SPECIAL ISSUE
Article invited
DOI: http://dx.doi.org/10.12660/joscmv8n1p72-87

Risk Management in the Supply Chain of the Brazilian automotive industry

Edson Júnior Gomes Guedes
FGV-EAESP
edson.guedes77@gmail.com

Alexandre de Vicente Bittar
FGV-EAESP
alexandre.bittar@fgv.br

Luiz Carlos Di Serio
FGV-EAESP
luiz.diserio@fgv.br

Luciel Henrique de Oliveira
FGV-EAESP
luciel.oliveira@fgv.br

ABSTRACT: With a growth scenario found in few places in the world, the Brazilian automotive market has become attractive, jumping from investments of about 1 billion dollar in 2005 to more than 5 billion dollars in 2012. This article has the objective to give a vision of the supply chain risk management in the Brazilian automotive industry through a case study, when samples of a strong (an automaker) and a weak (a second tier supplier) links were compared based on existing theory in order to understand their limits, variables and potential new findings. Secondary data generated by Sindipeças, ANFAVEA and national institutes were used in the context of the case study, as well as semi-structured interviews with executives and experts in risk management and supply chain areas of an automaker and a second tier supplier installed in Brazil.

Keywords*: Risk management, supply chain, automotive industry, case study.*

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

1. INTRODUCTION

The Brazilian automotive industry is one of the most important automotive industries in the world, both from the point of view of vehicles production as of consumer market. It is currently the seventh largest producer and has the fourth largest consumer market, with 26 automakers established in the country, including the production of buses and trucks (ANFAVEA, 2013).

From 2002 to 2011 the Brazilian automotive market grew 145%, while production progressed at a slower pace, reaching 109% in the same period. This growth scenario was found in very few places in the world, which made the Brazilian automotive market attractive for investment by automakers in the country, jumping from just over $ 1 billion in 2005 to nearly $ 5.4 billion in 2012 (ANFAVEA, 2013). Thus, the Brazilian automotive industry has guaranteed presence in macroeconomic discussions of the country, with a share of the Brazilian industrial GDP of 21% and total GDP of 5%.

In an environment where internal demand was higher than local production was capable to supply, the quest for competitiveness and productivity gains became a recurring theme in the executive agenda in order to increase market share and profitability, and at the same time the search for risk reduction and its consequent losses began to be discussed in the companies.

The supply chain of the automotive industry is characterized by (1) a lot of links from raw materials to the final consumer (dealerships, automakers, auto parts manufacturers, manufacturing industries and raw material producers), (2) outsourcing, (3) increasing reliance on suppliers in the strategic procurement process, (4) use of information technology and communication tools in a cooperative way, and (5) globalization (Narasimhan & Talluri, 2009). Due to this context of high complexity, it is growing the interest in risk management in the recent literature on supply chain management.

In addition to the complexity of the automotive supply chain, Wagner and Neshat (2009) suggest the increase of natural disasters (i.e. droughts, floods, hurricanes and earthquakes) and disasters generated by human action (i.e. wars, accidents, strikes and terrorist attacks) as sources of vulnerability of supply chains. Therefore, issues such as competition based on quality, cycle time, delivery and technology (Lee, Padmanabhan & Wang, 1997; Flynn & Flynn, 2004) have been revisited under the concept of the resilience of the supply chain (Zolli, 2012; Christopher & Peck, 2004).

Despite a growing interest in supply chain risk management in developed countries, the subject is poorly treated in the Brazilian academic literature, as shown by the bibliographic reference of one of the few publications available (Di Serio, Oliveira & Schuch, 2011). In a recent field research conducted by Sodhi, Son and Tang (2012), it was concluded that this new field of business practice has three significant weaknesses: (1) supply chain risk management terms and definitions are not yet consolidated and present significant differences between researchers, (2) inadequate coverage of the responses to the risks of incidents and (3) inappropriate use of empirical methods in published research.

This article has the objective to provide a case study related to the supply chain of the Brazilian automotive industry, with particular attention to risk management, seeking to understand the supply chain risk management in the Brazilian automotive industry, considering the network of manufacturers (OEMs), systems suppliers (first tier) and mainly their suppliers (second tier). Thus, the research question is:

How is the supply chain risk management in the Brazilian automotive industry, based on a case study?

This paper is organized into five sections: the first one consists of this introduction, presenting the theme and its relevance to the business practice. In the second section, it is made a presentation of the theoretical basis, with a brief history of the evolution of risk management in the supply chain field. The third section deals with the methodology, with details of the tools used for the data collection, treatment and analysis. The fourth section brings the case study itself, followed by the fifth section, with discussions about the case and the conclusions, with its main findings and contributions to business practice.

2. LITERATURE REVIEW

The theorethical framework of this section will cover three streams of study: supply chain management, risk management, and supply chain risk management.

2.1 Supply Chain Management

There is an extensive literature related to the supply chain management. The criticality of processes and operations integration among every link has been discussed and analyzed by scholars over the past 30 years (Wheelwright & Hayes, 1985; Porter, 1986; Lee, Padmanabhan & Wang, 1997; Flynn & Flynn, 2004; Souza

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

Filho, Pereira, Di Serio & Martins, 2011 and 2012).

The term supply chain management (SCM) was coined in the 1980s by a group of consultants after the conclusion that problems related with materials flow had direct impact in the business, bringing to discussion the importance of this theme and proposing a management of the chain of the suppliers. The popularity of the SCM concept has been fostered by many researchs from correlated events as (Chen & Paulraj, 2004): (1) the quality revolution, (2) the discussion over materials management and integrated logistics, (3) the growing interest in industrial markets and their networks, (4) the notion of increasing focus, and (5) the publication of relevant studies on specific industries.

In terms of theoretical development, two approaches were observed. The first is to fragment the scale of management issues in the supply chain into more manageable pieces and then develop the theory in relation to this specific problem. Examples of this can be seen in the emergence of sustainable supply chain management (SSCM) and supply chain risk management (SCRM). The second one is to keep a broad conceptual approach and integrate the theories being developed from many different perspectives. This is the approach adopted in the seminal works of Mentzer et al. (2001) and Lamber and Cooper (2000).

In the automotive industry, terms such as cooperation, collaboration and competition have become common in a globalized business environment (Souza Filho et al., 2011), with technological and specialized human resources shared among manufacturers and members of the supply chain, known as systems suppliers (first tier) and their suppliers (second and third tiers).

