Universidade de Aveiro
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Framework de apoio à tomada de decisão para a vantagem económica: Plataforma de Gestão do Conhecimento no setor energético

Framework to support the economical competitive advantage decision-making: The Trading Knowledge Management Control Platform

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Engenharia e Gestão Industrial, realizada sob a orientação científica da Doutora Marlene Paula Castro Amorim, Professora Auxiliar do Departamento de Economia, Gestão e Engenharia Industrial e Turismo da Universidade de Aveiro e coorientação de Carla Raquel Castro Madureira, Professora Auxiliar Convidado em regime laboral do Departamento de Economia, Gestão e Engenharia Industrial e Turismo da Universidade de Aveiro.

“O cérebro também come.” – Chico Nuno

À Marianinha e ao Chico Nuno, cuja sabedoria e coragem despertaram em mim a vontade incessante de desbravar novos horizontes e abraçar os desafios da vida.

o júri

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palavras-chave

Gestão de Conhecimento, Inteligência do Negócio, Indústria 4.0, BPMN, *Power BI*, Vantagem Competitiva, Pilar Económico da Sustentabilidade

resumo

É crucial privilegiar a experiência organizacional, orientada para os dados, no mundo atual. Investir no desenvolvimento de técnicas e estruturas que envolvam as lacunas de informação, oportunidades e tecnologias é uma prioridade para garantir a vantagem competitiva e a sustentabilidade económica das empresas. O objetivo deste artigo é auxiliar na tomada de decisões na escolha de navios para o negócio entre empresas, facilitando o acesso rápido a dados e informações sobre movimentações portuguesas e espanholas, bem como dados suplementares pertinentes. Para isso, sugere-se a criação de uma *framework* tecnológica que avalie cada requisito do processo. Isso inclui a pré-seleção de uma lista de navios a serem pesquisados, a sua posição atual e as restrições das instalações envolvidas. A *framework* mencionada também procura selecionar e processar todas as informações de forma rápida e eficaz, de modo que possam ser reunidas e assimiladas de maneira ágil. É extremamente pertinente aumentar a vantagem competitiva de uma empresa mantendo a sustentabilidade económica como um princípio fundamental, ao compartilhar conhecimentos organizacionais bem definidos e claros com a comunidade empresarial. Este estudo também chama a atenção para uma lacuna na literatura existente neste campo em rápida expansão. Para promover um ambiente corporativo mais conectado e melhorar a comunicação, é necessário uma distribuição e investigação mais amplas desse tema. Foi necessário seguir um plano pré-determinado, que envolveu desde a deteção da lacuna existente e a compreensão da situação atual até uma fase de processamento e tratamento de dados. De seguida, o *framework* baseado em tecnologia foi testado e avaliado pelo grupo de colaboradores envolvidos, nesta fase inicial. Na versão final, será apresentada a proposta que melhor se adapta às necessidades enfrentadas. Este estudo contribuirá para o aumento do conhecimento nesse tópico, criando essa estrutura e solucionando as faltas da literatura existente. A competitividade das empresas envolvidas aumentará com o acesso rápido a informações pertinentes e a facilidade na seleção de navios adequados para o negócio entre empresas. Um avanço significativo no ambiente corporativo também será a promoção da disseminação do conhecimento organizacional e da sustentabilidade económica.

keywords

Knowledge Management, Business Intelligence, Industry 4.0, BPMN, Power BI, Competitive Advantage, Economic Pillar of Sustainability

abstract

It is crucial to respect organizational expertise in the data-obsessed world of today. Investing in the development of techniques and frameworks that address information gaps, opportunities, and technologies is a priority in order to ensure the competitive advantage and economic sustainability of businesses. This article's goal is to assist decision-making in the choice of ships for commerce between enterprises by facilitating rapid access to data on Portuguese and Spanish movements as well as pertinent supplementary data. To do this, the creation of a technology-based framework that assesses each requirement for the process is suggested. The pre-selection of a list of ships to be researched, their present position, and the confines of the facilities involved are all included in this. The framework also seeks to pick and process all information so that it may be gathered and assimilated in an agile way rapidly and effectively. It is feasible to boost a company's competitive advantage while retaining economic sustainability as a key tenet by sharing well-defined and clear organizational knowledge to the business community. This study also draws attention to a gap in the existing literature on this quickly expanding field. In order to grow and improve communication in the corporate environment and foster more connectedness between organizations, a wider distribution and investigation of this subject are needed. It was necessary to follow a predetermined plan, which involved everything from detecting the existing gap and understanding the current situation to a phase of data processing and treatment. Next, the technology-based framework was tested and evaluated by the group of collaborators involved in this initial phase. In the final version, the proposal that best adapts to the faced needs will be presented. This study will increase knowledge in this topic by creating this framework and resolving the shortcomings of the existing literature. The competitiveness of the concerned enterprises will increase with the provision of rapid access to pertinent information and the facilitation of the selection of suitable ships for commerce between companies. A significant development in the corporate environment will also be the promotion of organizational knowledge dissemination and economic sustainability.

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1. Introduction

Today the world is witnessing the development of a whole new acceptance and learning in all areas in the way it performs, commands, or even processes tasks, covering even the most routine activities of daily lives.

Digitalization has a variety of applications in businesses with various ownership structures or market sectors (Ma & Li, 2022).

This idea covers all aspects of an organization's technological transformation, including business models, goods and services, operational procedures, and IT infrastructures (Azizan et al., 2022). Every organization has the chance to digitalize its business operations and information technology architectures (Azizan et al., 2022). Promoting interactive organization contact through digital channels is a managerial necessity in the era of ever-evolving information technology (Azizan et al., 2022). Almost every multinational corporation has expanded their organization by applying digitalization because of the leading change toward prospective accomplishments (Azizan et al., 2022). As a result of changes brought on by digitalization, it is well-recognized that the organization's IT department is now coping with a quickly evolving technical environment (Azizan et al., 2022).

A virtual company built on I4.0 has the capacity to address both the forward and backward supply chain issues at once (as cited in (Kumar et al., 2022)). It can concurrently assist to save costs and lead times (as cited in (Kumar et al., 2022)). By reducing the power imbalance, it can change how supply chain actors interact with one another (as cited in (Kumar et al., 2022)). It may enable the supply chain to operate sustainably (as cited in (Kumar et al., 2022)). As cited in (Kumar et al., 2022), it can aid in the flexible distribution of resources.

Organizational models based on knowledge management and value creation must be developed by businesses to boost performance via innovation (Antunes, 2020). Additionally, the connection between technology and knowledge as well as their role in innovation and co-creation are seen (Antunes, 2020).

As cited (Shah, 2022) asserts that KM aids in the creation of platforms and procedures for the dissemination of tacit knowledge. It aids in the process of turning tacit information into explicit knowledge and facilitates collaborative work to encourage creativity at work (Shah, 2022). It promotes information accessibility throughout the organization to speed up the innovation process (as cited in (Shah, 2022)).

It becomes more important for knowledge management practices to adjust to the complexity of business processes as companies adopt them and to be in line with the digital revolution (Gupta et al., 2022).

Since they may transform the ad hoc knowledge of processes into formal information, business process management and business process models can play a significant role in knowledge management (as cited in (Salvadorinho & Teixeira, 2021). The Business Process Model and Notation (BPMN) is one of the technologies that has been deemed essential for modeling business processes (as cited in (Salvadorinho & Teixeira, 2021)).

Knowledge has been recognized as being essential for businesses to create and maintain competitive advantages in the era of the knowledge economy (as cited in (Wu et al., 2022)). Knowledge has been recognized as being essential of technological capabilities based on technological knowledge are thought to be essential, especially for the technology-intensive firm, because of the complex market competition and rapidly evolving technologies (Wu et al., 2022).

By engaging learning in these core areas of knowledge management and digitalization, it is intended, using the BPMN tool, to create a model to support decision-making regarding the range of vessels that will increase the company's competitive advantage and thus ensure the strengthening of the economic pillar of sustainability.

2. Contextualization and Objectives

Businesses need to ensure their systems are adaptable enough to support new workflows and the regulatory mandates for pre-and post-trade transparency as well as the stricter operational risk management control demanded by internal risk management teams (Thomson Reuters, 2012). With the right format and protocols, Thomson Reuters Context can accept data from one or more input sources and stream it to any location (Thomson Reuters, 2012). This, together with the features of the Enterprise Platform, enables companies to streamline their content distribution infrastructure and offer a fully robust, scalable solution to a huge audience (Thomson Reuters, 2012). Today's most knowledgeable and successful traders and analysts in the physical and financial energy sectors utilize Vortexa® reliable data and analytics to spot and seize market opportunities before their competitors (Vortexa, 2022). The world-class team of Vortexa® is still driven by the original purpose of its foundation to open, connect, and optimize energy flows by fusing its cutting-edge technology and industry knowledge. To assist market sustainability and efficiency, Vortexa® aims to offer unmatched access to data on the world's waterborne oil and gas activities (Vortexa, 2022).

The company where the process takes place belongs to the oil and gas industry and, presently, is integrating in its structure Vortexa® platform. It should be added that, in the practical case presented, the team that works directly with the factory supply - shipping team - is one of the most important players in the case in question.

