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Theme:

The contribution of key performance indicators (KPIs) to the optimization and management of operational risks in port supply chains

The case of: The Port of DjenDjen

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Abstract

Managing operational risks in port activities remains a major challenge, particularly in developing countries where performance issues are often linked to weak monitoring practices. This study explores how Key Performance Indicators (KPIs) can support the improvement of risk management at the Port of Djen Djen in Algeria. Drawing on an interpretivist epistemological stance, a qualitative methodology was adopted, combining semi-structured interviews using Nvivo, direct observation, and internal document analysis, and the FMECA method to systematically identify and prioritize operational risks. The findings reveal that the integration of KPIs into operational processes significantly enhances risk identification, early detection of problems, and operational performance monitoring, while strengthening decision-making at the managerial level. This study concludes that KPIs constitute a strategic lever for operational risk optimization in port logistics, and recommends the formalization of a KPI-based performance monitoring framework tailored to the specificities of Algerian port infrastructure.

Keywords: Operational Risk Management, Key Performance Indicators (KPIs), Port Performance, FMECA method

Résumé

La gestion des risques opérationnels dans les activités portuaires reste un défi majeur, particulièrement dans les pays en développement où les problèmes de performance sont souvent liés à des pratiques de suivi insuffisantes. Cette étude explore comment les Indicateurs Clés de Performance (KPIs) peuvent contribuer à l'amélioration de la gestion des risques au Port de Djen Djen en Algérie. S'appuyant sur une posture épistémologique interprétativiste, une méthodologie qualitative a été adoptée, combinant des entretiens semi-directifs traités avec Nvivo, l'observation directe et l'analyse de documents internes, ainsi que la méthode AMDEC pour l'identification et la priorisation systématiques des risques opérationnels. Les résultats révèlent que l'intégration des KPIs dans les processus opérationnels améliore significativement l'identification des risques, la détection précoce des problèmes et le suivi de la performance opérationnelle, tout en renforçant la prise de décision au niveau managérial. Cette étude conclut que les KPIs constituent un levier stratégique pour l'optimisation des risques opérationnels dans la logistique portuaire, et recommande la formalisation d'un cadre de suivi de la performance basé sur les KPIs, adapté aux spécificités des infrastructures portuaires algériennes.

Mots-clés : Gestion des Risques Opérationnels, Indicateurs Clés de Performance (KPIs), Performance Portuaire, méthode AMDEC

الملخص

تُعدّ إدارة المخاطر التشغيلية في الأنشطة الميناءية من أبرز التحديات التي تواجهها الدول النامية، لا سيما في ظل ضعف آليات المتابعة والرقابة على الأداء. تسعى هذه الدراسة إلى استكشاف الدور الذي يمكن أن تؤديه مؤشرات الأداء الرئيسية (KPIs) في تعزيز إدارة المخاطر بميناء جن جن في الجزائر. اعتمدت الدراسة على منهج نوعي قائم على التفسير والفهم، وذلك من خلال إجراء مقابلات شبه موجهة حُللت بواسطة برنامج NVivo ، إلى جانب الملاحظة الميدانية المباشرة وتحليل الوثائق الداخلية، فضلاً عن توظيف طريقة FMECA لتحديد المخاطر التشغيلية وترتيب أولوياتها. وقد كشفت النتائج أن دمج مؤشرات الأداء في العمليات التشغيلية يُسهم بشكل ملموس في تحسين رصد المخاطر والكشف المبكر عن الاختلالات، كما يدعم اتخاذ القرار على المستوى الإداري. وتخلص الدراسة إلى أن مؤشرات الأداء الرئيسية تمثل أداة استراتيجية فعّالة لتحسين إدارة المخاطر في اللوجستيك الميناءي، وتوصي بوضع إطار رسمي لمتابعة الأداء يراعي خصوصية البنية التحتية للموانئ الجزائرية.

الكلمات المفتاحية: إدارة المخاطر التشغيلية, مؤشرات الأداء الرئيسية (KPIs), اداء الموانئ, طريقة FMECA

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

AFNOR: French Association for Standardization

AHP: Analytic Hierarchy Process

CSF: Critical Success Factors

CSR: Corporate Social Responsibility

EBITDA: Earnings Before Interest, Taxes, Depreciation, and Amortization

EP-DJENDJEN: Port Authority of Djen Djen

FMECA: Failure Mode, Effects, and Criticality Analysis

FNEP: National Foundation for Enterprise and Performance

FR: Frequency Rate

HSE: Health, Safety and Environment

ICT: Information and Communication Technology

IMS: Integrated Management System

ISO: International Organization for Standardization

KPI(s): Key Performance Indicators

PMI: Project Management Institute

ROE: Return on Equity

ROI: Return on Investment

RO/RO: Roll On / Roll Off

SCM: Supply Chain Management

SERPORT: Algerian Public Port Exploitation Group

SR: Severity Rate

TEU: Twenty-foot Equivalent Unit

TOPSIS: Technique for Order of Preference by Similarity to Ideal Solution

UN/LOCODE: United Nations Code for Trade and Transport Locations

UNCTAD: United Nations Conference on Trade and Development

GENERAL INTRODUCTION

In a constantly changing environment, where economic exchanges are growing and time pressures are increasing, the efficient management of port operations has become a strategic necessity. Ports play a key role in facilitating international trade and supporting national economic development, serving as critical nodes in global supply chains. Yet, the performance of port infrastructure remains highly affected by a wide range of operational disruptions, making the need for structured and reliable management frameworks even more urgent.

Performance, in the organizational sense, refers to the ability of an entity to achieve its objectives efficiently and effectively. In port environments, performance has several dimensions, it includes operational efficiency, service quality, safety, and the ability to respond to changing demand. Measuring and monitoring performance is therefore not only a technical task, but also a strategic necessity that influences the competitiveness and sustainability of port operations.

Key Performance Indicators (KPIs) have become important tools for turning performance objectives into measurable and practical indicators. In port operations, KPIs provide accurate and continuous information about the actual state of activities, helping managers identify problems early, monitor progress, and make better decisions. Their role is especially important in complex logistics environments where many actors, processes, and flows operate concurrently.

At the same time, port activities face various operational risks, such as equipment failures, human errors, communication problems between stakeholders, and non-compliance with safety procedures. When these risks are not identified or managed effectively, the consequences can be serious, including service disruptions, financial losses, accidents, and damage to the port's reputation. Managing operational risk is therefore not simply an additional measure, but an essential condition for ensuring the continuity and performance of port activities.

The Port of Djen Djen is a relevant case for studying the link between KPI-based performance monitoring and operational risk management. As one of Algeria's strategic ports, it manages important industrial and commercial traffic while facing challenges such as poor coordination of information, limited risk management practices, and difficulties in aligning

strategic decisions with daily operations. This context makes the port an interesting field for examining how KPIs can help improve risk management in a complex environment.

Research Problem

In order to examine the role of KPIs in the management of operational risks at the portof Djen Djen, the central research question of this study is formulated as follows:

How do Key Performance Indicators (KPIs) contribute to the optimisation of operational risks within the supply chain of the port of Djen Djen?

Secondary Questions

This research also seeks to address the following secondary questions, related to the central problem:

- How do operational risks manifest within port activities, and what are their main causes and consequences for port performance?
- To what extent are the performance indicators currently used at the Port of Djen Djen adapted to the identification and monitoring of operational risks specific to its activities?
- To what extent do the KPIs currently used at the port of Djen Djen enable managers to anticipate operational disruptions?
- How does the systematic use of KPIs help operational performance and reducing risk at the port of Djen Djen?
- What corrective actions and KPI-based monitoring mechanisms can be implemented to reduce operational risks and improve performance?

Choice of Subject

The motivation behind this research stems from a growing interest in the role of KPIs in improving operational risk management. Although KPIs are widely used to measure performance, their role in supporting risk management remains less explored, especially in organizations where monitoring and coordination practices are still limited.

The Port of Djen Djen offers a relevant context for examining the relationship between performance measurement and operational risk management due to the operational and organizational challenges it faces, making it an appropriate case for this study.

Research Objectives

The objectives of this research are as follows:

- To identify the KPIs currently used within theport of Djen Djen supply chain.
- To analyse the perception and actual use of these indicators by port actors in their daily operational practices.
- To evaluate the contribution of KPIs to the identification and mitigation of operational risks within the port.
- To propose context-specific recommendations for strengthening KPI integration and exploitation in port risk management.

Research Methodology

This study adopts a qualitative, interpretivist approach aimed at exploring stakeholders' perceptions and practices regarding the use of Key Performance Indicators (KPIs) in operational risk management within the port of Djen Djen. Data is collected through semi-structured interviews with key port actors. A conceptual matrix linking KPIs to identified operational risks is developed to confront theoretical perspectives with actual practices in the port context.

Thesis Structure

This thesis is organized into three chapters, each divided into two sections.

The first chapter: The Theoretical and conceptual foundations of the study. It presents a literature review covering the key concepts related Key Performance Indicators, and operational risk management, with a particular focus on port environments.

The second chapter: The Research methodology and the presentation of the study setting. The first section details the research approach adopted, the data collection used, and the analysis methods applied. The second section presents the port of Djen Djenas an organisation, describing its structure, vision, mission, and main activities.

The third chapter: The results and Discussion, presents the findings of the analysis and observations, and discusses their implications.The study concludes with a set of recommendations aimed at strengthening the role of KPIs in port environment.

CHAPTER I: THEORETICAL FRAMEWORK

Introduction

This chapter aims to establish a theoretical and conceptual framework for our study. It is divided into two main sections. The first section is a literature review, organized into two main themes. The first theme addresses key performance indicators, and the second theme focuses on the role of key performance indicators in risk management. The second section presents the essential foundations that constitute the conceptual framework of our study, in order to clarify the key elements necessary for understanding our work.

Section 1: Literature review

This section provides an overview of previous research related to our topic, with a focus on key performance indicators (KPIs) and their role in optimizing operational risks. In a context where risk management has become a strategic lever for improving organizational performance, KPIs serve as essential tools for measuring, monitoring, and controlling risk exposure.

The analysis aims to understand how these indicators contribute to the identification, assessment, and mitigation of operational risks, while supporting more effective decision-making. The objective is therefore to identify best practices and propose avenues for improving the integration of KPIs into risk management systems.

Based on recent academic studies, this section helps establish a structured theoretical framework that serves as a reference for the remainder of the study.

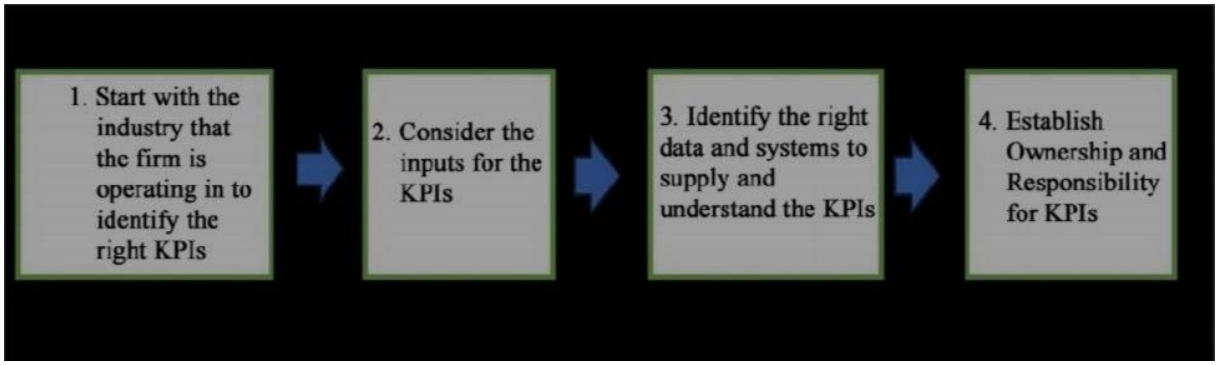
Theme one : Key performance indicators (KPIs)

According to the study by (Mtau & Rahul, 2024), titled ***"Optimizing Business Performance through KPI Alignment: A Comprehensive Analysis of Key Performance Indicators and Strategic Objectives"***, the authors examine how aligning Key Performance Indicators (KPIs) with strategic objectives can improve overall business performance.

To achieve this objective, the study proposes a practical four-step framework for building meaningful KPIs: starting with the industry context, considering the right inputs, capturing relevant data, and establishing clear ownership for each indicator . This approach allows them to understand how organizations implement and use KPIs in practice and how they are connected to strategic goals. The results confirm that the effectiveness of key performance indicators is primarily linked to how well they align with the organization's overall strategy, as this effectiveness is influenced by various factors such as organizational culture, the business environment, and the level of technology use. The

authors conclude that aligning these indicators with strategic objectives is a critical element in improving performance, as it enables organizations to clearly define their priorities, monitor their progress efficiently, and adapt to surrounding changes. (Mtau & Rahul, 2024)

Figure N° 1: The four main steps of KPIs



Source: (Mtau & Rahul, 2024)

Based on the study by (Balon, Dziadkowiec, & Niewczas-Dobrowolska, 2024), titled ***" Key Performance Indicators (KPIs) in the Quality Management System"***, the authors investigate how organizations can design and use specific indicators to measure the effectiveness of their quality management systems.

This approach allowed the researchers to create a structured way for companies to monitor whether their quality systems are actually functioning as intended. The results confirm that the effectiveness of these indicators is linked to their ability to provide a clear picture of both operational efficiency and quality management health. The findings also show that well-designed KPIs provide a clear picture of operational efficiency and quality performance, help identify problems early, track team progress, and support continuous improvement. The authors conclude that using a well-defined KPI model is a critical element for modern management, as it enables organizations to make data-driven decisions, manage risks more effectively, and ensure that their products or services consistently meet high standards. (Balon, Dziadkowiec, & Niewczas-Dobrowolska, 2024)

According to the study by (Benkhedda, El Hakmi, & Bennaceur, 2023) titled ***"Les déterminants de la performance logistique portuaire: Cas du port de Casablanca"***, the main objective was to identify the key factors influencing port logistics performance.

The results show that port logistics performance depends on several key indicators, including service quality, time (delays), cost, cargo security, and coordination among stakeholders. In addition, the study highlights the importance of human resources, digitalization,

infrastructure, and information technologies as key elements for improving performance. The authors also affirm that port logistics performance is a complex concept that depends on the interaction of multiple actors and factors. (Benkhedda, El Hakmi, & Bennaceur, 2023)

Relying on (Talkhokhet, Mahraz, El Yamani, & Moutmih, 2023) in their article ***"The performance of port supply chain: dimensions and indicators",*** the objective was to define a comprehensive framework for measuring the performance of the port supply chain by identifying the most relevant dimensions and indicators.

The authors propose an integrated framework structured around four main dimensions:

From the customer perspective, the key indicators include waiting time before berthing, connectivity to transport networks. The financial dimension is mainly represented by overall traffic volume and value added. Regarding internal processes, the most relevant indicators are quay productivity and the quality of port infrastructure. Finally, the learning and innovation dimension is captured through management training rate, staff turnover etc

The study highlights that structuring KPIs across these dimensions provides a more comprehensive evaluation of port performance and supports better decision-making and operational improvement.(Talkhokhet, Mahraz, El Yamani, & Moutmih, 2023)

According to the study by(Purwoko, Kamsariaty, Rubadi, Saksana, & Soehaditama, 2023), titled ***"Key Performance Indicator: Concept, Implementation to Performance Management"***, the main objective was to provide a general explanation of Key Performance Indicators (KPIs) and to analyze their role in organizational performance management.

