Global supply chain risk management: a multicase study in the mango exportation chain

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Abstract
The purpose of this study is to understand how different members manage risk in the global supply chain. Through a multi-case study of the Brazilian mango exportation chain to the United States, four actors of this chain were investigated: supplier, exporter, importer and logistics operator. A research protocol was developed based on previous research conducted by Christopher, et al. (2011). Main results show that risk management is heterogeneous among members of the mango chain, the exporter is the most penalized by the results of the risk chain and collaboration is the main mitigation strategy observed.

Keywords: Supply chain risk management; mitigation strategies; types of risk

Introduction
With increasing globalization, the supply chain is becoming more complex. Therefore, information systems and management tools should also follow the increasing geographical distribution of operations and cultural differences to maintain or improve the effectiveness and competitiveness of the chains. The complexity of the chains at levels associated with global searches for efficiency, volatility of demand, adoption of lean practices and increasing natural disasters and terrorist attacks show increasing disruptions in supply chains. (Christopher; Peck, 2004; Zsidisin et al. 2005).

Therefore, understanding the behavior of risk in the supply chain and proposing efficient ways to manage and mitigate the uncertainty is of fundamental importance to maintaining the competitiveness of firms and chains.

Supply Chain Risk Management (SCRM) has attracted the interest of both academics and practitioners in recent years (Tang; Musa, 2011). Despite the growing interest of this subject, SCMR research is still in its initial stage of development (Vanany et al., 2009; Juttner; Peck; Christopher, 2003). According to Sodhi, Son e Tang (2012), research on SCRM is recent and there is more need of deep empirical studies (Khan; Burges, 2007). There is still a gap in the theoretical understanding of how companies evaluate and deal with risk in the supply chain (Christopher et al., 2011).

A recent study conducted by Christopher et al. (2011) with importation companies from different sectors revealed that most companies adopt informal approaches of SCRM. However, Christopher et al (2011) recognizes the limits of their study as they have considered only the perspective of the buyer firm.
This work aims to contribute to research on Supply Chain Risk Management (SCRM) by answering the following research question: “How do the different members of a global supply chain manage risks?”

The growing demand for healthy food and technological advances in the production process has leveraged the expansion of the Brazilian fruit chain in the international market (Vitti; Boteon, 2008). Brazil is currently the third largest exporter of mango in the world, exporting approximately twenty-five thousand tons of mangos to the USA in 2011 (National Mango Board, 2012). However, several risks have threatened the flow of products and the profitability of its mango chain. Previous studies have estimated losses of 20% to 40% in the chain after harvesting the fruits (Choudhury, 1995).

The main objective of this research is to analyze empirically how the different members of the mango exportation supply chain from Brazil to the USA manage risk.

The study of the operation of a product that is perishable, seasonal and with a short window of exportation allows the observation of various phenomena of risk. The study investigates four links of the mango supply chain: suppliers of the São Francisco Valley in Brazil, exporters, logistics operators and importers in the United States. The research was based on the perception of the executives involved with the mango exportation supply chain from Brazil to the United States (U.S.).

**Risk Categories**

The origin of the word risk is uncertain (Rao; Goldsby, 2009). Some researchers refer to the Latin word, “risicare” - meaning “of daring” (Bernstein, 1996). Others refer to “risq” in Arabic - meaning "gift of God" (Khan; Burnes, 2007). Several other meanings were incorporated into the word risk as well. For example, threat, hazard, likelihood, probability assessment, consequence dimension and dispersion measures.

Jüttner, Christopher and Peck (2003) divide the risk into three categories, one as a source within the organization and the two others from the supply chain, environmental and network. Similarly, Christopher and Peck (2004) consider risk in three dimensions: internal, external and environmental. However, risk unfolds in five categories, two internal to the organization (process and control), two externals to the firm but internal to the network’s inter-organizational relationships (demand and supply) and one related to the network of organizations (environmental).

As suggested by Christopher and Peck (2004), followed by Christopher et al. (2011) and used in this work, risks of process and control, which are internal to the organization, can be grouped into a same category of risk and defined as the firm's internal risk that can affect the supply chain (Christopher, Peck, 2004).