The major goal is to create a technology-based framework with the intention of giving businesses a technical tool (platform) and action plan methods. This unified technology framework attempts to offer businesses a complete solution by giving them access to useful and pertinent data on their performance, market, and competitive landscape. The technological toll is intended to provide a single location for all pertinent, significant, and useful information, to keep businesses informed to decide the range of vessels that meet the ideal characteristics to perform an inter-company business, which will enable the company to obtain a competitive advantage and maintain the pillars of sustainability with a greater focus on the economic pillar. The technology-based framework will also include a dashboard that offers information on the most recent news in the energy market, notably in the shipping sector. In this way, the entire organizational community will have access to explicit and well-defined knowledge to enable the positioning of the company in question in the market in which it operates, using the automation and digitalization of the tasks associated with the business.

For the development of the process to be successful, the implementation of the Vortexa® platform was monitored, as well as the use of another platform – Reuters®. For each one, its purpose and implementation context were defined.

3. Methodology

The orderly and organized development of the process was based on the Design Science Research methodology. For each stage, it was defined what was done for the practical case and these points will be presented in the next topic.

3.1. Trade Knowledge Management Control Case

For this process to be possible, it was necessary to acquire knowledge, mainly from the shipping team, about their needs and the type of information that was pertinent to include, acquire or even build so that it was possible to increase, facilitate and automate the organizational knowledge, having in mind that this was made possible to more stakeholders than just the mentioned team. Thus, with the information collected and some discussions about building the process from scratch, it was possible to create a model that would better position and highlight as well as increase the competitive advantage. In this way, having the questions that existed previously a solid answer is closer to achieving the final objective of this study.

3.2. Design Science Research

It was chosen to adhere to the Design Science paradigm for the development of the methodology. A variety of study approaches have been created for Design Science Research (DSR), a prominent new research paradigm (Pries-Heje et al., 2017), to fulfill our goals and create a variety of artifacts for our study (Gupta et al., 2023).

Design science research has emerged as a new method for studying organization theory and information systems management (DSR), since the late 90s (cited in (Jacob et al., 2021)). DSR has also been used recently in management control and service management study (cited in (Jacob et al., 2021)). However, DSR can add to both academic and practical knowledge with a view to resolving managerial issues (cited in (Jacob et al., 2021)).

Work employing DSR tries to produce objects within the paradigm of the sciences of the artificial by drawing on both observation of activities and preexisting scientific knowledge (cited in (Jacob et al., 2021)).

Research in design science tackles significant, challenging real-world issues (Akoka et al., 2022). By enhancing the descriptive and prescriptive knowledge bases, DSR adds to research on how to tackle specific challenges (cited in (Brendel et al., 2021)).

Though widely acknowledged as a component of information systems study, describing how knowledge production originates and its underlying dynamics is nevertheless necessary to start or advance a design science research endeavor (Akoka et al., 2022). Given the corpus of information now available on design science research, it ought to be feasible to draw from it to further future work. Innovative artifacts are produced through design science research to address challenging real-world issues and provide design knowledge (Akoka et al., 2022). Across a wide range of application fields, significant effort has been put into developing and reporting several unique forms of knowledge contributions (Akoka et al., 2022). The research process is dynamic in a DSR study because distinct knowledge moments or points in time that occur throughout a project have various assumptions and methodologies (cited in (Akoka et al., 2022)). Researchers might understand how to use, combine, and expand what

has been discovered from previous work while still contributing new information (Akoka et al., 2022).

A first attempt at formalizing DSR was undertaken by Walls et al., which was followed by March and Smith and Hevner et al, who emphasize the use of design science in decision support (Akoka et al., 2022). Gregor and Hevner suggested some basic principles(Akoka et al., 2022). Socio-technical systems produce a variety of objects, for which design science is required (cited in (Akoka et al., 2022)). Design science research, according to Arnott and Pervan, offers a technique to enhance decision assistance (cited in (Akoka et al., 2022)).

According to (Brendel et al., 2021), to have a bigger impact on research and practice, design science research must address two significant challenges:

a) encourage frequent reuse of artifacts and design ideas (Brendel et al., 2021).
b) boost the main knowledge in the area (Brendel et al., 2021).

The emphasis of design science research methodology (DSRM) is on the creation of artifacts that advance the field of information systems (IS) in organizations (Haryanti et al., 2022). Its distinguishing features give credence as the foundation for a prospective DSR genre (cited in (Haryanti et al., 2022)). This approach focuses on artifact development (Haryanti et al., 2022). The resultant DSRM departs from the assumption that the intended artifact is probably going to be a system or object to assist system development (procedures, algorithms, data theory) (Haryanti et al., 2022). Design science is the scientific study and production of human-made artifacts used to address real-world issues of public concern (cited in (Haryanti et al., 2022)). Humans create artifacts with the intention of using them to address a practical issue (Haryanti et al., 2022).

As cited in (Peffers et al., 2007), DSR should focus on significant and pertinent issues and include the following three steps: problem identification, motivation, design and development (Peffers et al., 2007), as shown in figure 1. Defining the specific research issue and demonstrating the necessity of a solution are steps in the problem identification and motivation process, whereas persuading the researcher and audience to explore the issue and accept the conclusions is the goal of motivation (Peffers et al., 2007). Step 2 entails establishing and deriving the goals of a solution from the problem specification (Peffers et al., 2007). Step 3 is design and development, which entails choosing the intended architecture and functioning of the artifact and making the actual item (Peffers et al., 2007). The ability to apply theory to a problem is one of the resources needed to go from objectives to design and development (Peffers et al., 2007). A single demonstration act or a more formal assessment of the generated artifact are only a few examples of the solutions (Peffers et al., 2007). While step 5 includes watching and evaluating how effectively the artifact supports a solution, step 4 entails demonstrating how to utilize the artifact to address one or more instances of the problem (Peffers et al., 2007). Numerous methods of evaluation exist, including client feedback, satisfaction surveys, simulations, measurable measures of system performance, and comparisons of the functionality of the artifact with the goals of the solution (Peffers et al., 2007).

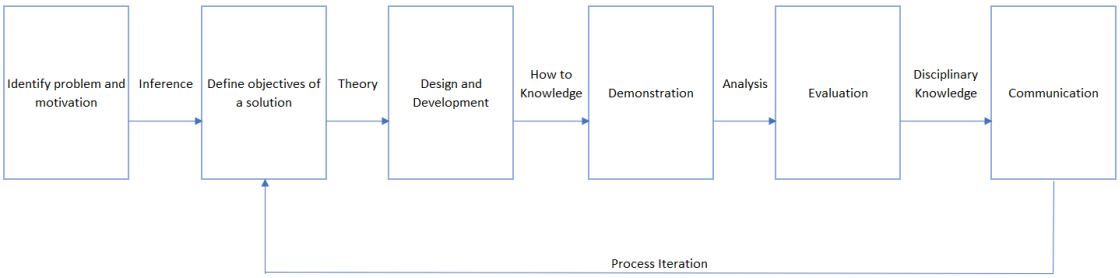


Figure 1. DSRM
Font: (Peffers et al., 2007)

Although the steps in this procedure are organized in a nominally sequential manner, it is not assumed that the researchers will always work in this order (Peffers et al., 2007). The nominal sequence is built on a problem-centered methodology and begins with step 1 (Peffers et al., 2007).

In the context of this project, the introduction of the Vortexa® platform provided an opportunity to increase knowledge of worldwide ship movements, routes, products, historical statistics, and other related functions. As such, there was no internally developed technology-based framework capable of providing reliable and interactive information of this kind.

Considering this, the developed framework would enable the promotion of action plans and strategies that need to be defined. Such framework would facilitate collaboration in addressing the company's challenge of selecting ships for maritime transport operations, as this function relies on accurate and up-to-date information. Without it, making informed decisions was difficult, and the ship selection process was delayed.

It was in this context that the motivation arose for the creation of the Power BI platform, which aimed to provide comprehensive information on available ships, historical information, and other relevant data that could help in decision-making. The final solution had to be interactive and user-friendly, allowing users to access and analyze data quickly and efficiently. To achieve this goal, the developer needed to create relationships between tables and process data so that all interaction between them was possible. This involved working with data in Power Query, a powerful tool that allowed efficient data processing and manipulation.

The Power BI platform was developed with graphic and interactive features, making it more attractive and easier to navigate, with clear and simple menus that allowed users to quickly obtain the information they needed. Thus, in the process of developing the platform, it was necessary to create a structure that allowed easy integration between different tables and data sources, clean and process data to ensure that the presented information was accurate and reliable.

During the technology-based framework development stage, the developer had to work closely with the rest of the team (internal environment) to ensure that the solution met business requirements and provided support for decision-making. This required an agile and iterative approach, with frequent testing of the framework to identify potential issues and adjust as necessary. To achieve this, graphical resources were used to present the data clearly and concisely. Different types of charts, such as bar charts, maps, and line charts, were used to help users visualize and interpret the information quickly and efficiently.

To evaluate the technology-based framework effectiveness, two evaluation methods were developed: a focus group and a usability test. The focus group involved gathering a group

of users to obtain feedback on the Trading Knowledge Management Control (TKMC) framework. The goal was to gather information on technology-based framework's usability and the quality of the information provided. The usability test, in turn, involved observing users as they interacted with the technology-based framework to identify possible issues or difficulties in use. Based on this feedback, improvements to the TKMC framework were made, ensuring that it met user needs. The adjustments made were tested again and refined until the technology-based framework achieved the expected level of quality.

