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Supply chain risk management in French companies

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ABSTRACT

The risk thematic is not new in management, but it is a recent and growing subject in supply chain management. Supply Chain Risk Management (SCRM) plays a major role in successfully managing business processes in a proactive manner. Supply chain risk has multiple sources including process, control, demand, supply and environment. Supply chain management, faced with these risks, requires specific and adequate responses such as techniques, attitude and strategies for management of risk. This paper is based on an empirical study of 142 general managers and logistics and supply chain managers in 50 different French companies. It demonstrates that for organizations to be effective, SCRM must be a management function that is inter-organizational in nature and closely related to strategic and operational realities of the activity in question. Moreover, the findings of our empirical study suggest that effective SCRM is based on collaboration (collaborative meetings, timely and relevant information exchanges) and the establishment of joint and common transverse processes with industrial partners.

1. Introduction

In 2002, Christopher and Towill indicated that supply chain management was experiencing increasing exposure to risk [8]. Shortly thereafter, Blackhurst et al. [2] confirmed that firms were being confronted by increasing supply chain risks and Zsidisin et al. [66] underscored the dramatic consequences of negative events on companies. Market globalization, reduced product lifecycles, complex international networks of industrial partners, unpredictable demand, uncertain supply, cost pressures, the necessity to be lean and agile, increasing use of outsourcing and off-shoring, and reliance on suppliers make up some of the elements contributing to these difficult and ongoing situations [10,17,20,22,24,39,43,52].

Mitroff and Alpaslan [42] make an historic pronouncement concerning major crises. According to their analysis, the number of "normal" accidental crises, whether natural or man-made, is increasingly being overshadowed by abnormal or deliberately precipitated crises. Coleman [9] confirms this by stating that the frequency of man-made disasters increased exponentially during the 20th century in OECD countries. His analysis shows that this exponential growth in disaster frequency is largely due to an increase in traditional hazards such as fires and explosions, rather than from new technologies. Elkins et al. [11] observe that this increase concerns both the potential for and magnitude of disruption. There is a limited number of DSS for supply chain risk management and one of them is by Li and Liao [33] and Tsai [55]. They developed DSS for dynamic alliance and cash flow risks in supply chain.

Supply chain risks are numerous and varied and many studies have tried to list them including those by Chopra and Sodhi [5]; Christopher and Peck [7]; Hallikas et al. [16]; Jüttner et al. [25] and Jüttner [24]. Studies concerning sources of supply chain risk are also numerous. For example, Harland et al. [17] focused on different classifications of risk types in their literature review spanning from 1996 to 2000. These risks concern different branches of management including (but not limited to) strategy, operations, supply, customer relations, asset impairment, competition, reputation, financial markets, fiscal and regulatory requirements, and legal.

Chopra and Sodhi [5] propose disruptions, delays, systems, forecasts, intellectual property, procurement, receivables, inventory, and capacity as the nine main sources of supply chain risk. Meanwhile Christopher and Peck [7] identify process, control, demand, supply, and environment as five risk sources. In 2003, Jüttner et al. [25] focused on environmental, network and organizational risk sources for supply chains. But some years later, Jüttner [24] noted two other sources of risk: supply and demand. Taking a slightly different angle, Kleindorfer and Saad [27] emphasize three sources that increase disruption risk: operational contingencies (including equipment malfunctions and systemic failures), natural hazards (earthquakes, hurricanes and storms), terrorism and political instability. Kiser and Cantrell [26] highlight internal risks (risks in manufacturing, business, planning and control, mitigation and contingency) and external risks (risks in demand, supply,

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environment, business and physical plant). And finally, Wagner and Bode [57] divide the sources into five distinct classes: demand side; supply side; regulatory, legal and bureaucratic; infrastructure, and catastrophic. Hua et al. [21] develop a multi-agent simulation model to study the impact of various operational parameters and decisions, such as horizontal competition among retailers, order allocation strategies of retailers, wholesale price of manufacturers, characteristics of market demand and number of retailers, on bankruptcy propagation.

Supply chain vulnerability can also be considered a risk factor and can be defined as "*exposure to serious disturbance arising from supply chain risks and affecting the supply chain's ability to effectively serve the end customer market*" [37]. Extant literature has focused on identifying sources of uncertainty and the risk emanating from them. Several authors develop methodologies for risk identification and assessment [5]. Risk identification consists of quantifying risks and this information can then be used in deriving risk mitigation strategies [5].

As outlined above, SCRM is very important given the new economic and industrial environment in which firms currently work. The purpose of this present research is to contribute to and provide a more complete understanding of SCRM by studying three aspects of SCRM: attitudes toward risk, tools used to understand risk, and the ways in which decisions are made. We have formulated three general research questions for the study: (i) What are supply chain managers' attitudes toward risk? (ii) What tools are used to manage risk? (iii) What managerial techniques are considered the most effective in minimizing supply chain risk, and most efficient in terms of supply chain risk management? In an attempt to answer to these questions, we employ an empirical methodology (questionnaire with closed questions) and statistical analysis. We will not try to identify or define different supply chain risks because many studies have already broached this daunting subject including Chopra and Sodhi [5], Tang and Tomlin [50] and Jüttner [24]. Other studies have addressed specific fields such as networks [14–16,44], agility [38], and inbound perspective [59]. Still others have dealt with domains such as fashion products and commodities [39], aerospace supply chains [47], the American chemical industry [27,28], the American automotive industry (using a qualitative methodology) [10], the aerospace industry in the UK [19], and the European automotive industry [58]. Only a limited number of research projects have focused on (i) the organizational structure of the SCRM in a firm, and (ii) ways to manage supply chain risk in a dyadic approach (with industrial partners). Therefore, our research is microeconomic in focus that is, at a firm level and not macroeconomic focus. Moreover, in our study we try to adopt a practitioner's perspective, focusing on analysis of tools and attitudes adopted in a firm.

2. Research background

In this section, we try to provide a perspective on the evolution of SCRM based on a literature review of general SCRM issues. This includes a generic definition of risk, a definition of risk in supply chain management, risk management processes, differences between supply risk and supply chain risk and our definition of SCRM.

2.1. Generalities

Risk is present in numerous firm activities and having been studied from many perspectives including strategy, finance, production, accounting, and marketing, there are differences of opinion concerning its definition. Risk can also be studied from the Supply Chain Management (SCM) point of view. Lambert et al. [31] define SCM as "*the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders*". These processes include not only traditional logistics activities such as warehousing, inventory management and inventory, and transportation, but also non-traditional activities such as procurement, production support, packaging, sales management, and customer sales order processing [54]. In addition, SCM involves integration, coordination, cooperation and collaboration between organizations in the supply chain. That means, according to Gimenez and Ventura [13], that SCM requires integration of both internal (intra-organizational) and external (inter-organizational) elements.

