b) require wider and deeper empirical research, and (c) need to develop well-founded models of SCRM . Also, recently, Christopher et al. (2011) pointed to future research that might (d) consider the input suppliers and logistics service providers involved, and (e) the formation of multi-research groups looking at different perspectives of risk for SC globally.

After this, the purpose of this study can be justified as a way to contribute to the growth of empirical material in the area of SCRM. The main steps followed to implement the Risk Management were: To analyze existing methodologies for Risk Management already performed by other departments in the company (Pros x Cons), to define and initiate a risk management methodology for the management of Logistics and Transport with the teams responsible for controlling and enforcing contracts;; Dissemination and Release of the methodology for all stakeholders; Performing workshops in each of the national units with their respective stakeholders; analyze results of the workshops; Building up an Action Plan; Restitution to responsible for risk mitigation and continuous monitoring.

When structuring in one organized way the steps that make up the realization of a job or task, including its flow, inputs, activities and products generated, it is often possible to obtain systematic information and understand critical points, opportunities for improvement and especially the variations or fluctuations due to normal causes (intrinsic to the nature of the process) or due to abnormal or specific causes. In short, the aim was to develop processes capable of ensuring activities harmonization as well as the information flow for all national units. One of the main characteristics of this mission was to make it simple; consequently these processes should be easily understood and utilized by all users.

3 Literature Review

3.1 Risk Management

In the supply chain many can be the sources of risk, since different parts of the chain will be exposed to different hazards. In addition, organizations, in order to become more agile and lean, are becoming more dependent on external agents, which also contributes to greater overall vulnerability (FAISAL ET AL., 2006).

A survey performed by Aon Corporation, in 2009, with business leaders from over 40 countries, including 551 companies, raised a list of the top 10 most important risks in these participating organizations. The research clearly shows that a crisis impacting the global economy was identified as the most important risk in their organizations. Other major risks cited include compliance with regulatory standards, business disruption, face the challenges of increased competition, commodities price risk, protecting the reputation, managing risks associated with cash flow, supply chains, dependence on third parties and recruit and retain talented individuals. Each of these risks has increased in scale and complexity, given the state of the current economic environment.

According to Christopher (2009), it is important to identify the risk profile of a business, because from that profile you can find "critical paths" within a network. This profile aims to find the main vulnerabilities and establish what is the probability of business disruption.

Thereby, the author classifies the main sources of risk on the network as: *supply risk*, these risks are related to the flow of products, services and information that arise between the supplier and the enterprise, related to the supply chain before the production or operation. Ex: acquisition of global products,

dependence on suppliers, poor management of supplies, etc. Concomitantly, *demand risk* is related to the flow of products, services and information that arise between the company and the consumer market. Ex: Volatility of demand, bullwhip effect.

Process risks are related to the way organizations produce goods or services, beginning by obtaining raw materials, through processing, until the delivery of finished products. Ex: Identifying bottlenecks in manufacturing, availability of additional production capacity etc. Another important source of risk is the control of monitor, standards, procedures and policies systems that manage how the company exercises control over the process. Ex: disorder and distortions caused by inappropriate internal control of their own systems such as, request opportunity, lot sizing and safety stock policy away from the real demand. At last, there is *environmental risk* linked with the external environment of the supply network and not controlled by the organization, such as regulatory changes, socio-political, macroeconomic and natural or manmade disasters. Although the type and timing of these events cannot be predicted, its impact must be evaluated.

The efficient coordination of the supply chain is directly related to the company's ability to achieve competitive advantage. The flow of goods and services must be integrated from the beginning to the end of the chain in order to contribute to customer satisfaction. (Cousins and Spekman, 2003). The leaner and more integrated supply chains get the greater is the likelihood of uncertainties, dynamics and accidents in one link affect other links in the chain (FAISAL, BANWET ET AL., 2006).

Risk management is the identification, assessment and prioritization of risks followed by coordinated and economic resources application to minimize, monitor and control the likelihood and / or the impact of intrusive events. Manage the SC risks becomes an important tool to add value to the market and it's also a more proactive way for companies to avoid disruptions throughout its supply chain.