4. Theoretical Background

4.1. Energy Market vs Industry 4.0

The role of energy in fostering growth and development has always been crucial, but it has recently become much more and is closely tied to economic expansion (Khan et al., 2021). Energy consumption is steadily rising in a globalized society where the demand for resources has grown insatiable due to population expansion (cited in (Gibellato et al., 2023)). The trend toward replacing fossil fuel energy sources like oil with renewable energy is unavoidable if we are to combat global warming and the energy problem (Liu & Feng, 2023). Climate change law pertaining to the energy industry is proof of the significant international efforts made in this direction (Liu & Feng, 2023). One of the strongest proponents of the production of renewable energy is the new circular economy model, which is focused on careful production and consumption via waste reduction and natural ecosystem management (cited in (Gibellato et al., 2023)).

A transition in the energy landscape is imminent because of the heavy use of traditional fossil fuel sources, greenhouse gas emissions, and environmental damage in recent years (Sai Ramesh et al., 2023). Therefore, it is essential to do research and implement renewable energy (cited in (Sai Ramesh et al., 2023)). The current and future developments of renewable energy are largely dependent on the adoption of novel technologies via the best use of natural resources (cited in (Sai Ramesh et al., 2023)). Over the past few decades, the rapid depletion of fossil fuels has been a major worry in the hunt for alternative fuels (Sai Ramesh et al., 2023). Hydrogen fuel has emerged as a possible replacement in bridging the current gap (Sai Ramesh et al., 2023).

Driving a secure, egalitarian, and sustainable energy transition while ensuring clean energy transition remains a challenging issue (World Energy Council, 2022). Converging issues in 2022 strengthened the need for equilibrium in the areas of energy security, affordability, and sustainability (World Energy Council, 2022). The Trilemma framework continues to provide a starting point for creating and generating fresh insights to help areas comprehend the effects of and monitor the advancement of their energy transitions (World Energy Council, 2022). The provision of secure and economically robust energy infrastructure is essential to prevent an economic disaster due to the many geopolitical constraints brought on by the current Russian invasion to Ukraine (cited in (Gibellato et al., 2023)). Therefore, when energy sources are examined, several environmental, economic, and social issues come up (Gibellato et al., 2023).

The World Energy Council is the leading, independent network of energy practitioners and leaders advocating for a cost-effective, reliable, and environmentally conscious energy system for the benefit of everyone (World Energy Council, 2022). Energy Security, Energy

Equity, and Environmental Sustainability of Energy Systems are the three main pillars on which the World Energy Council bases its concept of energy sustainability (World Energy Council, 2022). The "Trilemma" of balancing these three objectives makes balanced systems necessary for national growth and competitiveness (World Energy Council, 2022). The energy systems of 127 nations are compared and ranked (World Energy Council, 2022). It offers an evaluation of the effectiveness of a nation's energy system, indicating balance and sturdiness in the three Trilemma dimensions (World Energy Council, 2022).

Strong energy systems provide a well-managed, balanced trilemma between the three essential components of energy security, energy equity, and environmental sustainability (cited in (Khan et al., 2021). Strong energy systems are secure, equitable, and ecologically sustainable (Khan et al., 2021). Passive trade-offs with equally significant objectives are necessary to maintain this equilibrium in the context of a rapid shift to decentralized, decarbonized, and digital systems (cited in (Khan et al., 2021)). The performance of energy systems in relation to the three trilemma dimensions is measured by the energy trilemma (Khan et al., 2021). The nation's capacity to meet current and future energy demands, resilience, and the dependability of the energy infrastructure are all factors in energy security (Khan et al., 2021). Energy equality assesses a country's capacity to provide accessible, cheap, and sufficient energy for household and commercial usage (Khan et al., 2021). To address climate change, environmental sustainability refers to the conversion of the energy infrastructure to low- or zero-carbon sources by bringing carbon dioxide emissions down to manageable levels (Khan et al., 2021). This concept also provides a framework for understanding the benefits and drawbacks of the decentralization of the used energy system (cited in (Khan et al., 2022))

The ability of a nation to fulfill both present and future energy demands is gauged by the Energy Security component (World Energy Council, 2022). A society that is energy secure will also be able to absorb supply shocks and adjust to them in a way that causes the least amount of disturbance to customers and the economy (World Energy Council, 2022). The dimension uses sub indicators to assess the efficiency of managing both internal and external energy sources as well as the dependability and resilience of the energy infrastructure in order to calculate an energy security score (World Energy Council, 2022).

As two asynchronous inputs that must be addressed simultaneously to enable economic development and prosperity, dependable access to inexpensive energy is measured as part of the Energy Equity dimension. Both a binary fundamental criterion associated with UN Sustainable Development Goal 7 and, increasingly, the more complex metric of quality energy access necessary to support economic growth are used to evaluate reliable energy access (World Energy Council, 2022). Energy pricing and larger socio-economic advancements, which affect how accessible a commodity like energy truly is, are combined to define energy affordability (World Energy Council, 2022).

Environmental Sustainability gauges a nation's energy system's effectiveness in preventing environmental harm and reducing climate change (World Energy Council, 2022). It considers the efficiency of energy resources, carbon sequestration, carbon dioxide and methane emissions, and air pollution (World Energy Council, 2022). The Sustainability score is derived using data on population, overall energy production, and GDP to enable fair comparisons across nations (World Energy Council, 2022).

The current state of Europe serves as a perfect illustration of why the Trilemma's three dimensions—energy security, energy equity, and environmental sustainability—need to be

considered together rather than separately (World Energy Council, 2022). Nevertheless, it is evident that many nations worldwide, notably those ranked in the top 10 performance in Europe, are reporting issues with energy security (World Energy Council, 2022). Energy security concerns in Europe have clearly been impacted by the interruption of Russian energy shipments (World Energy Council, 2022). However, there are differences in supply and generation across Europe, and each country depends on a varied mix of imports (World Energy Council, 2022). Some nations have benefited from their integration into a complicated, linked energy system by seeking to maximize local generation capacity (World Energy Council, 2022). Since each of the top 10 might have a different effect on energy security, it may not be unexpected to see so many European nations continuing to rank in the top 10 (World Energy Council, 2022).

The events of 2022 have served as a stark reminder of the Trilemma framework's applicability (World Energy Council, 2022). The multiplicity of issues faced by nations is more apparent than ever, and there has never been a more urgent need to strike a balance between energy security, equity, and environmental sustainability (World Energy Council, 2022). Although there is a worldwide energy crisis, it is being felt differently in different parts of the world (World Energy Council, 2022). Socioeconomic growth is made possible by having access to dependable, inexpensive, high-quality energy (World Energy Council, 2022). For the energy equity equality gap to be closed and to guarantee that the lowest performers are not left behind, further effort must be made toward granting fundamental universal access (World Energy Council, 2022). Energy systems must develop to take advantage of indigenous production opportunities that are sustainable, minimizing reliance on imported energy sources whose wholesale prices are unstable (World Energy Council, 2022).

The method utilized to allocate financial and other resources is vital due of the vast investment segmentation and the pressing demand for energy (Khan et al., 2021). During the energy transition and while allocating investment to maintain future energy demand, the three concerns of energy security, energy sustainability, and energy affordability must be addressed (cited in (Khan et al., 2021)). Energy transition needs controlling these three fundamental aspects of energy systems throughout the process since it is a major strategic problem (cited in (Khan et al., 2021)).

The necessity of renewable energy has been acknowledged, and a swift switchover to renewable energy and energy efficiency is currently underway (Sai Ramesh et al., 2023). The development of green hydrogen, a 100% carbon-free fuel, has been made possible by improvements in electrolysis and cost reductions as well as the availability of renewable energy sources, making it a serious competitor to change the energy industry (Sai Ramesh et al., 2023). The recent use of artificial intelligence to the energy business has significantly advanced the field (Sai Ramesh et al., 2023). Support vector regression, artificial neural networks, machine learning, and fuzzy logic models are some examples of artificial intelligence techniques and models that can significantly improve the generation, storage, and delivery of hydrogen energy (Sai Ramesh et al., 2023). They are crucial in the control of hydrogen production, the prediction of different factors, and safety regulations (Sai Ramesh et al., 2023). Furthermore, it is anticipated that developments in artificial intelligence will lead to the development of significant state-of-the-art tools and technologies for hydrogen and battery technology, which might aid in resolving the present crises and issues related to energy (Sai Ramesh et al., 2023).

When sustainability criteria are included into business strategies, managing knowledge exploitation and exploration for a company becomes even more difficult (cited in (González-Ramos et al., 2023)). While innovation and knowledge management may aid a company in generating revenue, in sustainable environments, they should also enable the company to discover solutions to meet the demands of stakeholders (cited in (González-Ramos et al., 2023)). Therefore, gathering information about the goals and demands of stakeholders would be an extra necessity to focus innovation efforts on exploration and exploitation ambits (cited in (González-Ramos et al., 2023)). A company should also be able to balance its short-term and long-term priorities while taking into consideration the demands of sustainable innovation in the future and its current organizational structure (cited in (González-Ramos et al., 2023))

The worldwide shift to renewable energy is currently moving much too slowly and unevenly, despite encouraging advancements and the immense environmental and economic advantages connected with it (cited in (Seriño, 2022)). The export of climate-friendly technology is necessary for the further integration of renewable energy in emerging nations (cited in (Seriño, 2022)).