2.2. General definition of risk

Yates and Stone [62] emphasize three elements to define a risk: the extent of loss (*elements of loss*), its importance (*significance of loss*) and its probability of appearance (*associated uncertainty of loss*). Following the work of Mitchell [41], Harland et al. [17] define risk as "*the probability of loss and the significance of that loss to the organization or individual*". Mitchell uses the following formula to evaluate the risk of an event n from the probability of loss [P (loss_n)] and the importance of the loss [L (loss_n)].

$$\text{Risk}n = \text{P}(\text{loss}_n) * \text{L}(\text{loss}_n)$$

Kraljic [30] studies risk in the context of logistics/supply. He shows that risks exist because of procurement market complexity as characterized by the shortage of suppliers, replacement products and technology. Also bearing a degree of responsibility are entry barriers such as logistics costs, complexity and monopoly or oligopoly market conditions for suppliers.

2.3. Definition of risk in supply chain management

If we focus on the definition of risk in the field of supply chain management, it is possible to cite the work of March and Shapira [36] who define it as "*a variation in the distribution of possible supply chain outcomes, their likelihood, and their subjective values*". According to this definition, a risk is a breakdown of flows between different components of the supply chain. This variability can potentially affect the flow of information, materials and/or products, and it may modify the use of human and equipment resources. In 1992, Sitkin and Pablo [48] defined risk as "the extent to which there is uncertainty about whether potentially significant and/or disappointing outcomes of decisions will be realized". Zsidisin et al. [65] later defined supply risk as "*the transpiration of significant and/or disappointing failures with inbound goods and services*". A few years later in a study on the aerospace industry, Zsidisin [63] offered the following definition: "*supply risk is defined as the probability of an incident associated with inbound supply from an individual supplier failure or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or causes threats to customer life and safety*". This definition highlights an important criterion: the probability of risk occurrence. If risk is too strong, then it is no longer a risk but an event certain to happen. If the probability is too low, there is likely to be an unrealistic and unfounded fear that managers will not seek to manage the situation. This brings to the forefront the need to appropriately assess risk and develop processes to manage it.

For a list of operational risks, one can refer to Chopra and Sodhi [5], who identify nine risk categories: disruptions, delays, systems, forecast, intellectual property, procurement, receivables, inventory and capacity. Among the risks associated with supply chain, it is possible to include items such as delays in delivery of stock, machine breakdowns, delivered products that are not of the desired quality, use of information systems that create data integrity problems or systems becoming inoperative.

2.4. The risk management process

Some studies develop a risk management process that breaks down into four generic steps [16,17,63]. These steps are risk classification, risk identification, risk calculation, implementation/validation of risk management actions and sometimes risk monitoring. According to Zsidisin

et al. [66] and Zsidisin et al. [67], SCRM can be operationalized by a *business continuity plan* [66], or by a *supply chain continuity planning framework* [67] with four stages: awareness, prevention, remediation and knowledge management. Kleindorfer and Saad [27] created a specific, three-step model. The three steps are denoted as SAM: Specifying sources of risk and vulnerabilities, Assessment, and Mitigation. The tasks in the model "have to be practiced continuously and concurrently as the foundation of disruption risk management".

2.5. Supply risk, supply chain risk and SCRM

Analyzing Anglo-Saxon literature we discover "*supply risk*" and "*supply chain risk*" are quite similar. The first term is operational and covers supplies, deliveries, orders and operational management for extremely short-term focus. The second term is more strategic and cross-cutting and refers to the establishment, management and organization of flows between partners in a supply chain and the consequences for supply risk.

Company interest in the issue of SCRM is fairly recent. The first SCRM workshop identified by a scientific journal dates from 2003 in Great Britain (*Logistics and Transport Focus*; Rowat, 2003 [45]). One of the recommendations stemming from the workshop which brought together professionals from the logistics and supply chain management fields was to create "*a supply-chain risk management team to focus on identifying, reducing and managing risk across the extended supply-chain*". At that time, several trigger events marked the moment and companies were pushed to focus on SCRM issues. Events like the attacks of September 11, 2001, the typhoon that disrupted suppliers in South East Asia in 2001, and the SARS outbreak in 2002 all demonstrated inherent weaknesses in supply chains and their management. The term SCRM is a recently coined expression. It appears simultaneously in 2003 in two journals, one in the area of Supply Chain (*Supply Chain Management Review* in an article entitled "Risk-adjusted supply chain management" written by Hauser [18]), and the other in the field of procurement (*Purchasing*, in an article entitled "SCRM — Riding out global challenges" written by Atkinson [1]). Following the aforementioned evolutions in professional experience and practices, researchers began exploring these issues in greater depth. Jüttner [24] was among the first authors to provide a definition of SCRM: "*the identification and management of risks for the supply chain, through a co-ordinated approach amongst supply chain members, to reduce supply chain vulnerability as a whole*".

2.6. Our definition of SCRM

Our definition of SCRM is the management of risk that implies both strategic and operational horizons for long-term and short-term assessment. It refers to risks that can modify or prevent part of the movement and efficient flow of information, materials and products between the actors of a supply chain within an organization, or among actors in a global supply chain (from the supplier's supplier to the customer's customer). SCRM can be seen as the capacity to be agile. According to Braunscheidel and Suresh [3], the cultivation of agility is viewed as a risk management initiative that enables a firm to respond rapidly to market changes, as well as to potential and actual disruptions in the supply chain. Thus, agility is of value for both risk mitigation and in response to its effects.

2.7. Summary

A limited number of articles (for example, [2,23,52,58,65]) deal with ways to minimize and manage supply chain risk with suitable empirical research. Moreover, few studies try to observe supply chain manager attitudes toward risk. Some studies have been done on SCRM in Australian companies [46], Chinese companies [23] and German companies [52], but none have been undertaken using French companies. To fill this gap, this study addresses the subject of supply chain risk management in French companies. Our aim in this paper is not to analyze the impact of French culture, particularity in SCRM, unlike other research of, for example, Cannon et al. [4]. Our sample contains French companies, but our goal is not to understand the moderating role of culture in SCRM.

