Concepts, Challenges and Opportunities of Risk Management in Port Logistics Environment

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Abstract.

Risk management in companies of the port logistics sector helps achieve strategic objectives defined by implementing best market practices and service-oriented specifications. Since this activity is not fully explored by organizations, this project aims to explore the capabilities of effective risk management. The objective of this project is to present the critical risks which these companies are exposed to, and propose mitigation measures for each identified risk, adding value to the business. As research methods, the best practices concepts in this area are described by standards and reputable entities, as well as practical experiences in corporate governance in this specific industry. The description of critical risks is defined by possible activities that can materialize the adverse mapped event, as well as their consequences. Mitigation measures are characterized by their capacity to reduce the impact and/or probability of risks and are validated through the results obtained after them successful implementatio. In conclusion, risk management is a set of actions and tools aimed at identifying potential risks in a company and managing them through the definition and implementation of risk responses, reducing their probability and/or impact, and supporting the company in achieving its strategic objectives. To illustrate this, examples of five critical risks identified in companies of this sector are provided and how the management of these exposed events is realized.

1. Introduction

Despite the economic benefits that commercial relations can bring, there are challenges and issues to be considered, such as the protection of labor rights, environmental preservation and the search for fairer and more balanced trade. International trade continues to evolve and adapt to economic, political and technological changes, reflecting the complexity and interdependence of countries on the global stage. With the advance of the Industrial Revolution in the 19th century, there was a significant acceleration in international trade relations.

Technological innovations and improvements in transportation systems allowed trade to expand, enabling large-scale trade between faraway nations. Trade treaties and agreements were established between countries to facilitate the movement of goods and establish rules for the protection of commercial interests and property rights.

Trade relations between countries are conducted through bilateral and multilateral agreements, such as free trade agreements and regional economic organizations. These agreements aim to reduce trade barriers, tariffs and regulatory restrictions, facilitating the exchange of goods and services between nations. Globalization and the development of information and communication technologies have boosted international trade, allowing instant transactions and facilitating access to new markets.

Commercial relationships involve the exchange of physical products, but also trade in services, foreign investment, technology transfer and capital flows. Multinational companies play a key role in this scenario, establishing global supply chains and acting as drivers of international trade.

The concept of risk management has emerged as a crucial approach to increasing quality, efficiency and reducing losses in organizations. Recognizing the complexity and unpredictability of operating environments, companies began to adopt proactive strategies to identify, assess and mitigate the risks involved in their activities. Risk management allows for a better understanding of potential adverse events that may affect the quality of products or services, as well as operational efficiency. By predicting and responding to these risks, organizations can implement preventive and corrective measures to reduce losses, ensure compliance with regulations and quality standards, as well as promote continuous process improvement, thereby increasing the overall quality and efficiency of operations.

Thus, based on the above, this project's main objective is to identify the most critical risks in the port logistics environment, as well as provide mechanisms to manage them based on best market practices and practical experiences of governance in a company in the sector.

As a result of the main objective, naturally arise proposals for mitigating measures for the aforementioned risks, which may be actions with project characteristics having a final date for conclusion or periodic actions that can be verified, characterizing the secondary objective of the work.

The work ends with the concluding chapter, which confirms the benefits of carrying out risk management in a functional and effective manner, bringing value to the company. The need to identify each of the risks presented is also dealt with in this chapter, as well as the justification for taking mitigation actions for critical risks.

2. Literature Review

Identifying cybersecurity-related vulnerabilities in control systems, as well as solutions, are available in Ten et al. (2010). The relationship between security measures and cyber threats such as virtual terrorism was visualized in Senarak (2021a). With case studies in Thailand's international ports, mapping their information technologies and security, and how to effectively integrate risk management into the objective, Senarak (2021b) introduced us to the subject. As in Gunes et al. (2021), best practices for developing mitigating actions for the risk of cyber-attacks in ports are reported.

With the unpredictability of information on the subject, Yang et al. (2018) explores a risk and cost methodology for preventive measures to environmental impacts, as well as more effective action plans.

The relationship between individual human and work factors capable of causing accidents is described in Zakaria, Mansor (2012), also portraying solutions for the identified problems. In Kristiansen (2013), measures of accidents at work, testing the effectiveness of mitigation plans, risk analysis techniques, safety forms and human factors are reported.