In order to classify the different supply chains according to their scope, Mentzer et al. (2001) points out that "any organization can be part of numerous supply chains. Walmart, for example, can be part of the supply chain for candy, clothes, computers, and many other products". It can be seen then that a clear definition of a particular supply chain will depend on the company used as a reference. For this reason, Mentzer et al. (2001) proposes three definitions of supply chain complexity: a direct supply chain, an extended supply chain, and an ultimate supply chain. A direct supply chain consists of a minimum complexity, where a company and its direct supplier and customer are involved in the upstream and downstream flows of products and information. In the other extreme, an ultimate supply chain includes all the organizations involved in all the upstream and downstream flows of products, services, finances, and information.

Another classification that supply chains often receive is related with the degrees of separation from the focal company: its suppliers are called first tier and the suppliers of suppliers are called second tier (Lambert & Cooper, 2000).

Along three decades of the subject of the supply chain management, academics and professionals contributed to the consolidation of the constructs (Table 1). Unlike what is most recently seen in supply chain risk management (SCRM), the terms and definitions in SCM show little variation and can be used as a basis for understanding SCRM.

Table 1 – SCM constructs by author

SCM Literature Constructs		
Burgess, Singh & Koroglu (2006)	"Soft" Constructs	Leadership
		Intra-organization relationships
		Inter-organization relationships
	"Hard" Constructs	Logistics
		Process improvement orientation
		Information system
		Business results and outcomes
Stadtler (2005)	Integration of organizational units	Choice of partners
		Network organization and inter-organizational collaboration
		Leadership
	Flow coordination	Use of Information and communication technology
		Process orientation
		Advanced planning

Chen & Paulraj (2004)	Environmental uncertainty	–
	Customer focus	–
	Information Technology	–
	Strategic purchasing	Competitive priorities
		Purchasing strategy
	Supply network coordination	–
	Supply Management	Communication
		Supplier base reduction
		Long term relationships
		Supplier selection
		Supplier certification
		Supplier involvement
		Cross-functional teams
		Trust and commitment
	Logistics integration	Internal integration
		External integration
	Supply chain performance (Buyer and Supplier)	Financial performance
		Operational performance
		Supply chain performance
Mentzer et al. (2001)	Integrated behavior	–
	Mutual sharing of information	–
	Mutual sharing risks and rewards	–
	Cooperation	–
	The same goal and the same focus on serving customers	–
	Integration of processes	–
	Partners to build and maintain long term relationships	–
Lambert & Cooper (2000)	Physical and technical management components	Planning and control methods
		Work structure / Activity structure
		Organization structure
		Product flow facility structure
		Information flow facility structure
	Managerial and behavioral management components	Management methods
		Power and leadership structure
		Risk and reward structure
		Culture and attitude

2.2 Risk Management

The concept of risk used by IBGC (Instituto Brasileiro de Governança Corporativa - Brazilian Institute of Corporate Governance) is important for the understanding of the hypothesis and to delimit the scope:

> *Risk as the possibility of something does not work is a common understanding, but the current concept of risk involves the quantification and qualification of uncertainty, both with respect to losses and earnings, and with respect to the direction of the planned events, whether by individuals or by organizations. Operational risks stem from the possibility of losses (production, assets, customers, revenue) resulting from faults, deficiencies or inadequacy of internal processes, people and systems or from external events such as natural disasters, fraud, strikes and terrorist acts. (IBGC, 2007)*

Risk is defined as the potential for undesirable negative consequences which can arise from an event or activity (Rowe, 1980). Waters (2011), in turn, defines risk in a supply chain when unexpected events can interrupt the flow of materials in their journey of initial suppliers through end customers. The potential occurrence of an incident or the failure to seize opportunities can generate a financial loss for the company (Zsidisin & Smith, 2005). In a study by Kerner and Lynch (2011), more than 709% of the 300 participating companies in-

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

dicated to have suffered an interruption of supply, and 50% of these companies had the experience of more than one rupture. Many of these risks are unavoidable, clearly noted when it is involved natural disasters.

It is important to note that risk management is not intended to eliminate risk completely, but to evaluate the various risk treatment alternatives, including:

a) Avoid the risk: not to act in a situation where certain risk occurs

b) Accept the risk:

b.1) Hold the risk: keep the risk at the current level of impact and probability

b.2) Reduce the risk: minimize the current level of impact and probability

b.3) Transfer / Share risk: reduce the impact and/or probability by transfer or, in some cases, sharing part of the risk

b.4) Explore the risk: increase the degree of exposure to the extent that it enables competitive advantages

Despite the literature concentration in financial risk, most of the entrepreneurial efforts in the prevention and reduction of risks generated significant experience in the risk management, mainly operational risks, as well as in the management of adverse impacts and situations of interruption of organizations in several industries. Thus, it is possible to exemplify situations where each type of operational risk produces losses (Protiviti, 2006):

Table 2 – Operational risks (Protiviti, 2006)

OPERATIONAL RISKS (Protiviti, 2006)	
Efficiency Risk	High production cycle time generating excessive inventory
	Increase in errors during production
	Increased production costs
Capacity Risk	Underutilized productive capacity of the business unit
	Productive capacity of the business unit is not adequate to meet the customer demand
Scale Risk	Inability to operate efficiently in high volumes, preventing better recovery of costs and resulting in loss of economies of scale and better margins
	Production process equipaments are obsolete
	Operational labor not able to operate in large volumes
	Production process equipments do not support high volume production
Performance Risk	Inferior quality when compared to the competition or the best in the market
	High costs when compared to the competition or the best in the market
	High production cycle time when compared to the competition or the best in the market
Cycle time Risk	High cycle time means greater need of capital use, blocking capital release for investment in growth strategies
	Shorter cycle time allows the use of JIT (Just-in-Time), reducing the size of inventories and increasing cash flow
	Shorter cycle time enables greater flexibility of delivery, reduced costs, better communication and greater reliability
Interruption Risk	Unavailability of raw materials
	Unavailability of experienced and/or skilled workforce
	Crash of critical systems for business continuity

The impact of these risks in supply chain management will be evaluated in this study in order to show that the investment in the fixed assets of Brazilian business community must take into account not only the traditional financial return as EBIT, ROE or ROA, but also the reduction of this risk in order to not expose the company and its customers to production losses, consumers, and ultimately, revenue (IBGC, 2007).