With this in mind, the paper starts by reviewing the general structure of SCRM, the theoretical background of the tools used to manage risk, and attitudes and decisions taken toward risk. Following this, the conceptual model of SCRM is developed and finally, the results of our empirical study validate the model. Besides focusing our research objectives on SCRM, we identify three streams of research about SCRM: (1) Research on risk management processes and different steps in the SCRM methodology [16,17,63,66,67]; (2) Research on risk in a particular activity sector, trying to demonstrate that SCRM is industry specific [46,52]; and (3) Research on multiple and different sources of risk [7,24–27,57]. In the following section, we develop a conceptual model for SCRM.

3. A conceptual model for SCRM

We define our conceptual model for SCRM (see Fig. 1) as a combination of three elements: (i) Attitude toward risk, (ii) Tools used in risk management (to identify, understand and estimate risks) and (iii) Techniques to minimize risk in the Supply Chain. This conceptual model has been studied with empirical data collected from French companies. Details of the model are discussed below with reference to the literature survey and analysis.

3.1. Attitude toward risks

Many researchers have attempted to find risk mitigating strategies in SCRM. This has resulted in several different models, however, a four-step system seems common as a means to manage risk. These four steps are identifying risks, assess risks, implement solutions and control risks.

According to Harland et al. [17], attitude toward risk depends on trade-offs made by organizations; what is deemed as an acceptable level of risk, the size of the benefit and the attitude of the organization concerning risk taking. Some organizations and individuals are highly risk-averse, others are risk-takers. Attitude toward risk is influenced by the nature of the business but also by individual style and behavior and it changes with experience and maturity. An individual, organization or sector accustomed to taking risks may change their attitude after experiencing heavy losses. Harland et al. [17] propose a model to manage risk in a logistics network (Fig. 1). This is described in the six steps: (1) map supply network (structure factors, key measures, ownership; (2) identify risk and its current location (type, potential loss); (3) assess risk (likelihood of occurrence, stage in lifecycle, exposure, likely triggers, likely loss); (4) manage risk (develop risk position and scenarios); (5) form collaborative supply network strategy and (5) implement collaborative supply network strategy [17].

Jüttner et al. [25] and Miller [40] distinguish five generic strategies including imitation, avoidance, control, co-operation and flexibility that companies undertake to mitigate risk. Jüttner et al. [25] consider that four of these (avoidance, control, co-operation and flexibility) can be adapted to supply chain contexts as presented in Table 2. Risk can be avoided by dropping specific products/geographical

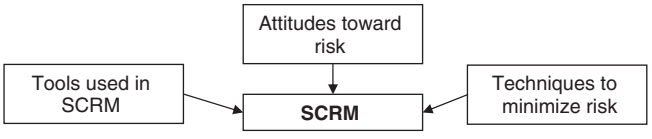

Fig. 1. The conceptual model for supply chain risk management.

markets/supplier and/or customer organizations. Strategies include vertical integration, increased stockpiling and use of buffer inventory, mainlining excess capacity in production, storage, handling and/or transport and imposing contractual obligations on suppliers. Co-operation in terms of joint efforts to improve supply chain visibility and understanding, sharing risk-related information and preparing supply chain continuity plans will lead to reduced supply chain risks. Also, flexibility strategies through postponement, multiple sourcing and localized sourcing will contribute to the reduction of supply chain risks [25]. Concerning co-operation from a supply chain perspective, according to Jüttner [24], the focus is on the development of multi-organizational supply chain habits and understanding that they improve long and short-term supply chain planning capacity. This includes sharing information, minimizing exposure to specific risk sources and, finally, preparing joint business continuity plans. Cooperative risk mitigation strategies were applied by many of the organizations interviewed, but they were mainly restricted to initiatives with key suppliers.

According to Hallikas et al. [17], a typical corporate risk management process consists of four stages: (i) Risk identification — this includes the location of risks, possible damage to the company and its partners, and the impact on the supply chain, organization and shareholders; (ii) Risk assessment — this involves determining the severity of risks, measuring the effect of risks through financial, production, logistics or trade performance, the probability of a risk becoming a reality and the potential extent of the loss; (iii) Risk monitoring and control — deals with control, containing and dominating risk using planned actions or reactions in the short, medium and long term, implementation of technical or prevention and protection measures, staff training, financial responses or risk sharing with partners, and the control indicators to monitor risk and the effectiveness of actions; and (iv) Decision and implementation of risk management actions — includes strategies for risk management such as risk transfer, risk taking, risk elimination, risk reduction, and further analysis of individual risks.

In Table 1, we propose six generic positions taken by organizations to confront risk. These six different propositions became evident during the initial exploratory study with interviews of supply chain managers that was the first step of our research. Second, they derive from the literature review and especially from research by Harland et al. [17] and Halikas et al. [16]. Halikas et al. [16] present five generally used strategies in supplier networks for risk management that include: risk transfer, risk taking, risk elimination, risk reduction and further analysis on individual risks.

3.2. Tools used in SCRM

The tools used to deal with the different phases of SCRM are: risk identification and analysis, risk assessment, decision and implementation of risk management actions, and risk monitoring [16,60,66]. These tools are often used in risk identification and risk assessment phases. Sinha et al. [47] present a generic prescriptive methodology for mitigating risk in an aerospace supply chain and propose the following five activities: identifying risks, assessing risks, planning and implementing solutions, conducting failure modes and effects analysis (FMEA) and continuously improving.

In their study, Tari and Sabater [51] identify seven total quality management (TQM) tools: flow charts, cause and effect diagrams, Pareto charts, histograms, run charts and graphs, X bar and R control charts, and scatter diagrams. Their study indicates that internal audits and graphs are the most widely used tools and techniques. Statistical process control and flow charts rank third and fourth, but lag far behind the first two instruments. The least popular tools are Pareto curves, cause – effect diagrams and correlation diagrams. The commonly used tools and techniques of TQM include: internal audits, graphics, SPC, flow chart, problem solving methodology, quality costs, histograms, benchmarking, FEMA, Pareto diagrams, and cause and effect diagram [51].

3.2.1. Concerning Failure Mode, Effects, and Criticality Analysis (FMECA)

FMECA is an extension of FMEA (Failure Mode and Effects Analysis). FMECA is a process to assess and classify risks by severity, and to determine their effects, with the intention of tackling the most important ones. Evaluating the "importance" of a failure mode involves Criticality and Risk Priority Number (RPN) calculation for each risk identified during the analysis. Criticality is calculated by multiplying three indices: severity, probability of occurrence and difficulty in detecting risk. This last index is higher in cases where risk is hard to detect.

