

# Supply chain risk management at seaport container terminals

## *Gerenciamento de risco da cadeia de suprimentos em terminais portuários de contêineres*

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**Abstract:** Since seaports are common and crucial links in the supply chains of several organizations, the objective of this work was to identify what risks a port can offer to the organizations in its chain and how they are treated by the port's managers. An exploratory survey was carried out using semi-structured interviews with employees of the company that operates the container and coal terminal of the second largest Brazilian port. The results revealed there is no structured risk management process by the port administration, but several actions taken revealed concern for reaction to risk situations. This highlights the benefits of clarifying the issues, contributing to the literature and assisting professionals in structuring a supply chain risk management process.

**Keywords:** Supply chain risk management; Seaports; Logistics; SCRM.

**Resumo:** Como os portos marítimos são elos comuns e cruciais nas cadeias de suprimentos de várias organizações, o objetivo deste trabalho foi identificar os riscos que um porto pode oferecer às organizações em sua cadeia e como eles são conduzidos por seus gestores. Uma pesquisa exploratória foi realizada utilizando entrevistas semiestruturadas com funcionários da empresa que opera o terminal de contêineres e carvão do segundo maior porto brasileiro. Os resultados revelaram que não há um processo estruturado de gerenciamento de riscos pela administração portuária. Entretanto, várias ações são tomadas como reação às situações de risco. Destaca-se, assim, o esclarecimento de tais questões e seus benefícios, contribuindo para a literatura e auxiliando os profissionais na estruturação de um processo de gerenciamento de riscos da cadeia de suprimentos.

**Palavras-chave:** Gerenciamento de riscos em cadeias de suprimentos; Portos marítimos; Logística; SCRM.

## 1 Introduction

Since the turn of the century, natural disasters (such as hurricanes Sandy and Katrina in the United States), economic crises (such as in 2008), terrorist attacks and labor strikes have caused large financial losses to companies, pointing to the need for better risk management of supply chains. For example, as described by Tang (2006), Ericsson suffered a loss of 400 million euros after a fire shut down production of its semiconductor supplier in 2000, and Apple was unable to supply various customers due to lack of electronic chips after an earthquake in Taiwan in 1999 interrupted the production of its main supplier. Also, according to Jüttner (2005), a strike that closed 29 ports on the West Coast of the

United States in 2002 caused losses estimated at a billion dollars.

Modern supply chain management practices, such as Lean Six Sigma, Just in Time and outsourcing, have made these chains leaner and more efficient (Wagner & Bode, 2008). But the risks of interruptions, as seen in the examples mentioned above, have caused firms to identify the need for a structured process for managing risks of supply shortages, leading to the concept of supply chain risk management (SCRM). The threat of financial and other losses of these interruptions has prompted growing academic interest in SCRM since 2004, as shown in Figure 1.

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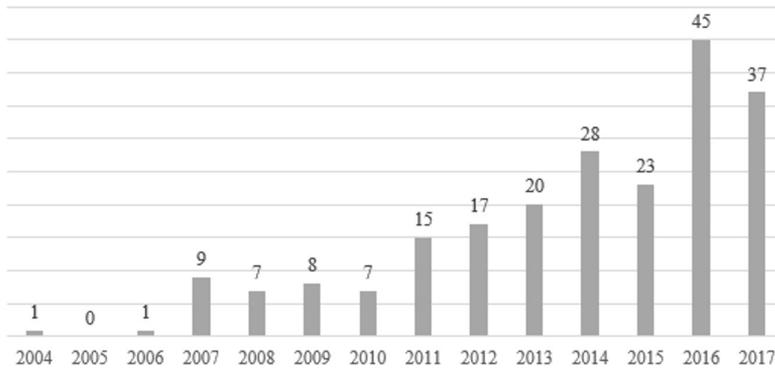


Figure 1. Annual number of publications about SCRM in the Web of Science database. Source: Web of Science (2018).

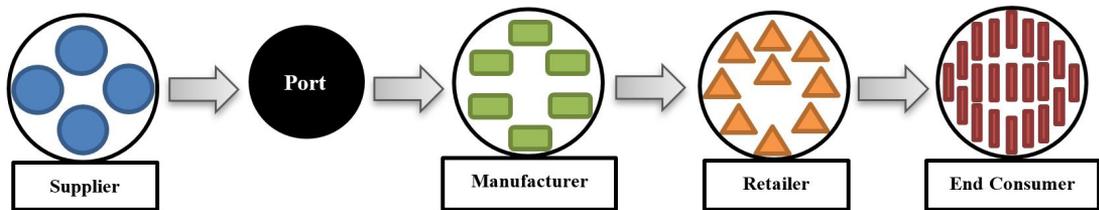


Figure 2. The port as a link in the supply chain. Source: Authors (2017).

SCRM is therefore a relatively new theme, with the first publication dating to 2004. According to Ghadge et al. (2012), the evolution of research about SCRM, as depicted by Figure 1, can be explained because it is considered to be a relevant and promising field by researchers and management professionals. Despite the growth of interest, the great majority of studies have been of the applied type, focusing on the manufacturing segments such as electronic goods, vehicles and food processing. Without detracting from the importance of these segments, there is a relative lack of research involving SCRM in other relevant segments, such as port terminals, where we did not find any studies.

Figure 2 depicts a simple example of a supply chain that has a port as one of its nodes. Port terminals form a crucial link in the supply chains of multiple companies simultaneously, and they can be present more than once in a single chain (e.g., between manufacturer and retailer and again between retailer and end final consumer). With the growth of seaborne transport since the 1980s and its rising importance in supply chains, it is important to study SCRM in the context of port operations.