One of the most crucial components of the global economy, oil is among the most significant raw commodities in the world and has been regarded as the most important fuel source since the middle of the 1950s (Aslam et al., 2021). The need for the reengineering of the oil industry has been created by the impact of new technologies, markets, and shifting customer demands on the competitive advantages of businesses (cited in (Aslam et al., 2021)). The oil industries operate based on the strength of natural resources, infrastructures, facilities, technological processes, human resources, and the most important market demands of energy products (Ghasemi et al., 2021). If one of the factors oscillates, it affects industry operations, planning, and production (cited in (Ghasemi et al., 2021)). In the current global scenario, given the technological and social growth associated with global competition, organizations need to implement a knowledge management strategy to manage global competition and improve their competence to meet the challenges of their business (Ghasemi et al., 2021). Thus, KM becomes the most essential key strategy for the oil industry (cited in (Ghasemi et al., 2021)). If not adequately handled, the expertise of those executives who occupy important positions in the sector and who are anticipated to retire in the future years might cause a reduction in knowledge and result in a significant knowledge gap in the oil business. (cited in (Ghasemi et al., 2021)). In such a condition, only knowledge management can provide a solution to obviate that intellectual loss (cited in (Ghasemi et al., 2021)). It is impossible to simply implement a future energy program without significantly negative economic implications when energy use favorably influences an economic activity (Petrović, 2022). In other words, it's crucial to consider how economically viable energy initiatives are (Petrović, 2022) and invest in continuous monitoring of an economically sustainable future.

4.2. Knowledge Management vs BPM vs BPMN

In today's climate of global opposition, knowledge is seen as a strategic aid that can highlight the company in the market in which it inserts(Zhou, 2022). When know-how becomes the core useful resource of the company and an asset of innovation, the focus of company management should shift from simple information collection to effective control of existing information and effective use of new knowledge (Zhou, 2022). The digital paradigm has created a knowledge-based civilization where many technology and informational items arise

(Pattanasing et al., 2022). If a company can't convert these things into knowledge, it won't have the data it needs to support decision-making (Pattanasing et al., 2022). As a result, knowledge management (KM) is essential to resolving these issues(Pattanasing et al., 2022).

KM also plays a pivotal role in the realization of processes and improving services, managerial decisions, and organizational adaptation and transformation (Valmohammadi, 2017). Besides, KM promotes an integrated approach to identifying, acquiring, retrieving, sharing, and evaluating all business information assets (Sofiyabadi et al., 2022). These information assets can include databases, documentation, policies, procedures, and implicit and explicit knowledge (Shi & Liao, 2013). Knowledge management tools enhance the decision-making process by fostering and facilitating the knowledge process(Tyndale, 2002). Related to this, as globalization intensifies, the efficient management of an organization's processes has become even more important (Ko et al., 2009). According to (Ko et al., 2009), citing Aalst et al. (2003), Business Process Management (BPM) "assists organizational processes by using methods, techniques, and software to design, act, control, and analyze operational processes involving humans, organizations, applications, documents, and other sources of information"(Ko et al., 2009). The most representative language that currently exists is the Business Process Model and Notation (BPMN). This language was developed to become the most comprehensive way to model a process, as it was intended that all users, regardless of their level of expertise, would be able to understand and use it. This happened due to its strong competence in offering the advantages of a graphical language, being simple, being standardized, and supporting execution processes (Arevalo et al., 2016). Thus, BPMN created a "bridge" between a gap that existed between the design of a business process and its implementation (Object Management Group, 2011). However, according to the authors (Hlupic et al., 2005) the biggest obstacle to the thoroughness of modeling in business processes is increased management awareness of the knowledge involved in modeling; as a result, investing in "process automation and acceleration" is necessary to get management more involved and aware of the advantages this concept entails. (Hlupic et al., 2005).

Through the utilization of individual knowledge resources and improved organizational collective knowledge, the application of BPM (Business Process Management) and KM (Knowledge Management) may assist businesses in enhancing their capabilities (Ramadhani & Mahendrawathi, 2019). Traditional BPM frequently runs into issues in unstructured and dynamic processes due to differences between the model and actual execution of the process as well as the inability to better ideas and innovation to the BPM process's end user (Ramadhani & Mahendrawathi, 2019). This issue can be resolved by encouraging different stakeholders to actively participate in the implementation of BPM (Ramadhani & Mahendrawathi, 2019). The organization's BPM must be well-defined and cognizant of the possibility that knowledge management might enhance performance to identify the requirements for knowledge management for processes (Tabares et al., 2016). A significant portion of human talent is required for knowledge management (Tabares et al., 2016). To accomplish the dynamics of collective intelligence in the company, the duties of knowledge creation and transmission during the execution of business activity should be specified and included in the workflow (Tabares et al., 2016). Knowledge thus becomes a crucial part of business operations as the process itself involves knowledge (Ramadhani & Mahendrawathi, 2019). BPM establishes a framework for knowledge management and decides how and when to use KM material. BPM serves as a framework for KM (Ramadhani & Mahendrawathi, 2019).

BPM and KM must work together to boost an organization's ability to compete in the rapidly evolving global marketplace (Ramadhani & Mahendrawathi, 2019).
It looks like BPMN is a good option for Knowledge Management roles (Object Management Group, 2011).

For (Kalpič & Bernus, 2006), BPMN is a vital tool for knowledge management because it enables the conversion of unstructured knowledge into structured knowledge, as well as the externalization, sharing, and eventual internalization of that knowledge (cited in (García-Holgado et al., 2015)).
In terms of making knowledge clear and easier to transmit, the representation of knowledge through process maps using BPMN has aided in the development of a database of information that can be consulted by new hires or departing staff (Salvadorinho & Teixeira, 2021).

For (Lig¸ Eza & Potempa, 2014), the strengths of BPMN as a KM tool are:

a) reasoning control or workflow control, which includes diagrammatic process definition with flow switching, ordering, and merging; data processing, including internal data processing and input, and output.
b) data flow specifications and structural description of the entire process, enabling visual representation at various levels of hierarchy (Lig¸ Eza & Potempa, 2014).

For (Sarnikar & Deokar, 2010) process orientation is essential from a knowledge perspective to offer task-appropriate information in the context of the organization's operational business processes (cited in (Salvadorinho & Teixeira, 2021)). Additionally, it is generally recognized that information helps any organization maintain its competitiveness over the long term and fosters long-term growth and development (Salvadorinho & Teixeira, 2021).

4.3. Digitalization and Industry 4.0 and process automation

Any organization must transform if it wants to prosper (Vokony et al., 2022). Many issues are presented by this digital transformation, including the overwhelming use of technology, the ability to benefit from it, emerging capabilities, cultural change, new organizational structures like digital infrastructure, new forms of cooperation, and digital inequalities, to name a few (Marnewick & Marnewick, 2022). We may apply our experiential knowledge to most of our daily activities (Vokony et al., 2022). Organizations are increasingly being forced to fundamentally alter their business models due to the rapid development of digital technologies and the volume of data that devices and applications gather daily (Marnewick & Marnewick, 2022).

Internet of Things (IoT), big data and data science, cloud computing, mobile technologies, social media, and big data all play a significant role in these technological improvements, as cited in (Marnewick & Marnewick, 2022). These technical developments and their use are progressively being incorporated into an organization's procedures and products (cited in (Marnewick & Marnewick, 2022)). Major changes are brought about in both organizations and society because of this increased reliance on technology (cited in (Marnewick & Marnewick, 2022)). For Saarikko et al (2020) digitalization uses digitized goods or systems to develop new organizational processes, business models, and products offering support to this sociotechnical process viewpoint (cited in (Marnewick & Marnewick, 2022)). The goal of Industry 4.0 is to increase productivity and efficiency through technology (Xu et al., 2021).

A structured design approach is necessary given the advent of Industry 4.0 and its associated technologies (Telukdarie, 2019).

Undoubtedly, the Internet of Things (IoT) provides a wide range of possible automation applications, from designing the installation of new plants to production management and more intelligent maintenance techniques using cutting-edge sensor technology (Isaksson et al., 2018). This makes it possible to estimate when a project will be completed, which facilitates project planning and scheduling (Rane & Narvel, 2021). With automation, business activity performance increases, and enterprise-wide monitoring and coordination are made possible (cited in (Rane & Narvel, 2021)). One of the fundamentals of digitalization is the capacity to construct systems, or systems of systems, to automate key business activities (cited in (Telukdarie, 2019)). The proponents of the industry expect the combination of cutting-edge industrial automation systems and industrial IoT technologies to become the standard for industrial automation. 4.0 (cited in (Kabugo et al., 2020)).