Flynn and Flynn [12] examine the relationship between quality management and supply chain management practices. Based on an extensive empirical study, the authors conclude that there is a strong relationship between quality management and supply management that affects business performance. Even if their study does not refer specifically to SCRM, it does concern SCM and we feel that their results can justifiably be applied to SCRM. This opinion is upheld by the fact that several of the supply chain managers interviewed were former quality managers. Seven classic quality management tools are identified in the literature. They are regularly used to identify, understand and solve supply chain risks and are presented in Table 2.

3.3. Techniques to minimize risk

Numerous techniques exist for minimizing risk in the supply chain, but we have chosen to discuss only a handful based on our literature review. Classification as short, medium or long term is a means to differentiate between certain of these techniques. Tomlin [53] addresses other techniques and distinguishes between mitigation tactics undertaken before a disruption and contingency and response tactics adopted only if a disruption occurs. The adoption of volume flexibility, for instance, is viewed as a mitigation tactic providing for the possibility of rerouting supplies after a disruption has occurred or has become imminent.

Kleindorfer and Saad [27] categorize two types of risk: (1) those related to supply and demand coordination and uncertainty, and (2) disruption risks that are caused by events such as natural disasters, terrorism and labor strikes. They formulate a set of ten principles for managing disruption risks in supply chains, mainly focusing on

Table 1
Factors about attitudes toward risk.

Label	Attitude toward risks in supply chain
A1	Transfer the risk to another actor in the supply logistics (supplier, subcontractor, service, distributor, customer, etc.) so they bear the risk.
B1	Share or divide the risk with another actor in the supply chain (supplier, subcontractor, service, distributor, customer, etc.).
C1	Singlehandedly try to reduce or eliminate this risk using internal solutions.
D1	Reduce or eliminate this risk with other partners in the supply chain (supplier, service, customer …)
E1	Finance the risk by budgeting and prepare for its consequences if it were to happen. For example you apply for insurance or you decide to record financial reserves.
F1	Do nothing at all and ignore the risk.

Table 2
Tools used in risk management.

Label	Risk management tools
A2	Question positioning approach ("What if?")
B2	Internal and external processes mapping (Value Stream Mapping)
C2	Scores method (a measure of intensity by aggregation)
D2	Pareto diagram, ABC Ranking
E2	FMECA (Failure Mode, Effects, and Criticality Analysis)
F2	Ishikawa Diagram, Brainstorming
G2	PDCA Cycle, Deming cycle, 6 sigma, permanent improvement

internal organization policies and on interconnections between different supply chain elements: (1) internal supply chain integration and optimisation must precede any inter-firm interfaces; (2) diversification of facility locations, products, sourcing options, operating modes and processes; (3) identification of vulnerabilities across the entire supply network together with early warning and crisis management systems; (4) risk assessment and contingency planning must precede risk reduction; (5) managing tradeoffs between robustness of supply chain to disruptions and the overall efficiency of the supply chain under normal operations; (6) redundancy and backup; (7) cooperation, coordination and collaboration across supply chain partners; (8) embedding weak point measurement in ongoing process management; (9) flexibility and mobility of resources, modular design, delayed differentiation; and (10) applying total quality management (TQM) principles, e.g., six sigma approach reduces disruptive risks" [27]. Finally, Braunscheidel and Suresh [3] identify market and learning orientation as solutions to develop integration, flexibility and agility to minimize risk.

As a result of our literature review, we identify 21 techniques to minimize risk levels, but we only present those we consider the most important (see Table 3). These nine techniques were repeatedly identified by managers during the interview process as effective means to minimize supply chain risk.

1. Some researchers show that internal safety stocks greatly reduce supply risk [32]. These stocks allow organizations to respond to variations in supply flow, supply problems, or internal production difficulties. Internal stocks, however, increase storage costs (space, handling, and insurance), risk of obsolescence and capital waste [64].
2. External safety stocks can be an alternative to the previous solution. This requires that suppliers assume responsibility for management and storage of excess inventory as well as the associated cost. This responsibility can be total (as with VMI: Vendor Managed Inventory) or partial (as with CMI: Co-Managed Inventory: in this case, the supplier must have customer permission to deliver products) and implies information exchanges and a certain level of trust between logistic and industrial partners [56,61].
3. Dual-sourcing, or multiple sourcing, can be another way to reduce supply chain risks by using one or more alternative suppliers. Knemeyer et al. [29] recommend building either redundancy or flexibility into the supply chain. They argue that redundancy is generally more costly because it involves adding safety stock, using multiple suppliers (even if the additional suppliers are more costly) and maintaining slack in utilization capacity. On the other hand, flexibility (i.e. promoting organizational ability to sense threats and respond to them quickly), may actually be a competitive advantage.
4. Establishment of emergency scenarios. The main contribution made by Knemeyer et al. [29] is their proposition of a sequence of steps that firms can utilize to proactively plan for catastrophic events in supply chains. They suggest designing a proactive planning process with four critical steps: identification of key supply chain locations and threats, estimation of probabilities and loss for each location, evaluation of alternative countermeasures for each location, and selection of countermeasures for each location. According to Harland et al. [17], risk management has to be holistic in its approach and accept that multiple approaches are required if risk is to be averted. To optimize its impact, modern risk management should incorporate scenario planning, use of expert panels and Delphi studies, in addition to prediction through statistically based forecasting methods.
5. Nomination of a Supply Chain Risk Manager can constitute a way to manage risk in an organization. This individual is charged with developing and maintaining what Zsidisin et al. [66] call Business Continuity Planning (BCP). This includes creating awareness, preventing supply discontinuity, remediating risk occurrence, and fostering knowledge management. Mitroff and Alpaslan [42] recommend creation of a crisis center to plan responses to catastrophic events where a specialized manager works exclusively on SCRM. This manager is trained to find solutions and develop SCRM tools and techniques.
6. Collaboration and information exchange. Braunscheidel and Suresh [3] show external integration with key suppliers and customers is the strongest predictor of supply chain agility, rather than internal integration or external flexibility. By achieving high levels of external integration through collaboration and information sharing, firms can improve their agility and better respond to market uncertainty in terms of both customer needs and foreseen/unforeseen disruptions [35]. Christopher and Lee [6] state that in the case of supply chains, "information is power" when shared. According to Mason-Jones and Towill [38], visibility throughout the supply chain is a key in effective, timely efforts to intervene and minimize adverse effects of disturbances in a supply chain. This visibility relies heavily on good information systems, connectivity throughout the supply chain, and collaboration between all supply chain partners [49]. Li and Lin [34] show that supplier uncertainty, shared vision between supply chain partners and commitment of supply chain partners are the three most important factors in SCRM.
7. Quality and performance improvement programs for suppliers and providers result in supplies that are more secure in terms of delay, quantity, and quality and therefore, supply chain delays and disruptions are averted. External partner performance can be improved through ongoing assistance by in-house supply chain and purchasing structures resulting in an improved order-fill ratio. Furthermore, these programs reduce costs, ensure delivery and quality.
8. Centralization of distribution, delivery and overall operations. Kleindorfer and Saad [27] turn to financial theories to explain the interest of supply chain diversification: "*the second principle is an extension of portfolio theory in finance, where a fundamental result is that portfolio diversification reduces the investor's risk […]. This theory is of particular relevance here as we extend its application to include diversification of facility locations, products and services produced, sourcing options used, as well as operating modes and processes; only with such multidimensional diversification can the full potential of risk minimization be reached*".
9. Harland et al. [17] highlight the importance of a focal firm in a supply chain and SCRM. The focal firm, by virtue of its size or importance in the overall functioning of the supply chain becomes a sort of leader in the development and application of risk management techniques. This proactive involvement coordinates the flow of services and