Similarly, Christopher et al. (2011) grouped environmental and sustainability risks, however, following the classification of sources of risk (organizational, supply chain and environmental) of Jüttner, Peck and Christopher (2003), environmental risk has its source in the macro environment, while sustainability risk, in turn, has its source in the organization and supply chain. Although these two types of risks are related to the external environment, one is originated by the external environment itself whilst the other is a threat to it. The same is not true for process and control risk, where the source of risk is the organization. Therefore, this study adopts five categories of risk classification: (1) process and control, (2) supply, (3) demand, (4) environmental and (5) sustainability. The definition adopted for supply and demand risk is proposed by Manuj and Mentzer (2008b), while the definition for process and control risk and environmental risk are from Christopher and Peck (2004). The definition for sustainability risk are from Christopher et al. (2011).
Mitigation strategy
Christopher and Peck (2004), based on previous strategies suggested by Sheffi (2005), observed four principles to promote resilience in the supply chain. Those principles are adopted in this work. The first principle is that the supply chain design must enhance or favor resilience. Secondly, there must be collaboration among supply chain members, as risks need to be both identified and managed. Third, the supply chain must be able to react quickly to unpredictable events. Finally, it must establish a culture of risk management so to avoid the occurrence of internal risk.

The design or redesign depends on a good understanding of the supply chain architecture, its connections, bottlenecks and sourcing strategy. Supply base strategy must consider the potential risk that the supplier can bring to the chain. One must keep several supply sources available constantly and assess efficiency versus redundancy. For example, an inventory above the minimum level required by the chain may increase the responsiveness to sudden changes in demand. Christopher; Peck, 2004.

The second principle is collaboration between members of the supply chain in order to reduce uncertainty and favor risk mitigation. The process of sharing information and generating knowledge among members of the chain is a key aspect for collaboration, as well as trust, transparency and cooperation (Christopher; Peck, 2004).

Another principle is the supply chain agility shown by product flow speed and quick response to unpredictable changes in demand or supply. According to Christopher and Peck (2004), the key factor for agility is the response time of the upstream and downstream members of the chain.

Finally, Christopher and Peck (2004) suggest the creation of teams of risk management and risk assessment in decision-making processes with the involvement of leaders to encourage the emergence of a culture of risk management in the organization.

The use of different strategies altogether can maximize its benefits, for example, greater collaboration among companies can increase the supply chain speed of response and thus minimize the likelihood of a risk of supply variation (Christopher et al. 2011).

Design / Methodology / Approach
Sodhi, Son and Tang (2012) suggest the need for new case studies in SCRM. Case studies can be useful for research in Supply Chain Management if it has a rigorous research process, ie, conducted in a structured and well documented way to allow further analysis of the phenomenon. It must also have quality, ie be valid and reliable (Seuring, 2008).

<table>
<thead>
<tr>
<th>Validity/Reliability</th>
<th>Research Steps</th>
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<tr>
<td></td>
<td>Design</td>
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<tr>
<td>Construct Validity</td>
<td>Use of SCRM Literature</td>
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<td>Internal Validity</td>
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Table 2 – Validity and Reliability
The population and cases were selected for theoretical reasons, allowing clear observation of the phenomenon and the relationship of the constructs investigated (Eisenhardt, Graebner, 2007; Miles; Huberman, 1994). According to Harland et al. (2003), the complexity of the product may increase the vulnerability of the supply chain, so the choice of research of the mango exportation chain between Brazil and the United States is appropriate so as to present a wide variety of risks that affect a global supply chain. Voss, Tsikriktsis and Frohlich (2002) reveal that case studies within a single firm have a high degree of depth in research, but have limitations on generalizations of findings, models and theories developed. Eisenhardt and Graebner (2007) claim that multi-case studies allow to identify whether a result is related to only one firm alone or is something common among a number of firms. The unit of analysis of this survey is the parties, or members, of the supply chain.

Data collection was divided into two stages. The first aimed to provide information on the mango exportation global supply chain of mango between Brazil and the United States, its characteristics and main threats, as well as defining the sample of firms studied. The second stage was a multi-case study of the supply chain parties.
The first stage consisted of a search for information and interviews with organizations supporting the mango supply chain between Brazil and the United States and qualified key informants who have a deep knowledge of the studied chain. Participating organizations were: Valexport, which represents producers in dealing with government agencies and non-governmental organizations and support the improvement of quality and productivity of agriculture in the São Francisco Valley in Brazil in order to achieve international standards; Embrapa, whose mission is to support research, development and innovation for sustainability of Brazilian agriculture; SEBRAE whose mission is to support and assist the emergence of cooperatives and associations of producers from the São Francisco Valley in order to strengthen the interests of producers in the supply chain; The National Mango Board, a research organization that promotes national and imported mango product in the United States, aiming to increase consumption of this fruit in the USA. Nine interviews with approximately twelve hours of material in total were performed.