Therefore, the objective of this study is to identify the risks a port can pose to the organizations of its chain and how these risks are treated by managers, based on an exploratory study conducted at the Port of Sepetiba in the state of Rio de Janeiro, Brazil's second largest port in terms of volume handled.

The paper is organized in five sections including this introduction. The second section covers the basic theoretical framework of supply chain risk management; the third section explains the methodological aspects; the fourth presents the results; and the fifth contains the final considerations.

## 2 Theoretical framework

As companies outsource more of their activities through a horizontal business model involving mutually beneficial partnerships (as opposed to a vertical structure), supply chains have taken on new importance. Therefore, competition is seen less in terms of individual companies and more in terms of networks of business relationships (Lambert & Cooper, 2000).

The benefits of this movement toward supply chains involve, for example, the possibility of focusing on a main business (core competencies), reduction of transaction and labor costs (with outsourcing) and reduced inventory expenses in lean manufacturing models (Hallikas et al., 2004; Thun & Hoenig, 2011; Blome & Schoenherr, 2011; Tang, 2006). However, an upstream or downstream problem in the chain could mean a breakdown of the entire process

Because of these characteristics, in particular the greater complexity in relation to a single verticalized company, where the firm is now seen as a link in the supply chain, more attention must be paid to managing supply risks than in the past. As framed

by Pfohl et al. (2011), the scope of risk management of a single company is very different than that of a supply chain. This context has led to the emergence of supply chain risk management, or SCRM, for the purpose of mitigating problems that can hamper the supply chain's smooth operation.

Therefore, in this section we briefly describe the key concepts of SCRM, for reference during the discussion of the empirical results (section 4) and also to enable a better understanding of the theme.

## 2.1 Supply Chain Management (SCM)

According to Lambert & Cooper (2000), the management of the multiple relations along the chain of supplies is referred to as supply chain management, which offers an opportunity to capture intra- and inter-organization synergies, with the overall goal of assuring the excellence of the business processes and relations with other members of the chain.

Rao & Goldsby (2009) and Blos et al. (2009) define supply chain management as the strategic and systematic coordination of traditional business functions inside and outside a company, with the objective of improving the performance of the chain as a whole. Boyson (2014) adds that this process includes management of production operations and other activities, such as marketing, sales, product design and finance. Trkman & McCormack (2009) propose a broader definition, stating that supply chain management (SCM) is a set of multifunctional and multidisciplinary activities dealing not only with the physical and tangible attributes and activities, but also the behavioral and other intangible aspects. They also consider it to involve the management of relationships and proactive integration among various members of the chain.

According to Shu et al. (2014) and Singhal et al. (2011), the interest in SCM began in the 1980s. To this, Tang (2006) adds that the reason for the emergence of this theme can be attributed to the growing trend in that decade for companies to outsource their secondary functions, including design, logistics and information technology, to focus on their core business. Firms perceived that this focus on essential functions and cooperation with other companies allowed them to reduce costs and product development times, while increasing quality at the same time. In this respect, Boyson (2014) recounts a brief history of the subject, stating that the expression was coined by Booz Allen Hamilton in 1982. In 1995 the University of Maryland conducts a survey among 1,300 firms to understand the interest in SCM, not only the internal integration initiatives, but also the strategies for integration with customers and suppliers. In 1996, the Supply Chain Council was formed by 69 companies and developed a set of processes called Supply Chain Operations

Reference (SCOR). In 2002 this council changed its name to Council of Supply Chain Management Professionals (Lambert & Cooper, 2000).

According to Wu et al. (2013), supply chains need to be managed for many reasons, including because of their importance in terms of meeting demand, their complexity and the numerous events that can interfere in one or more of their flows. According to Tang (2006), the supply chain deals with five main questions: design of the chain; relations with suppliers; supplier selection process; allocation of supply orders; and supply contracts. Trkman & McCormack (2009) indicate that forming an effective supply chain is not an easy task in turbulent environments undergoing rapid changes. They further state that effective supply chain management requires planning to overcome a multiplicity of risks, as seen in the preceding section.

Concern over interruption of flows and other risks to the chain is not mentioned in the SCM literature, and this is the starting point for the discussion of supply chain risk management.

## 2.2 Supply Chain Risk Management (SCRM)

Risk management is based on coordinated activities to guide and control an organization regarding risks (Oliveira et al., 2017). According to Norrman & Jansson (2004), a key factor for the reliability and good performance of supply chains is the sharing of risks and rewards, making the management of these risks a relevant aspect for the survival and competitiveness of the chains. Thun & Hoenig (2011) add that the consequences of ruptures in the chain go beyond immediate financial losses and include negative impacts on the firm's image and reputation, with consequent loss of demand.

Trkman & McCormack (2009) state that SCRM is a field of study that has been gradually gaining importance, originating from supply chain management, when researchers and practitioners turned their attention to the theoretical imperatives and professional needs regarding managing the risks to which chains are exposed.

Ritchie & Brindley (2007) stress the aspects for increased interest in the subject: the strategies and structures related to chains are evolving very quickly and changing formats in search of competitive advantage. In particular, technological changes, although generally beneficial, also pose threats to established supply chains.

With respect to the relevance of the theme, Xia & Chen (2011) consider that SCRM has a strong influence on the establishment of cooperation among the partners and on the performance of the chain as a whole. Hendricks et al. (2009) cite a survey among 151 executives, of whom 73% stated their firms had

experienced supply chain disruptions in the past five years and 48% expected the risk to increase in the next three years. Scannell et al. (2013) conclude that a risk-oriented supply chain enables firms to obtain strong competitive advantage and provides reliable long-term benefits for all stakeholders.