This research addressed the following problem: how to define, structure, and effectively implement KPIs in order to improve performance management within organizations.

To answer this question, the authors adopted a qualitative approach.Their study shows that KPIs are widely used in many sectors and different types of organizations.

The authors highlight practical tools that help managers measure how well their teams or processes are performing. For example, in human resources, KPIs are used to measure employee productivity, attendance, or satisfaction, as well as help evaluate project progress or overall performance. The study confirms that Key Performance Indicators (KPIs) are widely implemented across different sectors and disciplines as practical tools forsupporting

performance management, particularly in human resource management and organizational evaluation.

In conclusion, implementing KPIs successfully requires a structured approach. The effectiveness of KPIs depends on how well they are selected, communicated, and used within the organization. (Purwoko, Kamsariaty, Rubadi, Saksana, & Soehaditama, 2023)

The study by (Ansari, Banihashemi, Taherkhani, & Moradi, 2022),titled ***"Decision Support System for Analyzing Key Performance Indicators in Construction Projects Management"***, aim to improve the performance of construction projects by identifying and ranking the main causes of claims, and examining their impact on Key Performance Indicators (KPIs).

This research answered the following problem: how to analyze and prioritize the causes of claims in order to evaluate their effect on performance indicators and improve the management of construction projects?

To solve this problem, the authors adopted a quantitative approach based on multi-criteria decision-making methods, in particular the analytic hierarchy process (AHP) and the (TOPSIS) technique. six main causes of claims wereidentified: delays, design changes, acceleration orders, additional work, different site conditions, and contractual ambiguities. The findings indicate that delays represent the most significant cause of claims, with a closeness coefficient of 0.728. The study also demonstrates that these factors negatively affect overall project performance. Finally, the authors emphasize that the importance of having a documentation and reporting system in place for projects is obvious, in order to improve the efficiency of construction projects. (Ansari, Banihashemi, Taherkhani, & Moradi, 2022)

The authors (Turcanu (Marcu) & Gasparotti, 2021),in their study titled ***"Role of key performance indicatorsin port management"***, examine the vital importance of key performance indicators in understanding the current state of port operations and supporting strategic decision-making within the shipping industry. In this context, the authors identify several key KPI categories used to evaluate port performance, including operational performance, technical performance, environmental performance, navigation safety, security performance, health and safety management, and human resource management performance. These indicators allow continuous monitoring of port operations and help identify inefficiencies within the system. Moreover, using a structured and diversified set

of KPIs provides a more comprehensive evaluation of performance in a complex environment. The authors also underline that improving the relevance and reliability of these indicators improves the ability of port management to respond to operational challenges and maintain competitiveness. Therefore, KPIs are not only tools for performance assessment but also key drivers for operational efficiency, service quality, and long-term development in the port sector. (Turcanu (Marcu) & Gasparotti, 2021)

Based on (Mohammed, 2019) study titled ***" Realizing Sustainability Aspects Based on the Approach of KPIs during the Life of Emerging Buildings"*** , the objective was to propose an approache for integrating key performance indicators (KPIs) in order to improve the durability of buildings during their entire life cycle.

This research addressed the following question: how to identify, structure, and prioritize KPIs in order to achieve sustainability objectives (environmental, social, and economic) in construction projects?

The results of this study showed that the structured use of KPIs helped for better integration of the three sustainability dimensions into project decision-making. The author highlights that prioritizing performance indicators is an essential tool for guiding decisions toward more durable solutions. Overall, the study emphasizesthat adopting a clearly defined KPI system helps to improve the overall performance of construction projects. (Mohammed, 2019)

According to (Velimirović, Velimirović, & Stanković, 2011), in their article ***"Role and Importance of Key Performance Indicators Measurement"*** published in the Serbian Journal of Management, the authors study the role of Key Performance Indicators (KPIs) in evaluating organizational performance. They explain the importance of kpi's as tools that help organizations measure both financial and non-financial aspects of performance, based on their long-term strategic goals. They also state that setting up a well-organized KPI system makes it easier to monitor performance, supports management decisions, and encourages continuous developement.Using a practical example from Toyota dealerships, the authors show how KPIs are applied in different departments.Each department has its own indicators, which help measure its performance and identify areas that need improvement.

Finally, the authors conclude that frequent use of KPIs helps organizations manage their work more efficiently and encourages constant improvement.(Velimirović, Velimirović, & Stanković, 2011)

Theme two: KPIs contribution to risk optimization

In the study by (Bessi Aboganina & Ortega Morales, 2025), titled ***" Identification des risques comme moyen d'amélioration des performances desprojets de développement rural au Cameroun",***the objective of the research was concerned about the influence of risks on the performance of rural development projects.

The study was based on the analysis of three development projects in Cameroon to identify the main risks affecting these projects.The results of the study reveal that 22 major risks were identified in the analyzed projects. Among these risks, 68% were external, while 32% were internal and related to project management and organizational practices.The findings show that theses risks can influence project performance, particularly in terms of deadlines, budget management, and the quality of results.

The study concludes that early identification of risks is an important element in improving project management. By improving planning, allocating resources efficiently, and enhancing the quality of interventions, projects can become more effective and sustainable, delivering concrete benefits to rural communities. (Bessi Aboganina & Ortega Morales, 2025)

The article by (Almasarweh, 2024), titled ***" Key Performance Indicators in Operational Risk Management: A Strategic Approach to Organizational Performance"***, was to examine how Key Performance Indicators (KPIs) can support organizations in managing operational risks and improving performance.

This research addressed the following question: How can KPIs be used as effective tools to monitor, control, and reduce operational risks within organizations?

The study examined how KPIs can be included in operational risk management systems. It explained different types of indicators and showed their role in identifying potential risks before they become serious problems. The results show that KPIs systems should not be limited to measuring performance only. Instead, they should also increase risk awareness and support value creation within the organization. Moreover, the study explains that when KPIs are properly implemented, they encourage continuous improvement and help connect

strategic objectives with daily operational activities. Overall, the study concludes that performance management, risk assessment, and value creation should not be treated separately. They must be integrated into one coherent system to support long-term organizational sustainability and societal benefit.(Almasarweh, 2024)

According to The study by (Cernisevs, Popova, & Cernisevs, Risk-Based Approach For Selecting Company Key, 2023), titled **" *Risk-Based Approach for Selecting Company Key Performance Indicators in an Example of Financial Services"***,the objective was to develop a method for selecting key performance indicators (KPIs) using on a risk-based approach, particularly in the financial services sector.

The study focused on five main types of risks that come from inside the company: governance risk, ICT risk, operational risk, financial crime risk, and human resources risk. The authors created a model that connected these risks to financial risk and capital adequacy risk.

The results showed that most of the risk categories like governance, ICT, operational and financial crime risks are connected to capital adequacy risks. However, human resources risk was not closely. The authors demonstrate that choosing KPIs based on the risks a company faces makes it easier to monitor performance and make strategic decisions. They conclude that a risk-based methodology allows companies to design more comprehensive and suitable KPIs that are aligned with their specific Fintech business model. (Cernisevs, Popova, & Cernisevs, Risk-Based Approach For Selecting Company Key, 2023)

The study conducted by (Wendler-Bosco & Nicholson, 2019), titled ***"The Impact of Port Disruptions on the Maritime Supply Chain: A Literature Review"***, indicates that port disruptions have significant operational and economic impacts at different levels. At the port level, disruptions cause delays in cargo handling, reduced operational efficiency, and congestion. At the supply chain level, they cause product shortages, increase logistics costs, and delay manufacturers and shipping companies.

In terms of port performance indicators, the literature focuses on several key metrics impacted by disruptions, including:

Volume of cargo handled, Vessel turnaround time and delays, Port capacity utilization and congestion levels, Cost-related indicators (transportation, inventory, and operating costs), Maritime transport reliability and schedule adherence.

The authors conclude that ports remain highly vulnerable to disruptions, which can rapidly affect the entire supply chain. They emphasize the importance of developing more comprehensive performance indicators and adopting proactive strategies to improve efficiency, ensure operational continuity, and minimize economic losses. (Wendler-Bosco & Nicholson, 2019)

(Weeserik & Spruit, 2018), in their article titled ***"Improving Operational Risk Management Using Business Performance Management Technologies"***, the study purpose was to show how performance management technologies can help organizations better manage their operational risks.

The authors examine how operational risk management can be improved through better process organization and the use of performance indicators. They explain that operational risks mostly come from internal processes, systems, external events and human actions, which can negatively affect organizational activities.

The study shows that process modeling helps identify weak points and potential sources of error. The study also emphasizes that the use of Business Performance Technology as an approach plays an important role in managing these risks by identifying gaps between expected and actual results. Moreover, the findings indicate that combining process-based management model with the use of performance indicators contributes to better control of operational risks and improves overall organizational efficiency.

The study concludes that the use of Business Performance Technology can support better operational risk management by improving process analysis, strengthening performance monitoring, and supporting managerial decision-making.(Weeserik & Spruit, 2018)

In the artice ***"The Impact of the Operational Risk Management on the Performance of the Non-Financial Enterprises"*** by (Kouakou, 2016), the author examines how different risk management practices influence the financial success of companies.

To achieve this objective, the study analyzes a sample of 70 non-financial companies,

The researcher measured success using two main indicators: Return on Equity (ROE), which shows profit for shareholders, and EBITDA (EBE), which shows the company's operational health. This approach allowed the author to identify which specific risk-handling methods actually help or hinder a company's bottom line.

The results confirm that the effectiveness of risk management depends on the type of practice used. Specifically, the study found that having a strong risk culture among

employees and using financial provisions have a positive impact on both shareholder and operational profit. However, maintaining cash reserves or relying only on legal protections had a negative impact on overall performance.
The author concludes that companies should focus on being proactive and using smart accounting tools, which are more effective for improving overall performance.(Kouakou, 2016)

The research by (Khameneh, Taheri, & Ershadi, 2016),was to propose a conceptual framework for measuring the performance of project risk management system.
To achieve this, the authors divided performance indicators into two categories: the first category refers to the quality of the risk management system's design and its integration into the organization, while the second category focuses on the actual results achieved by the system, such as the number of risks avoided, the amount of costs saved, and the effectiveness of claims handling. By combining the results in both categories, managers can get a clear picture of the performance of their risk management system.
The study concludes that having this kind of tool matters because, without it, organizations are essentially managing risks blindly, investing time and resources into a system they cannot properly assess. By making performance measurable, the framework gives project managers real control over their risk management efforts and a concrete basis for making better decisions going forward. (Khameneh, Taheri, & Ershadi, 2016)

The literature highlights that KPIs are more than simple measurement tools, they play a strategic role in improving performance and managing operational risks. The studies reviewed show that KPIs help organizations not only track results, but also anticipate risks and support decision-making.
On the other hand, integrating a risk-based approach into KPI systems complements this by enabling more proactive management of operational risks, ultimately strengthening both performance and long-term organizational resilience.
However, although many studies have explored Key Performance Indicators (KPIs) and operational risk management, few have examined their combined application in a practical way specifically within port operations. It is within this context that our research is situated. By analyzing how KPIs are used to monitor and optimize operational risks in ports, our study aims to address this gap. It provides added value by connecting theoretical

knowledge about KPIs and risk management with real-world port operations and by offering insights for improving risk handling and operational performance.

Section 2: conceptual framework

This section establishes the conceptual framework of the research by exploring the notion of performance, including its key concepts, types, and components. It then focuses on key performance indicators (KPIs), outlining their objectives, types, and main characteristics.
The section further examines port performance, highlighting its determinants and different types. It also addresses the concept of risk by presenting its characteristics, types, and components. Finally, it explores operational risks, with particular attention to their sources and classifications.
The objective is to provide a solid theoretical foundation for understanding the relationship between performance, KPIs, and the optimization of operational risks.

1. Generalities on performance

Performance refers to an organization's ability to achieve its objectives while optimizing the use of its resources.Effective performance management enhances decision-making, ensures continuous monitoring of activities, and strengthens the overall competitiveness of the organization.

1.1 Definition of Performance

To ensure its sustainability, an organization must achieve a high level of performance by demonstrating strong effectiveness in both its strategy and its structure, while respecting the principles of sustainable development, which involve balancing economic, social, and environmental dimensions. In this context, several terms are used in the field of management control, such as performance management, which focuses on planning and guiding performance; performance metrics, which are used to measure results; performance evaluation, which focuses on analyzing the extent to which objectives are achieved; and performance assessment, which focuses on evaluating the efficiency and quality of performance.(Nabaoui, 2023)
Performance refers to the relationship between the results achieved and the resources used to achieve them; it is not limited to just reaching goals, but also includes how efficiently those goals are achieved. From this perspective, performance reflects both effectiveness

through the achievement of goals and efficiency through the optimal use of resources, thereby allowing for an assessment of the organization's overall success.(مزهوده، 2001)

Performance is characterized by its multidimensional nature: just as organizational goals are diverse. It can be understood either in a broad sense as the process leading to a result (Action), or in a strict sense as the achievement itself (the result, the accomplishment). In this context, performance is defined as the achievement of organizational goals, regardless of their nature or differences. (Bourguignon, 2000)

In this context, Performance can include: (FNEP, 2005)

- achieving objectives on time.
- obtaining the highest possible costs.
- increasing profits and revenue.
- profitability currently and in the future.
- profitable growth.
- a strong position relative to competitors.
- employees who are comfortable in their roles and in the right places.
- the outcome of the work, rather than the product or service delivered.
- An accomplishment or an overcoming. (FNEP, 2005)

1.1.1 Concepts related to performance

Efficiency

Product efficiency compares actual production and input values with their optimal levels. This can involve assessing actual output against the maximum possible output, or inputs used against the minimum required, or a combination of both referred to as technical efficiency.

Efficiency can also be evaluated from the product's behavioral objectives by comparing actual costs, revenues, and profits with optimal values or targets, considering constraints on quantities and prices. This is known as economic efficiency.(Fried, Lovell, & Schmidt, 2008)

Effectiveness

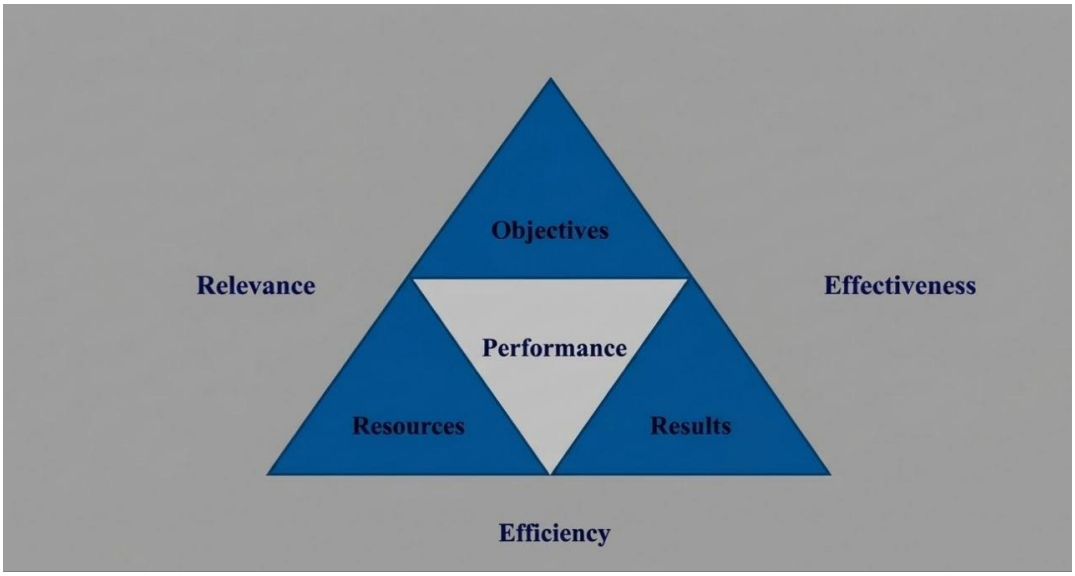
Effectiveness reflects the degree to which objectives are achieved and involves comparing predefined objectives with actual results. The aim is to measure gaps, understand their

causes, and analyze them. In this context, the evaluation process involves comparing planned goals with actual results at the level of each zone and each product, ensuring a clear understanding of the level of performance achieved. (Diouf, 2021)

Relevance

The assessment of relevance examines how well the project's objectives respond to the identified problems and real needs. It also checks whether these objectives are consistent with the expectations of the beneficiaries and the context in which the project is implemented.(Diouf, 2021)

Figure N° 2: Performance Model according to Giliberet



Source: (Gillet & Gilibert, 2009)

1.1.2 Types of performance

To measure the efficiency of a project, performance can be analyzed from several perspectives:

Economic performance:

A company achieves economic performance when it offers products that stand out in a competitive market and attract customers' attention. This competitiveness can be developed in two main ways: first, through price, when the product appeals to consumers due to an attractive cost, complemented by other non-price factors; and second, through qualitative elements such as product reliability, service quality, innovation, and the strength of customer relationships.