The capacity to make decisions can enhance automation levels (Kholiya et al., 2021). By utilizing numerous sorts of data, the new concept - Intelligent Process Automation (IPA) - helps firms automate operations (Kholiya et al., 2021). This idea combines process improvements with cutting-edge tools with the goal of reducing or eliminating routine and repetitive work while modeling human behavior and learning from it to become more effective with each iteration (Kholiya et al., 2021). Aside from improving accuracy, automating processes and systems will also provide company flexibility and scalability (Kholiya et al., 2021). Furthermore, modifications may be made immediately without requiring human workers to get additional process training (Kholiya et al., 2021). As a result, human labor may be used for jobs that are more difficult and sophisticated, increasing job satisfaction because employees are easily bored by monotonous, repetitive work (Kholiya et al., 2021). A company can consistently address compliance and regulatory issues thanks to automation as human error is eliminated in this method (Kholiya et al., 2021). As an illustration, IPA uses the power of artificial intelligence – AI - to make better decisions, which in turn provides consistency to tasks that are repetitive in nature (Kholiya et al., 2021). In addition, it contributes to a richer customer experience by processing customer queries more quickly and accurately (Kholiya et al., 2021). Finally, it tries to provide businesses with a competitive edge only when they develop a precise road plan for success (Kholiya et al., 2021).

To conclude, there are now several automation and digitization technologies in the industry that have matured in the market (Oesterreich & Teuteberg, 2016). All the firms can profit from a variety of advantages (Oesterreich & Teuteberg, 2016), however, despite the anticipated gains in production effectiveness, many businesses still struggle with it (Horvat et al., 2019).

4.4. Data Visualization

Increasing amounts of data have been generated over time and as information technology has advanced, leading to a "data explosion" (cited in (Moore, 2017)), which has increased organizational anxiety about how to manage it effectively for useful uses like formulating and implementing strategic decisions (Moore, 2017).

Data information is now a vital component of businesses, industries, research organizations, and technological advancement (Muskan et al., 2022). Every second, the amount of information utilized grows swiftly (cited in (Muskan et al., 2022)).

Data visualization makes it possible for people to comprehend the significance of records by summarizing and clearly displaying them (Muskan et al., 2022). Data visualization is a process for presenting large amounts of data in an approachable, understandable, and straightforward manner (Muskan et al., 2022). Visualization is a simple technique that may be used to develop a strong mental image of a future event (cited in (Muskan et al., 2022)). With the right visualization techniques, one might prepare in advance for the event, put it together well by imagining success, and develop the self-confidence required to perform well (Muskan et al., 2022). There are many different types of charts that can be used for operational purposes, such as increasing efficiency, monitoring procedures, examining the geographic distribution of data, searching for trends and relationships, reviewing the status of projects, developing ideas and writing reports, for example (Cuadrado-Gallego et al., 2021). A lot of database-related programs, including Excel ®, Google Sheets ®, Oracle Data Visualization Desktop ®, Microsoft Power BI® and many more, have also made substantial use of data visualization (Qin et al., 2020).

The Visual Organization by Phil Simon (cited in (Becker & Gould, 2019)) included case studies on the need of making data visible and available to organizational end users (Becker & Gould, 2019). It also discussed the tendency toward "self-service" in corporate intelligence and data analysis (cited in (Becker & Gould, 2019)). According to (Park et al., 2022), to comprehend, share, and enable collaborative engagement and decision-making with data and information, data visualization refers to visual representations like graphs and maps (cited in (Park et al., 2022)). People may use data visualizations to better comprehend data, get new perspectives, find answers to certain queries, and unearth hidden truths (cited in (Park et al., 2022)).

This concept is important in presenting and communicating complicated data intuitively by compiling and summarizing diverse types and volumes of data for efficient human information interpretation, especially in connection to big data, which adds another layer of complexity (cited in (Moore, 2017)).

The importance of measuring and keeping track of firm data is demonstrated by the high emphasis on performance metrics, data dashboards, and Key Performance Indicators (KPIs) (Islam & Jin, 2019). Businesses frequently track quantitative data such as sales volume, revenue by quarter, departmental costs and market share (Islam & Jin, 2019).

The ideal approach to show the data can be chosen by the user with the help of data visualization software, although this process is increasingly automated (Islam & Jin, 2019). The dashboard feature of data visualization software often enables users to combine many analysis' visuals into a single interface, which is typically a web site (Islam & Jin, 2019).

According to (Qin et al., 2020), there are five steps that can be used to illustrate the process:

1. Importing data involves getting the needed information from a desired data source.
2. To prepare the imported data for visualization, do data preparation steps include normalizing values, fixing incorrect entries, and interpolating missing values.
3. The third step in data manipulation is to choose the data that will be displayed and it's possible to combine this step with others like joining and grouping.

4. Mapping involves converting the information received from the procedure into geometric primitives and their associated characteristics (color, position, and size).
5. To turn the geometric data into a visual representation, render it.

Data and analytics have become more accessible to all employees inside a business thanks in large part to the development of data visualization tools (Islam & Jin, 2019). Compared to traditional statistical analysis tools or older iterations of BI software, they are often simpler to use (Islam & Jin, 2019). As a result, more lines of business are using data visualization tools independently, without assistance from IT (Islam & Jin, 2019).

With that in mind, knowledge is created by combining information, and it might be useful to the decision-maker by helping to solve problems (cited in (Moore, 2017)).

Data driven decision-making (D3M) has been highlighted as a practice that adds value to decision-making inside businesses (cited in (Moore, 2017)). D3M leverages data to provide evidence-based information for end-user decision-making through improved analytics and related information management systems (cited in (Moore, 2017)). Consequently, the decision-making process is dependent on data analysis (cited in (Moore, 2017)).

Companies can modify data visualization in any of the following ways (Muskan et al., 2022):

• Giving the study team experience with collaborative systems for data exchange, use, and expansion.

• Improving analysts' knowledge of the various data visualization technologies, which will lead to the use of dated software, BI tools, or visual analytics tools.

• Workers with design backgrounds may be given training in data visualization techniques so they may join analytics teams. The visualization of enormous data quantities can be aided using low-cost open-source tools.

A possible drawback of the data-driven decision-making method is that decision-makers risk becoming overly metric-driven and closing themselves up to innovative thinking.

4.4.1. Power Apps – Low Code Development Platform

Low-code programs might be one way to make customized platforms in the lack of a "perfect" platform(Rajaram et al., 2022). Low-code software development involves the creation of programs mostly using drag-and-drop capabilities of pertinent components, eliminating the need for heavy coding and reducing deployment effort (cited in(Rajaram et al., 2022)). Low-code development tools enable users with little technical expertise to create apps, including those for mobile devices, and are often hosted online (Rajaram et al., 2022). There are several paid and open-access programs (cited in(Rajaram et al., 2022)). One such online visual tool for developing low-code apps is Microsoft Power Apps (cited in (Rajaram et al., 2022)).The Power Apps platform has tools for building web applications, and its canvas-style apps provide users a variety of displays to interact with data (Rajaram et al., 2022).The Power BI dashboard is integrated using Power Apps and transformed into an application so that users may quickly access and view the dashboard through the app (Zulkafli et al., 2022). Power Automate is used to control workflows, and SharePoint is used to store data (Rassameeroj et al., 2022). Small and midsize departments or companies with constrained financial resources and software engineers might consider using low-code development platforms (Rassameeroj et al., 2022). Being able to log in with their university credentials and use Microsoft Office 365

for free is beneficial for schools and institutions who utilize Office 365 Education (Rassameeroj et al., 2022) and may be employed to safely connect to and obtain information from pre-existing Microsoft services on a company's secure server (Rajaram et al., 2022).

4.5. Business Intelligence

The managers and specialists of businesses place a high focus on improving organizational performance (J. Wang et al., 2022). Capabilities for performance evaluation are actions taken to make better use of information at hand and accomplish organizational objectives (J. Wang et al., 2022). Knowledge information is effectively utilized in businesses to educate employees while also being used in management decisions (J. Wang et al., 2022). Companies must gather, analyze, and understand massive amounts of data to make better, more informed decisions in the highly competitive business world of today (Foster et al., 2015). For most businesses, there is fortunately a wealth of data available (Foster et al., 2015). However, these data might prove useless in the absence of proper data quality and government regulations (Foster et al., 2015). When attempting to extract meaningful information, data quality is a requirement (Foster et al., 2015). Because without it, a business might be forced to rely on faulty data to make skewed decisions or guess at a course of action (Foster et al., 2015). Therefore, to achieve high quality, the data must be reliable, accessible, comprehensible, and pertinent to the issue at hand (Foster et al., 2015). Effective, data-driven decisions are ultimately required for organizational sustainability (Foster et al., 2015). Unfortunately, a lack of data confidence makes a company's decision-making processes significantly more difficult (Foster et al., 2015). The performance of the organization is negatively impacted by this lack of confidence (cited in (Foster et al., 2015)). Implementing the data to its full potential will help businesses develop sustainably as well as gain competitive advantages and, ultimately, improve productivity at work (F. Y. Wang et al., 2011). The key to achieving the aim is BI analysis and mining based on accurate data, and its dependability is based on analysis and mining of huge data, which traditional BI models find challenging to get (F. Y. Wang et al., 2011). Business intelligence (BI) applications have grown significantly in recent years and are now regarded as one of the most important applications of information technology, with a distinct place dedicated for them (Moghimi & Zheng, 2009). Hence, using intelligent BI platform technologies to monitor socioeconomic indicators is objectively necessary (Sakhnyuk et al., 2020).