Table 3
Techniques to reduce supply chain risk.

Label	In your opinion, the following techniques are effective to reduce supply chain risk
A3	Activity planning using Advanced Planning Systems (APS)
B3	Responsiveness, reactivity thanks to Supply Chain Event Management (SCEM)
C3	Safety stocks (vendor owned inventory (VOI) or in-house)
D3	External safety stocks which are co-owned by the partners
E3	Dual sourcing (or dual manufacturing)
F3	Establishment of emergency scenarios
G3	Introduction of strict and formal procedures that are systematically applied
H3	Appointment of a risk manager who convenes a SCRM group
I3	Communication and exchange of information (forecasting, operations)
J3	Geographical proximity to partners
K3	Cultural proximity with partners
L3	Friendly personal relationships with partners
M3	Long term continuity in partnerships
N3	Introduction of sanctions and penalties for misconduct, faults, mistakes
O3	Introduction of rewards in absence of misconduct and faults
P3	Assisting providers/suppliers in improving their performance
Q3	Forecast accuracy
R3	Reduced number of suppliers
S3	Centralization of decisions
T3	Centralization of operations (stocks, production and / or distribution)
U3	Presence of a focal firm which coordinates the supply chain

goods between the industrial partners and indirectly provides efficient SCRM.

4. Research objectives and methodology

By observing SCRM strategies and practices in companies, this study tries to better understand and analyze how organizations are structured and managed so as to deal with the presence of supply chain risks. As part of our research, an initial exploratory study was conducted between February and September 2007 and involved nine companies (SMEs and subsidiaries of large international groups) in a variety of industries including information technology, heavy earthmovers, electrical and electronics from the Rhône-Alpes region in France. The interviewed population consisted of supply chain managers and supply chain risk managers (when present). Face to face interviews of more than 2 h were conducted by following an interview guide and a qualitative methodology. This first study provided an in-depth view of supply chain risk management in each of these organizations and allowed us to define managerial practices. It also improved our overall understanding of SCRM at a general level. This initial qualitative stage helped prepare for the second phase: a quantitative study with a methodological framework and questionnaire.[3]

The quantitative study was conducted using questionnaires administered face to face or by e-mail in rare cases. The questionnaires were administered between December 2007 and February 2008. The study focused on 142 people in 50 different French companies. General Managers and logistics and supply chain managers were asked to respond to 96 questions. No technicians were included in the sample.

The questionnaire is divided into five themes: organizational structure and SCRM, risk perception, attitude and risk management tools, risk minimization techniques and general questions. Questions designed to solicit information about the respondent and his company are found at the beginning and end of the document. In this questionnaire, we are interested in manager perceptions and representations concerning risk management in their company. Closed questions seek to determine respondents' level of agreement or disagreement using a seven point Likert scale: “strongly disagree”, “disagree” “somewhat disagree”, “no opinion”, “somewhat agree”, “agree” and “strongly agree” with respective notes from 1 through 7. In case of no response, no note was assigned. Neutral response to an answer is 4 on the scale. All statistical analyses were performed using SPSS version 15.0.

5. Empirical results

Principal results obtained including attitude toward risks, tools used in SCRM and techniques employed to minimize risks, using statistical analysis with SPSS, are presented below.

5.1. Brief description of our sample

Seventy eight percent of the respondents work in firms having more than 500 employees. Eighty two percent are part of a group, and nearly 90% of the companies have an international dimension. Our study focuses on SCRM as practiced by large companies rather than in SMEs. Seventy-five percent of the 142 respondents work in industry and 65% of this population are employed in manufacturing. Men comprise 75% of our sample. The median age in our sample (the value which cuts the sample into two subgroups of the same size) is 34. These individuals average 6.5 years with their current company and 7.6 years in the supply chain field. The respondents work in logistics and supply chain at operational levels (primarily functional and managerial), and have expertise in their field.

[3] Questionnaire is available upon request from the authors.

The companies surveyed have used logistics for more than 23 years on average. The median creation date for these divisions is 1995. Given the extensive corporate experience in logistics/supply chain, and the vast professional experience of the respondents, our sample has an abundant knowledge of both Supply Chain Management and the Logistics field.

5.2. Attitude toward risks

This study underscores that manager attitudes toward risk are critical if SCRM is to be effective and that SCRM must be managed across multiple organizations. The study results, presented in the table below, show that organizations primarily seek solutions to manage and reduce or eliminate supply chain risks with their industrial partners. Question D addresses this approach and shows an average high and low standard deviation, reflecting consensus as the preferred solution among the interviewed managers. The results have been ordered by increasing average as shown in Table 4.

A complementary result is evident in this table: the majority of companies adopt proactive attitudes toward risk. Only 2 of the 142 respondents (1.56% of our sample) replied that they “*somewhat agree*” with the phrase “*confronted with a risk, you do nothing at all, and you ignore the risk*”. For our entire sample, the response to this position produced a low average (1.49) and a very low standard deviation (0.92), reflecting a strong unanimity of responses. Managers agree that it is essential to act and to take risk into account in supply chain management decisions.

A surprising answer emerges concerning financing of risk. Over 20% of respondents do not know if risk exposure is funded or not. For other issues, the average “*no opinion*” is 5.04%, here it is 22.7%! This result highlights the fact that financing of certain risk is carried out at the top-management level, and that, therefore, the officials we interviewed were not informed of their companies' position on this subject. In reading the results of this table, it appears that risk managers adopt attitudes of exchange and collaboration (reducing and sharing risk with partners) when seeking logistics solutions. Isolated practices and individualistic or opportunistic behaviors (such as transfer and management of risk in isolation) are rejected by companies.