Organizational performance:

Organizational performance reflects how efficiently a company is structured and managed. The processes referred to in this context include the set of steps and procedures a company adopts to plan and organize its activities. Therefore, a company is considered to have good organizational performance if it successfully applies these processes in a systematic way to achieve its operational and strategic goals.

Social performance:

It focuses on all aspects intended to improve working conditions and
employee satisfaction within an organization.

Societal performance :

Societal performance refers to the extent to which a company respects the requirements for a positive environmental, natural, humanitarian, and cultural climate, among others. This performance can be assessed using CSR (Corporate Social Responsibility) tools. (Nabaoui, 2023)

1.1.3 Performance components

The performance of any project cannot be accurately evaluated without first establishing clear criteria. As (Kaplan & Norton, 1992) stated, “What you measure is what you get,” meaning that setting clear and relevant performance criteria is essential to guide the project toward its goals and ensure effective tracking of its progress.

For this purpose, the three main performance criteria in project management can be identified as follows:cost, qualityand timeframe:

Cost:

A cost can be defined as all the expenses and charges related to a specific element (such as a product, activity, or function), representing the total amount spent to carry out an operation. The concept of cost is closely linked to a company’s activity, whether it involves selling goods or producing products, as this activity uses financial, human, and technical resources whose monetary measurement forms the cost.(Bouamama, 2025)

Companies are always looking to minimize production costs, either to increase their profit margins or to make themselves more attractive to customers by lowering their selling prices . Costs are generally divided into two categories:

Direct costs: refer to all the resources used to carry out a service that can be clearly and directly assigned to that specific service.

Indirect costs:include resources that cannot be attributed exclusively to a single service, as they also contribute to other activities. These include indirect labor costs related to support functions, as well as other shared expenses distributed across multiple services.(Hamadmad, 2017)

Quality:

Quality can be described as the degree to which specified requirements are fulfilled. As defined by **ISO 9000:2015**, an organization's product or service quality is measured by its ability to meet customer needs and by the expected or unexpected effects on all relevant stakeholders. However, quality means fulfilling the established requirements while also considering the effects on all parties influenced by the products or services.

According to (Falzon, Di Cioccio, Mollo, & Nascimento, 2013), quality is based on the definition and application of standards, rules, and procedures designed to structure work and guide actions toward expected outcomes. It assumes that actual work aligns as closely as possible with prescribed work through the use of reference frameworks and standards to be followed.

In this context, we can identify two types of quality:

Regulated quality: based on the establishment of rules, procedures, and guidelines, as well as their application by actors.

Managed quality: depends on individuals' ability to adapt, take initiative, and deal with the uncertainties of real work situations.

Quality is defined as an essential condition across all company activities that fosters innovation and enhances overall performance. Innovation and performance are most effective when there is a synergy between quality practices and business operations. However, depending on contextual factors, quality may exert both positive and negative effects on performance. (Raja & Wei, 2015)

Time frame:

The concept of time frame is associated with time and can be defined as the period granted for the completion of something. The time frame related to product realization is represented by the interval between the moment the order is received and the moment the product is deliveredThis interval is a key indicator of operational efficiency, as shorter and predictable time frames often enhance customer satisfaction and overall performance. (Hamadmad, 2017)

1.2 Key performance indicators

Key performance indicators are used to for measuring the achievement of project objectives and adapt strategies based on the results attained, they help evaluate whether the objectives of the project are being achieved and contribute to improving overall performance. also, these indicators facilitate decisions by providing quantifiable data.

1.2.1 Definition of Key performance indicators

Organizations can achieve stable and satisfactory results through the use of KPIs, which support their growth and long-term success in a competitive and changing environment.They allow organizations to monitor performance and ensure that activities are aligned with strategic objectives. However, these results are only possible when employees work in a coordinated way. Through collaboration, they can continuously contribute to achieving the organization’s goals and maintaining the overall performance defined by these indicators. (Camilleri, 2024)

Key performance indicators offer a clear look at the results achieved and show how the organization is performing overall. They help managers spot poorly performing areas, and with accurate information, make better decisions and take corrective actions when needed. KPIs also help the organization use its resources wisely and guide in improving its processes. However, Regular use of KPIs improves the organization’s performance, helps it reach its goals, and supports long-term growth. (Midor, Sujová, Cierna, Zarebinska, & Kaniak, 2020)

KPIs are measurable indicators used to evaluate the performance of a project or an organization. They are related to csf's, which represent the most important areas that influence success. By measuring these important aspectsKPIs help organizations follow their progress and determine whether their objectives are being achieved. They also help managers evaluate performance and confirm that actions are consistent with the organization's strategic goals. (Kerzner, 2017)

Based on the above definitions, Key Performance Indicators can be defined measurable tools that guide organizations in tracking progress, improving performance, and making better decisions, also Regular use of KPIs supports long-term growth and organizational success.

1.2.2 Objectives of Key performance indicators

KPIs are indicators that help organizations measure performance relative to strategic goals and plans. They serve as a management tool that identifies problems early, facilitates quick decision-making, prioritizes actions, and encourages improvements in company processes. KPIs also allow for the identification of non-performing areas, monitor progress, and evaluate employee performance.(Balon, Dziadkowiec, & Niewczas-Dobrowolska, 2024)

They are developed to achieve several objectives:

- To link the organization's vision, mission, and strategy with its performance objectives and operational activities in order to reach the expected results;
- To measure the performance of the organization or its different divisions and identify whether there is improved or reduced performance;
- To compare the current performance of the organization with its past performance or with that of other concurrences, which helps identify strong and weak points and create opportunities for improved performance;
- To provide a base for defining work objectives and performance indicators for departments or individual employees;
- The results of the achievement of KPIs can be used as a reference for giving rewards and consequences so that KPIs also have the benefit of encouraging employee work motivation and good behavior from employees. (Setiawan & Purba, 2020)

1.2.3 Types of Key performance indicators

Financial KPIs:
aim to optimize financial profitability.

For example:

- **Return on investment (ROI):**
  Return on investment measures the profit or loss earned on an investment relative to the original amount invested. It is a crucial indicator for evaluating the profitability of projects and initiatives within an organization.

- **Operating costs:**

  Operating costs are the costs related to the organization's daily activities. Monitoring them helps control spending and improve profitability.

Operational performance KPIs:

They aim to measure the effectiveness and efficiency of an organization's daily activities.

For example:

- **Productivity:**

  Productivity measures the effective use of an organization's resources to produce goods or services. It is a key indicator for identifying opportunities to improve production processes.

- **Cycle time:**

  Cycle time is the time needed to accomplish a specific process or operation. It helps evaluate and improve the efficiency of work flow and production schedule.

Quality KPIs:

aim to measure continued improvement and optimize performance.

For example:

- **Default rate**

  The default rate indicates the percentage of products or services that are not consistent with the established quality standards.

- **Customer satisfaction**

  Customer satisfaction measures customers' impression of the products or services provided by the company. (Djami, 2024)

Problem Resolution KPIs:

aim to address the causes of identified problems.

For example:

- Percentage of corrective actions completed to track progress in addressing problems.
- Rate of problems resolved/problems identified measures the organization's ability to resolve detected problems. (AFNOR, 2002)

According to the Project Management Institute, performance indicators are divided into two types, leading indicators and lagging indicators:

Leading indicators are measures that help anticipate possible changes or trends in a project. When these trends seem negative, the project team evaluates the root cause of the leading indicator measurement and takes corrective actions to reduce the negative effect . In this context, leading indicators help reduce performance risks by revealing potential problems before they cross the acceptable limits.

Leading indicators can take different forms. Some are measurable, such as the size of the project or the number of items that are in progress in the backlog. Others are less measurable but still provide useful warning signs, but still provide useful warning signs of possible problems. Moreover, the absence of a clear risk management process, ineffective stakeholder engagement, or unclear project success criteria may indicate that project performance could face difficulties.

Lagging indicators are used to evaluate the results or events of a project and
help show what has already happened and give information about the project's past performance or situation. they can also help identify links between outcomes and environmental factors. if a delay in the project schedule appears as a lagging indicator, it may be linked to project team member dissatisfaction. Exploring this link can also help the project team address the root cause of a problem, that might not have been obvious if schedule status was the only thing being tracked.(PMI, 2021)

1.2.4 Tools and techniques used to measure Key performance indicators

Dashboards

A dashboard is a structured set of selected indicators designed to support decision-making. It enables managers to assess performance, identify deviations from objectives, and effectively monitor ongoing activities. (Lagoda, 2022).

A dashboard is A visual display of key performance indicators, metrics, and project data presented through charts and graphs, used to monitor and communicate project progress and performance to stakeholders. (PMI, 2021)

Balanced scorecards

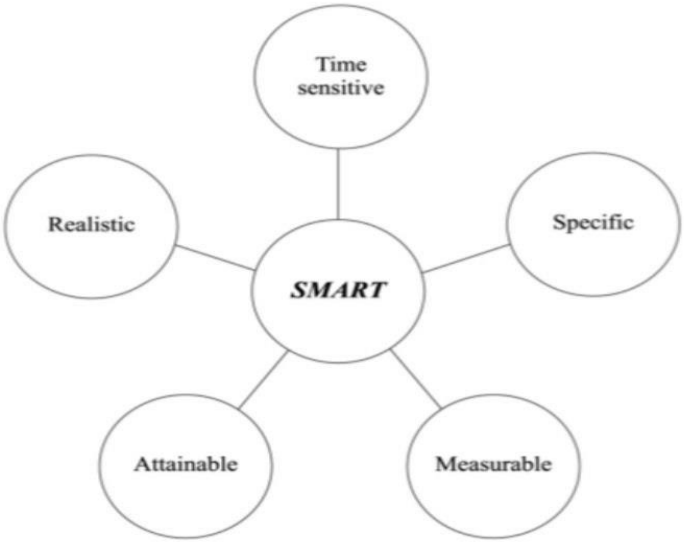
The Balanced Scorecard is a strategic tool that evaluates organizational performance through multiple dimensions beyond financial measures. By organizing indicators into four

main perspectives, it helps translate strategy into actionable objectives and ensures a balanced approach to performance management. (Kaplan & Norton, 1992)

The smart method

Clear definition of organizational objectives is essential, as it provides a clear direction and establishes the targets the organization aims to achieve.To make these objectives more effective, **the SMART** method is often used, as it helps ensure that goals are clear, focused, and achievable, increasing the chances of successfully reaching them. (Camilleri, 2024)

Figure N° 3: The SMART Method components



Source: (Shahin & Mahbod, 2007)

Specific:

Clearly defined goals are essential for effectiveness. Unlike general objectives, specific goals facilitate responsibility assignment and enable easier tracking of progress and achievement.

Measurable:

Objectives need to be written in a way that allows them to be evaluated. They should be measurable with numbers or at least assessed using clear criteria to see if they have been achieved.

Attainable:

Goals should be within reach given the current conditions. They should not be impossible to achieve, but still require some effort to encourage progress.

Realistic:

A goal should be suitable for the organization's situation. It needs to consider the available means and be consistent with its priorities.

Time-bound:

Each objective must be set within a deadline.Having a time limit helps follow progress, plan the work, and finish tasks on time. (Shahin & Mahbod, 2007)

1.3. Port performance and supply chain

In the context of globalization and increasing logistics complexity, ports are no longer confined to their traditional role of cargo handling but have evolved into integral components of global supply chains. Supply chain management (SCM) can be defined as the coordination and integration of material, information, and financial flows among multiple stakeholders to deliver value to the final customer. (Lu & Swaminathan, 2015)

Main objectives of supply chain performance measurement:

- Assess cost efficiency across the chain;
- Monitor delivery reliability and responsiveness;
- Identify bottlenecks and areas for improvement;
- Align operational performance with strategic goals. (Schönsleben, Hämmerle, & Hofer, 2023)

Performance measurement operates across strategic, operational, and tactical levels, with emphasis placed on measurement systems and approaches rather than isolated metrics.

1.3.1 Definition of Port performance

In the port sector, stakeholders work in an environment that often changes and is uncertain, especially because of new regulations and strong competition. In this context, economic performance becomes a key factor for ports. For this reason, it is important to measure this performance carefully in order to identify the limits of port activities and choose appropriate strategies, Performance evaluation is generally based on two main concepts:

effectiveness and efficiency.

Effectiveness describes the capacity of an organization to achieve its objectives, while efficiency relates to the proper use of available resources. A port is therefore effective when it meets its objectives and efficient when it uses its resources in an optimal way. (Foulquier & Lamberts, 2014)

Port performance is no longer considered separately from the supply chain that it relates to, however, it is now directly linked to the efficiency and reliability of that logistics chain. Today, shippers do not choose ports based only on their location or efficiency, but mainly on their ability to provide fast, time- and cost-effective access to competitive markets. In order to satisfy the needs of end customers and enhance shipper's competitiveness, Therefore, ports are required to provide the resources and capabilities necessary to create value and and improve overall performance. Ports are required to provide the resources and capabilities necessary to create value and improve overall performance. As a result, their efficiency becomes an essential part of the global performance of the port chain. (talkhokhet, mahraz, el yamani, & moutmihi, 2023)

1.3.2 Determinants of Port Performance

Port performance depends on several aspects that reflect how well a port operates and competes within the logistics system. These factors help assess the efficiency and quality of port activities. The main determinants include:

Table N° 1: Port performance determinants

The determinants	**Description**
Marketing strategy	helps ports understand user needs and strengthen their competitive position in the maritime market.
Natural conditions of the port	Natural factors related to the port environment influence its ability to operate efficiently.
Port infrastructure and equipment	Refers to the available physical resources and operational means at the port that support its activities and ensure their proper functioning.

Port productivity	Refers to the port's ability to manage its operations effectively, with minimal delays and improved overall efficiency.
Pricing of port services	The cost of port services plays an important role in the selection of ports by shipping companies and other port users.
Quality of services	High service quality improves customer satisfaction and overall performance
Human resource competence	The competencies, skills and experience of port employees are essential for effectively managing port operations.