In the literature it is possible to find a number of reasons and tendencies in the business world that increase the vulnerability of supply chains:

- Opportunities to compete globally increase the chain's exposure to risks and add new risk dimensions: Thun & Hoenig (2011) state that firms are required by current trends to think about global markets, both in terms of consumers and suppliers. Despite the opportunities for higher revenues and reduced costs, this increases the complexity of chains and hence their vulnerability to risks and the difficulty of managing them;
- Interdependence among the members is growing steadily: Hallikas et al. (2004) argue that partnerships are a key factor for companies, by which they can reduce transaction costs, concentrate on core activities, and have easier access to technology and information. However, they point out the risks of this interdependence, such as resistance to change, discord over practices among the members and relationship conflicts;
- The size and complexity of chains bring risks like lack of trust, information asymmetry, dependence on outsourcing and inflexibility of standardized contracts;
- Outsourcing can go too far: Tang (2006) and Thun & Hoenig (2011) state that outsourcing makes firms increasingly interdependent, making it harder to control their own fate. As seen previously, accidents and other risks suffered by suppliers can cause direct losses to downstream companies. The authors cite the example of Land Rover, which in 2001 had to spend millions of dollars to avoid a production shutdown for nine months and the layoff of 1,500 workers caused by the bankruptcy of a supplier;
- Theories such as Six Sigma and Just in Time can pose problems when put into practice: According to Norrman & Jansson (2004) and Thun & Hoenig (2011), while these theories promise greater efficiency and competitiveness and confer a measure of status on adopters, they also make supply chains more vulnerable.

As noted by Pfohl et al. (2010), the small stocks of raw materials, parts and/or finished products means that any disruption in the supply chain can jeopardize the manufacturer's ability to supply customers, and hence its reputation for reliability in the market;

- Natural and/or man-made disasters can disrupt supply chains: The focus of risk management is to try to avoid or soften the effects of disasters or ruptures in the flows in the chain. Examples are the damage done to crops by Hurricane Floyd in North Carolina (USA) in 1999, which interrupted supply of key foodstuffs for seven days, and a fire in 1997 that forced Toyota to close 18 factories for two weeks, which cost US\$ 195 million in direct costs for supply chain adjustments and US\$ 325 million in lost vehicle sales (Norrman & Jansson, 2004).

According to Wieland & Wallenburg (2012), effective SCRM involves both managing the routine risks to which chains are exposed as well as the extraordinary ones, such as natural disasters and major accidents, as mentioned above. Furthermore, this management should be both reactive (monitoring changes in the chain, needs of customers, technological advances and competitors), to enable rapid response to adverse events, and proactive (identifying potential risks and implementing actions to prevent or minimize the impacts)

Lavastre et al. (2012) bring a different perspective, stating that SCRM implies an evaluation, over short- and long-term strategic and operational horizons, of the risks that can affect the flows of information, materials and financial resources, and is centered on the ability to identify risks in advance or the agility to react to them to diminish the adverse effects.

In turn Trkman & McCormack (2009) mention the identification, evaluation and analysis of the areas of vulnerability and risk in supply chains. Both Rao & Goldsby (2009) and Manuj et al. (2014) review the literature to summarize concepts of SCRM, finding that the objectives are to reduce vulnerabilities and apply risk management tools in collaboration with the other members of the chain to deal with risks and uncertainties. The objective can also be described as identifying potential sources of risk and implementing suitable actions to avoid or contain the chain's vulnerability. Manuj & Mentzer (2008), in studying risk management in global supply chains, add that the objective also can be to reduce the probability or velocity of adverse events or the time to detect these events, for the overall purpose of limiting losses.

A consensus exists among many authors (Trkman & McCormack, 2009; Hallikas et al., 2004; Tuncel

& Alpan, 2010; Kern et al., 2012) that the basic risk management process consists of:

- **Identification:** This step allows decision-makers to learn about the events and phenomena that cause uncertainty, with the main goal of recognizing future risks so that the organization can manage them proactively (Hallikas et al., 2004);
- **Evaluation:** The risks previously identified are prioritized, generally by comparing the severity of their consequences and probability of occurrence, to define the actions that will be taken (Hallikas et al., 2004; Shi, 2004);
- **Mitigation:** This step depends directly on the previous ones, which will indicate the actions to be taken in response to specific risks. The mitigation strategies can be to transfer risk, to assume it as an individual responsibility, eliminate or reduce it, or analyze it again (Hallikas et al., 2004);
- **Control:** Neither the organization nor the environment is static. They are constantly changing, as are the risks, so they must be constantly monitored. The objective is to detect trends for increased likelihood of occurrence or severity of impact (Hallikas et al., 2004).

### 2.3 Seaports and SCRM

Ports are strategic elements for global economic growth, especially by handling containers, which now account for a large portion of seaborne cargo due to the greater agility and reduced logistics costs they enable, thus enhancing interface of international markets. There can be no question that ports play a leading role in global logistics, by handling inbound and outbound cargo and aggregating value through their various services (Figueiredo, 2000).

Xiao et al. (2015) also stress the importance of ports in international trade and the global economy, specifically mentioning the economic and social importance of the various elements of port infrastructure, such as the warehouses and terminals that compose modern multimodal systems.

According to Monié & Vidal (2006), the evolution of maritime transport toward greater focus on containerization has caused ports to change in many aspects within the dominant logic of competitiveness, whereby the need for differentiation in relation to competitors has required reformulations to reduce operational costs and raise productivity.