To make correct and wise business decisions as quickly as possible, BI has been offered as a tool, product, and system, encompassing applications and analytics based on operational and analytical databases (J. Wang et al., 2022). It takes judgments on creative business ventures and supports such decisions (cited in (J. Wang et al., 2022)). BI equips users with the ability to reason, decipher, and utilize business information in a timely and suitable manner (cited in (J. Wang et al., 2022)). Intelligent business systems' efficiency and effectiveness play critical roles in a company's performance and ability to compete favorably (cited in (J. Wang et al., 2022)). Due to the scope and long-term advantages of these systems, their assessment is looked at from a variety of angles (cited in (J. Wang et al., 2022)). To support management, marketing, and corporate development by fully using current business information and cutting-edge methodologies, it may extract and arrange the information that is already accessible (F. Y. Wang et al., 2011). Additionally, by analyzing and seizing new opportunities and spotting potential threats, BI can boost financial performance and services to sustain

competing merit and bring more economic benefits for the company (F. Y. Wang et al., 2011). For (F. Y. Wang et al., 2011), the fundamental steps of BI are: prior to loading valuable data into a data warehouse or market, useful data must first be cleaned to confirm its authenticity from various data sources; following that, the data is analyzed and disposed of using the appropriate data mining, analysis, and inquiry tools, etc (F. Y. Wang et al., 2011). Finally, the findings are presented to management and offer organizational decision assistance (cited in (F. Y. Wang et al., 2011)). Solutions based on business intelligence are defined as objective-driven, dependable, and accurate methods or procedures used to examine regular production data sets and give an application or approach to the firm for wise decision-making (cited in (Van Der Walt et al., 2021)). A cited in (Van Der Walt et al., 2021), BI solutions are a crucial component of decision-making that a company may use to outperform its rivals and achieve more successful and lucrative business results (Van Der Walt et al., 2021). Any organization's data center is its business intelligence, which allows for the consideration of current operational data when making critical operational business decisions or resolving challenging operational business situations (cited in (Van Der Walt et al., 2021)). Production data may be subjected to fresh and perceptive analyses and forecasting methods thanks to the interpretations of a carefully thought-out BI architecture (Van Der Walt et al., 2021). The volume and complexity of the data, however, make managing these systems increasingly difficult as a company develops (Van Der Walt et al., 2021).

For academics, practitioners, and executives of information systems (IS) organizations, business intelligence has gained increasing attention and priority, and many businesses have increased their investments in software services and BI cloud (cited in (Gina & Budree, 2020)). Despite the expansion and development of the different business intelligence solutions that may be used, there is still a high chance of failure and improper tool selection (Gina & Budree, 2020). As more product options and solutions flood the market, decision-making in the realm of software technology selection gets increasingly complicated and challenging (cited in (Gina & Budree, 2020)). The acquisition of the software tool to use constitutes a significant diversion from the organization's goals if the choice of the software tool is not driven by a clear plan (cited in (Gina & Budree, 2020)). Intelligent power consumption is made possible by the introduction of BI systems, which will stimulate the development of intelligent communities and open new economic options (F. Y. Wang et al., 2011). In addition to relying on technologies, methodologies, and procedures, creating a business intelligence environment also needs qualified business people to carefully guide these in the proper path (Moghimi & Zheng, 2009). The business needs should be understood well, together with the objectives to be set, the related processes to be examined and defined, the type of data to be used, and the sources and targets for that data to be used for BI analysis (Moghimi & Zheng, 2009).

Without taking process models into account, business intelligence solutions concentrate on disseminating data relevant to businesses (Polyvyanyy et al., 2017). As a result, the difference between data-driven BI techniques and process-centric BPM approaches is readily apparent (Polyvyanyy et al., 2017). Approaches for process mining are meant to close this gap (cited in (Polyvyanyy et al., 2017)). Process mining follows other BPM methodologies in being process centric (Polyvyanyy et al., 2017). Process analytics refers to methods, strategies, and technologies that give process participants, decision-makers, and other stakeholders information on the efficacy and efficiency of operational processes (Polyvyanyy et al., 2017). Process analytics and process mining have a tight relationship. Insights and improvements in performance, quality, compliance, forecasting, and planning of processes

operating in dynamic commercial environments can be supported by the search, correlation, aggregation, analysis, and visualization of process events (Polyvyanyy et al., 2017). Process querying examines (automatic) techniques for organizing, such as filtering or altering, repositories of models that represent actual and/or imagined processes, as well as the connections between them (Polyvyanyy et al., 2017). A process query is a (formal) command to manage a process repository, and a process querying method is a methodology that, given a process repository and a process query, systematically executes the query in the repository (Polyvyanyy et al., 2017). Once a query has been executed, the user should be informed of the outcome (Polyvyanyy et al., 2017). The user needs assistance to make sense of query results since searches might provide complex instructions that result in operations over vast data sets (Polyvyanyy et al., 2017). To this purpose, the framework has a specific section that oversees deciphering the outcomes of queries that have been run (Polyvyanyy et al., 2017). All the framework's "Interpret" section's components share the common objective of helping users better understand the results of process querying (Polyvyanyy et al., 2017). The components take whatever action is necessary to make the user's understanding of the result of running a certain process query simpler (Polyvyanyy et al., 2017). The components of the "Interpret" part of the framework rely on all the crucial inputs and outputs of the Process Querying component, i.e., they take all the pieces that are used to execute the query as input, to identify and explain the differences between the original repository and the resulting repository as well as the reasons for the differences (Polyvyanyy et al., 2017).

Business intelligence systems offer up-to-date, trustworthy, and adequate business information, enabling users to reason about and comprehend the significance of that information through the information discovery and analysis process (J. Wang et al., 2022). These systems offer data that might be the foundation for a significant shift in a certain firm (cited in (J. Wang et al., 2022)). These include accepting novel markets, acquiring novel customers, presenting novel goods to customers, and confirming novel fields for partnership, all of which point to the ability to assess the effectiveness of the organization (cited in (J. Wang et al., 2022)).

4.5.1. Power BI

A business intelligence dashboard tool is used to gather, analyze, and show data using a variety of data visualization techniques and processes (Khatuwal & Puri, 2022). Today, to survive in this cutthroat market, an organization must be quick in data sharing, accessing, and generating quick insights so that the flow of data within the organization remains constant (Khatuwal & Puri, 2022). By leveraging multiple data visualization approaches, BI dashboards enable staff to independently generate meaningful dashboards (Khatuwal & Puri, 2022). A cloud-based knowledge enquiry called Power BI (Business Intelligence) may be used to analyze and alert users to information from a variety of sources (Khatuwal & Puri, 2022). For both power users and business specialists, Power BI is straightforward and quick to apply (Khatuwal & Puri, 2022). BI engineers may leverage Power BI, a mature and fantastic technology, in business frameworks to model situations and combine complicated information (Khatuwal & Puri, 2022). This serves as an online assistance data analysis tool that is primarily targeted at business intelligence (Khalwadekar & Gogate, 2022). Performance improvement mainly depends on optimization, which is changing the data model's present configuration to make it work more effectively (Khalwadekar & Gogate, 2022). Information is the foundation of Power

BI (Khatuwal & Puri, 2022). All these ideas and responses are derived directly from data sets used to compile information, create graphs and other visuals, and engage in early Q&A (Khatuwal & Puri, 2022). The MS Power BI software product can be used as a statistical and analytical basis for pragmatizing decisions in the face of uncertainty, in the absence of 100% relevant information, which is inherent in contemporary trends in higher education, and is one of the tools that enables making structured, best-founded decisions (Shaulska et al., 2021).

A Power BI report has one or more pages, each of which can include a group of one or more visualizations (Becker & Gould, 2019). Without changing the definition of the underlying table, fields of data may be readily shifted between axis labels, legends, and area values (Becker & Gould, 2019). This application offers a variety of bar, line, and area charts as well as scatter plots, tree maps, and map-based presentations (Becker & Gould, 2019). Tables, pivot matrices, and a range of indicator cards make it possible to highlight a single figure in dashboard-style presentations (Becker & Gould, 2019). It can be illuminating to rapidly extract a table from a bigger data repository and then experiment with various data visualization techniques (Becker & Gould, 2019).

The exported spreadsheets may be linked to Microsoft's Power BI program, a Business Intelligence (BI) tool that enables data aggregation, analysis, visualization, and sharing, making it feasible to display the findings on dashboards (Kadcha et al., 2022). As a result, information is easier to grasp and is presented in a clearer and more structured manner for use in making decisions (Kadcha et al., 2022). The numerous benefits it provides when building reports or dashboards make Power BI the tool of choice for this visualization activity Kadcha et al., 2022). Power BI's visualization helps users avoid being hampered by the overwhelming volume of conflict data by intelligently and effectively analyzing it. Power BI dashboards are extremely dynamic and intelligently connect to one another (Kadcha et al., 2022). Among the features are dashboards, which combine many data visualizations into a single platform and provide a straightforward way to see important execution pointers using benchmarks, tree charts, funnel charts, or fill charts; input data, model it, and publish Power BI updates without using Excel thanks to Power BI Designer (Khatuwal & Puri, 2022). Real-time visualization updates, secure transmission, quick setup, and interaction with current IT systems are all advantages (Khatuwal & Puri, 2022).