The risk management process is focused on understanding risks, minimizing their impact by using, for example, probability and direct consequences. Generally, companies act on recurrent and low impact risks on their SC, and have a propensity to ignore those with high impact and low probability of occurrence. But it is important to be careful, because disasters, as recently observed in Japan, natural or even manmade, had a low probability of occurrence, but ended up causing major damage. Thus, it is necessary to rethink the approaches to SCRM, since, due to globalization, companies appear to depend on partners from different nations and continents.

3.2 Mitigation Strategies

Incidents of risk and disruption in the value chain occur continuously in globalized supply chain. Still, it is possible to say that currently there are several facilitators that help mitigate (attenuate) risks in the SC.

There are many risks and approaches to mitigate risks to consider, but two things are important when starting building a strategy SCRM. First, you must create an understanding throughout the organization about the risks that are in SC. Next, determine how to adapt a generalized approach to mitigating risks to the circumstances of a particular company. (Chopra and Sodhi, 2004)

Faisal, Banwet *et al.* (2006), presented a compilation of some factors that act as facilitators in mitigating the risks related to the supply chain, following the ideas proposed by some other authors on the literature, they are: (a) *Information sharing* - Increasing the visibility of demand information across supply chain reduces the risks (Chopra and Sodhi, 2004). Thus, communication and coordination among all elements of the supply chain are essential to its success. (b) *Agility in the supply chain* defined as the ability to thrive in a continuously changing, unpredictable business environment (Prater et al., 2001). Companies can minimize inventory risks by working with a highly responsive supplier (Chopra and Sodhi, 2004). (c) *Trust among supply chain partners* expectation that partners will not act in an opportunistic manner even if there are short-term incentives to do so and can contribute significantly to the long-term stability of an organization and its supply chain (Spekman *et al.*, 1998). (d) *Collaborative relationships among supply chain partners* - In order to manage risk effectively in a supply chain, organizations are moving to adopt closer relationships with key suppliers. (e) *Information security*, the goal of security is to

reduce the enterprise's risk of losses caused by intrusion, system misuse, privilege abuse, tampering, fraud, etc. Protection must be provided against external threats and from internal abuse.

Other factors equally relevant are: (f) *Corporate social responsibility* - Socially responsible companies consider the full scope of their impact on communities and the environment when making decisions, balancing the needs of stakeholders with their need to make a profit. (g) *Aligning incentives and revenue sharing policies in a supply chain*, induce supply chain partners to behave in ways that are best for everybody, companies have to create or modify monetary incentives. A supply chain works well if the incentives of its member companies are aligned which requires the risks, costs, and rewards of doing business are distributed fairly across the network. (h) *Strategic risk planning* - companies that will be successful are those that can identify and develop contingency plans for the various risks that exist internally and externally to the organization. Formulating an appropriate and effective organizational strategy can to a certain extent mitigate supply chain risks (Finch, 2004). (i) *Risk sharing in a supply chain* - the company must identify not only direct risks to its operations, but also the potential causes or sources of those risks at every significant link along the supply chain (Christopher et al., 2002). (j) *Knowledge about risks in a supply chain* - By understanding the variety and interconnectedness of supply-chain risks, managers make better decisions and can tailor balanced, effective risk-reduction strategies for their companies, which may decrease the risks of both a single organization and a whole network. (Chopra and Sodhi, 2004).

At last, (k) Continual risk analysis and assessment, continual monitoring of risks assumes importance because business environments in which supply chains work are very dynamic, and risks to a supply chain may change due to changes in the political/economic conditions of the environment, mergers/acquisitions, etc.

4 Case study in the aeronautical industry

This company launched a 4 years corporative project, started on 2007. It was a turnaround program that had been developed consisting in the implementation of a new business model, continuous improvement and reduction of cash exposure. Therefore, mid-2007, the department decided to restructure the operations of two major manufacturing support functions, "*Manufacturing Engineering*" and "*Supply Chain & Logistics*".