The intensification of globalization as of the 1990s has been marked by expanding production,

consumption and circulation of goods on all scales. Companies have developed new growth strategies to preserve their profit margins, by searching for new markets for diffusion of their products, especially in emerging countries of Asia and Latin America where consolidated consumption niches already exist. This has transformed the global economy and increased the importance of the international seaport system. Over this period, the evolution and modernization of seaborne trade has gone hand-in-hand with increased cargo capacity and handling speed (Monié & Vidal, 2006).

Another standout feature of globalization is outsourcing of production and relocation of factories, especially in sectors with low to medium technological needs, to regions that offer lower production costs and good accessibility to infrastructure, with China being the leading example. The multiple location of production and assembly has surged ahead as a business strategy, and maritime transport is the tool that enables this strategy to operate (Monié & Vidal, 2006).

According to Velasco & Lima (1998), the operation of the main Brazilian ports, originally each under the control of a local government-owned port authority (called a “Companhia Docas”), was largely privatized in the 1990s by concession, lease or authorization under a monopoly regime. This is the case of the Port of Sepetiba (The port takes its name from the bay where it is located. Its official name was changed in 2006 to the Port of Itaguaí, after the municipality within the bay were it is located), the focus of this study.

Tovar & Ferreira (2006) present a brief history of Brazil’s port structure. Until the 1990s, the national port system was composed of ports administered directly by the federal government through a holding company called Portobrás (Empresa de Portos do Brasil S.A.), which in turn delegated management of each port to a local port authority (Companhia Docas) as well as to private concessionaires and state government agencies in some cases. With the extinction of Portobrás in March 1990, the process of decentralization of the port structure (consisting of 36 ports at the time) started. In the particular case of the state of Rio de Janeiro, this was accompanied by the absorption of the National Institute of Waterway Research (Instituto Nacional de Pesquisa Hidroviária - INPH) and the Brazilian Dredging Company (Companhia Brasileira de Dragagem - CBD) into Companhia Docas do Rio de Janeiro.

Further according to those authors, the next step was the enactment in 1993 of Law 8,630, known as the Port Modernization Law, establishing a new legal framework for the sector, aiming to promote competition between terminals, especially through privatization of operation of ports to allow participation of pre-qualified private entities. This attracted a good

deal of interest from private investors due to the potential profitability of port operations against the backdrop of growing international commerce. Under this framework, ports can be operated through three legal mechanisms:

- Concession, through a long-term contract awarded by international tender. At the end of the concession, the contract can be renewed or the assets will revert to the government for concession to another operator;
- Lease of port areas and installations. In this case the operation of port activities is also awarded through an auction or other tender process, except when the lessee already holds useful domain of the area, in which case all that is needed is authorization from the National Waterway Transportation Agency (ANTAQ);
- Private port operator qualification and acting: this is achieved through an administrative act from port authority, to compliance with the norms, qualification and provision of cargo handling services, performed exclusively by private operators.

According to Lacerda (2005), the transfer of responsibility for operating ports to the private sector is a trend observed in many countries, in particular to enable investments in modernization and expansion of capacity and to reduce handling costs (which can decline by up to 50% both for containers and dry bulk cargo).

With respect to supply chain risk management of ports, very few articles have been published, and to the best of our knowledge none with focus on a Brazilian port.

Xiao et al. (2015) developed an integrated model that incorporates the risks of natural disasters in investments in port infrastructure, in particular the increasing risk of economic and social losses from such disasters due to global climate change. The authors believe that the risks of natural disasters can lead to political instability and damage to transportation infrastructure, especially seaports, and propose an analytical model of investments in port infrastructure to allow reducing these damages by response mechanisms. In their bibliographical discussion, they indicate the lack of references on risk management of the link in supply chains represented by ports.

In turn, Fan et al. (2015) performed a study of the risk focused on container transport. They state that many factors, such as increased demand for goods in general, expansion of routes and ship sizes and need for speed combine to pose risks for this type of transport. Thus, they propose an analysis focused on

an American port and its container terminal, given the volatility of demand.

In the Brazilian case, despite the significant improvements resulting from the privatization program, discussed briefly above, ports still suffer from many problems, with the main bottlenecks being long lines for trucks to enter port facilities and lack of proper dredging. These aspects are emblematic of the shortfall of the country's port installations in relation to many other countries, even though Brazil has the world's one of the 10 biggest economies in the world. According to Tovar & Ferreira (2006), the efficiency of ports is intimately connected to economic development, on which count the Brazilian port system needs to improve its infrastructure to allow the country to reach its full foreign trade potential.

## 3 Method

### 3.1 Methodological procedures

We conducted an exploratory case study in the field. The data collection instrument was semi-structured interviews, with a questionnaire composed of quantitative and qualitative questions.

According to Gerhardt & Silveira (2009), one of the steps for data collection is to pretest the instrument employed. Therefore, we carried out a pilot test of our questionnaire with two specialists in the logistics area of Fluminense Federal University (UFF) in Rio de Janeiro, to obtain their feedback.

The taxonomy of risks, with the division used for the quantitative part, was based on the SCRM literature, as indicated in Table 1.

Besides this, the questionnaire contained open-ended questions to base discussions, whose responses are reflected in the results presented.

The interviews were conducted in person, and the field study also involved a guided tour of the port facilities, where the respondents could show the interfaces of their work and the justifications for their responses.

Other data were collected from documents made available by the company, covering the structure, location and market positioning of the port in relation to other Brazilian ports, besides specific information on the types of activities of the port and the container terminal.