Source: Elaborated by us based on (Elouidani & Kada, 2015)

1.3.3 Key Factors of Port Competitiveness

Port competitiveness is not based on one single factor. It depends on several elements that work together and influence how well a port can compete in the market. According to (Anisser, 2021),three main aspects help explain this:

- **Competition intensity:**

  Competition intensity represents a fundamental determinant of port competitiveness. Ports operate in a competitive environment where they try to attract the same clients, such as shipping companies and cargo owners. When competition is high, ports need to improve their services and sometimes reduce costs to stay attractive. In this context, ports must also define their competitive position, whether as leaders, challengers, or outsiders, in order to adopt appropriate strategic approaches.

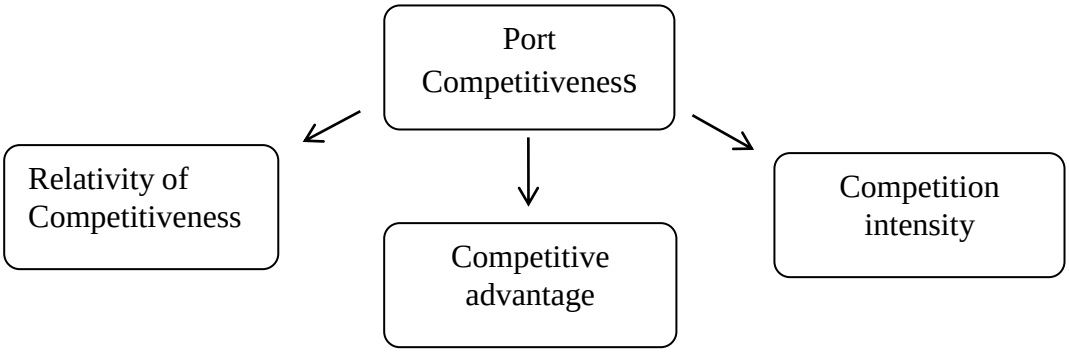
- **Competitive advantage:**

  Competitive advantage is a key determinant that explains why some ports outperform others. A port is considered competitive when it is able to develop specific advantages that differentiate it from its competitors.For example, a good location, fast operations, or better services.However, such advantages are not permanent and require continuous investment, innovation, and effective strategic management to ensure their sustainability over time.

- **Relativity of Competitiveness:**

  Competitiveness is a relative concept a port cannot be considered competitive in isolation, but only in comparison with other ports operating within the same market.This relativity implies that competitiveness evolves over time depending on market conditions, competitors strategies, and external influences such as technological, economic, and regulatory changes. Consequently, ports must adopt a long-term perspective, continuously monitor their environment, and remain strategically flexible in order to maintain their competitive position.

Figure N° 4: The key factors of port competitiveness



Source: Elaborated by us based on (Anisser, 2021)

1.3.4 Lean port performance

A management approach applied to port operations that emphasizes internal capabilities and process optimization as drivers of efficiency. Lean practices enhance operational effectiveness and create value for port stakeholders through waste elimination, continuous improvement, and cycle time reduction. (Mwambipile & Ryoba, 2025)

Lean management practices influence port logistics performance through three key dimensions: (Mwambipile & Ryoba, 2025)

- **Cycle Time Reduction** refers to speeding up port processes such as loading, unloading, and cargo clearance, which leads to faster and more efficient operations.
- **Waste Elimination** means removing unnecessary steps and repetitive tasks from port operations, making the overall process smoother and less costly.

- **Continuous Improvement** involves regularly training employees, refining daily procedures, and acting on feedback to gradually improve port performance over time.

1.3.5 Port performance indicators types

Financial indicators:

These indicators give a general idea about the port's financial situation by looking at its income, profits, and main costs.

- **Port revenue**: Shows the income earned from port activities and services.
  Examples: Total revenue, revenue from port services, port charges.
- **Profitability**: Indicates whether the port is able to generate a profit from its daily activities.
  Example: Operating profit.
- **Cost structure**: Shows the port's main costs and how funds are allocated.
  Example: Labor costs.

Ship operations performance indicators:

These indicators measure the efficiency of maritime services and the utilization of port equipment.

- **Maritime activity volume**: Shows the level of ship traffic at the port.
  Example: Number of ship arrivals.
- **Vessel operational efficiency**: Measures the efficiency of quay operations.
  Examples: Average waiting time at the quay, average working time at the quay.
- **Infrastructure utilization**: Monitors the use of quay and other equipment to optimize capacity.
  Example: Quay utilization rate

Cargo operations performance indicators:

These indicators measure how efficiently cargo is managed.

- **Volume and handling capacity**: Show the amount of cargo handled and the port's ability to manage this volume.
  Examples: Total cargo volume handled, cargo handling capacity.
- **Equipment productivity**: Measures the efficiency of the equipment used for charging and discharging operations.

- **Logistics flow**: Measures how quickly cargo moves through the storage area.
  Example: Average container dwell time in the storage area.

Human resources performance indicators:

Measure the management, productivity, and development of port personnel.

- **Staff structure**: Shows the number and distribution of employees in the port authority.
  Example: Average number of employees in the port authority.
- **Working conditions**: Measure employee attendance and work delays.
  Examples: Absenteeism rate, number of work stoppages.
- **Human capital**: Shows how much the port invests in training its employees.
  Example: Training expenses. (UNCTAD, 2016)

Moreover, Port performance indicators can be studied at two complementary levels: intra-port and inter-port performance.

- **Intra-port performance**: refers to the evaluation of activities that take place inside the port. It focuses on assessing how efficiently port operations are carried out and how resources are used in daily port activities.(Elouidani & Kada, 2015) It may also be influenced by internal factors, such as investments in equipment and infrastructure, as well as some physical characteristics of the port.In this context, performance can be evaluated by comparing the port's real activity level with its maximum potential.(Benkhedda, El Hakmi, & Bennaceur, 2023)

However, evaluating only the internal operations of a port is not enough to fully understand its performance. Because ports operate in a competitive environment, it is also important to look at inter-port performance.

- **Inter-port performance**: is related to the position of a port compared with other competing ports. Port authorities need to consider the competition coming from other ports and the logistics networks linked to them. In this context, (Heaver, Meersman, & Van de Voorde, 2001) explain that the growing competition between ports encourages port authorities to develop systems to evaluate and improve their performance. When intermodal transport services improve, they can make alternative port routes more attractive and increase the competitiveness of these ports.

2. Fundamentals of risk

In this section, we first define risk and outline its main characteristics, along with its different types and fundamental components. We then focus on operational risks by examining their various sources and classifications, highlighting their impact on organizational performance.The objective of this section is to build a clear and structured theoretical basis for understanding operational risks, thereby facilitating their identification, classification, and effective management.

2.1 Definition of Risk

According to **ISO 31000:2018**, risk is defined as “the effect of uncertainty on objectives.” It is also considered as a potential danger, disadvantage, or unfavorable situation to which an organization may be exposed, potentially affecting its ability to achieve its objectives.
and it can be addressed in terms such as:

- Source: such as the elements that can individually or combined to generate risk.
- Event: by manifesting or alteration of a specific set of circumstances.
- Consequences: is the result of influence of the event on objectives.
- Likelihood: which means the probability of something happening.

Therefore, managing risk depends on the organization’s ability to identify, analyze, and address these risks effectively by taking appropriate actions.

Risk is an uncertain event that may occur and have negative consequences for the achievement of an objective. It is therefore linked both to the uncertainty of its occurrence and to the potential damage it may cause.
In other words, risk refers to the possibility that an unexpected event may hinder or interrupt the achievement of an objective by having a negative impact. (Schick, Vera, & Bourrouilh-Parège, 2014)
To conclude, based on these definitions risk represents the possibility that uncertain events may negatively affect the achievement of objectives, impacting people, assets, the environment, or an organization’s reputation.

2.1.1 Risk Management

ISO 31000:2018 defines risk management as "coordinated activities to direct and control an organization with regard to risk", framing it as a comprehensive approach covering the

identification, analysis, evaluation, treatment, and monitoring of risks, with the fundamental purpose of creating and protecting value across any organization.

Risk management can also be defined as “an organized process carried out at all levels of an organization, recognizing that some events, whether expected or not, can arise and have a positive or negative effect on its goals”. (PMI, The standard for risk management in portfolios, programs, and projects., 2019).

2.1.1 Characteristics of risk

According to Courtot (1998) and Villarreal-Lizarraga (2005), risk has been characterized by various elements, which are listed in the following table: (Bouzidi, 2019)

Table N° 2: Characteristics of risk

Elements	Definition
Nature	Refers to the category or type of risk involved. A risk can fall under financial, human, organizational domains, among others.
Cause	Encompasses the organizational, functional, or environmental contexts in which risks emerge. It includes all direct or indirect factors contributing to the occurrence of a risk. Notably, the causes of one risk may themselves stem from the consequences of another.
Consequences or impact	When a risk occurs, it produces an effect that can be measured in terms of cost, time, or performance. The size of this effect and how it is estimated are also taken into account.
Scope	Relates to how the risk, if it occurs, challenges the objectives set at various levels of responsibility within a project.
Detectability	Reflects the ability of those involved in an activity to anticipate, identify, and respond to early warning signs before a risk fully manifests and disrupts operations. It depends on the amount of available information about the risk.
Controllability	Distinguishes between risks that are chosen and those that are imposed. It covers all preventive and corrective measures designed either to prevent a risk from occur-

	ring or to reduce its impact if it does.
Severity	This indicates how serious a risk could be if it happens. It helps distinguish between minor risks that can be ignored and major ones that could cause significant damage.
Probability or occurrence	Expresses the likelihood that a risk will materialize. This likelihood can be assessed either qualitatively or quantitatively.
Responsability	Risk management must have a designated person in charge — someone with the authority to make decisions and take the necessary actions to manage it.

Source: (Bouzidi, 2019)

2.1.3 Types of risk

According to (Métayer & Hirsch, 2007), there are nine categories of risk, listed below:

Process Risks: These risks are linked to the company's "know-how." A process is a set of interrelated activities that transforms inputs into outputs, and risks generally emerge at the interfaces or boundaries between these processes;

Project Risks: These concern a “unique process” (the project) that has a specific beginning, end, and objective. They are usually evaluated against the "quality triangle": adherence to costs, quality, and deadlines ;

Human Risks: In this book, these are specifically defined as risks where the human being is the target (such as occupational health and safety), rather than risks caused by humans ;

Financial Risks: These relate to the monetary assets and financial sustainability of the organization, covering everything from daily cash flow to long-term investments ;

Customer Risks: Because "without a customer, the company has no reason to exist," these risks are tied to customer satisfaction, complaints, and loyalty ;

Resource Risks (Internal and External): These affect the availability and quality of the means necessary for operations. This includes personnel, equipment, partners, and subcontractors ;

Legal Risks: These are defined by the threat of consequences related to non-compliance with laws and regulations ;

Environmental Risks: The potential for a company's activities to cause harm to nature, including pollution or damage to public safety. (Métayer & Hirsch, 2007)

In general, the author notes that a risk only exists when a threat (danger) intersects with a target. It is measured by its criticality, which is a combination of the probability of it happening and the severity of its effects.

2.1.4 Components of risk

Risk can fundamentally be defined through three essential components:

Danger:

A danger is defined as a possible source of damage, including any element, event, or situation that can cause it. Danger is the cause of risk, and its presence indicates that a risk may exist. Dangers are often more visible and easier to detect than risks, which remain abstract until they affect vulnerable targets. Identifying risks, therefore depends directly on identifying dangers, which are essential for assessing and managing risk. (Le Ray, 2015)

The target threatened by this danger:

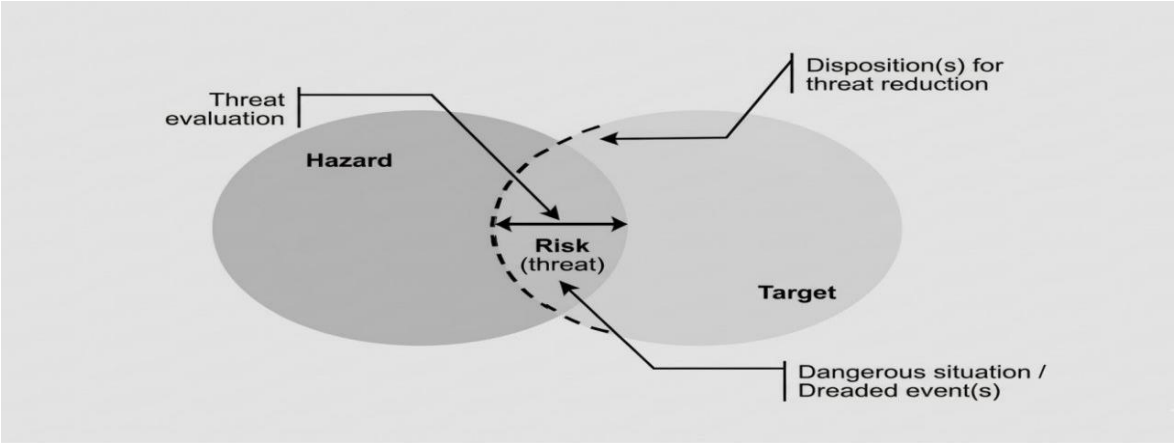
A risk only occurs if the danger can affect a target, meaning something exposed, such as a person, an asset, or an organization. The interaction between the danger and the target creates a dangerous situation in which a threat appears, corresponding to the unwanted event. (Le Ray, 2015)

Estimating risk:

Estimating risk refers to assessing the likelihood of a danger affecting a target and its potential consequences. This requires measuring both the probability of the event occurring and the potential impact it might cause. Measuring both aspects helps in understanding and managing the risk. (Le Ray, 2015)

Risk emerges only when a source of danger and an exposed element coexist. Their interaction generates a hazardous context in which a potential threat develops, meaning there is a likelihood that harmful events could affect the exposed target. When this threat is analyzed and evaluated, it is then defined as risk, as represented in the following figure.

Figure N° 5: Standard Risk Modelling



Source: (Le Ray, 2015)

2.2 Operational risk

Operational risks are a major category in the management of organizations. They include all uncertainties and events that can disrupt the normal flow of processes and daily activities.

2.2.1 Definition of operational risk

According to (Kenett & Raanan, 2011), operational risk is defined as the potential problems that can negatively affect an organization. These risks are generally predictable and, in many cases, preventable if not by stopping the events entirely, then by minimizing their consequences on the organization.Operational risk covers the full range of risks that can have direct or indirect consequences for an organization, potentially leading to damage, financial loss, or additional costs. These effects may be either endured or generated by the organization and can occur over the short, medium, or long term as part of its everyday operations. (Jean-David, 2013)

According to (Bâle, 2013), operational risk refers to the possibility of financial losses caused by weaknesses or breakdowns in internal processes, human factors, or systems, as well as by external occurrences. In this perspective, the concept is approached by first identifying the outcomes (losses) and then linking them to their underlying sources, such as inefficiencies, failures, or external factors.

Operational risk refers to the full range of potential failures arising from processes, human factors, systems or external events within an organisation. It affects the entire operating cycle, from conception to delivery, where failures may negatively impact the end customer and result in financial or reputational losses. (Jean-David, 2013)

Operational risk can be understood as the likelihood of loss resulting from various human, or technical errors, often connected to failures in payment and settlement processes, business interruptions, and administrative or legal exposures. (Ogien, 2008)

2.2.2 Sources of operational risks

Based on the previous definitions, we can identify four main factors that may give rise to operational risk; they can be outlined as follows: (Saidani, 2012)

Process failures: These occur when established procedures are not properly followed. They may include mistakes in transaction recording, data entry errors, duplicate processing of checks, or assigning a transaction to an incorrect beneficiary.