In this context, for the Supply chain and Logistics department, one of the Key projects was to develop an integrated European approach to company's Logistics based on 4PL/3PL model, the goal was to end the multitude of existing contracts with current providers by implementing this new concept of a European single provider. This would therefore allow company to achieve its rationalization objectives, involving in particular the establishment of regional hubs, warehouse automation, more efficient logistics solutions, etc. eliminating activities that didn't add any value and were expensive for the company

Therefore two main companies had been selected as lead logistics and transport providers ("Lead Logistics Provider - LLP" and "Lead Transport Provider - LTP", respectively) for state of the art companywide solutions and to secure planned savings, maintaining or increasing the level and quality control throughout their supply chain.

Within the operational function of Central Supply Chain, together with local logistics services managers in Europe (LSM), it was begun to collect and analyze the requirements in terms of risk analysis (for contract management LLP / LTP), propose and implement a risk management process in correspondence with the internal audit resulting in a convenient way to carry out the operations.

The following illustration (figure 1) shows one way to interpret risk management in a time scale.

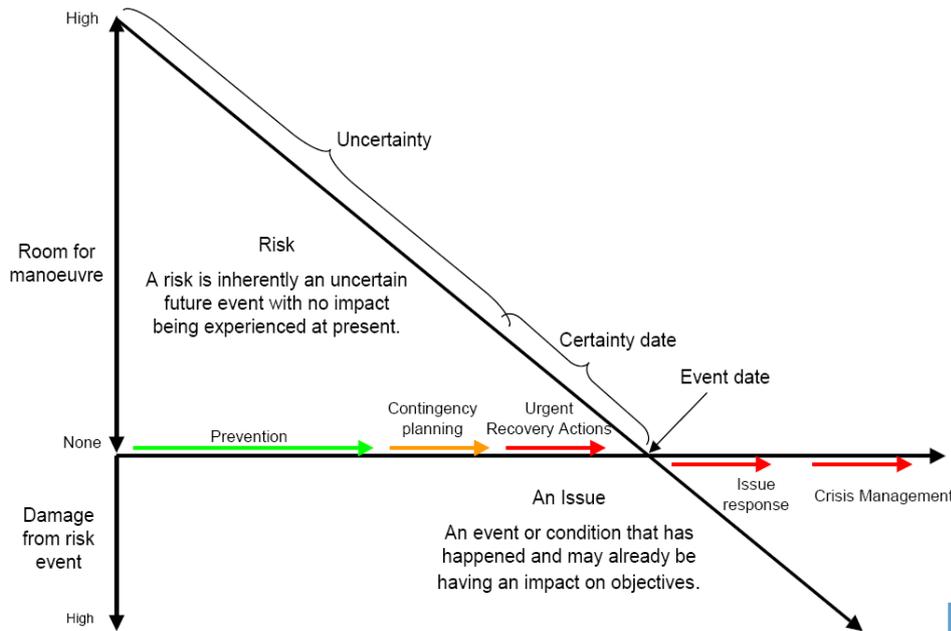


Figure 1: Risk management in a time scale. Source: Company's internal documentation 2009.

After analysis of existing methodologies for risk management, considering its pros and cons, the tool FMEA - Failure Mode and Effects Analysis - was considered the most suitable to be implemented in the Logistics and Transport operations department. The FMEA can be described as a systematic group of activities designed to:

- ▶ Recognize and evaluate potential failures of a product or process and the effects of that failure.
- ▶ Identify actions that could eliminate or reduce the chance of occurrence of potential failure
- ▶ Document the process.

In FMEA, failures are prioritized according to how serious their consequences are, how frequently they occur and how easily they can be detected. The purpose of the FMEA is to evaluate risk management priorities for mitigating known threat vulnerabilities, starting with the highest-priority ones.

As for the Operational Logistic / Transportation management, the following illustration (figure 2) describes basically the necessary loop to perform the risk management. Later, on table 1, this circle will be explained item by item.