The tools provided by Power BI span the gaps between databases and spreadsheets and knowledge workers and the mountains of data they all wish to mine for insights to share with coworkers, managers, and the general public (Becker & Gould, 2019). With Microsoft's large user base and industrial-sized support infrastructure, Power BI combines these features in a user-friendly package (Becker & Gould, 2019).

Many businesses that deal with huge volumes of information may swiftly analyze it and obtain data-driven insights to simplify many elements of their operation by fusing best practices for data visualization with contemporary digital technologies (Islam & Jin, 2019). However, according to the literature, developing visualizations is difficult because it requires sufficient user involvement to make the connection between data and human intuition (cited in (Moore, 2017)).

Power Query offers tools for retrieving tabular data in a wide range of file types, from basic text files to massive databases (Becker & Gould, 2019). When called from Excel or Power BI Desktop, Power Query, also known as Get and Transform, appears as a graphical user interface (GUI) window, but it is a front end for a programming language known as "M" (Becker & Gould, 2019). This table of data is then assembled and put into Excel or Power BI's

visualization tool (Becker & Gould, 2019). Each step has a name and consists of a function applied to another step with the same name or to a query that has already been constructed (Becker & Gould, 2019). The data required for the project may then be focused on by filtering and sectioning the generated tables (Becker & Gould, 2019). Users may go through the numerous transformations to troubleshoot issues or recover previous stages of the transformation because the data import process is programmed (Becker & Gould, 2019).

Despite the possibility of variations, each technique will ultimately result in a smaller Power BI file, which will have a ripple effect on the entire Power BI ecosystem as well as numerous other aspects of BI solutioning (Khalwadekar & Gogate, 2022).

4.6. Competitive Advantage and Economic Pillar of Sustainability

The prevalence of departmental communication issues is particularly high in large businesses with many production facilities that outsource parts of their operations (Meski et al., 2019). To make database queries simple to comprehend and use, building data and knowledge bases must be integrated logically (Meski et al., 2019). By increasing manufacturing efficiency and safety, cutting-edge digital technologies like the Internet of Things (IoT), sensors, and automation have revolutionized several sectors (Liang et al., 2023). But the enormous amounts of data produced by these technologies have also brought about previously unheard-of difficulties in terms of managing, visualizing, and analyzing this data (cited in (Liang et al., 2023)).

Business processes are becoming increasingly varied, dynamic, and adaptable because of information technology's rapid advancements and the globalization of marketing, necessitating the use of an agile business process management system (BPMS) (Luo & Chen, 2011). The utilization of information technology will put businesses in a good position by facilitating market access, differentiating their products, and reducing costs (cited in(Syahchari et al., 2020).

The ability to supply items quickly and with exceptional quality, classified by a variety of novel products with high appeal, reduced costs, and superior excellence compared to the competition, is made possible by the area of information technology (cited in (Syahchari et al., 2020). With the use of information technology, businesses may offer quick and secure services to boost competitive advantage (cited in (Syahchari et al., 2020). All spheres of human activity are being continuously digitalized because of the growth of the information society and knowledge, particularly in commercial and economic contexts where an organization's competitiveness is heavily reliant on its capacity to manage information (Solana-González et al., 2013).

In the current global economy, the competitive edge has grown to be a major worry for businesses (Syahchari et al., 2020). In the contemporary environment, there is continual change due to the quick evolution of technology to fulfill consumer demand and the escalating levels of fierce international competition (Syahchari et al., 2020). Business organizations must contend with fierce competition and unsteady overall performance in a changing setting (Syahchari et al., 2020). The capacity of a company to establish a position that it can retain over its competitors is known as a competitive advantage (cited in (Syahchari et al., 2020). If a business has resources and competencies that set it apart from competitors, it should be possible for it to gain a competitive edge if it has a strategy that makes effective use of these resources and competencies (Syahchari et al., 2020).

Because of the rapidly changing settings of technology and development, businesses are undergoing significant transformation (Shehabat, 2020). Therefore, firms should concentrate on maintaining their competitive edge by continuously improving their people, processes, skills, and performance (Shehabat, 2020). It should be noted that organizations should use all their resources, especially their intellectual ones, to accomplish this aim (Shehabat, 2020). Knowledge is as a crucial asset to boost innovation and insights, vision, and objectives, and to assure superior organizational performance with high profitability over rivals within an organization (Shehabat, 2020). The most successful businesses are those that serve client requirements and stay ahead of their rivals even when unforeseen circumstances arise (Shehabat, 2020). Consequently, many businesses aim and should use their expertise as an asset to boost revenues and develop a long-lasting competitive advantage (Shehabat, 2020). Other studies backed up the good effects of knowledge management by using innovation and intellectual property as a strategy to obtain and preserve a competitive edge over rivals (Shehabat, 2020). Every firm must thoroughly understand how knowledge management may boost and promote innovation (Shehabat, 2020). Studies on intellectual capital and human capital have shown that effective knowledge management techniques, particularly information sharing and transfer, are essential to fostering and enhancing creativity and innovation and, as a result, sustaining and gaining competitive advantage (Shehabat, 2020). According to several academics, knowledge management is strongly, positively, and significantly related to innovation, organizational performance, and long-term competitive advantage (Shehabat, 2020). It is critical to understand that social context influences how people use technology, not the technology itself, which defines how IT supports knowledge management methods (cited in (Joe Turner et al., 2009)). The right social environment that may benefit from electronic communication technology will thus be more important than IT skills for the organization's usage of IT (cited in (Joe Turner et al., 2009)).

As was previously said, the capacity to digest information is related to competitive advantage, but it is also related to the efficiency of decision-making (Cao et al., 2019). As cited in ((Arruda & Madhavji, 2017), the decision-making process is made up of factors including accountability, result evaluation, the number of participants, and the caliber of the analysis (Arruda & Madhavji, 2017). Effective decision-making will enable employees to "act confidently and decisively in a fast-paced marketplace" or "act more quickly" (cited in (Cao et al., 2019)); better understand customers; better serve them, and increase customer loyalty (Cao et al., 2019).

Organizations should always endeavor to investigate the finest methods that may be used to support them in achieving their long-term strategic objectives and bolstering their competitive advantages in strategic management (cited in (Ramadan et al., 2022)). Technology virtuosity is crucial in the current Industry 4.0 age to enhance firms' capacity to react fast to market demands (Ramadan et al., 2022). Additionally, to implement new human-based technical practices and investigate the most recent production-supporting approaches, businesses need to expand their internal research and development capabilities (cited in (Ramadan et al., 2022)). This will enhance their capacity to carry out internal operations and duties, digitalize technical knowledge that is based on intangibles, and investigate Industry 4.0 best practices to support technical virtuosity (cited in (Ramadan et al., 2022). The ability of an organization to acquire or develop new competitive factors quickly enough to use them to support its economies of scale and success drivers is what gives it a sustainable competitive

advantage in today's volatile markets (cited in (Ramadan et al., 2022)). This is true whether the assets are tangible or intangible (Ramadan et al., 2022).

Making strategic decisions requires significant financial and time commitments before outcomes become apparent (Shen-Hsieh & Schindler, 2022). Experience, intuition, and subjective judgment are used to guide these decisions, along with quantitative and qualitative data (Shen-Hsieh & Schindler, 2022). These choices weren't made by robots; they were made by people (Shen-Hsieh & Schindler, 2022). Data serve as the foundation for the development, capture, use, and exchange of knowledge. Additionally, problems with Knowledge Management (KM), data abstraction, analyses, storage, and accessibility continue, leading to knowledge loss and rising costs (Maindze et al., 2019). A strategy and technology are needed to handle these issues given the increase in the production of research data, algorithms, technical publications, reports, and logs (Maindze et al., 2019).

Users may interpret and utilize this data with the aid of a customizable visualization system (Joe Turner et al., 2009). It is crucial to remember that the user's selection of visual forms and their information-processing capabilities dictate the variety of activities they may engage in and provide purpose to otherwise meaningless acts like mouse clicks, keystrokes, and interaction patterns (Joe Turner et al., 2009).

Information visualization is a discipline that is connected to knowledge visualization (X. Y. Wang & Mu, 2009). Both knowledge visualization and information visualization make use of our natural propensity to digest visual information efficiently, yet they nevertheless differ (X. Y. Wang & Mu, 2009). To get fresh insights or just make the stored data more accessible, information visualization tries to investigate enormous volumes of abstract data (X. Y. Wang & Mu, 2009). By enabling people to convey their knowledge in more varied ways, knowledge visualization attempts to enhance the development and transfer of knowledge among individuals (X. Y. Wang & Mu, 2009). Knowledge visualization generally aims at enhancing knowledge-intensive communication between persons, whereas information visualization often serves to enhance information retrieval, access, and display of big data sets – notably in the interaction of humans and computers (X. Y. Wang & Mu, 2009). Thus, the term "knowledge visualization" refers to all graphic techniques that can be used to create and communicate sophisticated insights (X. Y. Wang & Mu, 2009). Visualization has a variety of applications in knowledge management (X. Y. Wang & Mu, 2009). Transferring and exchanging information is one of these (X. Y. Wang & Mu, 2009). A methodical strategy to using visual representations for the transmission of information that will both speed up and improve the quality of the transfer is provided by knowledge visualization (X. Y. Wang & Mu, 2009). There are many levels at which information is transferred: between people, between groups, between groups, and from individuals and groups to the entire organization (X. Y. Wang & Mu, 2009). Knowledge visualization may act as a conceptual connection at each of these levels, connecting not just people's brains but also groups of professionals and departments (X. Y. Wang & Mu, 2009). Although the field of knowledge visualization is still in its infancy, the relevant concepts and techniques have long been researched (X. Y. Wang & Mu, 2009). There are multiple methods available to graphically arrange the knowledge, such as idea maps, interactive visual metaphors, conceptual diagrams, and knowledge maps (X. Y. Wang & Mu, 2009). Given that both graphic representations differ from conventional visual renderings, it appears appropriate to refer to them as knowledge visualizations (X. Y. Wang & Mu, 2009).