Internal system failures: These occur when an organization's technological systems or equipment malfunction. They may include IT breakdowns resulting from hardware defects , network failures that temporarily block the execution of transactions in financial markets, or communication disruptions between branches of the same institution.

Human-related failures: These arise when employees fail to meet the required standards of competence or availability, such as in cases of absenteeism or fraudulent behavior.

External events: These include all external factors beyond the organization's control that can negatively impact its operations, such as cyberattacks or robberies.

2.2.3 Types of Operational risk

(Thai, 1999) was among the first to categorize different types of operational risks, notably: (Mehar, 2024)

Malfunction risks: which include factors such as:

- Insufficient staff capability during temporary replacements or permanent departures.
- Mistakes, oversights, or lapses.
- Disruptions caused by changes in management without prior communication.

Fraud-related risks: characterized by elements such as:

- Collusion between individuals.
- Risks of failure arising from non-compliance with established procedures. (Mehar, 2024)

The Basel II framework further developed this initial classification by dividing operational risk into seven categories:

Internal fraud: This is perpetrated by individuals within the organization, including employees, interns, temporary staff, or even relatives and friends of employees.

External fraud: This is committed by parties outside the organization, such as cybercriminals, hackers, scammers, organized crime members, petty offenders, or other malicious actors. (Jean-David, 2013)

Employment and workplace safety: Losses from violations of employment, health, or safety conditions.

Clients, products, and business practices:

Losses due to errors or negligence affecting clients or issues related to product quality or design.

Physical assets:

Losses from damage or destruction of physical assets caused by natural events.

Business interruption and systems: Losses caused by operational disruptions or failures in systems.

Execution and process management: Losses from poor management of transactions with third parties, like vendors or partners. (Henri & Jean, 2014)

Table N° 3: Examples of operational risk categories based on Basel II

Event category	**Examples of events**
Internal fraud	Inaccurate information on positions, thefts committed by an employee
External fraud	Damages caused by computer hacking
Employment Practices and Workplace Safety	Breaking health and safety rules, complaints about discrimination
Clients, Products, and Business Practices	Breaking trust with clients, sale of unauthorized products
Damage to Physical Assets	Earthquakes, fire
Business interruption and systems	Information technology outages and failures in telecommunications systems
Execution, and Process Management	Errors in client account access and deficiencies in legal documentation

source: (Boussaid & Belkacem, 2023)

Conclusion

In conclusion, this chapter has established a conceptual framework by defining the concept of performance, its main concepts, types, and components. We then examined key performance indicators (KPIs), outlining their objectives, types, and essential characteristics. The study also focused on port performance, identifying its determinants and various forms. Subsequently, the concept of risk was analyzed in terms of its characteristics, types, and components, before focusing on operational risks, highlighting their sources and classifications as well as their impact on overall performance.

This theoretical framework provides a solid basis for the rest of the study, particularly for analyzing how KPIs are applied in managing operational risks.

CHAPTER II: METHODOLOGICAL FRAMEWORK AND ORGANIZATION PRESENTATION

Introduction

This chapter is structured into two sections. In the first section, we will present the methodological framework adopted to conduct this study, detailing the approach followed as well as the data collection and analysis tools. In the second section, we will present the organizational context through a general overview of the port of Djen Djen.

Section 1: Methodological Framework

In this section, we will outline the methodological approach adopted for our study, specifying the tools and methods used for data collection and analysis. All of these elements are intended to ensure the scientific rigor of our work.

1. Epistemological Framework of the Research

Epistemological positioning is the essential theoretical framework used to ensure the rigor of scientific research. It involves examining the nature of the knowledge produced and how it is developed to justify its validity. This fundamental choice defines the researcher's perspective and dictates all methodological decisions, typically through the adoption of paradigms. These paradigms play a vital role as they represent the established research traditions within a specific field (Benhaddouch & El Fathaoui, 2022). By providing a structured framework of accepted theories and methodologies, paradigms act as a lens through which the entire study is conducted. They are typically based on paradigms such as post-positivism, interpretivism, or constructivism. (Dehbi & Angade, 2019)

- Positivism: This approach considers reality as objective and independent of the observer. It aims to identify general laws through observation and hypothesis testing. The researcher maintains neutrality and remains separate from the subject of study.
- Constructivism: This vision argues that knowledge is not a reflection of an external reality, but is actively constructed by the individual.Reality is seen as a continuous process shaped by the researcher's experiences, aiming to create practical knowledge rather than absolute truths.
- Interpretivism: This current considers reality to be subjective and dependent on individuals. By emphasizing subjectivity, it seeks to understand the sense and intention behind human actions. (Ait Lemqeddem, Er Rays, & Ezzahiri, 2022)

In this study, which examines the contribution of key performance indicators (KPIs) to the optimization of operational risks in the port environment, we adopt an interpretive approach. This choice is driven by the objective of understanding how stakeholders perceive, use, and interpret KPIs, particularly within the Djen Djen port.

2. Methodological Approach

Methodology represents the framework that guides a research project, it not only outlines the general strategy but also specifies the methods to be applied. These methods determine the techniques for collecting data or, in some cases, the procedures for calculating specific results. (Alharahsheh & Pius, 2020)

This approach is part of an abductive qualitative methodology that aims to explore how Key Performance Indicators (KPIs) help improve the management of operational risks in the Port of Djen Djen. The research is based on collected data from KPIs provided by the port authorities. The focus is on interpreting these indicators and understanding stakeholders' perspectives, which helps reveal how KPIs influence risk management in practice. This approach is useful for studying real-world processes and the connections between performance measures and decision-making.

Qualitative research is based on exploring the meanings and processes behind human experiences. It aims to provide an understanding of a phenomenon from the perspective of its participants, with a focus on detailed insights instead of broad generalizations. Through comprehensive and exploratory studies, qualitative research seeks to generate specific, useful informations that captures the details of the subject being studied. (Alharahsheh & Pius, 2020). Abductive reasoning usually starts from a partial or incomplete observations and seeks the most likely explanation for them. This approach is valuable because a phenomenon can often be explained in many different ways making the selection of the most likely one a critical step in the reasoning process. (Dehbi & Angade, 2019)

3. Data collection tools and methods

In order to collect the data needed for this study, we relied on three main tools, which are presented as follows.

3.1 Documentary analysis

Documentary analysis, according to (Creswell & Creswell, 2018) is a qualitative method that involves collecting and analyzing existing documents, whether public or private. It allows researchers to understand participants' views through their own words. These documents are analyzed systematically to identify patterns, themes, and meanings relevant to the study.

For our study, we explored various academic resources, including ResearchGate, Google Scholar, ScienceDirect, and relevant literature, to provide the theoretical and methodological basis to deepen our research. Additionally, we reviewed several internal documents from the host organization such as context analyses and data shared during the internship period, which helped strengthen our analysis.

3.2 Observation

Observation is a direct, systematic method of data collection in social research that involves watching and recording phenomena as they occur in natural or controlled settings. It becomes scientific when it is purposefully planned, recorded, and checked for validity and reliability, enabling researchers to gather real-time data on human behaviour while acknowledging the potential influence of the observer's own values. (Islam, Khan, & Baikady, 2022)

In this context, qualitative observation enabled us to analyze the practical application of key performance indicators (KPIs) within Djen Djen port. A direct observation approach was adopted on-site, focusing on interactions between stakeholders and examining how KPIs are utilized in daily operations and influence decision-making processes.

All observations are conducted ethically, with participant awareness and consent.

3.3 Interview

According to (Creswell & Creswell, 2018) , an interview in qualitative research is a data collection method whereby the researcher asks open-ended questions to participants in order to gather their personal views, experiences, and historical information. It may be conducted face-to-face, by telephone, in focus groups, or online, and the resulting data consist of participants' own words as recorded through an interview guide.

In general, interviews can be divided into the following types: (Alsaawi, 2014)

- Structured Interview: A well-organized and planned method where the researcher uses a fixed list of questions asked in the same order for all participants.This helps keep the

discussion focused and makes it easier to compare answers.Moreover, it is most suitable when the researcher already knows exactly what specific information is needed.

- Unstructured Interview: An open, flexible method resembling a natural conversation. The researcher begins with one general question and allows the interviewee to speak freely, expand on their ideas, and guide the discussion with little interruption. This type is Ideal when the researcher wants to explore a specific phenomenon in detail.
- Semi Structured Interview: This type mixes both structured and unstructured approaches. The researcher prepares open-ended questions in advance, while still allowing the participant to speak freely, clarify their answers, and introduce new ideas. It offers a general understanding of the topic while still capturing detailed and rich responses.

In our study, due to the balance between structure and flexibility, a semi-structured interview was used. This approach allows for specific questions to be asked that facilitate discussion directed toward the goals of the thesis, while also permitting room for participants to provide a more thorough analysis and fresh perspective. This interview is divided into three themes.

Theme 1: Operational Risks at the Port of Djen Djen: Questions about the main operational activities exposed to risks, the most frequent types of operational risks encountered, and how these risks are identified and formally documented within the port supply chain.

Theme 2: Key Performance Indicators: Exploring the KPIs currently used to monitor operational risks, their specificity to each process, the frequency of monitoring, the digital tools used, the reliability of data, and how KPI results are communicated to operational managers.

Theme 3: Impact of KPIs on Risk Optimization: Examining the concrete improvements observed since KPI integration, their capacity to anticipate future risks, their alignment with the evolution of port activities, and the recommendations of respondents for strengthening the existing risk management system.

These discussions provided precise information on performance monitoring and evaluation practices, as well as the tools used.

To structure these interviews, an interview guide was developed around three main themes (Appendix B**)**, covering operational risk, KPI monitoring and analysis, and their

contribution in identifying and improving operational risk management, while also considering the involvement of different stakeholders.

4. Data analysis tools and methods

To analyze the data collected, we used the following tool.

4.1 Nvivo analysis

NVivo is a software program designed to support qualitative data analysis. This program enables researchers to manage, code, query, and visualize qualitative data from multiple sources, including text, audio, video, and surveys within a single project file, offering rich insights and a deeper understanding of collected data. (Mortelmans, 2025)

As part of this study, we used NVivo to analyze the responses collected from semi-structured interviews conducted with four managers from different hierarchical levels. This software enabled us to organize the data, identify key themes, and illustrate the findings through visualizations such as word clouds, which helps achieve a clearer understanding of the data and a more accurate interpretation of the responses. A summary of the interview participants is shown in the table below:

Table N° 4: Summary of the participants in the interviews

The interviewee	Profile	Time
1	Head of the Stevedoring Department	60 minutes
2	Head of the Cargo Handling Department	40 minutes
3	Head of the HSE Department	60 minutes
4	Head of the Officers' Department	40 minutes

Source: Elaborated by us

4.2 Data Analysis and Interpretation

In our study, qualitative data analysis was used to identify patterns, themes, and key relationships in the data collected through semi-structured interviews with operational managers at the Port of Djen Djen. This approach allowed for an in-depth understanding of the

respondents' experiences regarding KPI use and operational risk management within the port supply chain.

The process involved a thorough reading of the interview transcripts, followed by systematic coding of relevant passages into three main thematic sections. Codes were then grouped into themes, paying attention to both explicit statements and latent meanings across the four respondents. This promoted a transparent, systematic, and credible understanding of the results in alignment with the research objectives.

The information collected in the field was used to develop the FMECA matrix, applied as a complementary tool for operational risk analysis. This method consists of systematically identifying potential failure modes within port operations, assessing their effects, and evaluating their criticality based on: The frequency of occurrence and the severity of consequences. Each risk is assigned a criticality index ($C = F \times S$), which allows for prioritizing corrective actions according to the level of risk, thereby strengthening the reliability and objectivity of the overall analysis.

Section 2: organizational context

This section provides a comprehensive overview of the host organization, highlighting its core goals, mission, key activities, and other relevant details.

1. Presentation of the Port of Djen Djen

The Port of Djen Djen is a commercial port located in the Jijel province, in the eastern part of Algeria. It is considered one of the most important ports in the country due to its large capacity and deep-water characteristics. The port plays a strategic role in maritime transport, particularly in container transshipment. It is also ranked among the major port infrastructures in the Mediterranean region. With a draft reaching approximately -18.20 meters, the port is capable of accommodating large vessels, which strengthens its importance at both national and international levels. In addition, the port includes a container terminal currently under development, with an estimated capacity of around 2 million TEUs per year, enabling it to handle a significant volume of goods and support trade activities.

Table N° 5: General information about the Port of Djen Djen

Field	Information
Official Name	Djen Djen port
Operator	(EP-DJENDJEN)
Parent Group	SERPORT (Algerian public group)
UN/LOCODE	DZDJE
Port Type	Deep-water seaport
Status	Main commercial port of eastern Algeria
Website	djendjen-port.dz
Phone (General)	+213 (0)34 54 21 64
Fax	+213 (0)34 54 21 60
Email	ep@djendjen-port.dz

Source: Based on the data collected at the host organization

2. History of the Port of Djen Djen

The Djen Djen port project dates back to the 1970s, when it was planned as a maritime outlet to support industrial development, particularly the steel complex in the region. Construction work officially began in 1984 and was completed in 1992, marking the start of the port's operations. Since its establishment, the port has undergone several phases of development and modernization. Today, it continues to evolve into a major logistics hub in the Mediterranean, contributing to Algeria's economic competitiveness.

3. Geographical Location of the Port of Djen Djen

The Port of Djen Djen benefits from a highly strategic geographical location. It is situated: in the municipality of Taher, Jijel province about 10 km from the city of Jijel approximately 350 km from Algiers close to Jijel Airport (around 2–3 km).

The port is also located less than 50 miles from the main international maritime route connecting the Suez Canal to the Strait of Gibraltar, giving it a major advantage in global trade. Furthermore, it is considered the closest port to southern oil fields, particularly Hassi Messaoud, which enhances its economic and logistical importance.

4. Missions of the Port of Djen Djen

The main missions of the Djen Djen Port Authority are related to the management and operation of port activities. They include:

- Ensuring the handling of ships under optimal conditions of cost, time, and safety.
- Managing and operating port infrastructure and equipment.
- Carrying out cargo handling and stevedoring operations.
- Providing port services such as pilotage, towing, and mooring
- Ensuring security and safety throughout the port area.

5. Vision of the Port of Djen Djen

The vision of the Port of Djen Djen is based on long-term development. It aims to:

- Become a strategic logistics hub in the Mediterranean region.
- Establish itself as an international transshipment port.
- Strengthen Algeria's position in global maritime trade.
- Develop into a modern, competitive, and attractive platform for investors.

6. Objectives of the Port of Djen Djen

To achieve this vision, the port has several objectives:

- Economic objectives: Promote non-hydrocarbon exports Increase maritime traffic and container volumes attract national and international investments.
- Logistical objectives improve the flow of goods and logistics efficiency reduce ship turnaround time develop infrastructure (container terminal, railways, highways).
- Strategic objectives become a key trade gateway for Algeria and the Sahel region position itself as a regional and international transshipment hub.

Table N° 6: Certifications of the Port of Djen Djen

Field	**Information**
Integrated Management System (IMS)	Certified since November 2018
ISO 9001: 2015	Quality Management System
ISO 14001: 2015	Environmental Management System
ISO 45001: 2018	Occupational Health & Safety Management

Source: Based on the data collected at the host organization

7. Activities of Djen Djen port

High standards of service quality are guaranteed by the Djen Djen Port Company (ship services, handling, and logistics).