The interviews sought to understand the system of production, processing, distribution and mango supply chain architecture; industry characteristics (strengths and weaknesses); and potential threats to the mango chain (climate, logistics, politics, etc.). It was also requested of each interviewer to suggest suppliers, exporters, importers and logistics operators of this chain to be interviewed.

At the end of each interview, a statement was recorded with as much information as possible that was discussed in the interviews.

Management leadership in most exporters and importers is composed of the owners, who are the ones who are involved in decisions and supply chain management. In the category logistic operators and suppliers, management leadership is mainly composed of engineers and regional sales managers.

This research was based on a semi-structured questionnaire developed by Christopher et al. (2011). After interviews with key informants of mango supply chain supporting organizations, changes were incorporated to the questionnaire and some questions specific to the mango supply chain were incorporated (i.e. questions about climate risk, pests and diseases in the field). After the changes, a pilot test was conducted in order to fit the language of the questions to the best understanding of the interviewees.

After the first contact and the confirmations of the interview, an e-mail with the research objective and questionnaire was sent to each interview so that respondents could understand the scope of the study and prepare for the interview. The interviews were conducted over five weeks between June and July 2012. Some interviews were conducted in the cities of Petrolina-PE, Juazeiro-BA and São Paulo-SP. The key informants of other regions were not personally interviewed due to distance, mobility and budget constraints. We requested permission to record every interview. Informants from the same company were interviewed separately.

In the case of exporting 2, one of the key informants selected could not attend the interview, so we considered the participation of another informant from the same company to replace the previously selected informant. However, as there were not potential informants knowledgeable enough to replace him, it was decided to include a new member of the company's exportation department (Exporter 3). In the importer company, the same happenstance occurred. One of the informants previously selected from importer 2 could not participate. It was decided not to replace him with another informant from the same company. Therefore, attempts were made to contact another importer, but this was not possible within the timeline of the study.
According to Yin (2010), there are three important principles of data collection that may help to cope with problems of construct validity and reliability: (1) the use of multiple sources; this research conducted semi-structured interviews with managers from different companies of the global mango supply chain. It also requested and collected documents with information about the studied chain. In some companies it was possible to visit the business premises in which evidence was collected through direct observation of facilities and operations. Secondary data was also collected from the internet, in websites of companies and organizations that supports the mango chain. (2) Build a database; written summaries of interviews (reductions), recordings of interviews, recordings of researcher comments, internet files and internal documents are stored with the researcher and are available for future research. (3) The chain of evidence; Yin (2010) suggests to quote the relevant parts of the database in the research report, give details of data collection and follow defined procedures for data collection.

Sample data reductions were conducted after interviews with key informants. The reduction was carried based on the notes of the interviews of the first stage of data collection and, subsequently, with the contents of the recordings, comments and notes made in the second stage of data collection. After data reduction, new contact was made by phone with respondents in order to obtain the missing information.

A coding system was developed and based on this system, an analysis was carried out within each case and across other cases, with the goal of detecting commonalities and differences between the risks and mitigation strategies (Eisenhardt, Graebner, 2007), i.e. the organizations studied were analyzed by the members of the supply chain (supplier, exporter, importer and logistics operator). Data from key informants were crossed examined for every company and data from different companies were crossed examined for every supply member. It was then possible to identify the major risks and mitigation strategies. It was also possible to compare the risks and strategies among different members of the supply chain. This comparison made it possible to answer the research question.

Findings
The main findings of this research are summarized on Tables 3, 4, 5 and 6.

Table 3 – Supply chain risk management adopted by suppliers

<table>
<thead>
<tr>
<th>Strategies, actions and techniques for risk management in mango global supply chain</th>
<th>Mitigations strategies proposed by Christopher and Peck (2004)</th>
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<tr>
<td>Suppliers have long-term relationships with their customers. In the case of supplier 1, a monopoly limits the options of exporting. Supplier 1 has a made-to-stock production and supplier 2, made-to-order. Vendors often make simple contracts with exporters and establish payment terms of up to sixty days. Joint plans are made by exporters and suppliers for harvest volumes and resources, but there is no formal evaluation of the relationship. The companies have quality control teams in their plants. They adopt various tools for internal risk identification. Mango supply chain risk management is shared between local and regional management offices. Suppliers do not rectify details of other members of the chain beyond the supplier. The strategies employed by suppliers are: anticipating products for the harvest; use of inventory for coping with risk of demand, supply or internal to the organization; information sharing to forecast products volume; careful analysis of credit for exporters or direct sale to the importer; attempts to develop alternative markets for mango export chain, and integration of cross-functional teams.</td>
<td>1 - Re-design: strategic choices of supply; 2 - Collaboration: information transparency; cooperation with other members. 3 - Agility: response time of the upstream and downstream members under variations in demand and supply; firm’s flexibility to changes in demand</td>
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Table 4 – Supply chain risk management adopted by the exporter