The selection of optimal models for the transport of special loads can be observed in Erkut, Verter (1998). The identification of the variables with the greatest impact on this risk is described in Clark, Besterfield-Sacre (2009), as well as models for decision-making. Analysis of techniques on operational continuity in the port sector are seen in Ono et al. (2016). In Notteboom et al. (2021) there are examples of the operation before and after the 2008 crisis and the COVID-19 pandemic, as well as the adaptation mechanisms used. In Trucco et al. (2008) human and organizational factors are integrated with risk factors, applied in the maritime industry sector, but usable in several others. In Kwak (2014), measures seeking to reduce the probability and impacts of risks related to port logistics are cited.

3. Methodology

To justify the choice of the critical risks that impact the port logistics environment, the main concepts addressed in risk management and related areas must be clarified. The description of the specific day-

to-day risk management nomenclatures will support the reason why companies in the port logistics sector, as well as many others, adhere to the use of an area responsible for managing risks in a structured and integrated way.

3.1. Risks

Risk was defined by NBR ISO 31000 of 2018 as the effect of uncertainty on objectives, with the possibility of being positive or negative, and capable of resulting in opportunities or threats. Similar concept was exemplified as an event where it's possible materialization affects negatively the achievement of objectives by COSO, corporate risk management - integrated structure. The main difference between the sources is the distinction of an event with a positive impact, being rarely managed by the responsible area, since companies, for the most part, prioritize preventing negative impacts that may arise from their activities, which are comparatively more harmful than the positive impact of possible existing opportunities. In this way, we define risk as a future and uncertain event, capable of negatively impacting some dimension of the company, consisting of threats capable of materializing them soon and the possible impacts caused.

3.2. *Risk Appetite*

Risk appetite is the limit accepted by the organization for achieving its objectives, directly related to the company's value creation strategy. It directs the allocation of resources to projects and serves as the basis for top management decision-making.

3.3. *Impact and Probability*

From the very definition of risk, there is the impact, which is necessarily negative, identified as losses due to the materialization of the risk, which can be measured quantitatively or qualitatively, such as financial damage, reputational damage, damage to people, legal proceedings, among others. In the other side, there is the probability, which is the risk chance of materialization in the near future. A matrix is used as a basis for evaluating those concepts, with the aim of comparing values from different sources and enabling the definition of risk criticality.

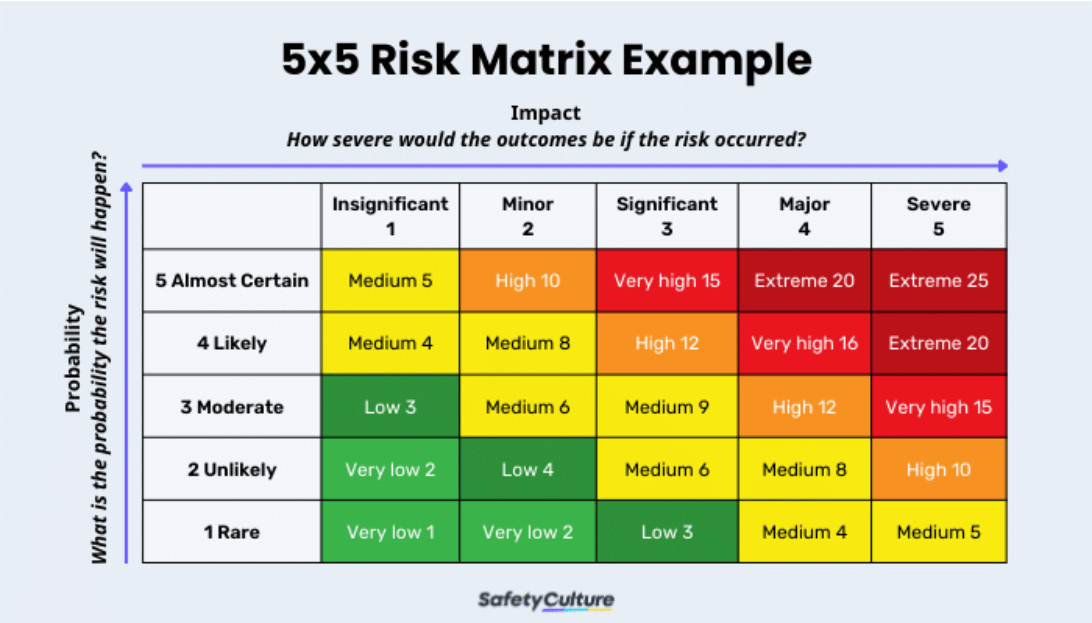

Figure 1 - Risk Matrix Source: Quality Tools - risk matrix. Source: Safety Culture 2023.