Table 4
Rank of attitudes toward risks.

Rank	Confronted with a risk, you adopt which of the following attitudes?	N		Average	Standard deviation
		Valid	Missing		
1	D1. Together with other partners in the supply chain (supplier, service, customer …) you try to reduce or eliminate the risk.	128	14	5.54	1.33
2	B1. You try to share or divide the risk with another actor in the supply chain (supplier, subcontractor, service, distributor, customer, etc.).	133	9	4.71	1.61
3	E1. You finance by budgeting for this risk and its consequences if it were to happen. For example, you apply for insurance or you decide to record financial reserves.	132	10	4.24	1.75
4	C1. You try to singlehandedly and internally reduce or eliminate this risk.	131	11	3.95	1.85
5	A1. You try to transfer the risk to another actor in the supply logistics (supplier, subcontractor, service, distributor, customer, etc.) and to oblige them to bear this risk.	134	8	3.01	1.73
6	F1. You do nothing at all and you ignore the risk.	128	14	1.49	0.92

Table 5
The relationship between company size and will to manage risk alone.

SME vs. large company		C1. You try to singlehandedly reduce or eliminate risk			Total
		Disagree	Neither agree nor disagree	Agree	
Distinction between SME and large company	SME	26.7%	6.7%	66.7%	100%
	Large company	54.1%	3.1%	42.9%	100%
Total		47.7%	3.9%	48.4%	100%

Pearson Khi 2: meaning asymptotic (bilateral): 0.029.

Question C addresses attitudinal differences between SMEs and large companies (see Table 5). SMEs attempt to individually reduce risk while large firms use collaborative approaches involving their logistics partners. To achieve this, they rely on different levers such as bargaining power and pressure related to the larger purchase volumes and activity they generate. This allows them to impose certain risk management rules and practices on their industrial partners.

Two typical cases illustrate pressure large companies exert on their suppliers. The first is the creation of remote storage facilities under shared supply management where suppliers retain ownership of materials until they are used. Known as vendor managed inventory (VMI) this inexpensive solution minimizes risk because upstream partners support consequences of the arrangement. Another example of the weight exerted by large companies is the development of forecast sharing tools based on Collaborative Planning, Forecasting and Replenishment (CPFR). Large companies often impose deployment of these tools on their industrial partners.

SMEs tend to have more "local" suppliers than do large firms, thus limiting their supply chain partner options. Partner participation in risk management is less certain in this case and as a result, small firms are obliged to manage their own risks. In addition, SMEs are by definition less structured, have smaller management teams, and risk management is poorly organized and informal. Large companies on the other hand can manage risk by calling upon their partner's network of contacts. Greater supply chain maturity also enables large companies to initiate partner reflection on specific subjects such as investment in robust information systems, establishment of safety stocks and the creation of formal, strict procedures.

5.3. Tools

The most popular supply chain management tools are those relating to continuous improvement (PDCA, six-sigma, continuous improvement, etc.) and this study confirms that six-sigma methodology is very fashionable at present (see Table 6). Mapping is well known and widely used to manage supply chain risk. FMECA is infrequently mentioned, coming next to last in the list of possible tools. It is, however, a tool cited in Anglo-Saxon literature either under the label Failure Modes and Effects Analysis (FMEA) or as critical paths, and cost-benefit analysis. The scoring method is less recognized, having the lowest number of respondents and being less often used than the other techniques (lowest average). Ultimately, risk management tools are, in fact, fairly standard quality management tools (PDCA, six-sigma, continuous improvement, etc.). Their advantage is rigorous methodology, especially in the case of six-sigma, and they provide important safeguards in management of risk. Pareto diagrams and ABC Ranking are fundamental in management as illustrated by the low non-answer response (12) but they are not the most effective tools. Finally, it was possible for respondents to mention other tools not noted in the list. These included "Total Care" at Airbus or the "Business Resumption Plan" at Hewlett Packard.

5.4. Minimizing techniques

In this section, we discuss risk minimizing techniques in supply chain management based on empirical data and analysis.

5.4.1. Results presentation

Communication and information exchange with partners is considered the best way to manage risk. Supplier support, forecasting accuracy and industrial relations continuity follow closely as the most frequently chosen alternatives (see Table 7). Together, these four factors suggest that management of organizational relations is important in managing risk. The least popular means are appointment of a supply chain risk manager, cultural proximity and presence of a firm backbone. Internal safety stocks and implementation of sanctions are the two solutions most often cited (with a number of valid responses at 135 in both cases), because solutions are known by all respondents.

5.4.2. Discussions about some results

5.4.2.1. Discrepancies in responses. The elements that indicate the greatest discrepancy between respondents are dual sourcing, reducing number of suppliers and activity planning using APS. At first glance, dual sourcing and reducing the number of suppliers may seem contradictory. The significant deviation between the two can be explained by the fact that these are incompatible solutions. In practice, the objective is to reduce the number of suppliers, retaining one representing 70% of sales and purchasing, and a second one (hence the dual sourcing) representing 30% sales and purchases. The second supplier is called upon in case of problems with the first partner for example. APS, the last solution, yields an important standard deviation, as few people are familiar with it, but those who are, consider it effective.

5.4.2.2. Dual sourcing. Dual sourcing may be an effective way to manage risk. To reduce safety stocks, companies buy class A products for their production (using the ABC method) and deploy external and/or internal dual sourcing solutions. Externally, this can mean having two suppliers or plants for the same product to avoid a monopoly situation. A simple calculation can indicate the percentages that should be allocated to each supplier with monthly review. Internally, it is possible to have redundant production equipment. However, even if

Table 6
Rank of tools used in SCRM.

Rank	In risk management, you use the following tools	N		Average	Standard deviation
		Valid	Missing		
1	G2. PDCA Cycle, Deming cycle, six-sigma, permanent improvement	130	15	4.84	2.01
2	B2. Mapping internal and external processes (Value Stream Mapping)	130	15	4.52	1.86
3	A2. Question Positioning Approach ("What if?")	129	16	4.50	1.94
4	F2. Ishikawa Diagram, Brainstorming	130	15	4.41	1.98
5	D2. Pareto diagram, ABC Ranking	133	12	4.40	2.12
6	E2. FMECA (Failure Mode, Effects, and Criticality Analysis)	131	14	3.84	2.12
7	C2. Scores method (measure of intensity by aggregation)	127	18	3.49	1.86

Table 7
Rank of risk mitigation methods.