<table>
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<tr>
<th>Supply chain member</th>
<th>Strategies, actions and techniques for managing risk in the mango global supply chain</th>
<th>Mitigation Strategies proposed by Christopher and Peck (2004)</th>
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<tr>
<td>Exporter</td>
<td>The exporter has long-term relationships with other members of the chain, some based on reliability and performance of partners, others by the conditions of monopolies of products and services. The exporter usually values more the word given in deals rather than formal agreements written in contracts. The marketing of fruit per consignment demands formal periodic meetings with the importer to review and assess business performance. The owners are the managers of the organizations and of the key risks that threaten the business. Due to certification requirements, exporters use formal tools, such as HACCP to identify internal risks to the organization, and have staff dedicated to risk management and compliance with international protocols. Information sharing (about climate and fruit production, in stock and in the marketing) with sectors’ supporting organizations (National Mango Board and Valexport), with other Brazilian and foreign producers, suppliers, shipowners and, mainly, with importers, is the most talked-about strategy and cited as important by exporters to mitigate risks. Other mitigation strategies employed are: diversification of volume production for the domestic market and expansion of the base of package suppliers by means of international competition. However, the strength of the relationship with the members of the chain is the main mitigation factor when there are product and service shortages during the harvest. Finally, the use of stock to ensure supply of resources during the harvest is still considered a redundancy with more benefits than risks.</td>
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| Logistic operator   | 1 – Re-design: formal assessment; understanding of potential risks from other members.  
2 – Collaboration: trust in other members; information transparency; cooperation with other members.  
3 – Agility: supply chain visibility;  
4 – Risk management culture: risk management team; leadership involvement. |

Table 5 – Supply chain risk management adopted by logistics operators

<table>
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<tr>
<th>Supply chain member</th>
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<th>Mitigation Strategies proposed by Christopher and Peck (2004)</th>
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</thead>
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<tr>
<td>Logistics operator</td>
<td>The logistics operators form a monopoly in shipping services, and due to that, relationships with exporters are become long term. The criteria for customer selection is the balance between profitability and volume of cargo loaded. Customers with a better and long withstanding relationship are privileged when there is a service shortage. Operators have specific departments for risk management. Decisions and risk management for the mango supply chain are shared between the local offices and management in Sao Paulo. Logistic operators develop joint logistical planning of shipments with exporters and sign a contract before harvest. Negotiations are made with prepayment. The main strategy used by logistics operators is informational sharing of volume of fruit to be shipped, in order to reduce the possibility of the ship leaving without optimizing its full capacity. The use of container inventory is the action adopted to mitigate the effects of seasonality in demand. Other actions, such as root diversion and acceleration of the vessel, are employed to minimize environmental risks, demand risks and internal organization risks.</td>
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<td></td>
<td>2 - Collaboration: information transparency;</td>
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Table 6 – Supply chain risk management adopted by importers.

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<th>Supply chain actor</th>
<th>Strategies, actions and techniques for managing risk in the mango global supply chain</th>
<th>Mitigation Strategies proposed by Christopher and Peck (2004)</th>
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<tr>
<td>Importer</td>
<td>There is a limited choice of qualified companies to export mangoes to the United States due phytosanitary treatment requirements and exchange rate instability. Therefore, there is a low turnover in the supply base and relationships tend to be long-term. The consignment sales model requires trust between partners, reducing the importance of contracts. At least twice a year formal meetings are held to establish plans to ship fruit for the next harvest and to evaluate the performance of the partnership with the exporter. The owners are the management leaders of importing organizations and participate in the risk management of the business. There are departments of control and quality inspection of the fruit according to the standards required by supermarkets. Information sharing with exporters and knowledge of the downstream operations and of other exporting countries are the major risk mitigation actions adopted by importers. The mitigation strategy of supply is to select a reliable supplier, ie, certified. The diversification of the supply base with other exporting countries is necessary due to the high price of Brazilian fruit compared to other imported mangoes and the continuous replenishment demanded from supermarkets. However, the Brazilian export window is unique, and requires the use of multiple suppliers during this period to mitigate supply risks. However, the good relationship with exporters can determine product supply in times of mango scarcity.</td>
<td>1 - Re-design: formal assessment; understanding of potential risks from other members. 2 - Collaboration: trust in other members, transparency of information and collaboration; 3 - Agility: supply chain visibility; 4 - Culture of Risk Management: involvement of leaders and teams risk management</td>
</tr>
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Conclusion, Further research and recommendations