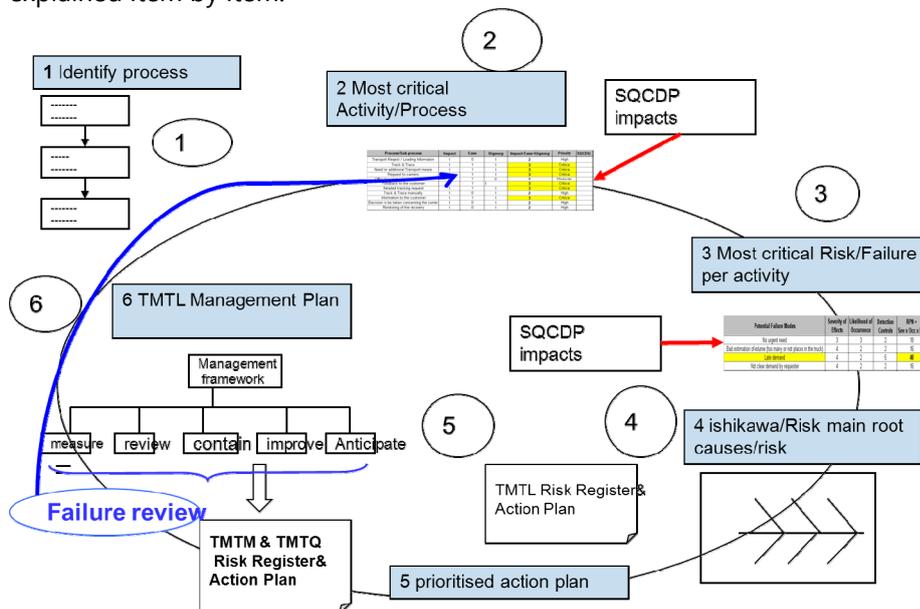


Figure 2: Operational Logistic / Transportation loop. Source: Company's internal documentation 2009.

Table 1: Process description

Process Activity	What	Who
1 Identify process	“Process Mapping” review. Analyze if the Process defined by logistics department is applicable and correspondent to real life activities (Make sure it contains all process and sub-process to be analyzed further on) PS: Where particular business needs or departmental operating methods necessitate changes to detail these processes, these changes are acceptable. All comments and suggestions to improvements must be addressed to the process owner.	Lean & Organisation Manager
2 Most critical Activity/Process	Classify by order of Criticality all the pre-defined activity sub-processes (Critical Priority to be analyzed mandatory for risk assessment; the ones classified as High Priority are to be discussed, between team members, if a risk assessment analysis is necessary.)	Team members by common sense and business feedback experience (Team Member by Lean & Organisation Manager)
3 Most critical Risk/Failure per activity	Identification of all the risks per sub process (Brain Storming). Definition of Severity of effect, likelihood of occurrence, detection control and Security, quality, cost, delivery, people (SQCDP) risks impact assessment. Risk assessment decides which risks the project must pay attention to and allocate resources to manage	
4 Root causes analysis/risk (Ishikawa)	Identification of likely the root causes by using for example the 5M Methodology (The «5M» method permits not to forget any constituent during the studied activity analysis.) either 5 why Methodology. (Analysis and Brainstorming based on company’s organization & processes , internal service level agreements, current rules and practices either LLP/LTP organizations and contractual agreements) Root causes will help to find appropriate Risk owner and to establish the adequate action for risk mitigation.	
5 Prioritised Action Plan	Define contingency and mitigation action plan for most critical risks previously identified and assessed taking in account the root causes raised previously. One action defined may be applied to one or several different risks when identified root causes are equal.	
6 TMTL Management Plan	Communicate, present the Workshop conclusions and mitigation plan to Risks owner in order to confirm, develop and launch the actions highlighted during the risk management workshop. Follow up the action Plan (actions status and results)	Lean & Organization Manager

Source: Company’s internal documentation 2009.

The methodology adopted to be performed during the ‘workshops’ with the stakeholders embraced some key elements for it to work properly, such as: **Anticipation Approach** - to avoid Business disruption and potential impacts for Customers, Aircraft deliveries ,safety, non quality, extra costs; **Based on their feedback and experience** on Day by Day Business Management, meaning that it should not be considered as a theoretical exercise; **Closely linked to business performance monitoring; Participative** way of working; **Accessorized by a Quality** specialist on risk management, who would drive the risk management methodology; **Step by step and Continuous approach** - Risks identification and assessment based on criticality (quarterly) and risk mitigation plan review (monthly).