2.3 Supply Chain Risk Management

Since the 1990s, initiatives to increase corporate profitability (ie revenue growth, cost reduction, asset impairment) occurred simultaneously with the increasing complexity of supply chains (Craighead, Blackhurst, Rungtusanatham & Handfield, 2007). Bakshi and Kleindorfer (2009) and Sodhi (2005) point to factors such as globalization of the supply chain

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

and reducing the life cycle of products as responsibles for a greater exposure to the risk of supply chains. In addition, the increase in the number of natural disasters (ie droughts, floods, hurricanes and earthquakes) and disasters generated by human action (ie wars, accidents, strikes and terrorist attacks) are sources of vulnerability of supply chains (Wagner & Neshat, 2009). Authors like Sheffi (2005) and Tang (2006) have called attention to the need for resilience or strengthening of supply chains in order to reduce the vulnerability brought by these external factors.

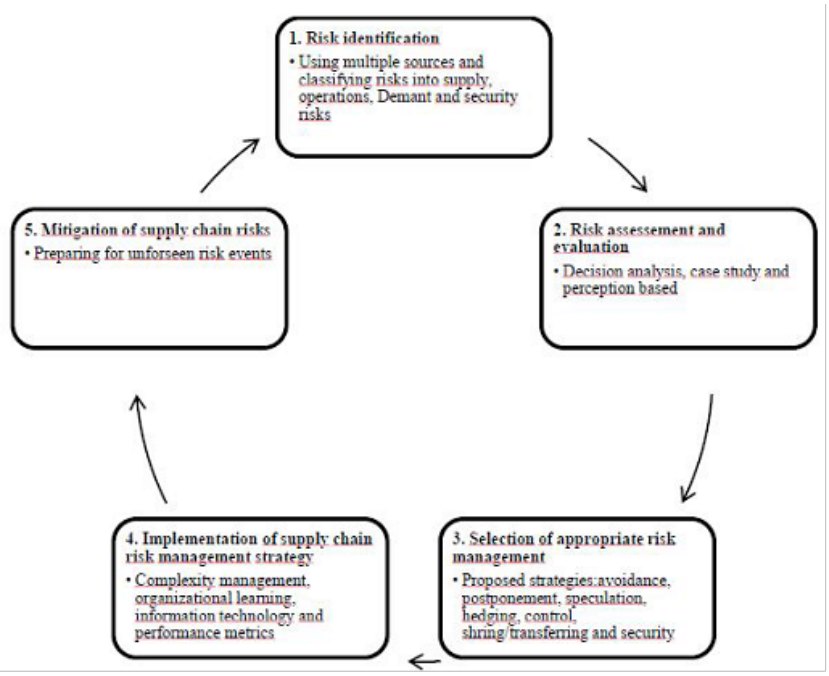
Examples of supply chains disruptions cited in academic and professional publications show the diversity of risks and industries exposed to them. Ford and Land Rover, both of the automobile industry, faced significant breaks in 2001 for incidents arising from distinct risks: while Ford closed its factories for days due to the terrorist attacks of September 11, Land Rover dismissed over 1,000 employees after a bankruptcy of one supplier of its chain. The information technology and communication supply chains have also suffered disruptions, with names like Dell, Sony and Ericsson joining the list of companies with financial performance impacted by the failure of one link (Chopra & Sodhi, 2004; Martha & Subbakrishna, 2002; Sheffi, 2005; Hendricks & Singhal, 2003, 2005a, 2005b; Wagner & Bode, 2008a, 2008b).

However, few incidents infringed operational and financial impact as big as those that occurred in Fukushima, Japan, in 2011. In a series of natural and nuclear disasters, the supply chain of the Japanese automotive industry, characterized by the concept of lean manufacturing and globally known by JIT (just-in-time) practices, faced extended rupture of its production causing millions in financial losses. As an example, Toyota and Honda had losses of more than $ 3,200 million and $ 800 million respectively. Since then researchers began to distinguish the supply chain risk management studies in two research lines: the management of the supply chain to respond to risks of high probability (or occurrence) and low impact, also called operational risks (Blackhurst, Craighead, Elkins & Handfield, 2005; Tang & Tomlin, 2008; Braunscheidel & Suresh, 2009), and the management of the supply chain to respond to risks of low probability (or occurrence) and high impact, called catastrophic risks (Norrman & Jansson, 2004; Kleindorfer & Saad, 2005; Knemeyer, Zinn & Eroglu, 2009).

Wagner and Neshat (2009) report a long list of incidents and their consequences for the companies inserted in a supply chain when their vulnerabilities are not identified, assessed and mitigated. According to them, supply chain managers should be better prepared methodologically and have available tools of supply chain risk management, and not remain only in the conceptual or normative level theme.

Manu and Mentzer (2008) demonstrate illustratively the five steps for managing the process of supply chain risk management and its mitigation.

Figure 1 – 5 steps to managing the risk management process and its mitigation in the supply chain



ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

A case registered in the United States (Bednarz, 2006) shows how the supply chain risk management can support the business continuity, even in situations where the damages challenge the most sophisticated contingency plans. For Procter & Gamble, a business continuity plan was essential to the recovery of the business, which was submerged after Hurricane Katrina swept the Gulf Coast region in August 2005. In less than a month, the company had reached more than 85% of its coffee production level from third-party sources and alternative sites of the company.

Carvalho et al. (2011) reports in his article the interchangeability of terms such as disturbance (Mason-Jones & Towill, 1998), rupture (Blackhurst et al., 2005), vulnerability (Svensson, 2004; Wagner & Neshat, 2009) and risk (Chopra & Sodhi, 2004) in the supply chain management. It appears then that this new field of administrative practice presents significant gap in the consensus on terms and definitions, and that it is necessary for the evolution of supply chain risk management the consolidation of such terms and definitions in order to minimize the significant differences between researchers.

Many studies suggest strategies such as risk assessment and mitigation in order to deal with disruptions in the supply chain (Kleindorfer & Saad, 2005). According to Ji and Zhu (2008), Norrman and Jansson (2004), Pickett (2006) and Kull (2008), strategies for risk management in the supply chain should significantly contribute to the reduction of losses, probability, speed, frequency and exposure to risk events. The sensitive point of these suggestions is the balance between the benefits and costs of supply chain risk management, since some of the proposals for risk mitigation go against cost reduction initiatives such as the sustained decrease in inventory levels by lean production (lean manufacturing concept) and JIT / JIS (Just-In-Time / Just-In-Sequence).