7.1 Ship services

Ship services include all operations related to assisting and managing vessels within the port. These services ensure safe and efficient navigation. They include:

7.1.1 Pilotage

Pilotage is guiding ships when entering and leaving the port and advising the captain on navigation conditions.

Pilots assist masters in bringing their ships to and from the entrance of inland waterways, harbors, and anchorages.

While performing pilotage movements, the pilot is under the command of the captain of the vessel being piloted.

The pilots can also interact with port professionals, such as tug masters and authorities, and crew, who help with ship berthing as well.

7.1.2 Towing

The purpose of towing is to help any kind of vessel navigate the port in any situation:

- Incorporate pushing or tugging the container.
- The process of docking, transferring, or starting a ship.
- Assistance with vessel navigation maneuvers.
- Towing and support in the operation of port equipment and facilities.

7.2 Handling services

As the handling part is often considered the most significant part of port operation, since it entails the main responsibility of processing goods, primarily loading and unloading of such goods.

The hierarchical system governing the Port of Djen-Djen consists of several trades of equal significance. In these specialized roles, awareness needs to be higher for multiple factors, including safety and strict adherence to procedures to protect both employees and the products themselves.

7.2.1 Vertical handling

Vertical loading and unloading are technically referred to when a crane is applied to land activity. Such works permit to performance of loading and unloading of freight in vessels of different tonnage.

7.2.2 Horizontal handling

These major features at the dock or some professionals who carry and secure the goods, he localizes and loads them on the ship. Djen-Djen port (RO/RO — Roll On/Roll Off) has three ramps for rolling stock.

7.2.3 Stevedoring

Includes operations aimed at ensuring the receipt, tallying, and inspection on land of loaded or unloaded goods, as well as their storage/safekeeping until shipment or delivery to the consignee.

7.2.4 Logistics

Besides managing normal unloading, what makes the port of Djen-Djen special is also the fact that they have their truck fleet, which substantially boosts their logistical knowledge. Besides moving cargo from the pier to storage sites on port-owned land, the port is a one-stop "Port-to-Door" service. This adds a value proposition that ensures customers that the items will be delivered straight to the destination. By internalizing both inland and maritime logistics, the port assured an end-to-end, secure, and efficient delivery process.

Conclusion

This chapter presented the methodological framework adopted for this study and the organizational context in which it was conducted. Drawing on an interpretivist paradigm, a qualitative approach was chosen, combining semi-structured interviews, direct observation, and internal document analysis for data collection, alongside thematic analysis via NVivo and the FMECA method for risk assessment. The second section provided a detailed overview of the Port of Djen Djen, situating the study within its specific operational and institutional environment. These foundations prepare the ground for the analysis and interpretation of results presented in the following chapter.

CHAPTER III: RESULTS AND DISCUSSION

Introduction

This chapter presents and discusses the results of the empirical investigation conducted at the Port of Djen Djen. Drawing on semi-structured interviews with port managers, direct field observation, and the analysis of internal operational data, it examines the extent to which Key Performance Indicators contribute to the optimization of operational risks within the port's core activities.

Section 1: Results of the study

In this section, we will present the various results obtained from a risk evaluation based on the key performance indicators used within the port.

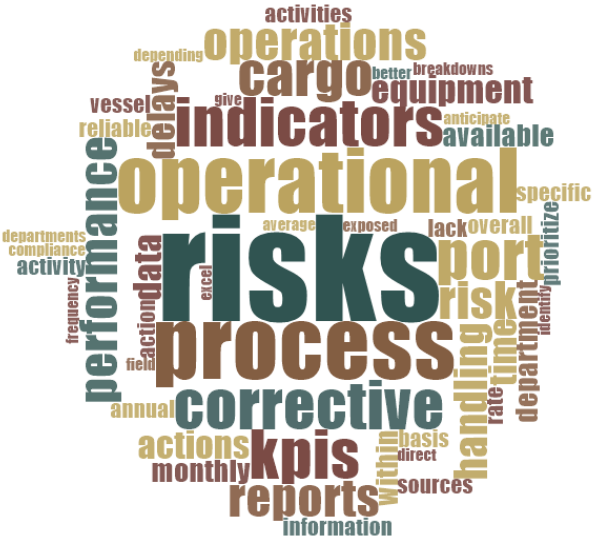
1. Results of the semi-structured interviews

This analysis is based on semi-structured interviews conducted with managers at the Port of Djen Djen. It aims to identify similarities and differences in how they use and perceive key performance indicators (KPIs) to manage operational risks in the port environment.
The analysis covers several main themes, including operational risks within the port, key performance indicators. It helps identify what works well and what holds back better operational management. It also shows how using KPIs affects teamwork between port actors, the ability to respond quickly to problems, and the building of a performance culture within the port.

1.1 Lexical Analysis

A lexical analysis was conducted based on the verbatim transcripts of the interviews in order to identify the most frequently occurring terms. This approach makes it possible to highlight the key themes mentioned by respondents when discussing about the KPI contribution and operational risk optimization within the port.

Figure N° 6: Word Cloud



Source: Nvivo analysis

Interpretation of Dominant Terms

The term “risks” (2.80%) emerges as the central term of the analysis, confirming that respondents’ thinking is primarily structured around the management and anticipation of operational risks. It serves as the pivot around which the other key themes are organized. The term “process” (1.87%) also holds a prominent place, reflecting a strong interest in the formalization and structuring of procedures. This notion is closely linked to “operational” (1.73%), suggesting that the optimization of operational processes is perceived as a fundamental lever for performance. The significant presence of “corrective,” “indicators,” and “KPIs” (1.33% each) highlights respondents’ sensitivity to performance measurement and corrective monitoring. The emphasis is placed on a proactive management approach, in connection with result-driven and compliance constraints. The terms “port” (1.33%) and “cargo” (1.20%) clearly anchor the discourse in a specific port and logistics context, grounding the analysis in a concrete operational reality, with its own tools, constraints, and internal references. The strong co-occurrence of “performance” and “reports” (1.07% each) reveals the importance attached to reporting and organizational accountability. Transparency and communication of results emerge as essential management factors. Finally, the terms “delays,” “equipment,” and “handling” (0.80–0.93%) reflect a constant concern for managing field-level disruptions breakdowns, delays, cargo handling, attesting to a structured approach aimed at minimizing operational disturbances.

This analysis shows that risk management, KPI-based monitoring, and the optimization of operational processes are at the core of respondents' concerns. The prominence of terms related to port, cargo, and equipment underlines an approach firmly grounded in operational reality. Finally, the recurrence of corrective and reporting-related terms reflects an organizational culture oriented toward measurable performance and continuous improvement.

Table N° 7: Word frequency table

Word	Length	Count	Weighted Percentage (%)
Risks	5	21	2.80
Process	7	14	1.87
Operational	11	13	1.73
Corrective	10	10	1.33
Indicators	10	10	1.33
KPIs	4	10	1.33
Port	4	10	1.33
Cargo	5	9	1.20
Operations	10	8	1.07
Performance	11	8	1.07
Reports	7	8	1.07
Risk	4	8	1.07
Handling	8	7	0.93
Actions	7	6	0.80
Data	4	6	0.80
Delays	6	6	0.80
Equipment	9	6	0.80

Source: Elaborated by us based on Nvivo analysis

1.2 Linguistic Analysis

The table below displays the Pearson correlation coefficients measuring the similarity among the four respondents in terms of the vocabulary used throughout their interviews.

The Pearson correlation coefficient is a statistical measure that quantifies the degree of lexical overlap between two sources, with values closer to 1 indicating stronger similarity. These coefficients were generated by NVivo through a word similarity query applied to the interview transcripts. The strongest correlation is observed between Respondent 4 and Respondent 3, with a coefficient of 0.647, indicating a high degree of similarity in their vocabulary and suggesting that these two respondents share closely aligned conceptual frameworks around operational risk management. Respondent 3 also shows strong correlations with both Respondent 2 (0.638) and Respondent 1 (0.634), positioning

Respondent 3 as the most lexically central figure in the dataset a linguistic bridge between the other participants. The correlation between Respondent 4 and Respondent 1 (0.613) and between Respondent 4 and Respondent 2 (0.610) remain strong, confirming a broadly shared institutional vocabulary across the four interviews. The lowest coefficient is observed between Respondent 2 and Respondent 1 (0.607), though this figure still reflects substantial lexical proximity, and the difference between all pairs is relatively ranging from 0.607 to 0.647 suggesting a high overall degree of discursive convergence among all respondents.

Table N° 8: Correlation coefficient table

Source A	Source B	Pearson correlation coefficient
Internals\\respondent_4	Internals\\respondent_3	0.647642
Internals\\respondent_3	Internals\\respondent_2	0.638806
Internals\\respondent_3	Internals\\respondent_1	0.634894
Internals\\respondent_4	Internals\\respondent_1	0.613715
Internals\\respondent_4	Internals\\respondent_2	0.610309
Internals\\respondent_2	Internals\\respondent_1	0.60749

Source: Elaborated by us based on Nvivo analysis

2. Observation results

2.1 Operational risk identification

Risk identification was based on three complementary sources: documentary analysis of internal port statistics and HSE data, semi-structured interviews conducted with four operational staff members, and direct field observation during the internship period.

Given that the Port’s main activity consists of loading and unloading vessels, the risks associated with the processes of this activity have been identified as presented above.

Table N° 9: Identification of operational risks

Process	Identified Risk
Cargo Handling	Incompatibility of the cargo plan
	Non-compliance with planning
	Human error / lack of coordination during loading-unloading
	Cargo damage / improper handling during storage
	Unavailability and inadequacy of lifting equipment
	Cargo falling / improper use of equipment
Stevedoring	Non-conformity of the vessel file
	Ineffective or incomplete inspection of on-board cargo
	Errors in cargo identification on land
	Absence or ineffectiveness of the monitoring system
	Unavailability of export cargo / lack of port space
	Labelling errors / non-compliance with the cargo plan
	Unavailability of cargo transfer equipment
	Accidental spill of hydrocarbons during handling
	Non-conforming equipment / risk of fire or explosion

Source: Elaborated by us based on internal documents

Following the identification of risks within the Djen Djen Port, it is essential to assess them in an objective manner. This evaluation involves assigning a rating to each risk based on two main criteria:

- The frequency of occurrence of the risk;
- The severity of the potential damage associated with it.

The criticality level of each risk is obtained by multiplying these two assessment criteria, according to the following formula:

Criticality = Frequency **X** Severity

Table N° 10: Risk Severity intervals

Criticality rate	Frequency	Severity	Description
(1 - 4)	**1 – 3**	**1 – 3**	Low criticality: combination of low severity and low occurrence
(5 – 8)	**2 – 4**	**2 – 4**	Moderate criticality: preventive actions to be scheduled
(9 – 12)	**3 – 4**	**3 – 4**	Unacceptable: immediate intervention required

Source: Elaborated by us

Calculating criticality is an essential step in the risk management process. It makes it possible to prioritize risks based on their potential impact on the Port of Djen Djen.

The different levels are explained as follows:

Table N° 11: Description of criticality

Criticality	Risk level	Acceptability
$1 \leq C \leq 4$	Acceptable	Continuous monitoring, no immediate action required
$5 \leq C \leq 8$	Moderate	Acceptable, preventive measures should be planned
$9 \leq C \leq 12$	High	Unacceptable, corrective action required

Source: Elaborated by us

Before identifying the risks related to the vessel loading and unloading process, we carried out field observations to detect the main challenges that could affect this process. The findings were then gathered into an FMECA table (**Appendix C, D)** to analyze each risk, identify its causes and impacts, and assess its level based on frequency and severity.

Table N° 12: Extract from the FMECA (AMDEC) table

Process	Activity	Risk	Impact	S	F	R
Cargo Handeling	Planning of cargo handling operations	Incompatibility of the cargo plan	Delays in operations	4	2	8
	Loading and unloading	Improper handling operations (human error, lack of coordination, non-compliance with procedures)	Operational delays and reduced handling efficiency	3	4	12
Stevedoring	Inspection of cargo on board	Ineffective or incomplete inspection procedures poor storage conditions	Operational disruptions and delays Increased risk of accidents/incidents	2	3	6
	Berthing	Unavailability of export cargo / Lack of port space	Vessel waiting time and operational delays	4	2	8

Source: Elaborated by us based on internal documents

2.2 Key Performance Indicators Analysis

The empirical analysis draws on three complementary internal data sources: port traffic and operational statistics, roadstead waiting and quayside stay records, and the official HSE Activity Report for 2025. These were supplemented by direct field observations and semi-structured interviews conducted with operational staff.

In this study, we focused on three KPIs whose data were considered reliable for conducting the research. They are presented as follows:

2.2.1 Average Vessel Waiting Time

The average vessel waiting time is defined as the mean waiting duration at the anchorage before berth allocation. It is the most visible indicator of port congestion and planning efficiency. A long waiting time directly leads to demurrage costs for shipping companies and creates chain delays throughout the supply chain.

Table N° 13: Average vessel waiting time indicator

Vessel Type	2024 (days)	2025 (days)	Variation (%)
Cargo vessels	11.59	9.39	−18.96%
Timber	15.69	13.89	−11.46%
Iron / Pipes	11.48	8.61	−24.96%
Grain carriers	15.57	13.95	−10.43%
RO/RO	0.98	1.00	+2.41%
Container vessels	**1.78**	**6.18**	**+247.10%**
Overall Average	**8.39**	**7.99**	**−4.75%**

Source: Elaborated by us based on internal documents

The overall average waiting time decreased marginally from 8.39 days in 2024 to 7.99 days in 2025 (−4.75%), Most vessel categories recorded improvements notably iron/pipe carriers (−24.96%) and cargo vessels (−18.96%). However, container vessels represent a critical exception: their average roadstead waiting time surged from 1.78 to 6.18 days, an increase of **+247.10%.**

This anomaly, occurring while overall traffic is decreasing, indicates a specific and serious operational risk in the container segment and requires close priority monitoring.

2.2.2 Cargo Release Time (Quayside Dwell Time)

Cargo release time is estimated by the average quayside stay, measuring the total berth occupation time between a vessel's mooring and departure. This indicator captures the combined efficiency of handling operations, documentary processing, and port logistics coordination.

Table N° 14: Cargo release time indicator

Vessel Type	2024 (days)	2025 (days)	Variation (%)
Cargo vessels	9.93	11.56	+16.38%
Timber	23.04	23.13	+0.37%
Iron / Pipes	10.52	10.43	−0.83%
Grain carriers	15.13	12.12	−19.88%
RO/RO	0.93	1.55	+66.74%
Container vessels	**3.24**	**5.62**	**+73.60%**
Overall Average	**8.56**	**9.01**	**+5.29%**

Source: Elaborated by us based on internal documents

The overall average quayside stay increased slightly from 8.56 to 9.01 days (+5.29%). At a detailed level, grain carriers showed a clear improvement (−19.88%), reflecting better co-ordination of bulk grain operations. In contrast, container vessels showed a +73.60% increase in quayside stay (from 3.24 to 5.62 days), confirming the result identified under the previous KPI. The simultaneous increase in both waiting time and quayside stay for container vessels represents the strongest operational risk signal from this analysis.

2.2.3 Number of Operational Incidents

The number of operational incidents is a fundamental safety KPI measuring the frequency and severity of workplace accidents. The HSE Activity Report 2025 provides comprehensive accident data for both 2024 and 2025, enabling rigorous comparative analysis.