After mapping the process to be analyzed, each step of this process must then be evaluated to create activities prioritization subsequent to the needs of assessment in relation to risks rising. This prioritization is done following three arguments represented in binary way: impact, ease of identification / recognition and urgency, as shown on table 2.

Table 2 – Prioritization Arguments

IMPACT		Importance of the part / process
0	Moderate Importance	Minor impact on production or business
		Not critical to safety
		No affect to external customers
1	High importance	Directly affects aircraft performance or safety
		Directly impacts a long lead-time or high-cost item
		Could cause severe production or business disruption
		A potentially serious hazard to personnel
		New design, material or process. Unknown capability
		A feature with known problems
EASE		Difficulty of analysis
0	High Resistance	Lack of adequate information availability
		The right people and skills are not accessible
		Lack of management support / focus
1	Low Resistance	Adequate information / data is available
		The required people and skills are available
		A good level of support / focus from the local management teams
URGENCY		Time constraints
0	Non urgent	No immediate concern to productivity, safety, quality
		Not a current threat to the programme
		Customer not affected by delay
1	Urgent	Immediate concern to productivity, safety or quality
		A current threat to the programme
		A customer is impacted

Source: Company's internal documentation 2009.

As a result of this assessment, the sub processes will be classified as Critical if the sum is equal to 3; High if the sum is equal to 2; Moderate if the sum is equal to 1 or Low if the sum is equal to 0.

The Risk identification step can be considered as the most important step in risk management - risks that are not identified cannot be managed. It is also the stage at which people in the unit are most involved. Almost all risk identification involves tapping into the knowledge of people in the unit - they tend to have the most knowledge of the subject, the practical concerns and the organizational issues.

The evaluation of each one of the risks, raised by managers, according to their priority is performed based on three items, the severity of the effect, the likelihood of occurrence, detection control, evaluated on a 1-5 scale, according to the characteristics defined in Figure 3, Figure 4 and Figure 5.

SEV	Local effects at the Process Manufacturing Operation	
1	Negligible effect on safety, quality, costs, productivity or assets. Slight inconvenient	
2	Minor, recoverable impact eg. Concession, rework, tool breakdown, intervention	
3	Moderate eg; significant cost / scrap impact, major rework, recordable safety event	
4	High eg. Major cost / scrap impact. Stopped production. HSE reportable event	
5	Severe impact eg. Production Shutdown, permanent disability	
Subsequent Internal Operations		Aircraft End-user / Customer
Negligible adverse effect		Negligible customer effect
Recoverable impact eg. Delays, repairs		Noticeable but no impact on performance or safety
Significant (non-recoverable) delays/cost/work		Dissatisfied eg. quality, delay. No safety impact
Major disruption to production or people safety		Performance / functional / safety / regulatory failure
Production / business disruption		Loss of market share or regulatory compliance

Figure 3 - Severity of the effect scale. Source: Company's internal documentation 2009.

OCC	Process capability	Failures	Cpk (fail rate)
1	Robust, consistently meets requirements	Remote very unlikely	>1.3 (1 in 20K)
2	Adequate capability	Infrequent / Rare	1.1 (1 in 2000)
3	Borderline process capability	Occasional	0.95 (1 in 500)
4	Poor process capability	Frequent / Regular	0.75 (1 in 100)
5	Unreliable, not capable for manufacture	Persistent : Inevitable	<0.55 (1 in

Figure 4 - Likelihood of occurrence scale. Source: Company's internal documentation 2009.

DET	Prevention and Detection Controls	Detection
1	Controls provide early warning and should allow the failure to be prevented	Before fail
2	Failure can sometimes be prevented. If it does occur detection is very likely	Same op.
3	Failure / defect should be readily detected, but this could be at a later stage	Subsequent op.
4	Detection is possible but unreliable, some fails / defects remain undetectable	Customer
5	Detection difficult or unlikely with poor / no controls. Defects reach customer	In-service

Figure 5 - Detection control scale. Source: Company's internal documentation 2009.