Azevedo et al. (2008) proposes that the management of the supply chain progresses to a level of resilience of organizations through the following variables: level of inventory, supply chain, outsourcing and information sharing level.

Di Serio, Oliveira and Schuch (2011) propose four objectives for a job focused on the supply chain risk management: (1) organizations consider risk management as an important initiative for carrying out their strategies and obtaining sustainable results; (2) organizations include formal risk analyses in their decision-making processes; (3) identification, analysis and handling of financial risks is more developed than in the case of operating risks, and (4) the adoption of a structured organizational risk management system has a positive impact on performance.

Considering the growth scenario of the Brazilian automotive market boosted by high investments recorded between 2005 and 2011, there was an increase in production demand and productivity of the entire supply chain. Assuming the use of direct and indirect labor, equipment, raw materials, energy, and other resources are related with production function, the impact of risk management that senior managers have on operational decisions is relevant, as quality, cost, flexibility, reliability and cycle time are key factors to respond to a growing demand for production in an increasingly complex environment.

In a complex supply chain as in the automotive industry, there are a lot of links from raw material to the final consumer (dealerships, vehicle manufacturers, systems suppliers and parts manufacturers, manufacturing industries and raw materials producers). In addition, outsourcing, the growing dependence on suppliers in the strategic purchasing process, the cooperative use of information technology and communications tools, and globalization (Narasimhan & Talluri, 2009) should be taken into account in the risk management. These factors make this supply chain susceptible to ruptures when the weak link is not evaluated, monitored and changed to meet the requirements of quality, cycle time, delivery and technology (Lee et al., 1997; Flynn and Flynn, 2004).

3. METHODOLOGY

Considering the gap identified in the research, notably the terms and definitions of supply chain risk management not consolidated yet and significant differences among researchers, inadequate coverage of the responses to the risks of incidents and, finally, the inappropriate use of empirical methods in the published researches (Sodhi, Son & Tang, 2012), it was decided to use case study as the methodology for this paper, since it offers a suitable mean of in-depth analysis of emerging practices (Voss, Tsikriktsis & Frohlich, 2002).

Yin (2009) points three characteristics as crucial to make a case study relevant: (1) the case is not common and is of interest to the general public, (2) the subliminal problems of the case are of national importance, whether from the point of theoretical view

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

or from a practical point of view, and (3) the case features the two characteristics above.

Taking into account that the supply chain risk management is a world emerging issue, with little treatment in academic publications and journals when compared with issues such as supply chain management or risk management, and being the chosen locus for this work the Brazilian automotive industry, relevant to the Brazilian economy, it is considered that the specifications for a case study was met.

The objective of this study is to provide a scenario that allows the reader to infer how is the supply chain risk management in the Brazilian automotive industry through a case study of two analytical units integrated into the same supply chain and exposed to the same economic and industrial macro-environment. This is done through the characterization of each individual case, before any generalizations that can be given at the conclusion of this study (Yin, 2009; Voss et al., 2002; Eisenhardt, 1989).

From the point of view of the approach, this work adopts the form of an exploratory research (Creswell, 2007) in order to verify if the characteristics of the supply chain risk management of the Brazilian automotive industry have some correlation with the different risks from this theoretical review and from the interviews based on semi-structured questionnaire used for the preparation of the case study.

The case study was conducted in two links of the Brazilian automotive supply chain industry - an automaker and a component supplier company, also called as second tier. The reason for this choice was what Flyvbjerg (2011) calls extreme cases or outliers. Systematic investigation of outliers can increase the chances of discovering new ideas. The variables of each company - number of employees, annual billing, capital source and risk management structure (Table 3) are extremelly divergent, contrasting the units of analysis, which enables deeper understanding of risk management in the supply chain and open space for developing and discussing new concepts about it.

Table 3 - Comparison between Automaker and Component Supplier

	AUTOMAKER	COMPONENT SUPPLIER
Number of Employees	> 10.000 employees	< 500 employees
Total Revenue per year	> US$ 1 billion	< US$ 100 million
Capital Source	USA	Brazil
Risk Management Structure	Organized, uses assessment tools and has formal decision-making process based on risk analysis	Not organized, no use of assessment tools and has no formal decision-making process based on risk analysis

The use of multiple sources of evidence, such as secondary data generated by Sindipeças, ANFAVEA and national institutes is justified as support for the supply chain risk management context among the various participants in the Brazilian automotive market. In addition, semi-structured interviews (Flynn, Sado, Schroeder, Bates & Flynn, 1990) were held with executives and specialists in risk management and supply chain areas from the automaker and from the second tier supplier to build such case study. Any finding or conclusion of the case study is more accurate through the triangulation of data sources. Thus, it is possible to unite in one case study personal experience and extensive field research (Yin, 2009).

4. CASE STUDY IN THE BRAZILIAN AUTOMOTIVE CHAIN

The availability of components has been a recurring theme in the Brazilian automotive industry in recent years, mainly due to the production growth of motor vehicles in Brazil. The increase in the number of vehicle manufacturers in the country (ANFAVEA, 2013), the amount of investment in fixed assets in the sector (IBGE, 2010) and the increasing dependence on automakers and their suppliers on import components (Sindipeças, 2012) has raised the interest of professionals and researchers in a rising area: supply chain risk management.

4.1 Automaker Case

Installed in Brazil as the first subsidiary outside its country of origin, the automaker of this case study is listed among the top 10 in vehicle sales in Brazil and worldwide. In 1956, it began a process of nationalization of production of its vehicles through

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

the efforts of the Automotive Industry Executive Group (Grupo Executivo da Indústria Automobilística - GEIA) for the consolidation of the Brazilian industrial park. It is an exemplary sample for the study of supply chain risk management because it has a global political governance, requiring from the subsidiaries around the world the application of procedures and attendance of legal requirements not always required by the legislation of the country where the subsidiaries are located.

After the disaster of Fukushima, Japan, in 2011, the headquarters began a series of changes aimed at integrating the various tools for the assessment, measurement and mitigation of risks. The stated goal was to prevent that low probability and high impact events could affect business continuity and to avoid that they passed unnoticed in decision-making - from the installation of a new plant to the purchase of components from suppliers installed in regions of high risk of supply disruption.