Rank	The following methods effectively and efficiently minimize risk	N		Average	Standard deviation
		Valid	Missing		
1	I3. Communication and information exchange (forecasting, operational)	133	12	5.50	1.57
2	P3. Accompanying providers/suppliers in improving their performance	132	13	5.41	1.70
3	Q3. Forecast accuracy	133	12	5.26	1.83
4	M3. Long term continuity in relations with partners	128	17	5.15	1.67
5	C3. Safety stocks (Vendor owned inventory (VOI) or in-house)	135	10	5.07	1.85
6	F3. Establishment of emergency scenarios	130	15	4.91	1.74
7	G3. Introduction of strict and formal procedures that are consistently respected	131	14	4.89	1.62
8	A3. Activity planning using Advanced Planning System	132	13	4.86	1.95
9	D3. External partner-owned safety stocks	133	12	4.82	1.91
10	E3. Dual sourcing or manufacturing	134	11	4.67	2.01
11	B3. Responsiveness due to Supply Chain Event Management	129	16	4.55	1.87
12	N3. Introduction of sanctions and penalties for misconduct, faults, or mistakes	135	10	4.44	1.86
13	T3. Centralization of operations (stocks, production and/or distribution)	131	14	4.31	1.80
14	S3. Centralization of decision making	130	15	4.26	1.77
15	R3. Reduction of number of suppliers	133	12	4.26	1.93
16	J3. Geographical proximity to partners	132	13	3.92	1.89
17	O3. Introduction of rewards in absence of misconduct or faults	131	14	3.89	1.84
18	L3. Personal, friendly relationships with partners	130	15	3.87	1.83
19	H3 Appointment of risk manager who convenes an SCRM group	131	14	3.81	1.84
20	K3. Cultural proximity with partners	131	14	3.75	1.84
21	U3. Presence of focal firm which coordinates supply chain	124	21	3.36	1.64

physical capital is doubled, risk cannot be abolished. Here are two concrete examples: if equipment is used at 100% capacity, then the risk is untenable because there is no margin for increasing capacity if needed. On the other hand a store has an occupancy rate of greater than 80% and risk is substantial. However, financing a 20% stock increase costs comparatively little and retains a margin for reacting to risk.

5.4.2.3. Internal and external safety stocks. Because safety stocks are mentioned in fifth position we consider that they are not a means of risk management. These expensive assets hamper flexibility and run contrary to the concept of a lean supply chain and company. Delayed differentiation or postponement is, however, a difficult choice due to technical limitations preventing implementation.

Nonetheless, when forecasts are extremely uncertain, unpredictable or distorted by external events, safety stocks can provide an interesting response to risk management demands. These stocks may take various forms: raw materials (to overcome delivery delays), finished products (to meet rush orders or production demands), or spare parts in case of failure or for maintenance. They may either be attributed to the customer or kept in reserve by the company. The level of these stocks is contingent upon the situation and the customer, and need to be updated regularly according to client size, delivery needs, production, and consumption. A collaborative partnership is vital with calculations to improve forecast accuracy, penalties for poor performance and rewards for efforts resulting in a good match between predictions and results.

A company with significant bargaining power can easily set up a safety stock system with its customers to limit risk of supply chain breakdown. Large enterprises tend to favor deportee stocks or advanced stocks when managing external safety stocks. In this system, a portion of a supplier's stock is managed directly by the company. The supplier retains ownership of its goods, and only bills the firm when the product is "taken off the shelf". This practice presents a number of advantages including reduced inventory-related finance charges and fewer management decisions; risk taking is transferred to a partner, and there is reduced structure and greater flexibility. It is particularly suitable for products with short life cycles and significant, rapid price discounts as in the IT sector. Variants of this system exist, like SMI (Supplier Vendor Inventory), VMI (Vendor Managed Inventory) or CMI (Co-Managed Inventory). Ultimately, safety stocks constitute an excellent way to eliminate or reduce risk, but their maintenance generates other types of risk thus creating a vicious circle. Companies are obliged to make constant trade-offs between bearing and funding risk.

5.4.2.4. A paradox?. All interviewees agreed on the importance of the role and involvement of partners in risk management. This is manifested by the establishment of permanent relationships, promotion of communication, and exchange of information. However, questionnaire analysis highlights a certain irony in the responses. Organizations are conscious of the benefits of establishing relationships with their partners (as shown by the results for questions about communication and information exchange, accompanying providers/suppliers in improving their performance, and the long term continuity in relations with partners) to minimize risk in their supply chain. But, they do not really want to develop or maintain overly close relationships (whether geographical, cultural or personal proximity) with suppliers as a means to minimize risk. This is illustrated in the table above (average values for questions: proximity 3.92; personal relationship: 3.87; cultural proximity: 3.75). This phenomenon can be explained by the simple fact that in the professional world, businesses do not seek to establish personal ties or friendships: "business is business". There is no place for emotion. Labor relations are and remain professional. This attitude may explain certain differences between large companies and SMEs, since SMEs are more likely to develop close relationships with their partners.

5.4.2.5. Plan or react? Advanced Planning System (APS) vs. Supply Chain Event Management (SCEM). Among the various means proposed to minimize risk, two are potential antagonists; planning activities and responsiveness to events (See Table 8).

In risk management, it appears that planning is preferred over reactivity as reactivity is generally expensive and uncertain in its implementation. APS is used more frequently by SMEs or large companies that are "equipped". These companies tend to reject SCEM because reactivity can be understood as relatively unstructured and is seen as a major drawback.

A large global company with a medical equipment production unit in the Grenoble region has chosen to plan for any and all situations. Managers run their entire supply chain by planning and predicting the activities of all the players and by attempting to anticipate all possible contingencies. This requires implementation of an Advanced Planning

Table 8
Details of answers to questions concerning APS and SCEM.

Rank	The following ways effectively/efficiently minimize risks	N		Average	Standard deviation
		Valid	Missing		
8	A4. Activity planning using Advanced Planning System	132	13	4.86	1.95
11	B4. Responsiveness due to Supply Chain Event Management	129	16	4.55	1.87

System: a comprehensive information system serving the entire supply chain with an added layer of enterprise resource planning. It is a powerful tool for simulation, optimization and planning of the entire supply chain as it can simultaneously take into account all system constraints (applications, resources, capacity, time, cost, availability, etc.) in real time, and examine potential disruptions in the supply chain. Installation and use of APS is, however, very cumbersome from financial, organizational and informational standpoints.