3.4. *Risk Matrix*

To define the level of criticality of the risk, the event is positioned in the risk matrix, which consists of the relation of 2 axes, referring to the values of risk impact and probability. Each region of this matrix has a unique relation between the values found, where a set of specific regions form risk zones, usually in 3 sectors: In the region of the origin of the axes (low criticality), where the impact and probability are maximum (high criticality) and the last one in between the previous two (medium criticality). In the example in Figure 1, there are 5 levels for impact and probability, serving as the basis for the risk matrix, which has 6 risk zones, represented by different colors.

3.5. *Bow Tie Methodology*

In search of a complete understanding of the risk, the bowtie method is used, which consists of identifying the causes and effects of the risk event. This step is necessary for a future creation of controls and action plans capable of acting preventively on the mapped causes and in a contentive manner on the indicated effects.

3.6. *Risk Management*

Based on ISO 31000 of 2018 and practical experiences in a company with structured risk management, the risk management process is divided into 3 main blocks, namely: Risk identification, assessment and treatment.

3.7. *Inherent and Residual Risk*

Inherent risk is a concept that describes the probability and potential impact of an unwanted or uncertain event, considering only the existing circumstances and conditions, prior to the implementation of mitigation measures, identified in the risk assessment stage. It is the criticality of the risk without considering the effectiveness of the control strategies implemented by the organization, representing the maximum exposure to the identified risks. Residual risk is defined with the same concepts, but after mitigation measures implemented, reducing the criticality.

3.8. *3 Lines Defence Model*

According to the IIA 2020 3 lines of defense model, the governance of an institution requires appropriate structures and processes, ensuring that activities are in line with the interests of the company. In this way, each of the lines of defense has roles and responsibilities, which are different, but are related to performing some stage of risk management.

3.9. *Critical Risks*

The probability of cyber-attack materialization is high due to the different ways that organizations suffer attacks, whether due to the number of employees with access to the network and liable to fall into phishing, enabling criminals to gain access to systems and confidential information, or due to cybersecurity vulnerabilities not yet known and exploited by malicious hackers. Its impact is considered high due to the stoppage of critical systems interrupting activities, leakage of confidential information, reputational damage and financial fraud capable of unbalancing the company's cash flow.

When it comes to the port logistics sector, there is exposure to dangerous work, in addition to several other causes of loss or damage to human life, thus the risk of Fatal Accident or With Leave is managed by the governance of organizations as critical to the business model. Adverse global scenarios can affect companies in many sectors around the globe, such as the recent COVID-19 pandemic, wars between countries and financial crises. The risk of adverse scenarios is characterized as changes in the global scenario capable of considerably impacting revenue and altering the execution of activities necessary for the business. Its consequences can be a reduction in the volume of cargo for logistics, loss of revenue due to the reduction of customers or stoppage of activities due to diseases.

4. Results and Analysis

Risk management is capable of generating value to the organization both by mapping events that hinder the achievement of objectives defined by executives, and by creating measures capable of mitigating these events, or even by exposing critical situations to decision makers to better define what to do in a critical situation. As provided for in the objectives, critical risks in the port logistics environment and mitigating measures proposals- for each of the causes and impacts associated with the identified risks are presented here.

4.1. *Critical Risks*

The risks identified as critical in the port logistics environment are described below, as well as the justifications for the stipulation of this concept. Risk management in general, as already explained, is carried out indirectly by the various employees of the organization, as they are always exposed to some risk, whether serious or not. On the other hand, risk managers are responsible for the daily management of all risks, therefore, they are not able to detail the information of a risk completely, requiring contact with specialists in the areas for a better understanding of the processes and to bring about improvements aimed at the risk suffered.