The script for analyzing the data followed that employed by Gerhardt & Silveira (2009), as indicated below:

- Establishment of categories;
- Codification and tabulation;
- Content analysis.

**Table 1.** Risk taxonomy utilized in the study.

Risks	Description	Authors
Supply	Any risk of interruption of the flow between a company and supplier that prevents the supplier from satisfying its commitment to reliability.	Diabat et al. (2012), Pfohl et al. (2010), Scannell et al. (2013).
Environmental	Risks beyond the supply chain, such as economic crises, strikes, regulatory/legislative changes that influence the flows in the chain.	Pfohl et al. (2010), Jüttner (2005).
Demand	Risks inherent to supply and demand, including availability of stocks, adequate management of new products, variations in demand, etc.	Manuj & Mentzer (2008), Ghadge et al. (2012), Diabat et al. (2012).
Discrete	Exogenous events to the chain, normal not foreseeable and with negative consequences, such as terrorist attacks, contagious diseases and natural disasters.	Trkman & McCormack (2009).
Operational	Risks such as operational/technical failures, productive losses and technological changes in products and machinery.	Diabat et al. (2012), Manuj & Mentzer (2008), Tang (2006), Shi (2004).
Rupture	Disturbances caused by natural disasters and/or human actions, caused by a single factor or series of factors.	Tang (2006), Shu et al. (2014).

Source: Authors (2017).

The categories determined for segregation of the data were the types of risks described in Table 1, besides various other themes that were mentioned by the respondents. For the second step, of codification and tabulation, the interviews were transcribed completely and the comments were tabulated according to the categories. Finally, the content analysis involved systematization of the responses, for aggregation of data and objective inferences.

### 3.2 Port of Sepetiba

CSN Tecon is a company of the CSN Group (Companhia Siderúrgica Nacional, engaged principally in steelmaking) that holds a 25-year lease with Companhia Docas do Rio de Janeiro to operate the container terminal at the Port of Sepetiba (“Tecon” stands for “*terminal de contêineres*”). According to the interview conducted, a 25 years contract was originally signed in 1998 and negotiations are under way for its renewal, to Tecon and Tecar (coal terminal, that has the same contract type and belongs to CSN Group as well).

The lease agreement was signed in 1998, but operations only began in 2001. The company that operates the ore terminal, CPBS Vale, is a subsidiary of mining giant Vale.

The Port of Sepetiba is strategically located to serve companies in the states of Rio de Janeiro and São Paulo, the two largest contributors to Brazilian GDP. In terms of intermodality, the port is served by a railway and highways.

According to data from the National Waterway Transportation Agency (ANTAQ) for 2014, the Port of Sepetiba is the country’s second largest in terms of

volume handled, with 18.14% of the nation’s total, only behind the Port of Santos, with 26%. Figure 3 below illustrates the port’s structure.

### 3.3 Characteristics of the interviewees

We conducted two in-depth interviews: one with a port management specialist working for CSN, the parent company of the operators of the container terminal and coal terminal, who has graduate training in port management and experience abroad at the Port of Barcelona in Spain, and an employee of the supply sector of CSN, to obtain information of an internal and external nature.

As indicated, both respondents are employees of Companhia Siderúrgica Nacional (CSN), which through its subsidiaries operates the container terminal and the coal terminal in the Port of Sepetiba. The port operations specialist will be identified as “S” and the supply analyst as “A”.

It should be mentioned that although both respondents are assigned to the same department, their activities are not interconnected. The port operations specialist was designated by the development manager as someone with knowledge to answer all questions regarding the study based on his experience within the Port of Sepetiba and also for having worked abroad. The specialist then suggested interviewing the supply analyst, as someone with more intrinsic knowledge of the internal operations and supply chain of the port.

The information on the profiles of the respondents is presented in Table 2.

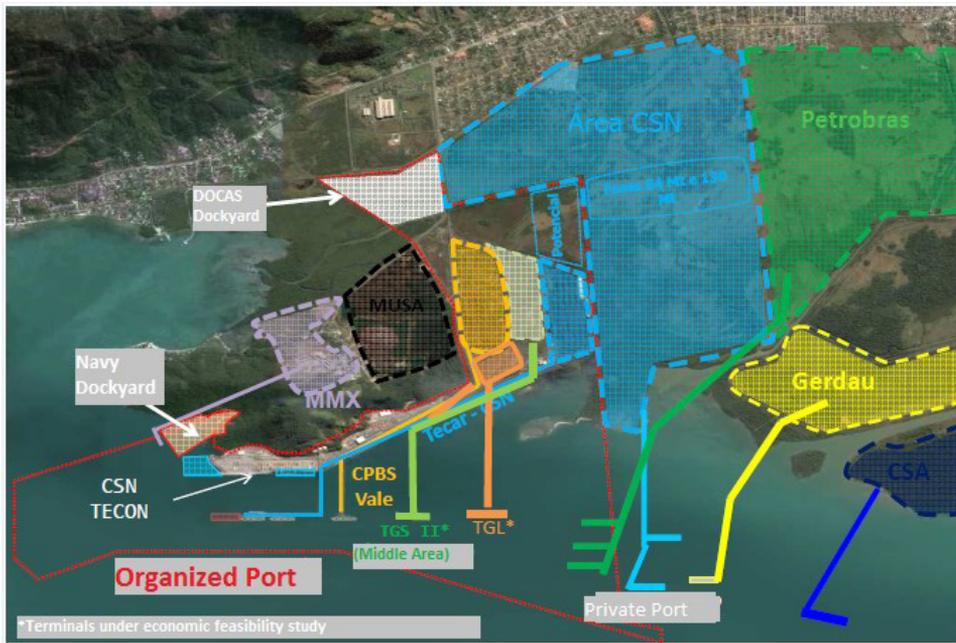


Figure 3. Structure of the Port of Sepetiba. Source: Document provided by the company (2017).