Table N° 15: Operational incidents indicator

Indicator	2024	2025	Variation
Total workplace accidents	101	119	+17.82%
Accidents with work stoppage	97	115	+18.56%
Accidents without work stoppage	4	4	0%
Mortel accidents	0	0	—
Total lost workdays	1,710	2,040	+19.30%
Workforce	1,310	1,563	+19.31%
Hours worked	2,685,465	2,960,653	+ 10.24%
Frequency Rate (FR)	**36.12**	**38.84**	**+7.53%**
Severity Rate (SR)	**0.64**	**0.69**	**+7.81%**

Source: Elaborated by us based on internal documents

The data reveals a significant deterioration in safety performance between 2024 and 2025. The total number of accidents increased from 101 to 119, which represents an increase of nearly 18%. At the same time, the number of working days lost due to accidents grew from 1,710 to 2,040, a rise of over 19%. The Frequency Rate, which measures how often accidents happen relative to hours worked, went from 36.12 to 38.84. The Severity Rate, which reflects how serious those accidents are, also increased slightly, from 0.64 to 0.69.

Taken together these three KPIs, vessel waiting time, quayside dwell time, and operational incidents, highlight the port's current operational challenges. While some improvements are observed across traditional cargo segments, container vessel operations and workplace safety consistently emerge as the most critical pressure points. These findings provide the analytical foundation for the risk-optimization analysis developed in the following section.

2.3 Linking KPI Performance to Risk optimization

After analysis of key performance indicators, we attempted to elaborate corrective actions for the major risks identified at the Port of Djen Djen. The actions below target exclusively the seven risks classified at criticality highest level, requiring immediate intervention

identified across the Cargo Handling and Stevedoring processes. Each corrective action is grounded in KPI data collected during the 2024–2025 operational period.

Table N° 16: Corrective actions for the major risks

Process	Risk	Impact	C	Corrective Action
Cargo Handling	Incompatibility o the cargo plan	Delays in operations	**8**	Before any operation begins, all teams must check and agree on the same cargo plan to avoid problems.
Cargo Handling	Improper handling operations (human error, lack of coordination)	Operational delays and reduced handling efficiency	**12**	Train staff regularly and make sure procedures are actually followed on the ground.
Cargo Handling	Cargo damage / Incorrect handling in storage	Cargo damage and storage inefficiencies	**12**	Organize storage areas clearly right labeling, right zones for the right cargo types. Regular checks and cameras in sensitive areas can help prevent damage before it happens.
Cargo Handling	Cargo damage or loss during lifting / delivery	Cargo damage or loss during handling	**8**	Require a quick equipment check before each use and make sure only trained staff handle lifting. Encouraging workers to report small incidents helps catch problems early.
Stevedoring	Lack of monitoring control / ineffective monitoring systems	Delays and poor decision-making	**8**	Set up a simple dashboard that shows the key indicators in real time.
Stevedoring	Unavailability of export cargo / Lack of port space (Berthing)	Vessel waiting time and operational delays	**8**	Plan space allocation based on the vessel schedule in advance.
Stevedoring	Unavailability and inadequacy of equipment (Cargo transfer)	Increased handling costs and equipment losses	**8**	Establish a preventive maintenance program to reduce the frequency of equipment failures.

Source: Elaborated by us based on internal documents

2.4 Monitoring Indicators for Corrective Action Effectiveness

To verify that corrective actions produce measurable results, the following KPI targets are proposed for reassessment after implementation:

KPI 1: Vessel Waiting Time:

- **Target:** Reduce the average waiting time for container vessels toward previously observed optimal performance levels within a six-month period.
- **Monitoring:** Weekly tracking of roadstead waiting time, by vessel type, with particular attention to container vessels.
- **Analysis:** A decrease in waiting time reflects improved berth allocation and better coordination between vessel arrivals and port operations. As this indicator is closely linked to congestion levels, sustained improvement would suggest that corrective measures are effectively addressing capacity and scheduling constraints.

  Inversely, limited progress may indicate persistent structural inefficiencies or inadequate operational planning.

KPI 2: Cargo Dwell Time:

- **Target:** Reduce container quayside stay toward more efficient levels within the same evaluation period.
- **Monitoring:** Weekly measurement of container dwell time per vessel call,
  analyzed separately from overall quayside performance.
- **Analysis:** This KPI captures the efficiency of cargo handling, clearance,
  and discharge processes. A reduction in dwell time would indicate smoother coordination between terminal activities, customs procedures, and inland transport. If no significant improvement is observed, it may reveal obstacles in cargo flow or delays in administrative processes, highlighting the need for better integration across stakeholders.

KPI 3: Operational Incidents

- **Target:** Achieve a noticeable reduction in overall incident frequency and decrease the proportion of accidents involving dock workers within the evaluation period.
- **Monitoring:** Regular tracking of incident occurrence and distribution across different workforce categories.
- **Analysis:** Improvements in these indicators would demonstrate the effectiveness of implemented safety measures and risk mitigation strategies. A decline in incident fre-

quency suggests enhanced workplace safety conditions, while a reduction in accidents among dock workers indicates more targeted and efficient preventive actions.

Section 2: Discussion of Results

This section confronts the findings from the interviews, field observations, and KPI analysis conducted at the Port of Djen Djen with the academic literature, structured around the five sub-research questions guiding this study.

The risk identification phase revealed fifteen distinct risks across two core processes: Cargo Handling and Stevedoring. The criticality assessment confirmed that the most severe risks involve improper handling operations and cargo damage due to incorrect storage practices. These findings resonate with (Wendler-Bosco & Nicholson, 2019), who demonstrate that port disruptions generate cascading consequences across the supply chain, including operational delays and increased logistics costs. Field observation confirmed that responses to disruptions at the Port of Djen Djen remain improvised, with no standardized corrective protocol, in place a pattern that directly amplifies these cascading effects. (Benkhedda, El Hakmi, & Bennaceur, 2023) further identify human resource competence and inter-stakeholder coordination as critical determinants of port logistics performance, both of which emerged as recurring sources of vulnerability in the risks identified at the port.

The three KPIs analyzed in this study, average vessel waiting time, cargo quayside dwell time, and number of operational incidents, provide a useful basis for monitoring operational risks at the port. (Turcanu (Marcu) & Gasparotti, 2021) identify several KPI categories essential for comprehensive port management, including technical performance, health and safety, and human resource management dimensions. Moreover, these indicators remain relevant but need to be interpreted carefully to better reflect the port's operational risk profile confirms the argument of (Talkhokhet, Mahraz, El Yamani, & Moutmih, 2023), who demonstrate that structuring KPIs across customer, financial, internal process, and learning dimensions provides a more comprehensive evaluation of port performance and supports better decision-making.

The lexical analysis conducted through NVivo reveals that respondents' discourse is dominated by notions of corrective actions and reporting, reflecting a management culture oriented toward reacting to problems rather than preventing them. This observation aligns

with (Wendler-Bosco & Nicholson, 2019), who emphasize the importance of proactive performance strategies to ensure operational continuity. The increase of both the Frequency Rate and Severity Rate between 2024 and 2025, despite an existing HSE reporting system, further confirms that current tools are generating early warning signals capable of triggering preventive intervention. As (Almasarweh, 2024) argue, KPI systems must actively increase risk awareness and support anticipatory decision-making rather than simply measuring outcomes after the fact.

Where KPIs are used with sufficient specificity, they do generate actionable insights. The identification of the container vessel anomaly was only possible through a disaggregated reading of the data, directly informing the corrective actions proposed. The FMECA assessment similarly connected frequency and severity scores to specific process activities, producing a prioritized corrective action plan grounded in operational data. (Weeserik & Spruit, 2018) demonstrate that combining process-based management with performance indicators improves control of operational risks and organizational efficiency. (Mwambipile & Ryoba, 2025) reinforce this from a port-specific perspective, showing that structured performance measurement supports operational effectiveness through cycle time reduction and continuous improvement,these findings can be directly used to address the operational issues identified at the port.

The seven highest-criticality risks identified through the FMECA assessment provide a concrete basis for corrective action. Proposed measures include planning tools, pre-operation coordination meetings, regular staff training, real-time dashboards, formalized space allocation procedures, and preventive equipment maintenance. Specific KPI targets are proposed for reassessment, covering container waiting time, quayside dwell time, and the accident Frequency Rate. (Khameneh, Taheri, & Ershadi, 2016) argue that without a structured performance measurement framework for evaluating corrective interventions, organizations manage risks without being able to assess whether their actions are actually working, making the proposed monitoring targets an essential component of the corrective plan. (Bessi Aboganina & Ortega Morales, 2025) further support this approach, demonstrating that early risk identification combined with efficient resource allocation and improved planning leads to more effective and sustainable performance outcomes, which is precisely the direction these corrective actions aim to achieve.

This study addresses the research gap identified in the literature review by providing field-based evidence on the combined application of KPIs and operational risk management within real port operations. The results from the Port of Djen Djen validate the claim of (Weeserik & Spruit, 2018) that combining process-based management with performance indicators improves operational risk control, the three KPIs analyzed here provided measurable signals that guided corrective actions in cargo handling and stevedoring operations. The results further support (Almasarweh, 2024) who argued that KPIs systems should go beyond measuring performance to also increase risk awareness, a function the port's current indicators only partially fulfill. Regarding risk identification, (Bessi Aboganina & Ortega Morales, 2025) concluded that early identification of risks is a key driver of project performance, this study confirms that finding, as the fifteen operational risks identified through FMECA analysis and field observation revealed that the absence of early detection mechanisms directly amplifies the severity of disruptions at the port. Finally, (Turcanu (Marcu) & Gasparotti, 2021) demonstrated that comprehensive port management requires KPIs spanning multiple dimensions, operational, technical, safety, and human resource, yet at the Port of Djen Djen, monitoring remains limited to productivity-oriented indicators, confirming the need for a more strategically aligned and multidimensional KPI framework.

Recommendations For Improvement

KPIs are a key tool for managing operational risks in port environments, but their impact depends on how well they are designed and used in practice. This study shows that the Port of Djen Djen has not yet fully benefited from this potential, The following recommendations are proposed to address these problems and help the port develop a more effective and proactive KPI-based risk management approach.

- Introduce three priority KPIs currently absent from the port's monitoring system:

The equipment breakdown rate to detect maintenance needs before they cause unplanned downtime;

The documentary error rate to reduce cargo plan incompatibilities identified as a high-criticality risk;

The container productivity rate to enable timely detection of segment-specific issues in container operations.

- Adopt dynamic dashboard solutions that centralize operational data in real time, enable continuous tracking of key indicators, and generate automatic alerts when performance thresholds are exceeded.
- Formalize corrective action protocols for the highest-criticality risks identified in the FMECA analysis.
- Establish a regular reassessment cycle for the proposed KPI targets, including container waiting time, quayside dwell time, equipment breakdown rate, documentary error rate, and accident Frequency Rate, in order to measure progress, evaluate the effectiveness of corrective actions, and adjust solutions where necessary.
- Invest in training programs covering KPI interpretation, risk assessment methodologies, and the use of digital monitoring tools to build the human capacity necessary for systematic risk management.

Conclusion

In this chapter, the analysis of KPI use and operational risk management at the Port of Djen Djen helped provide a better understanding of how the organization operates.

By combining interview findings, field observations, and port data, this work demonstrates that KPIs constitute a meaningful lever for the optimization of operational risks, enabling the identification of critical risk areas, the prioritization of corrective actions, and the establishment of measurable performance targets.

GENERAL CONCLUSION

The analysis examined how key performance indicators can contribute to the optimization and management of operational risks within a port supply chain. Conducted at the Port of Djen Djen, A qualitative interpretive methodology was adopted,combining semi-structured interviews with four operational managers, direct field observation, and documentary analysis of internal port statistics and safety reports.

To answer our central research question, we conducted a literature review covering the theoretical foundations of KPIs, operational risk management, and port supply chain performance. We then carried out a field study at the Port of Djen Djen, where we collected and analyzed data through three complementary methods: interview transcripts processed using NVivo, an FMECA-based risk assessment, and the analysis of internal KPI data covering vessel waiting time, cargo dwell time, and workplace incident rates.

The results obtained allow us to answer our central question. KPIs contribute to the optimization and management of operational risks at the Port of Djen Djen in several concrete ways. They enable the structured identification and prioritization of risks across core port processes, as demonstrated through the FMECA assessment. They provide measurable signals that guide corrective action, as shown by the KPI analysis of vessel waiting time, cargo dwell time, and workplace incident rates. They also help create a common understanding of performance and risk among managers from different departments, supporting a more coordinated and performance-oriented approach, as confirmed by the similar views shared by all interview respondents.

From an operational standpoint, the corrective actions proposed in this study, represent concrete pathways toward a more proactive and integrated approach to risk management. Their implementation, supported by the monitoring KPI targets defined in this research, would enable the port to shift from a reactive posture to a preventive one, strengthening both operational resilience and supply chain reliability.

Despite these contributions, the study presents certain limitations:

- Data access was limited to selected internal documents and KPIs, restricting a comprehensive analysis of all operational risk dimensions.
- The study focuses on a limited number of indicators (vessel waiting time, cargo dwell time, and incident rates), excluding other potential risk-related KPIs.

- The qualitative approach relies on a small sample of participants, which may not fully capture the diversity of operational perspectives.
- KPI contribution remains partial due to limited data availability, as the system is primarily focused on productivity metrics, resulting in reactive risk management and limited integration of risk-specific indicators.

These limitations open interesting research perspectives. Future studies could extend this investigation to other Algerian ports or comparable Mediterranean port institutions, enabling a comparative analysis of KPI practices across similar operational contexts.

The integration of additional indicators such as environmental performance, stakeholder satisfaction, or supply chain resilience strategies would further enrich the analytical framework.A longitudinal study tracking the implementation and effectiveness of the corrective actions proposed in this research would also offer valuable insights into the evolving relationship between KPI systems and operational risk management over time.