4.1.1. Fatal or With Leave Accident

The life of every employee or third party of the company must be a priority, as a human life cannot be valued, therefore, the guarantee of adequate and safe working conditions and training for the execution of dangerous activities, for example, must be monitored. Opportunities for improvements in operational activities, increasing their safety and suggestions for automating tasks must be communicated to prevent accidents, as well as the use of new technologies for the same purpose.

4.1.2. Cyber Attack

The integration between maritime industry systems and equipment, gradually improved through technological evolution, makes companies increasingly dependent on it, bringing with it risks and challenges. The need to guarantee the functioning of the systems, the security of the sensitive data handled on a daily basis and the ease of interacting with technology are real needs of practices in a port logistics environment, which, if not guaranteed, can cause critical impacts such as unavailability of systems, affecting essential activities, leakage of confidential information and financial losses.

4.1.3. Special Cargo Handling

Special loads can be considered as products of a chemical, biological or radiological nature with the capacity to cause damage to the environment or human beings. The transport or storage of this type of cargo requires several precautions and rules, therefore, any mistake in activities or processes related to this subject can lead to the materialization of the risk.

4.1.4. *Environmental Accident*

With the growth of the ESG (Environmental, Social and Governance), especially the vision of care for the environment is becoming increasingly important for the evolution of companies, especially those that are publicly traded. In this way, decision-making is associated with the possible environmental impact caused by them, where many of them are irreversible, such as a release of oil into the oceans seen or the construction of a new port that may impact the fauna and flora of that region.

4.2. *Global Adverse Scenarios*

With an increasingly globalized world and growing dependence on inputs from other countries, an adverse scenario, even abroad, can impact the operation of an entire country and of course its companies, as we saw during the COVID-19 pandemic, war in Ukraine and the global financial crisis, impacting the Brazilian port logistics scenario and that of several countries. Risk management, in turn, has as one of its objectives to maintain the continuity of the business, using strategies adapted to each case to adapt to the new reality and keep the company prosperous and profitable.

4.3. Bowtie Methodology implemented.

The identification of the causes and consequences of the risk event provided by the Bowtie methodology are important for the creation of mitigation measures, which are capable of reducing the criticality of the mapped risk. Table 1 depicts the result obtained using this methodology, which will serve as a basis for detailing the main measures to reduce the risk assessment addressed.

Table 1. Result obtained as a basis for risk assessment reduction measures.

Causes	Risks	Impacts
- Failure or lack of training - Failure or lack of firefighting system - Mechanical failure - Improper access to dangerous spaces - Contact with electricity - Falls - Occupational disease	*Fatal or With Leave Accident*	- Legal process (civil / criminal) - Financial loss - Reputational loss - Loss of human life
- Ignorance of information security - Vulnerabilities (security flaw) - Phishing	*Cyber Attack*	- Data loss - Unavailability of systems - Reputational, Financial loss - Information leak
- Improper storage - Load collision - Load drop - Failure in conveyor machines	*Special Cargo Handling*	- Damage to the community - Financial loss - Image damage
- Any unexpected event with environmental consequences (Collision of ships while berthing, cargo accident, supply hose rupture, shipwreck, …) - Mechanical or human failure	*Environmental Accident*	- Financial loss - Image damage - Physical damage to people and the environment
- Unexpected events of global proportion - Unfortunate decision-making by major global economies.	*Adverse Scenarios - Pandemic, Wars and Financial Crises*	- Shortage of inputs - Financial loss - Reduction of transported volumes - Loss of productivity - Discontinuity of the business

4.4. *Mitigation Measures*

Risk treatment is the last stage of the risk management cycle and has action plans and internal controls as its main concepts, characterized by being measures capable of mitigating risk events that materialize and impact the organization.

4.4.1. Fatal or With Leave Accident

Acting on the risk factor of lack or failure in the training of professionals, a control carried out is the review of the training agenda of employees in operational areas associated with the verification of the

completion of these trainings. Through corporate education platforms, it is possible to associate mandatory courses with each employee and define a deadline for completion, where the manager of this platform can generate a report and verify compliance with these dates and guarantee learning, mitigating risk. A review is also made of what training is needed or has stopped helping to combat the associated risk, thus increasing the efficiency of this control.