Examples of disruption of supply chains cited in academic and professional publications show the diversity of risks and industries exposed to them (Chopra and Sodhi, 2004; Martha and Subbakrishna, 2002; Sheffi, 2005; Hendricks and Singhal, 2003, 2005a, 2005b; Wagner and Bode, 2008a).

The automaker has a Risk Management department (figure 2), a formal functional structure of supply chain risk management, with risk management managers allocated in Finance and in Operations, the last one focused at the Purchasing activity. The influence of this risk departament is not restricted to these functional areas, because Supply Chain, Logistics and Manufacturing also respond in matrix for Risk Management.

Figure 2 – Automaker risk management organizational chart

These functional areas have a group of expert analysts in the assessment, measurement and mitigation of risk as part of cross-functional teams responsible for ERM - Enterprise Risk Management. They act from the strategic plan to the implementation of activities, with the overall objective to ensure business continuity. They are supported by consultants and insurers which have operations in the country, but whose hiring is under direct influence of the headquarters. In the interview with one of the consultants of the insurance companies that provides services to the automaker, it was detected the alignment of the Brazilian subsidiary with the governance policies of the headquarters. The attendance of local requirements occurs only when local legislation is prevalent in relation to the headquarters policies.

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

The risk management activity in the Financial and Purchasing areas is aimed at preventing the occurrence of incidents that result in business interruption. The analysis of the financial health of the suppliers is considered in new business, and take into account the supplier's capitalization, timely payment history, threats to break up in trade negotiations and more recently, access to credit.

For the interviewed employees in the automaker, risk management is understood as a multifunctional activity. In addition to a centralized structure (ERM) to support the different functional areas in specific risk management, each executive is responsible for supporting practices to identify, assess, manage and mitigate the material risks to business continuity or to the achievement of company goals.

The areas of Purchasing, Logistics and Supply Chain plays an important role in supply risk management as they are responsible for the procurement of parts for vehicles, machinery and equipment for factories, and products and services used globally by the Assembly. In these areas, supply chain risk management began in 2004 in response to the escalation in the number of suppliers who had chronic financial problems. According to one interviewed, "considering the complex structure of the deal, the automaker has a vast supplier base but still fragile. Moreover, our success or failure is intrinsically linked to our suppliers." It is important to notice that, in response to business requirements of the automaker, the component suppliers became to present a capital intensive business model, with higher necessity of capital to investments in development and material costs. Furthermore, these companies are exposed to long development cycles for new products.

In the Supplier Quality, Supply Chain and Logistics areas, there is no expertise in risk management. The use of assessment tools, measurement and risk mitigation at supply chain is not a regular and homogeneous activity. Although audited, the risk management in these areas is not relevant in the decision making process for new business with suppliers. The difficulty in quantifying the financial risks in quality, cycle time and delivery time (Lee et al., 1997; Flynn & Flynn, 2004) has been the biggest obstacle to these areas to influence the process of strategic purchasing. If revisited in the light of supply chain resilience (Zolli, 2012; Sheffi, 2005), such decision making processes should consider who and where the automaker will buy their components and systems, taking into account the total cost of the transaction.

It became clear during the interview that the supply chain risk management is in a higher stage of development in the areas of Finance and Purchasing than in Supplier Quality, Supply Chain and Logistics. According to one interviewee, this can occur due to internal policies related to SOX requirements (Sarbanes-Oxley) and the COSO II (Committee of Sponsoring Organizations of the Treadway Commission). These requirements, applied extensively after regulation aimed at reducing the risks of international and USA financial system, led to the development of risk management related areas in automotive companies.

The situation of a troubled supplier can be identified in many different ways, as well as by many different people. According to the Operational Risk Manager, it is imperative that the TS (Troubled Supplier) Team engages as soon as possible so that problems can be evaluated and the situation be remedied before further deterioration of the supply chain.

All cases of TS are ranked between "active management" or "proactive management". Active cases can be broadly characterized as suppliers with financial problems situations, where the TS team is actively involved in the development and implementation of a risk mitigation strategy. For proactive cases, the initial assessment of TS team can conclude that a risk mitigation strategy will be needed if the supplier become financially troubled.

Once the team is aware of a supplier with problems, a review of the situation is performed. If the team is informed of the real or potential situation on time, the automaker usually sends a team of internal operations and external financial advisers for a thorough examination of the business, including a review of operations and the viability in the short and long term. According to one interviewed, sometimes the staff is notified to the scene too late, and has not enough time to perform a thorough analysis. In such cases, the internal staff or external financial advisors, together with the greatest amount of information available, formulate a mitigation strategy for the chain rupture risk.

The goal of short term strategy is to understand the company's liquidity position and capacity to finance ongoing operations as well its working capital requirements over the next few days or weeks. In the short term, the company's cash position is the most important factor considered by the team.

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

The goal of long term analysis is to evaluate the company's ability to finance other demands such as payment of the outstanding debt or collection of taxes and legal deposits related to the payroll. The long term analysis includes a detailed examination of the supplier's capital structure in order to determine its viability as a going concern. Related to the analysis of the capital structure, external financial consultants also assess the company's value from the perspective of an ordered or forced liquidation in order to take appropriate decisions regarding the strategy of permanence or exit.

The financial analysis also describes the interests of other parties involved with the companies in difficulties as well as its strategic and economic interests. This list includes, but is not limited to lenders, owners, trade creditors and other clients.

Generally, operating in-depth analyzes are only possible when there is enough time. However, as far as possible, the analyzes are performed in situations of imminent break, especially in cases in which continuity of supply is involved. The primary objective of the operational analysis is to determine the company's ability to maintain the continuity of supply to the automaker.

Although the continuity of supply is directly related to the financial resources of a company, this analysis looks at the management capacity (some managers may have left the company due to bankrupt), ability and productive capacity. For example, if a company has several plants operating below capacity, there may be opportunity for consolidation, which not only improve operational performance, but also provide cost savings. This analysis becomes especially important if the launch of a new vehicle is involved or if the supplier is entering a new line of business, where there was no proven evidence of their capability.

The risk of natural disasters is also under the scope of the ERM. Brazil has not had yet systematic and integrated databases on disaster occurrences and therefore did not make available to professionals and researchers processed information about these events in historical series. In an effort Similar to the work done by the CRED (Centre for Research on the Epidemiology of Disasters) of the "Université Catholique de Louvain", the Brazilian Atlas of Natural Disasters is a product of research, a result of the cooperation agreement between the National Secretariat of Civil Defense and the University Center for Studies and Research on Disasters at Federal University of Santa Catarina.