This study examined empirically how different parties manage risk in global supply chain. Through a multi-case study of the Brazilian mango exportation chain to the United States, four supply chain parties were investigated: supplier, exporter, importer and logistics operator.

According to data collected, risks are heterogeneous among members of the global mango supply chain. The exporter is the most penalized by the consequences resulting from a risk to the chain. Parties involved in relationships are more affected by the supply chain risks than other parties. These results are also confirmed by previous research on the increased vulnerability of global transactions (Braithwaite, 2003; Christopher and Lee, 2004).

The two main risks to the mango supply chain are exchange rate variation and dependence on a single mode of transportation (shipping). These results confirm Manuj and Mentzer’s (2008b) comments on exchange rate and dependency among the most important risks in global chains. As the risk of a navigation monopoly does not affect the logistics operator, the risks can threaten a member of the chain as well as the entire supply chain (Manuj; Mentzer, 2008b). Through the analysis of the impact of the main risks in all parties of the supply chain, a higher intensity of threats to the demand, supply and sustainability of the exporter and importer were observed.

Risk management in the supply chain showed different patterns among the parties studied. The exporter and importer adopt more developed strategies for risk mitigation than logistics operators and suppliers.

Collaboration is the major form found in the supply chain to prevent and minimize the consequences of risk. In comparative analysis, the exporter and importer presented higher intensities of adoption of strategies of re-design, collaboration and risk management.
management culture than the other members of the supply chain. The supplier presented greater intensity in the adoption of agility strategy in the supply chain.

Although there are many tools and techniques for risk management in the literature, very little has been adapted to the practice of companies (Jüttner, Peck, Christopher, 2003). The formal tools adopted by members of the studied chain for risk management are only of process control. USDA and the U.S. supermarkets require importers and exporters to implement risk mitigation actions within their organizations. Suppliers and logistic operators are multinational companies with specific departments for internal risk management.

Risks with whom sources are in the network and in the environment are identified and evaluated, mainly by information shared amongst its members. However, Christopher et al. (2011) suggests the use of tools such as Total Cost of Ownership (TCO) and Life Cycle Costing (LCC) to improve the process of risk management.

The use of different mitigation strategies together can maximize their benefits (Christopher et al., 2011). Therefore, the association of management tools with strategies of re-design, collaboration, agility and the development of risk management culture may boost the resilience of the global supply chain.

The main theoretical contribution of this research is the suggestion of a new classification of types of risk to the supply chain. A further contribution is the development of propositions based on theory and data collected: I) The members of the global supply chain are more affected by external risks (supply, demand and environmental) than internal (process and control); II) The percentage of total revenues of the member of a global supply chain determines the intensity of the risks that threatens it; III) the member position in a global supply chain determines the types of risks that threaten the member's chain as well as risk management approaches adopted.

The main empirical contribution is identification and analysis of how different parties of the global mango supply chain manage risk. Types of risks, as well as risk mitigation strategies, are identified and described systematically in this paper. Research results may bring opportunities for the development and improvement of risk management for the studied supply chain. The results of this research presents a good opportunity for managers from different supply chains to be able to know what the strategies adopted for a global chain of fresh and perishable products that requires agility and low rate of failure to meet exportation windows.

There are two main research limitations. First, due to budget constraints, data collection and observation was conducted by only one researcher which might introduce some bias of the interpretation and reduces research reliability. Second, it was not possible to discuss the survey results with interviewees, which may compromise internal research validity.

The literature on risk management in supply chain is recent and most publications involve risks of global sourcing. Further studies are needed to understand risks across the supply chain, especially downstream. It also suggested the development of quantitative studies that may provide the adoption of validation and statistical generalizations. There are also opportunities for empirically tested risk categories proposed and mitigation strategies identified in this study. Longitudinal studies could also help to understand the dynamics of risk in a supply chain. According to the observed results, risks affecting the members of the chain a few years ago no longer threaten it anymore. Therefore, we may suppose that risk has a temporal component that could be investigated.
References