4.4.2. Cyber Attack

Due to the company's internal and external means of communication being carried out with the help of the internet, mainly by email, messaging applications, among others, the exposure of employees to cyber-attacks or crimes is high. One way to make them aware of the subject is to read and understand the company's information security policy and training, where the care and practices necessary for the organization's digital protection are reported, as well as the signing of a term that proves the knowledge of the information treated in the material by the worker and supports the company on possible mistakes.

4.4.3. Special Cargo Handling

Due to the need to separate common and special loads, such as explosives and flammables, standards dictate rules for the correct storage of these materials in the yard or logistics warehouse. For a more efficient cargo handling process, an automated system receives information on the characteristics of the containers received and tells the operator to take them to the correct location in the warehouse for later distribution to the final consumer. This measure aims to ensure that the system is sending accurate information on the loads so that they are correctly stored, respecting current regulations and reducing the probability of occurrence of the risk event.

4.4.4. Environmental Accident

As well as the risk of fatal or with leave accidents, preventive maintenance planning for equipment is also necessary to mitigate the risk of environmental accidents. In order to reduce the probability of materialization of events such as collision of ships at docking, breakage of supply hoses, accidents in cargo handling and their consequences, the need for maintenance of equipment must be monitored according to the periodicity defined by the manufacturer and monitored by equipment hour meters.

4.5. *Adverse Scenarios - Pandemic, Wars and Financial Crises*

Due to the high unpredictability of the risk and its critical impact, measures can be developed with the objective of reducing the consequences of the event, but the value generated by them may be lower than the cost of their execution. In this way, the most effective control to mitigate this risk is the elaboration of a business continuity plan, characterized by the detailing of activities to be carried out as soon as the event materializes, causing changes in the company's processes but keeping it efficient. This plan should be revisited whenever a study on similar events is carried out, seeking greater risk prevention effectiveness in the possible materialization of the risk.

5. Conclusion

This work concluded that Risk Management in the Port Logistics Environment is necessary, and its activities must be customized according to the current and future objective of the company in which it is applied, presenting concepts for application, benefits brought and expected from Risk Management, critical risks and associated mitigating measures. Characteristics of good practices as reported in ISO 31000, COSO ERM and practical experience of carrying out activities in the area in a company in the sector treated were used as a basis to highlight the reality of the subject. Five critical risks were defined, as mentioned in the results chapter:

1. In the case of fatal accidents or with leave, it is emphasized that the life of every employee or third party of the company must be a priority, guaranteeing adequate and safe working conditions. Training, automation and new technologies are capable of mitigating the risk.

2. For cyber-attacks, simple network security weaknesses can cause critical systems to be disrupted, data leaks, downtime and financial loss. Implementing an information security culture and performing penetration tests are ways to prevent this risk.

3. In handling special cargo, there are possibles environmental and physical impacts, financial damage and damage to the company's reputation, caused by failures in handling or storage processes. Carrying out frequent monitoring of compliance with the rules imposed for this service by the company or external regulator is a measure to be taken.

4. Regarding environmental accidents, developing measures that do not harm the environment, as well as help in its rehabilitation are necessary for the maintenance of the global ecosystem. With the rise of ESG and the "environmentally friendly" culture, companies that continue to ignore this issue will lose demand, as well as experience financial difficulties due to environmental regulations.

5. Considering adverse global scenarios such as pandemics, wars and financial crises, globalization brings dependence between distant or close regions for the continuity of numerous activities of countries. Business continuity plans can be implemented in order to get through turbulent times in the economy and maintain the company's activities in a sustainable manner.

Finally, opportunities for growth and improvements to the challenges were identified. In addition, the identification of critical risks is essential to help maintain and improve the company's efficiency. Decreasing negative surprises and increasing positive results are other benefits of implementing risk management, mitigating negative causes and impacts, and intensifying beneficial ones. Mapping the criticality of the risks and their probabilities brings valuable information for the company's executive board to make better decisions and distribute resources effectively. In general, risk management is responsible for business resilience and provides a short- and long-term vision for the company.

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