This research compiled and made available on the site of S2ID - Integrated Disaster Information, information on disaster records occurred throughout the country in the last 20 years (1991-2010). The survey of historical records, deriving in the preparation of thematic maps and production of the Atlas, is relevant because it enables to build an overview of the occurrence and recurrence of disasters in the country and its specificities for States and Regions. Therefore, it allows support the proper planning in risk management and disaster reduction, from the extended analysis covering the country, the observed frequency patterns, the periods of high occurrence, the relationship of these events with other global phenomena and the analysis on the processes related to disasters in the country.

The Brazilian Atlas of Natural Disasters is the first nationwide work, and presents thematic maps of natural disaster occurrences in Brazil, referring to 31909 records of occurrences, which show annually the risks related to natural disasters as sudden inundation, flooding, gradual inundation, windstorm and/or cyclone, distributed in thematic maps of events, which, together with the analysis of the records and human damage, give a complete picture of disasters in the country, in order to support the planning and management of the risk minimization actions. This work represents an effort by the state and the academy for proper planning in risk management and disaster reduction. Such information may be used by various entities of the automotive industry to mitigate the losses related to the risk of interruption of the supply chain.

Among the most frequent natural disasters in Brazil, the largest impact on the automotive industry supply chain is caused by the sudden inundation and flooding. As the national logistics is mainly based on road transport, this type of event usually stop partially or totally roads and highways. In evaluating the natural disaster map from sudden inundation and flooding in Brazil in 1991 and 2010 period and its respective distribution by region, there is a significant concentration in the South and Southeast regions. If we compare this concentration of occurrences with the concentration of vehicle manufacturers systems suppliers and component suppliers in the automotive industry in the same regions, which is 91.3% (IBGE, 2010), we conclude that the assessment, management and mitigation of such risks are justified.

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

4.2 Component Supplier Case

The supplier of components is a national capital company, whose founders act as executives directly linked to the areas of Engineering, Finance and Sales. It has been operating for more than 60 years in the domestic market of metal components, and despite its diversification of markets (electronics and white goods), the portfolio of automotive clients represents about 70% of annual sales.

The component supplier participates in the supply chain of the automaker (second tier). Risk management has no formal structure and is in charge of functional managers, which have no formal expertise in risk management. There are no expert analysts in the assessment, measurement and risk mitigation, but it is supported by consultants and insurers whose hiring is under direct influence of the automaker. In the interview with one of the executives not related to the controlling family, it was detected the alignment with the existing governance of the client.

The use of assessment tools, measurement and risk mitigation of the supply chain is not regular and homogeneous in the company. These tools were provided by the automaker and were found in the structures of Finance, Procurement, Supplier Quality, Supply Chain and Logistics. Although audited by the automaker, risk management in these areas is not relevant in the decision making process for new business with suppliers. The difficulty in quantifying the financial risks in quality, cycle time and delivery time (Lee et al., 1997; Flynn & Flynn, 2004) has been the biggest obstacle to these areas to influence the process of strategic purchasing. If revisited in the light of resilience of the supply chain (Zolli, 2012; Sheffi, 2005), such decision-making processes should consider who and where the Component Supplier buy their inputs, taking into account the total cost of the transaction.

The functional areas are not prepared to handle with the risks described in the literature as being causes of supply disruption. The company does not act preventively over the incidents indicated by the automaker, and reacts on the occurrence of incidents that result in business interruption.

Initiatives related to cross-functional teams responsible for ERM - Enterprise Risk Management are unknown in the company. They act in the strategic plan just for investment decisions and for the operationalization of activities, with the overall objective to ensure business continuity.

5. CONCLUSION

The objective of this article was to provide a case study related to the supply chain risk management of the Brazilian automotive industry, considering the network of manufacturers, systems suppliers (first tier) and mainly their suppliers (second tier), and to answer to the research question:

How is the supply chain risk management in the Brazilian automotive industry, based on a case study?

Through a case study with two units of analysis of the Brazilian automotive chain, the present work provided an exploratory analysis that implies there is heterogeneity in the risk management between the chain links. The intentional choice of a unit of analysis considered as strong link (automaker) and another one considered as weak link (components supplier) exposed the vulnerability (Wagner & Neshat, 2009) of the supply chain of the Brazilian automotive industry due to the lack of risk management in the second tier supplier. It was found that there are gaps in the supply chain risk management in the Brazilian automotive industry when compared with its global competitors. The main reasons are:

(a) the second tier supplier is basically working with risk management to attend the necessities of the automaker or your direct customer (first tier supplier). There is no own intention to invest on risk management: it is necessary investment in specialized people and resources, and in a situation of competitive resources the company prefers to invest on other demands;

(b) the automaker does not require the analysis of risk management of the second tier suppliers in their decision making with the first tier suppliers. The difficulty in quantifying financial risks in quality, cycle time and delivery time (Lee et al., 1997; Flynn and Flynn, 2004) has been the biggest obstacle to the areas of Quality and Risk to influence the strategic purchasing process. Such decision making processes should consider from who and where the supplier will buy their inputs, taking into account the total cost of the transaction. A detailed analysis of the risk management of the suppliers of the supplier is necessary.

There are tools and processes to support the supply chain risk management, though predominantly focused at the operational level. The awareness of the

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

importance to assess, measure and mitigate the risk of the automotive industry supply chain is growing. In response, a number of tools, processes and governmental and professional initiatives have been developed to reduce the impact of interruptions in supply chain networks and transportation. However, the tools that are applied varied for the following reasons:

(1) Significantly different levels of adoption of supply chain risk management tools between companies: in this work, the case study led to the confirmation of what the literature calls the vulnerability of the chain, characterized by its weakest link. The analyzed automaker ensures that your direct suppliers (first tier) implement risk management tools in order to minimize exposure to breakage. However, there is no systematic application of the same tools by their indirect suppliers (second and third tiers).

(2) Risk management initiatives are at the discretion of each company - considering that the automakers in Brazil are from distinct sources (American, European or Asian), the governance policy that each one takes is influenced by regulation and legal requirements of the country of source array. The automaker studied here is averse to risk exposure, a conservative feature of its management, keeping locally executives of the same nationality of the matrix to ensure adherence to the corporate governance policies. On the contrary, its first and second tiers suppliers adopt higher risk exposure management models, with greater flexibility to meet different requirements of several automakers in the country. Figure 3 demonstrates the risk management initiatives of the automaker and its second tier supplier, demonstrating that while the automaker has a strong risk management of its internal activities and with its first tier suppliers, the second tier supplier has few initiatives, usually induced by the automaker.