Table 2. Profiles of the participants.

	Employee “S”	Employee “A”
Schooling Level	Master’s Degree	Bachelor’s Degree
Time with the Company	5.5 years	7 years
Department	Port Operations	Port Operations
Position	Port Operations Specialist	Supply Analyst
Time in the Position	5.5 years	6 years

Source: Authors (2017).

### 4 Presentation and discussion of the results

At the start of the interviews, the respondents were asked about the situations of risk they had personally experienced in their positions. Employee “S” stated that some risks had materialized, while “A” stated no. On being asked if they had knowledge of risk management actions of the company, both responded negatively.

Table 3 presents the answers of the respondents to the questionnaire. The sources or risk were divided into the categories “Supply”, “Environmental”, “Discrete”, “Demand”, “Operational”, “Rupture” and “Others” (in the last case described at the initiative of the respondents). For each source of risk they were asked about the observed frequency and gravity of the impact on the supply chain, on a scale from 1 to 5 where: 5- Critical; 4- High; 3- Moderate; 2- Low; and 1- Negligible. They were also question about whether the risk could be avoided.

During the interviews, with the help of the questionnaire, it was possible to identify some inherent

risks of port operational activity that can have a direct impact on the entire supply chain:

- For supply risks, the company has a policy for minimization: procurement contracts worth more than R\$ 500 thousand are only signed with pre-qualified companies through a tender procedure, according to lowest price. For internal requisitions (scope of employee “A”), there is a specific requisition form, under the responsibility of all areas, requiring filling in all necessary information, to avoid errors as to quantity and specification. Employee “A” stressed that delivery delays mainly involve imported materials. Employee “S” explained that the port is a source of delay in deliveries to its clients, because the importation process depends on many factors, such as customs procedures. There are three channels for scrutiny of imported shipments by the customs authorities: green, when the goods are unloaded and cleared without any type of

Table 3. Response of the employees to the questionnaire.

	Employee E			Employee A		
	Frequency	Gravity	Could it have been avoided?	Frequency	Gravity	Could it have been avoided?
Supply	Monthly	NA	Yes	Quarterly	5	Yes
	Semiannually	4	Yes	Semiannually	5	Yes
Environmental	Semiannually	2	Yes	Semiannually	3	Yes
	More than annually	4	No	Annually	5	Yes
	Annually	4	No	Never occurred	NA	NA
	Weekly	1 to 5	No	Semiannually	1	No
Discrete	Never occurred	5	No	Never occurred	NA	No
	More than annually	5	Yes	Never occurred	NA	Yes
	Never occurred	5	No	Never occurred	NA	No
Demand	Twice monthly	5	No	Semiannually	5	Yes
	Annually	5	Yes	Monthly	5	Yes
Operational	Daily	1 to 5	Yes	Monthly	3	Yes
	Quarterly	5	Yes	Weekly	5	Yes
	Weekly	2 to 3	Yes	NA	NA	NA
	Annually	5	Yes	NA	NA	NA
	Weekly	5	Yes	Weekly	5	Yes
Rupture	Semiannually	5	Yes	Semiannually	5	Yes
	Annually	5	Yes	Weekly	5	Yes
Others	More than annually	5	Yes	Weekly	5	Yes
	Never occurred	5	Yes	Weekly	5	Yes
	Environmental (e.g., threats to a rare dolphin species, oil leaks, silting)					
	Access of supplier to the port installations			Semiannually	5	Yes
	Failure of a system or network			Weekly	5	Yes
	Location far from the urban center			Semiannually	5	Yes

NA = Not Applicable. Source: Authors (2017).