The previous assessment generates a RPN ("Risk Priority Numbers"), which consists in the multiplication of the three results obtained on each of the items evaluated. The purpose of risk assessment is simple - it is to decide which risks the project must pay attention to and allocate resources to manage; and which risks are lower priorities. Hence, the main risks are classified at intervals of "High to Critical (HC)" when $RPN \geq 25$ "Medium to High (MH)," $RPN < 25$, but the severity is ≥ 4 . (Figure 6).

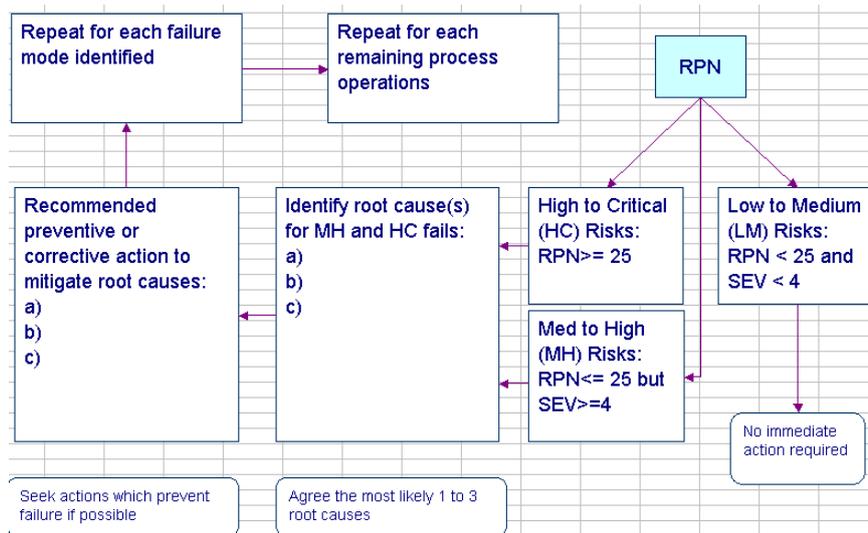


Figure 6 – Process flow according to risks RPN. Source: Company's internal documentation 2009.

As a result for the Operational Risk Management, after performing Workshops with all main stakeholders from Logistics team of every different facility, it was possible to classify many potentials failure mode and propose some action to mitigate those risks. The sheet template below (figure 7) is a summarized result of the Risk Analysis Workshops performed by the department and it was created with the aim of Risk Analysis Manage / control and follow Risks evolution on a global view.

undertaken to reduce the impact of a risk. (c) *Detection actions*, which are undertaken to discover as soon as possible if a risk will appear.

The continuously loop is essential toward solving problems. While apparently easy to understand, it is often difficult to accomplish on an on-going basis due to, distractions, loss of focus, lack of commitment, re-assigned priorities, lack of resources, etc. Is important to make sure the action plan is executed before the risk becomes the event.

5 Finals Considerations

The present study attempted to identify the concepts of risk and vulnerability, as well as to present the process of risk management in SC. Notably, the topic has gained relevance in the academy, because it consists of a current problem in terms of supply chains. It is perceived that dealing with risk management at the enterprise level is different from treating risk, specifically in the supply chain.

On the other hand, the practice in supply chain management also requires new attitudes of practitioners such as: (a) considering that risks of the company may not be the same as those on SC, (b) the shared management of risks goes by sharing information on SC, (c) understand the SCRM as a process, (d) mitigation strategies must be developed to the SC level and (e) enhance demand, suppliers and information management capabilities in the company and in the SC.

Therefore, the implementation of risk management, would enable an organization, for example: Encourage proactive management; Being aware of the need to identify and address risks throughout the organization, improving the identification of opportunities and threats; Improve stakeholder confidence, establish a reliable basis for decision making, control and planning; allocate and use resources efficiently for the treatment of risks; improve operational effectiveness and efficiency; improve performance in health and safety, as well as environment protection; improve loss prevention and incidents management and minimize losses.

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