(3) Tools and risk mitigation processes are often designed or applied on a local or regional basis, resulting in a non-cohesive management of the global risk.

(4) There is little standardization or official certification in the supply chain risk management.

(5) Laws and available certifications are developed in a stand alone model for a industry or segment, and are not integrated into business processes.

This study has limitations regarding its locus and the specifity of the analyzed industry. It was concentrated in only one country, although Brazil is an emerging country with the fourth largest consumer market in the world, and it was focused in the automobile industry, with its own characteristics. Thus, as a proposal for future work, can consider playing the same exploratory qualitative methodology in another locus or industry.

For future research, the authors suggest some topics that should be investigated:

- The relationship between supply chain risk management and performance

- Areas close to the end customer (Sales, After Sales and Customer Service) were not part of this study

- Relationship between automaker country of origin and collaborative practices with suppliers were underexplored in this study.

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

Figure 3 – Risk management tools and processes

Risk Management Tools and Processes								
Internal company tool / process			Cross-company tool / process			Professional bodies		
Tool / Process	Automaker Case	Component (Second Tier) Supplier	Tool / Process	Automaker Case	Component (Second Tier) Supplier	Participation in / Certified with:	Automaker Case	Component (Second Tier) Supplier
Track and trace tools	Y	OC	Supplier audit collaboration	Y	N	Industry associations, e.g. International Air Transport Association (IATA)	Y	N
Risk mapping/prioritization	Y	OC	Standardized certifications (e.g. BSI development on supplier continuity planning)	Y	N	Supply Chain Risk Leadership Council	Y	N
Business continuity planning	Y	N	Disruption news feeds	Y	N	Professional associations, e.g. Chartered Institute of Logistics; Business Continuity Institute	Y	N
Scenario planning	Y	N				Supply Chain Council and SCOR model	Y	N
Event management tools	Y	N				ISO 28000	Y	N
Centralized risk management unit/personnel	Y	N						
Centralized/standardized supplier assessments	Y	N						
Supplier codes of conduct	Y	N						
Quantification metrics	Y	N						
Employee training initiatives	Y	N						
Supply chain mapping	Y	Y						
Business impact analysis tools	Y	OC						
Legend:	Y = Yes, it is used	N = No, it is not used	UI = Under Implementation	OC = Occasional use				

6. REFERENCES

ANFAVEA: Anuário da Indústria Automobilística Brasileira (2013). São Paulo: ANFAVEA.

Annual Disaster Statistical Review (2012). CRED – Centre for Research on the Epidemiology of Disasters, Université Catholique de Louvain.

Bakshi, N.; Kleindorfer, P. (2009). Co-opetition and investment for supply-chain resilience. *Production and Operations Management*, 18(6): 583–603.

Bednarz, A. (2006). Supply Chain Execs Share Disaster-Planning Techniques. Available at: http://www.computerworld.com/s/article/9000810/Supply_chain_execs_share_disaster_planning_techniques. Accessed in November 24th, 2013.

Blackhurst, J.; Craighead, C.; Elkins, D.; Handfield, R. (2005). An empirically derived agenda of critical research issues for managing supply-chain disruptions. *International Journal of Production Research*, 43 (19), 4067–4081.

Braunscheidel, M. J.; Suresh, N. C. (2009). The organizational antecedents of a firm's supply chain agility for risk mitigation and response. *Journal of Operations Management*, 27(2): 119–140.

Burgess, K.; Singh, P.; Koroglu, R. (2006). Supply chain managament: a structured literature review and implications for future research. *International Journal of Operations & Production Management*, 26(7): 703–729.

Chen, I.J.; Paulraj, A. (2004). Understanding supply chain managament: critical research and a theoretical framework. *International Journal of Production Research*, 42(1): 131–163.

Chopra, S.; Sodhi, M.S. (2004). Managing risk to avoid supply chain breakdown. *MIT Sloan Management Review*, 46 (1), 53–61.

Christopher, M.; Peck, H. (2004). Building the resilient supply chain. *The International Journal of Logistics Management*, 15 (2), 1-14.

Craighead, C. W.; Blackhurst, J.; Rungtusanatham, M. J.; Handfield, R. B. (2007). The severity of supply chain disruptions: Design characteristics and mitigation capabilities. *Decision Science*, 38(1):131–156.

Creswell, J. W.; Piano Clark, V. L (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage.

Di Serio, L. C.; Oliveira, L. H.; Schuch, L. M. S. (2011). Organizational Risk Management – A case study in companies that have won the Brazilian quality award prize. *Journal of Technology Management & Innovation*, v. 6, n. 2.

Eisenhardt, K. (1989). Building theories from case study research. *Academy of Management Review*, 14(4): 532–550.

Flyvbjerg, B. (2001). *Making social science matter: why social inquiry fails and how it can succeed again*. Cambridge, UK: Cambridge University Press

Flynn, B. B.; Flynn, E. J. (2004). An exploratory study of the nature of cumulative capabilities. *Journal of Operations Management*, v. 22, n. 1, p. 439–457.

Flynn, B. B., Sado, S., Schroeder, R.G., Bates, K.A.; Flynn, E.J. (1990). Empirical research methods in operations management. *Journal of Operations Management*, 9(2): 250–284.

Guia de orientação para gerenciamento de riscos corporativos (2007). São Paulo: IBGC.

Hendricks, K. B.; Singhal, V. R. (2003). The effect of supply chain glitches on shareholder wealth. *Journal of Operations Management*, 21(5): 501–522.

Hendricks, K. B.; Singhal, V. R. (2005a). An empirical analysis of the effects of supply chain disruptions on long-run stock price performance and equity risk of the firm. *Production and Operations Management*, 14(1), 35-52.

Hendricks, K. B.; Singhal, V. R. (2005b). Association between supply chain glitches and operating performance. *Management Science*, 51(5): 695–711.

Kaplan, R. S.; Mikes, A. (2012). Managing Risks: A New Framework. *Harvard Business Review*, June, 2012.

Kleindorfer, P. R.; Saad, G. H. (2005). Managing disruption risks in supply chains. *Production and Operations Management*, 14 (1), 53–68.