- inspection; yellow, where the documents are checked for correct description and quantity of products, along with other information; and red, when both the documents and goods are inspected. When containers are routed through the red channel, they must be opened, which delays delivery and can lead to problems of clearance due to the involvement of other authorities. To mitigate this risk, the terminal operator has a sector that instructs all clients about the legal procedures for importation and exportation, to avoid clearance problems. Still, the risk of cargo irregularities is high, and the port has an “unclaimed goods warehouse” for storage of goods that for some reason are not retrieved by clients. These goods are sold at auction after a determined period. The impact of delayed clearance of cargo affects not only the client, but the terminal itself, due to the need for extra space;
- Environmental risks: According to “A”, economic crises affect the negotiations with suppliers of the internal chain of the terminals. During economic downturns, the pressures increase to reduce costs, even for activities that are fundamental for the efficacy and efficiency of the activities. For “S”, the only risk within the port is the chance of a strike of the port authority workers, which occurs annually at the time of renewing the collective bargaining agreement. But its impacts are avoided by advance planning. When a strike is impending, the terminals are notified and start to work in round-the-clock shifts so as to offset the effect. With regard to legal/regulatory changes, “S” explained that due to the large number of governmental authorities involved, rule changes are frequent and the impact depends largely on the time limit given for compliance with the new rule. However, public authorities are required to give a reasonable time frame for adjustment to new rules, so this does not pose a major problem. Internally, rule changes are sometimes instituted by CSN, such as the hierarchy for approval of material requisitions, which can increase the time for approval. To minimize the impact of strikes, the terminals plan for the work stoppage dates and release ships in advance and alter the windows for arrival, so that inbound and outbound traffic does not coincide;
  - Regarding natural disasters, both respondents said none have ever occurred. However, employee “S” mentioned that even though the bay has calm water and the region is not prone to earthquakes, tsunamis or storm surf, the risk exists of ships arriving late due such occurrences in other places. With respect to contagious diseases, at the time of the avian flu outbreak, the National Sanitary Surveillance Agency (ANVISA) required more rigorous inspection of ships. Furthermore, to minimize the risk of diseases spread by rodents, plastic guards are placed on the mooring lines to prevent animals from leaving or boarding ships (in the latter case also to reduce damage to cargoes);
  - With respect to demand risks, employee “S” stated that volatility of demand for terminal services is inherent to their operations. In turn, employee “A” mentioned that higher demand means greater utilization of consumable materials and greater need for maintenance of machinery and equipment, which if not performed correctly increases the risks of technical failures. Regarding inventory problems, employee “A” said this occurs on a monthly basis, especially due to lack of planning and control by the terminal’s manager;
  - Both employees stated that operational risks are the most frequent category. Because the machines for loading and unloading ships are large and heavy, breakdowns are a constant threat. Alterations in the dates of receiving ships are also frequent, but expected. A way to minimize the risk of delays or inability to receive a ship is the assignment of windows, or time intervals of a few days before and after the estimated time of arrival, during which a ship has priority to moor at the terminal. The technological changes occur in two situations, according to employee “S”: at the requirement of the Federal Revenue Service for use of non-invasive scanners to inspect containers, and technological changes in ships. According to the documents provided by the company, the changes in ship sizes have a direct impact on the port operations, and the ability to handle larger vessels is the principal factor in terms of competitiveness. Employee “S” also stressed that the main factor for the competitiveness of a terminal is its capacity to receive ships. Figure 3 shows the original plan for the terminal’s depth and the corresponding

draft limits of the ships. Besides the pressure to handle larger ships, he stressed the need to reduce costs and gain scale as causes of the need to alter the terminal. With respect to competitiveness, employee “S” explained the project to unify berths to enable the terminal to moor two ships simultaneously and commented about the capacities of the ports of Rio de Janeiro and Santos, explaining the need to make adjustments to adjust to the upgrades of competing ports;

- On the risks of rupture of the chain, employee “A” explained that sometimes suppliers fail to deliver products on time, especially imported products due to problems with customs clearance. Another problem that occurs in the terminal is the legal process for entry of goods in the terminal. This process involves the Federal Police and the Federal Revenue Service. Many times the red tape hampers the entry, and some suppliers of the terminal even have refused to make deliveries because of the bureaucratic hurdles and delays. The lack of information, especially internal, was also mentioned. Since requisitions have to be sent to the supply sector, sometimes the process does not work properly or the information on the priority of the demand is not available;
- Other risks: The respondents mentioned some specific risks of the terminals.

The natural process of silting causes the need for periodic dredging. But this requires various approvals, with a direct reflection on projects to improve infrastructure, in turn directly linked to competitiveness. Employee “S” explained that the dredging process of the terminal requires: 1) authorization of Companhia Docas; 2) license from the State Environmental Institute (INEA); 3) authorization from the Navy; and 4) compliance with the procedures described in NORMAN 11. When dredging is not performed timely, “special” maneuvering is required of ships, increasing the costs of clients.

When the depth is reduced because of lack of dredging, the pilots have to carry out “special” maneuvers, raising the cost to clients. Since pilots belong to an independent professional class, their demands cannot be foreseen or coordinated.

The ecological risks of the port activity are also high, in particular due to presence of the Guiana dolphin, a rare species for which increasingly stringent protection measures have been required by INEA in recent years.

A final risk mentioned was security on the “Metropolitan Arc”, the highway that provides access to the port. It is not properly policed, so the incidence of highjacking is higher than it should be.

It could be perceived from the two interviews that the company that operates the terminals does not have a formally structured risk management process. However, some actions are taken by the company that configure a strategy to minimize and control risks, especially operational ones. During the interviews, the respondents expressed the interpretation that the supply chain is an internal sector of the terminal. This was expressed when one of the respondents understands Supply as the warehouse sector. And they stressed that “[...] *the scope of the terminal starts at the moment the ship arrives at the ‘gate’*”, demonstrating that the supply chain is not seen in the broader concept of stretching from the suppliers of raw materials to the final consumers.

The company studied is not unique on not having a structured risk management process. Manuj et al. (2014) cited a survey of 600 firms where only 33% used risk management approaches to proactively and strategically manage supply chain risk, and only 45% of the executives interviewed believed their supply chain risk management programs were sufficiently robust to minimize risks.

However, for the majority of the risk categories presented to the respondents, they mentioned at least one action taken to mitigate or control the risk, indicating the company’s concern with minimizing the impacts of the risks investigated.

As an example of these actions, we can cite the company’s procurement process, which is subject to well-structured tender rules; the work done to inform clients about how to avoid delays in customs clearance; the planning to prevent losses due to strikes; and the placement of rat guards on the mooring lines to prevent access to cargoes.

The preventive maintenance sector was also indicated as instrumental in identifying, controlling and mitigating internal operational risks.

Nevertheless, the interviewees did not comment on any comprehensive and formal process to identify potential sources of future risks. This lack of structured risk management process is not a unique problem. The literature contains many references to difficulties of making available time and resources to identify and face risks. For example, Thun & Hoening (2011) state that firms have great difficulty to measure the benefits of hedging against risks, which hampers implementation of adequate instruments to identify risks and to structure SCRMP processes.