Alternatively, managers can opt for reactivity by using SCEM, rather than relying on chain planning. SCEM aims to pilot every step of the supply chain process. At each stage, events are monitored and when a problem arises, a decision is instantaneously produced because the system relies on a stock of pre-established solutions. This tool is used to identify and manage risk in real time.

These responses are antagonistic by nature: one responds simply and cheaply to events and is easy and fast to implement. The other relies on global logistic chain prediction and planning. It is more cumbersome and is suitable for global companies with robust, clearly identified processes. The establishment of one or the other of these solutions is a strategic choice with serious consequences as this decision commits a company to a particular mode of administration requiring adequate organization and resources.

Ideally, we believe it is possible to use these two methods in the same chain. Delayed differentiation or postponement in the upstream part of the supply chain (suppliers and production units) can be managed with APS. Downstream, closer to the customer and assembly unit distribution centers, can be managed with SCEM solutions, because of greater flexibility and reactivity when facing rapid commercial deadlines. In reality, however, circumstances sometimes dictate managements' course of action, and choosing between these two specific modes of management is not necessarily a possibility. Ultimately, the distinction between SCEM and APS comes down to choosing a general attitude toward risk management in the supply chain: plan or react.

5.4.2.6. The role of a supply chain risk manager. In SCRM, strategy and framework are often provided by management. However, implementation and operational decisions are determined at more functional levels. During the qualitative study (prior to the quantitative survey), we met a company that has adopted this approach. Working increasingly in the electronic components manufacturing field, this large Rhone-Alps based company has over a thousand employees and is still growing. Direction hoped to incite reflexion on risk in the management team by creating a risk related management position. Sporting the name of *Business Continuity Manager*, this individual heads the SCRM group and, as indicated by the title, is responsible for assuring the uninterrupted continuation of the company's activities.

This position supports a holistic, macro-economic view of risk, while encouraging and building a network of local correspondents that are, by definition, extremely responsive because they are closer to the realities of each business unit and therefore familiar with each risk. Line managers and their staff must support the project and be responsible for decision-making and resource allocation at the local level. Managers know their business well and are aware of the types and levels of risk being faced. These risks are monitored and assessed through key performance indicators (KPI) that are found in many areas of industrial management. These managers seek correspondents and advisers to help identify and better manage their risks. They "own" their risks. Ultimately, they are responsible for all aspects of managing the company's risk, including the financial component.

A lack of preparedness either in terms of not detecting a risk, or not having thought about solutions to potential problems can have grave consequences. If there is support from upper management, this position can help avoid inertia that tends to creep into daily functioning of a company. The *Business Continuity Manager* has a broad range of responsibilities and is one of the rare managers with a global vision serving to coordinate joint actions at a local level. This individual's job is to create an organization-wide environment of risk awareness and perpetual anticipation. A further responsibility of this post lies in prioritizing potential risks, despite the fact that certain risks are identifiable but not always completely manageable.

Emergency plan development is another aspect of the post. As with safety stocks and oversupply, emergency plans exist for major hazards. However, when a risk becomes a reality, things rarely go as planned. Despite this, emergency plans are helpful because they structure responses and provide a guide to appropriate answers. Responses can, for example, include increasing production lines or dual sourcing using domestic stocks or vendor managed inventory. The transversal quality of this position provides the business continuity manager an opportunity to disseminate the best practices throughout the various branches of the company. Management may also assign this individual the task of relaying common indicators to all sub-units that are designed to measure performance. Financial and risk responsibility falls to each "component" in this global/local organization, but risk often depends largely on other players both inside and outside the organization. Thus, in the case of this company, their SCRM philosophy can be summed up by the maxim "think and act local, monitor global".

Supply chain risk management needs to be managed collectively with industrial and logistics partners. We can compare development of SCRM and quality functions at the organizational level. Historically, quality was linked to production and the workshop and has gradually become autonomous and is now linked hierarchically to upper management. This movement toward independence was possible due to maturity of the function, developed through formalization of methods. It also resulted from generalized employee recognition of the importance of quality and development of academic and technical expertise. The question left unanswered is the timeframe required for supply chain risk management to achieve similar independence and recognition and to establish its necessarily transverse position in organizations.

6. Concluding remarks

In this section, we summarize key findings, limitations and some future research directions.

6.1. Key findings

The aim of this paper is to understand and analyze management of business risks associated with supply chains. After defining Supply Chain Risk Management (SCRM) from the literature, we sought to enrich this definition by providing both an inter- and an intra-organizational vision. We have also attempted to provide, via our empirical study, a transversal vision into several organizations making up the chain. We find that for the companies in our study identifying supply chain risk is an unavoidable and necessary task that continues to pose certain problems. This function is, however, integrated in performance measures for logistics partners. Thus, companies adopt a proactive attitude, they are aware of the risks, they allocate resources and are organized (individually or by coordinating with their industrial partners) to manage risk. The term SCRM was not frequently used in manager discourses encountered during our study; however, real practices dramatically demonstrate their concerns in this area.

A company is never isolated, as it is part of a chain. Likewise, to be effective, SCRM cannot be practiced in isolation. The very definition of supply chain management, managing the flow of products, components and information, must be transversal and seek to integrate supply chain partners. Transversal management seems very appropriate to effectively manage supply chains and risks. Our study clearly demonstrates that SCRM is an operational management tool with tangible actions manifesting in the field, relayed by department heads, and with the participation of operators and employees. It is also a strategic tool with a defined long term master plan allocating resources and demonstrating willingness to collaborate with industrial partners within an organization and between

different partners of the same chain. This conclusion fully supports current main stream research in Supply Chain Management, i.e. that collaboration is the key to overall supply chain performance.

6.2. Limitations of the research

Limitations to our research include methodological concerns in the statistical part of the paper, a sample composed of firms with differing characteristics from several fields, and the simplicity of the chosen statistical tools (average and standard deviation). With more sophisticated instruments much more could be done with the data base presented in this paper. In this study we were interested in respondent perceptions and not the reality of risk and of SCRM. As a result, there are some biases in terms of history, maturation, contamination, and selection. This is a classic problem encountered when the research question focuses on managers and their practices. Theoretical limitations concern the fact that we neither study the source of supply chain risks, nor their consequences on performance.

6.3. Further research

It would be interesting to construct a typology of attitudes toward risk and try to characterize companies based on their adoption of different responses to risk. Also, suitable models and techniques should be developed for evaluating the impact of risks in supply chain and its management. Detailed case studies should be conducted to study how different companies perceive risks in their supply chain, assessment of their risks both in terms of severity and impact on the organizational performance and subsequently the strategies, techniques and tools used for mitigating the effect of supply chain risks.

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