Knemeyer, A. M.; Zinn, W.; Eroglu, C. (2009). Proactive planning for catastrophic events in supply chains. *Journal of Operations Management*, 27(2): 141–153.

Kreps, D. (2004). *Microeconomics for Managers*. New York: W.W. Norton, 2004.

Lambert, D. M.; Cooper, M. C. (2000). Issues in supply chain management. *Industrial Marketing Management*, 29, 65–83.

Lee, H. L.; Padmanabhan, V.; Wang, S. (1997). The bullwhip effect in supply chains. *Sloan Management Review*, v.38, n. 3, p.93–102.

Manuj, I.; Mentzer, J. T. (2008a). Global supply chain risk management strategies. *International Journal of Physical Distribution & Logistics Management*, 38(3): 192–223.

Mason-Jones, R.; Towill, D.R. (1998). Time compression in the supply chain: information management is the vital ingredient. *Logistics Information Management*, vol. 11, Iss:2, pp. 93-104.

Mentzer, J. T.; DeWitt, W.; Kleeber, J. S.; Min, S.; Nix, N. W.; Smith, C. D.; Zacharia, Z. G. (2001). Defining Supply Chain Management. *Journal of Business Logistics*, v. 22, (2): 1-25.

Narasimhan, R.; Talluri, S. (2009). Perspectives on risk management in supply chains. *Journal of Operations Management*, 27(2): 114–118.

Norrman, A.; Jansson, U. (2004). Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident. *International Journal of Physical Distribution & Logistics Management*, 34(5): 434–456.

PIA - Pesquisa Industrial Anual (2010), v.29, n.1, IBGE, Empresa.

PIA - Pesquisa Industrial Anual (2012), v.30, n.1, IBGE, Empresa.

Porter, M. (1986). *Estratégia competitiva: técnicas para a análise da indústria e da concorrência.* 17a.

Edição. Rio de Janeiro: Campus, 1986.

Protiviti (2006). *Definition of business risks* (2006). Protiviti – Independent Risk Consulting.

Sheffi, Y. (2005). *The resilient enterprise: overcoming vulnerability for competitive advantage*. The MIT Press, Boston, USA.

Sodhi, M. S.; Son, B. G.; Tang, C. S. (2012). Researchers' perspectives on supply chain risk management. *Production and Operations Management*, 21(1): 1-13.

Souza Filho, O.; Pereira, S.; Di Serio, L.C.; Martins, R. (2011). Collaborative practices in the management automotive chain: does the origin of automakers matter? *Conferência Anual do POMS*, April, 2011.

Souza Filho, O.; Pereira, S.; Di Serio, L.C.; Martins, R. (2012). Alinhamento de estratégias de relacionamentos fornecedor-cliente na cadeia automobilística brasileira. XXXVI EnANPAD, September, 2012.

S2ID - Sistema Integrado de Informações Sobre Desastres. Available at: http://s2id.integracao.gov.br/portal/imagens/botao_atlas.png. Accessed in January 02nd, 2014.

Stadtler, H. (2005). Supply chain management and advanced planning – basics, overview and challenge. *European Journal of Operational Research*, 163, 575–588.

Svensson, G. (2004). Key areas, causes and contingency planning of corporate vulnerability in supply chains. *International Journal of Physical Distribution & Logistics Management*, 34 (9), 728–748.

Tang, C. S. (2006). Perspectives in supply chain risk management. *International Journal of Production and Economic*, 103(2): 451–488.

Tang, C. S.; Tomlin, B. (2008). The power of flexibility for mitigating supply chain risks. *International Journal of Production and Economic*. 116(1): 12–27.

Voss, C.; Tsikriktsis, N.; Frohlich, M. (2002). Case research in operations management. *International Journal of Operations & Production Management*, 22(2): 195–219.

Wagner, S. M.; Bode, C. (2008a). An empirical examination of supply chain performance along several dimensions of risk. *Journal of Business Logistics*, 29(1): 307–325.

Wagner, S. M.; Bode, C. (2008b). Dominant risks and risk management practices in supply chains. *Journal of Business Logistics*, 32(4): 234–256.

Wagner, S. M.; Neshat, N. (2009). Assessing the vulnerability of

ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 8 Number 1 pp 72 – 87

supply chains using graph theory. *International Journal of Production Economics*. v.126, 121-129.

Wheelwright, S. C.; Hayes, R. H. (1985). Competing through manufacturing. *Harvard Business Review*, v. 63, n. 1, p. 99–109.

World Economic Forum (2013). Global Risks Report.

Yin, R. (2009). *Case study research: design and methods*. Applied social research methods series. 4rd ed. Sage Publications, Thousand Oaks, USA.

Zsidisin, G.; Smith, M. (2005). Managing supply risk with early supplier involvement: a case study and research propositions. *The Journal of Supply Chain Management*, 41 (4), 44–57.

AUTHOR'S BIOGRAPHY

Edson Júnior Gomes Guedes: Degree in Mechanical Technology at FATEC-SP, Faculdade de Tecnologia de São Paulo, specialization in Quality and Productivity at Fundação Vanzolini/Escola Politécnica da USP and Master's degree at EAESP-FGV. Served in different locations the automotive industry including Brazil, Argentina and Thailand, with focus on Supply Chain Management and Supplier Quality.

Alexandre de Vicente Bittar: Degree in Civil Engineering at Escola Politécnica da USP, specialization in Administration at EAESP-FGV (CEAG) and Master's degree at EAESP-FGV. As an executive, has an experience of 24 years in Supply Chain and Operations in Philips, Gradiente, Legrand, Semp Toshiba and Lexmark. As a teacher works in the online education program of FGV Online. Develops consulting activities in Administration.

Luiz Carlos Di Serio: Graduated in Mechanical Engineering at the State University of São Paulo (UNESP). Master in Mechanical Engineering, with specialization in Industrial Engineering, at Marquette University in Milwaukee, Wisconsin, USA. Has a doctorate in Mechanical Engineering, with specialization in Operations Management from the University of São Paulo (USP). Research interest: SCM, Competitiveness and Innovation

Luciel Henrique de Oliveira: Agronomist Engineer graduation at Universidade Federal de Lavras (1987), master's in Administration at Universidade Federal de Lavras (1992) and ph.d. at Administration at Fundação Getulio Vargas - SP (1998). Experience in Administration, competitive strategy, integrated management system, risk, logistics and agribusiness.