Furthermore, one of the main risks mentioned by the respondents to the supply chain of terminals is the large number of regulatory entities of waterway transport in Brazil, as also identified in the literature.

Collyer (2013) noted that the large number of oversight and control authorities of waterway transport in Brazil places a heavy bureaucratic burden on companies in the sector. Indeed, there are over 30 such entities in the three spheres of government: among them at the national level the National Waterway Transportation Agency (ANTAQ), the Special Secretariat of Ports (SEP), the Federal Revenue Service (RFB), Brazilian Navy, Brazilian Institute of the Environment (IBAMA), Federal Audit Tribunal (TCU), Federal Police and National Sanitary Surveillance Agency (ANVISA). Many state and municipal agencies and departments have concurrent jurisdiction.

Besides the regulatory authorities, there are many laws that regulate port activities, again at all three levels of government, each one with follow-on regulatory decrees, edicts, resolutions, etc. Again, just at the federal level we can mention Law 8,630/93 (Law of Ports), Law 9,432/97 (regarding waterway traffic) and Law 10,233/2001 (which created ANTAQ).

Another problem related to the variety of governmental bodies with authority is the existence of a shipyard specialized in building nuclear submarines, at a site originally slated for expansion of berths. Besides the nuclear risks this poses to ships, cargoes and workers in the port, there was no prior communication to the operators of the terminals.

A final risk factor identified at the port is the volatility of demand, which also is in line with the literature on SCRM. Boyson (2014) states that in settings with large volatility of demand, formal controls are in general insufficient, which can explain the unstructured treatment of supply chain risks at the Port of Sepetiba. In turn, Trkman & McCormack (2009) affirm that market turbulence and demand volatility are by themselves motive to have a structured SCRM process to help reduce risks.

It is important to note that the main client of the two terminals is, naturally, CSN, the parent company, which benefits from having its own terminals. This itself can be understood as a strategy to mitigate risks of seaborne transport. The ownership structure of the railroad serving the port, MRS Logística, also is part of a risk mitigation and cost control strategy, since both CSN and Vale have substantial minority stakes (and Gerdau also has a small equity position). It mainly carries inbound raw materials and outbound finished products for these three companies.

We observed the importance of the port in the supply chain of CSN and the other two companies involved in mining/steelmaking as well as the container clients, and the leading role of the managers of the terminals in interface with regulatory agencies, pilots, ship owners and clients, with a fundamental role in managing supply chain risks. The effectiveness of this effort is a key factor for competitiveness in relation to other terminals.

In the examples of risk to supply, it was clear that the port management needs to provide substantial assistance to the companies that will receive the goods carried. Goods not released by customs are a risk to the receivers and the terminals themselves, due to the extra demand for storage space. Therefore, support for interface with customs and other regulatory authorities is a key service to clients by the terminal operators.

As best put by Trkman & McCormack (2009), in the present environment companies can no longer interact in a dichotomic manner. Instead, objectives need to be shared, whereby the ability to offer goods and services is the responsibility not of a single firm, but of the chain as a whole.

## 5 Conclusion

The results of this study reveal that the risks a port can pose to the organizations in its chain range from brief supply interruption to complete rupture. The risks of delays of raw materials to reach manufacturers or final products to reach customers due to problems during maritime transport and cargo handling in ports are large, as reflected in the comments of the interviewees.

Actions for identification and mitigation exist for the majority of these risks, as shown in the results, each one related to its characteristics.

However, the port in question does not have a structured supply chain risk management process, although the conditions exist to implement one based on the actions already taken and the contact among the managers of the terminals and various links of the chains of the terminals' clients.

When asked if the company carries out risk management actions, both respondents answered negatively. This demonstrates that the field of study can make a positive contribution in the country, as is the case internationally (given the growing number of publications observed since 2004).

Actions to prevent movement of rodents to and from ships, planning of ship arrivals, development of internal supply structures and orientation of clients on the bureaucratic processes for importation and exportation, cited by the interviewees, can be seen as risk mitigation actions.

We believe that with more frequent contact and better cooperation between the port managers and the other links in the chain, the risk management process can be structured, enhancing the efficacy of the mitigation and control steps. On the one hand, the terminals engage in interface with ship owners, pilots and regulatory agencies, while the client companies engage in interface with suppliers and final customers, so all that is lacking is a link between these two smaller chains to reduce the risks along the entire chain. In this respect, the port administrators

will play the key role, due to their privileged position and common interaction with all these agents.

This communication and interface among all the members can have beneficial consequences on the robustness and agility of the chain, with commensurate benefits for all the links.

With the interviews it was possible to attain the objective of understanding the risks the port operations can pose to the companies in its upstream and downstream chains and how they are treated by the managers. This involved listing the risks already identified by the managers and identifying others, by means of the questionnaire that contained risk categories mentioned in the literature.

Since we found very few publications on SCRM in ports in general, or on a specific type of risk, as presented in the theoretical reference, we believe this study contributes to the theme. Applying the questionnaire to identify what risks are perceived by the port's managers opens perspectives for identifying which are most relevant and frequent, and thus should receive priority treatment by the organization. In particular, we did not find publications seeking to identify the existence of a structured SCRM process or the actions carried out by Brazilian port administrations.

The main limitation of this study is the absence of analysis with any of the companies that use the port's services or final consumers, to obtain a more complete vision of the risks of import and export operations.

For a future studies, we suggest investigating the feasibility of structuring the supply chain risk management process in Brazilian ports, through analysis of the other companies that form the chain, and to analyze the viewpoints of other stakeholders, such as regulatory and other governmental entities, and upstream and downstream users of port services.

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