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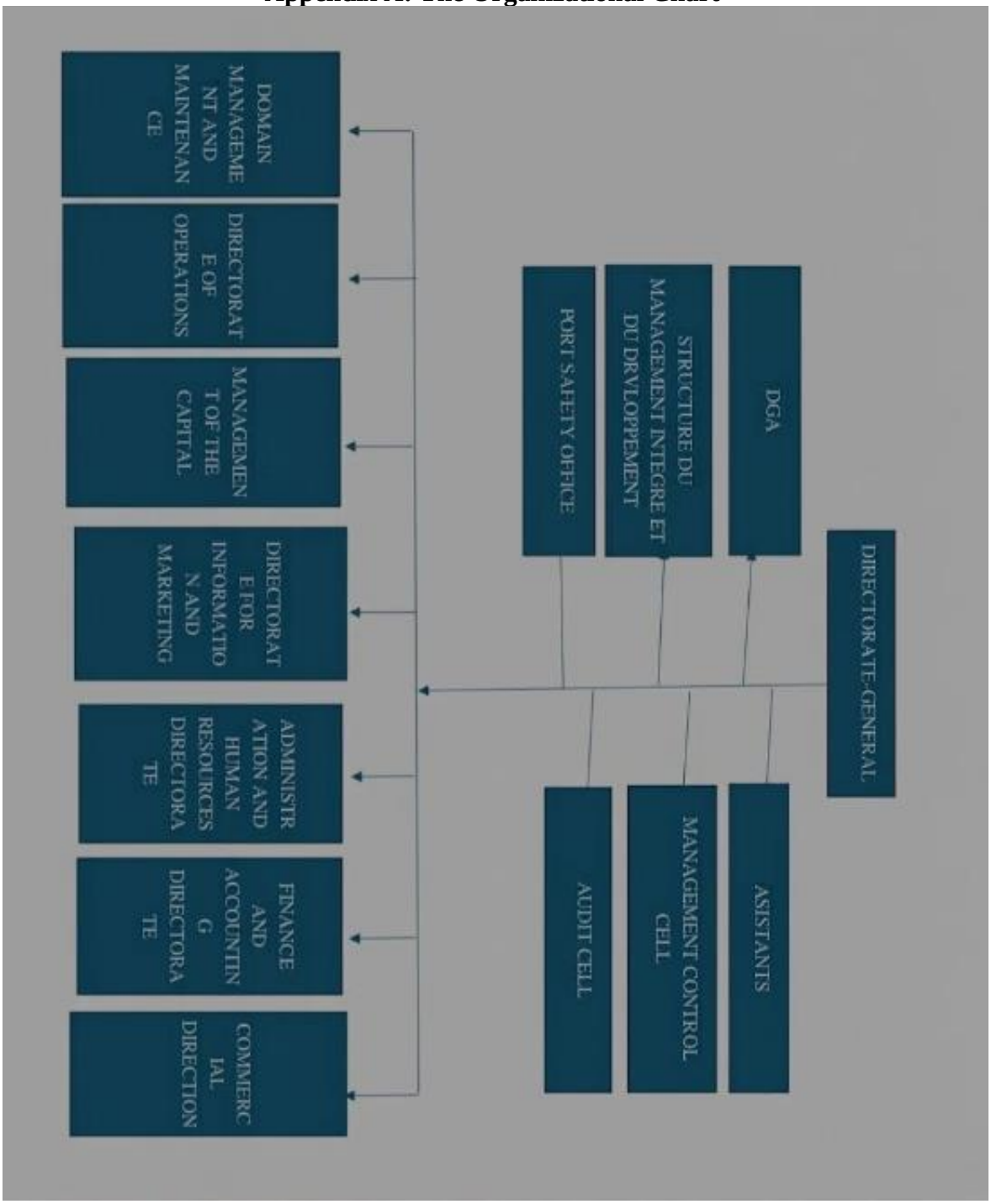
APPENDIX

Appendix A: The Organizational Chart



Appendix B: Interview Guide

DJEN DJEN	**Interview Guide**	المدرسة الوطنية العليا للمناجمنت Ecole Nationale Supérieure de Management

Hello, my name is BOUKAKIOU Hadil, a Master 2 student in Entrepreneurship and Project Management at the Higher National School Of Management. I would like to ask you a few questions, hoping to obtain responses that will contribute to the development of our end-of-study dissertation, focusing primarily on the contribution of KPIs to the optimization and management of operational risks within the port. Your responses, which will remain strictly confidential, will serve as a data source for the analysis of our study.

THEME 1: Operational Risks at the Port of Djen Djen

1. What are the main operational activities in the port supply chain (cargo handling, storage, berthing, maintenance, etc.) most exposed to risks?
2. What types of operational risks are most frequent in these activities (delays, HSE incidents, breakdowns, human errors, etc.)?
3. How are these risks identified and formally documented within the port?
4 .What types of operational risks do you encounter most often in your daily work?

THEME 2: Key Performance Indicators

5. What key performance indicators (KPIs) do you use to monitor operational risks?
6. How do these KPIs enable the detection of risks or dysfunctions in the port supply chain?
7. How frequently are the KPIs monitored and analyzed?
8. Are the KPIs specific to each process (cargo handling, maintenance, HSE, vessel assistance…)?
9. What digital tools or software are used to collect and analyze this data?
10. Is the data needed to calculate KPIs readily available and reliable?
11. How is the information derived from KPIs communicated to operational managers?

THEME 3: Impact of KPIs on Risk Optimization

12. Before the systematic integration of KPIs, what were the main problems encountered in risk management?

13. Since using KPIs, have you noticed an improvement in: incident reduction? meeting deadlines? safety? overall performance?

14. Do KPIs enable better anticipation of future risks?

15. In your opinion, do KPIs genuinely contribute to the optimization of operational risks in the Djen Djen port supply chain?

Are KPIs revised or updated in line with the evolution of port activities?

16. What KPIs would you recommend adding to better manage operational risks?

Appendix C: FMECA tablerelated to Cargo handling

Activity	Risk	Impact	S	F	C	Risk level
Planning of cargo handling operations	Incompatibility of the cargo plan	Delays in operations	4	2	8	**R1**
Implementation of cargo handling operations plan	Non-compliance with planning	Interruption of handling operations	3	1	3	**R3**
Loading and unloading	Improper handling operations (human error, lack of coordination, non-compliance with procedures)	Operational delays and reduced handling efficiency	3	4	12	**R1**
Cargo storage	Cargo damage / Incorrect handling	Cargo damage and storage inefficiencies	4	3	12	**R1**
Lifting / Delivery (equipment)	Unavailability and inadequacy of equipment	Operational delays due to equipment unavailability	3	2	6	**R2**
Lifting / Delivery (cargo)	Cargo damage / falling , improper use of equipment	Cargo damage or loss during handling	4	2	8	**R1**

Appendix D:FMECA tablerelated to Stevedoring

Activity	Risk	Impact	S	F	C	Risk level
Opening of the vessel file	Non-conformity of the file	Delays in operations	3	2	6	**R2**
Inspection of cargo on board	Ineffective or incomplete inspection procedures poor storage conditions	Operational disruptions and delays Increased risk of accidents/incidents	2	3	6	**R2**
Cargo identification on land	Errors in cargo identification	Customer claims due to cargo errors Reduced service quality and operational inefficiency	3	2	6	**R2**
monitoring	Lack of monitoring control / ineffective monitoring systems	Delays in operations and poor decision-making Increased financial losses due to lack of control	4	2	8	**R1**
Berthing	Unavailability of export cargo / Lack of port space	Vessel waiting time and operational delays	4	2	8	**R1**
Discharge operations	Error in placing labels , non-compliance with the cargo plan	Negative impact on company performance and reputation Delays in unloading operations	3	2	6	**R2**
Cargo transfer	Unavailability and inadequacy of equipment	Increased handling costs and equipment losses	4	2	8	**R1**

Handling and lifting	Environmental incidents / Accidental spill of oils, lubricants, fuels	Reputational damage and operational interruptions	3	1	3	**R3**
Emergency situations	Non-conforming equipment / short circuits, fire, explosion	Damage to infrastructure and equipment	3	2	6	**R2**

Appendix E: Performance Indicators

Attente en Rade & Séjour Moyen à Quai

Unité = jour

TYPES DE NAVIRES	ATTENTE MOYENNE EN RADE		VAR%	SEJOUR MOYEN A QUAI		VAR%
	2024	2025		2024	2025	
CARGOS	11.59	9.39	-18.96%	9.93	11.56	16.38%
SEMOULE / FARINE						
BOIS	15.69	13.89	-11.46%	23.04	23.13	0.37%
CIMENT	7.66	-	-	15.23	-	-
FER / TUBES	11.48	8.61	-24.96%	10.52	10.43	-0.83%
CEREALIERS	15.57	13.95	-10.43%	15.13	12.12	-19.88%
RO / RO	0.98	1.00	2.41%	0.93	1.55	66.74%
MINERALIERS						
P.CONTENEURS	1.78	6.18	247.10%	3.24	5.62	73.60%
BUTANIERS						
METHANIERS						
PETROLIERS						
AUTRES	1.92	0.46	-76.03%	1.14	1.76	54.35%
Moy.Générale	8.39	7.99	-4.75%	8.56	9.01	5.29%

Appendix F: Workplace accidents by type of vessel

REPARTITION DES ACCIDENTS DE TRAVAIL PAR TYPE DE NAVIRES (MARCHANDISES)

Type De Navires	Nombre d'accidents	Pourcentage %	Journées Perdues	Pourcentage %
Pipes/ Tubes	19	15.97 %	300	14.71 %
Big-Bag	08	06.72 %	162	07.94 %
Colis/caisses/matériels	06	05.04 %	173	08.48 %
Bobine	17	14.29 %	212	10.40 %
Clinker/calamine	02	01.68 %	10	0.50 %
Bois/MDF	12	10.08 %	222	10.88 %
Engins/camions/bus	11	09.24 %	152	07.45 %
Rond à béton	02	01.68 %	18	0.88 %
Plaque métallique	04	03.36 %	71	03.48 %
Fil machine	01	0.84 %	03	0.15 %
Poutrelles	02	01.68 %	35	01.72 %
Biellettes	01	0.84 %	45	02.20 %
Trajet	08	06.72 %	156	07.65 %
Autres lieux (échelle de coupé, parc engins, échelle de la cale, pont supérieur, bureau)	26	21.85 %	481	23.58 %
Total	**119**	**100 %**	**2040**	**100 %**

Appendix G: Workplaceaccidents by work area

Rapport d'Activité HSE
Année 2025

REPARTITION DES ACCIDENTS DE TRAVAIL PAR ZONE DE TRAVAIL

Lieux	Nombre d'accidents	Pourcentage %	Journées Perdues	Pourcentage %
Cale du navire/pont supérieur	43	36.13 %	704	34.50 %
Sur quai	21	17.65 %	299	14.66 %
Terre plein	16	13.45 %	204	10.00 %
Plateau du camion	15	12.61 %	381	18.68 %
Echelle de coupé	01	0.84 %	21	01.03 %
Sous station électrique N°06	01	0.84 %	25	01.23 %
Parc engins	04	03.36 %	59	02.90 %
Arrêt de bus	01	0.84 %	21	01.03 %
Atelier vulcanisation/mécanique	03	02.52 %	73	03.58 %
Vestiaires	01	0.84 %	37	01.81 %
Bureau	01	0.84 %	15	0.73 %
Parc ADM	01	0.84 %	05	0.25 %
Poste de garde	02	01.68 %	33	01.62 %
Voie ferrée	01	0.84 %	07	0.34 %
Extérieur du port (trajet)	08	06.72 %	156	07.64 %
Total	**119**	**100 %**	**2040**	**100 %**

Appendix H: Thematic analysis matrix

	A : key performance indicators	B : operational risks within the port	C : Impact of KPIs on Risk Optimization
Respondent 1	calculate the severity and frequency prioritize track the number of anomalies observe the frequencies prioritize it and implement corrective actions reduce it progressively monthly basis annual level allows us to track both short-term variations and long-term trends KPIs are process-specific covering the port rely mainly on statistical analysis Excel and internal reports the data is generally available internal reports and information circulating within the department The sources are accessible formal reports	the operations department stevedoring and cargo handling risks mooring and cargo handling operational delays lack of competence among the workforce insufficient equipment non-compliance with safety procedures incidents direct observation feedback internal reports maintenance or loading operations	lack of information sources related to risks insufficient cooperation between different activities and departments The KPIs allow us to better anticipate risks before they materialize contributes to reducing incidents improve our overall performance corrective action it signals that a specific activity is exposed to major risks KPIs do contribute to risk optimization revised regularly awareness and training on risks impact on port performance and operations

Respondent 2	we use KPIs related to vessel movements average berth time cargo traffic These indicators vary depending on the activity or the process being monitored If the gap is negative it immediately signals the need for corrective actions The deviation from the target is our main indicator that something is dysfunctional in the process the monthly review catches immediate issues, while the quarterly and annual analyses give us a broader picture of performance over time the KPIs are specific to each process within the port in our department we work with average berth time and vessel movements Each process has its own set of indicators We use dashboards and statistics produced by the IT department the data is available and we consider it reliable for our purposes	cargo handling lack of equipment delays in operations incompetent workforce cargo handling and equipment breakdowns delays reports document risks are identified reactively information gaps lack of communication between the different actors involved in the operation creates misunderstandings and errors throughout the process	The use of KPIs has led to better port performance overall When you can measure what is happening, you can manage it more effectively and that applies to safety, efficiency, and operational continuity alike when a KPI shows a negative deviation in a given activity implement corrective actions to try to reduce it every risk has a direct impact on the overall performance of the port The KPI acts as an early warning signal that something needs to be corrected before it escalates KPIs play a crucial role within the Port KPIs focused on continuous improvement indicators that track operational productivity, service quality, and process efficiency over time

	We use a combination of email and meetings The meetings are particularly useful because they allow for direct discussion collectively decide on the corrective actions to implement They are the foundation of performance evaluation		

Respondent 3	These two indicators give us a reliable picture of the sources of congestion and the risks present in the supply chain Calculations are performed and then we compare the deviations from the objectives Based on those gaps, we prioritize the risks that require the most urgent attention and corrective intervention monitoring is done on a monthly basis, and a comprehensive annual report is produced to consolidate the findings over the full year they are specific to each process depending on the activity Each operational field has its own set of relevant indicators adapted to what is being measured and managed We do not use any dedicated digital tools We collect the data ourselves and process it manually using Excel the data is available and sufficiently reliable for our operational needs The results are shared through monthly reports, which are distributed to the relevant managers to keep them informed of	the risks are mainly linked to cargo handling and vessel berthing operations, which represent the most exposed activities in our daily work Operational risks within the port are numerous cargo damage, non-identification of goods especially when multiple products or clients are involved, poor planning, inaccurate assessments, equipment breakdowns, and non-conformity of documentation files We prioritize them according to their severity and frequency Risks with a high frequency or high severity are treated first, along with those requiring immediate corrective action the most common risks we face are delays, equipment breakdowns, and non-identification of goods - these three tend to recur the most and disrupt operations the most significantly	The main problem was poor planning of corrective actions it is very difficult to identify and address operational risks in a timely and organized manner within the port We have seen a clear increase in overall performance since KPIs were integrated more systematically into our operations We are currently working on a project to integrate more KPIs into the port supply chain, which should significantly strengthen our ability to anticipate and manage risks proactively We try to adapt them to current activities and to the tools available at the moment It is an ongoing process - the goal is to keep the indicators as relevant and operational as possible given our current resources I would recommend adding a documentary error rate and an equipment breakdown rate These would be very reliable indicators for tracking two of the most recurring sources of operational risk in our daily work

	the performance levels and risk situation		

Respondent 4	We primarily use average vessel waiting time , the number of incidents recorded per month These indicators give us a fairly comprehensive view of where the operational risks are most concentrated When an indicator deviates significantly from its target, it immediately signals a dysfunction somewhere in the process We then investigate the root cause and determine whether corrective or preventive action is needed We monitor them on a monthly basis The annual report gives us the full picture and serves as the basis for our strategic planning Each process has its own indicators At the moment, we mostly rely on Excel and internally developed reporting templates We do not yet have an integrated port management system, which is a gap we are aware of and hoping to address in the near future The data is generally available, but its reliability can vary depending	the activities most exposed to risks are storage and cargo handling most frequent risks we encounter are related to human errors during handling operations, delays caused by poor coordination between departments We identify risks mainly through field inspections and operational audits Once identified, they are recorded in incident sheets and forwarded to the department head the documentation process is not always consistent across all departments the risks I encounter most are coordination failures between operational teams, delays in cargo release, and occasional non-compliance with safety procedures	risk management was largely reactive decisions were often based on experience rather than data, which led to inconsistent outcomes the improvement is noticeable better compliance with operational deadlines, and a more proactive approach When we analyze the trend of an indicator over several months we can identify patterns and anticipate potential risks before they escalate they genuinely contribute to risk optimization we are trying to do update them periodically to the new process and activites I would recommend adding a staff training rate on risk management, as well as a corrective action completion rate These two indicators would help us measure not just the risks themselves, but our actual capacity to manage and reduce them over time

	on the source When it comes from field reports filled in manually, there is always a risk of inaccuracy We try to cross-check information whenever possible to ensure consistency We communicate the results through a combination of written reports and meetings collectively decide on the actions to be taken		