It is indeed quite difficult to solve a complicated problem manually, but by using business intelligence and knowledge management, the effort is broken up and answers are found quickly (cited in (Qhal, 2022)). Knowledge management and business intelligence are crucial to solving corporate issues (Qhal, 2022). Maintaining a business and finding a solution to an issue it faces all alone is quite challenging (Qhal, 2022). Because there are numerous procedures that are challenging and complex for a human to complete in the vast process of business solving (cited in (Qhal, 2022)). Knowledge management and business intelligence are required (Qhal, 2022). Business intelligence and knowledge management support the control, archiving, analysis, and decision-making processes related to business problems (cited in (Qhal, 2022)).

Business intelligence and knowledge management both rely on information technology, including the Internet, hardware, software, and database technology (Yang et al., 2022). Both involve gathering, organizing, distributing, and using knowledge and information (Yang et al., 2022). Business intelligence and knowledge management interact and support one another, primarily concentrating on recognition (Yang et al., 2022). One the one hand, knowledge management places a lot of emphasis on individuals with strong cultures and expertise (Yang et al., 2022). Additionally, knowledge management stresses the significance of knowledge acquisition and efficient knowledge use (Yang et al., 2022). Business intelligence, on the other hand, is more concerned with technology and data (Yang et al., 2022). That is, it emphasizes the user's ability to solve business issues with the business intelligence system by using the quantitative analysis of a technical expert (Yang et al., 2022). Business intelligence and knowledge management are regarded as crucial instruments for contemporary enterprises because of their great value in fostering decision-making and enhancing organizational performance (Yang et al., 2022). Knowledge is used in business intelligence and knowledge management to enhance decision-making (Yang et al., 2022). The relationship between business intelligence and knowledge management is still up for debate (Yang et al., 2022). This uncertainty results from how these terms are defined (Yang et al., 2022). Knowledge management places equal emphasis on explicit and implicit knowledge, in contrast to business intelligence's concentration on explicit knowledge (cited in (Yang et al., 2022)).

A distinct and well-developed digital strategy is one of the factors that ensures success in BI-based innovative development (Olszak, 2022). It serves as the foundation for enabling businesses to grow their resources and skills in accordance with their goals (Olszak, 2022). The need for rigorous alignment between this plan and the company strategy was highlighted (Olszak, 2022).

Since more and more business operations are being supported and tracked by information systems, the volume of process-related data is expanding quickly (Polyvyanyy et al., 2017). In addition to the wealth of event data now available in business systems, Industry 4.0 and the associated industrial Internet of Things are going to produce fresh waves of process-related data (Polyvyanyy et al., 2017). Organizations, however, frequently fall short of transforming such data into strategic and tactical insight (Polyvyanyy et al., 2017). This is because there aren't any specific technologies designed to manage the information about processes that is stored in process models and process execution records in an efficient manner (Polyvyanyy et al., 2017). Process-related data is a crucial organizational asset, and to fully utilize it, specialized analytics are needed (Polyvyanyy et al., 2017). The digital strategy and goals of successful BI using organizations were well defined (Olszak, 2022). However, the digital transformation creates new opportunities for business model innovation and growth in

terms of processes, products, and business models(Vuchkovski et al., 2023). New leadership and team member positions that resulted from the digital revolution (Vuchkovski et al., 2023). The findings demonstrate that virtual teams are dealing with a sizable number of new team member jobs, including a social interaction facilitator to foster informal relationships within a team and new IT positions to manage knowledge (such as data manager and business intelligence manager) (Vuchkovski et al., 2023).

Data visualization is a widely used and well-recognized tool for I4.0, but many industrial companies have been sluggish to adopt it (Allen et al., 2021).

The notion of big data analytics is quickly gaining popularity in both academia and business (Raut et al., 2019). It has developed new tools for making decisions to create data-driven supply chains (Raut et al., 2019). Business intelligence, value generation, and business choices are opportunities provided by big data (cited in (Raut et al., 2019)). Sustainability in terms of the economy, society, and environment is crucial to the operation of the company (Raut et al., 2019).

In terms of economic (costs, resources, productivity, product complexity), social (demanding consumers, shifting markets, shifting organizational cultures), and environmental (energy efficiency, waste, and climate change) requirements, the corporate environment is becoming increasingly dynamic (cited in (Felsberger et al., 2022)). Manufacturers should operate economically to pursue other sustainability goals, according to the economic-manufacturing sustainability pillar (cited in (Ching et al., 2022)). This pillar, however, does not adhere to the maxim of "profit at all costs," since it also values the interests of partners and consumers (Ching et al., 2022). That is why, after the advent of Industry 4.0 and digital transformation, a new phrase known as economic innovation emerged. Economic innovation, as cited in (Ramadan et al., 2022), consists of many operations to optimize an organization's advantages by allowing digitally based creative improvements (Ramadan et al., 2022). Combined with technical innovation, this will enhance communication amongst all partners throughout the expanded value chain, creating new business models to accommodate changing market trends, and promoting economic growth (Ramadan et al., 2022). Economic innovation is key to attaining long-term economic success that boosts an organization's competitive advantages (Ramadan et al., 2022). The theoretical framework that is intended to visually demonstrate the relationship between theoretical ideas and the anticipated output—in this case, to make decision-making easier, thereby enhancing competitive advantage and preserving the economic pillar of sustainability—is shown below.

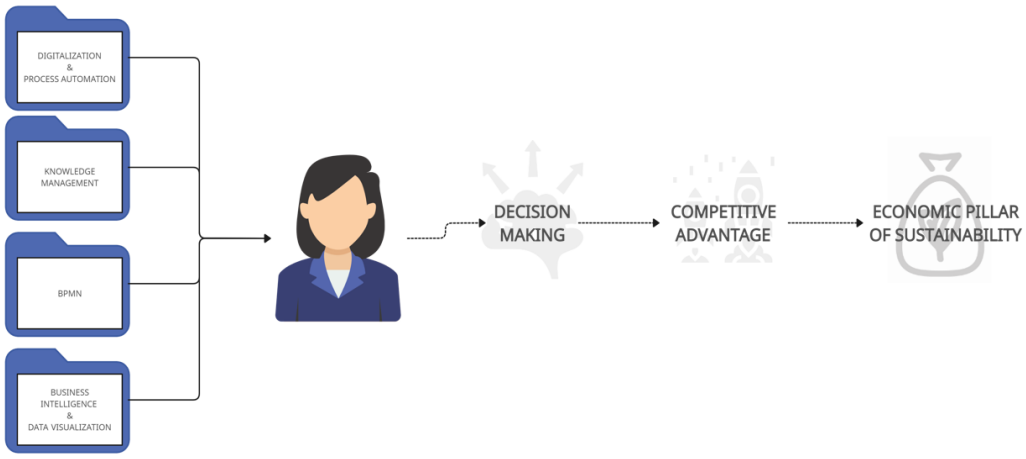


Figure 2 Theoretical Framework

5. Practical Study

5.1. Process Description | BPMN

This topic will provide a detailed explanation of the process, using the BPMN 2.0 notation as a basis to facilitate decision-making and thus increase the organization's competitive advantage. With clear and concise visualization of the processes and tasks involved, it is possible to identify opportunities for improvement and implement changes more agilely and effectively, ensuring competitiveness and economic sustainability.

According to the BPMN life cycle, one should first study the model as it stands, known as "AS-IS". However, in the business environment indicated above, this is an original and unprecedented study in this area where a well-defined and organized process is being outlined with the support of the new Vortexa® platform (introduced when the proposal for this process was presented) for decision-making on the range of vessels that will increase the competitive advantage of the company itself. As such, in this case, there is no "AS-IS" model to present.

The process can be summarized into three main parts, as described in Annex one: obtaining the Target List (ships with favorable conditions for inter-company business); selecting the time window and studying the variables involved to facilitate decision-making in the final phase.

The first crucial point for the process to begin is the need to create a list that includes all ships that meet the limitations of the Port of Aveiro and Prio Supply and Prio Bio. It should be noted that there are differences between the products and final purposes of imports, resulting in the existence of two distinct lists: the Target List Supply and the Target List Bio. These lists include the limitations of the Port of Aveiro as a basis and then the limitations of Prio Supply and Prio Bio, respectively. In other words, depending on the type of product and import purpose, it is necessary to check in which list the import fits to ensure that specific limitations are observed and fulfilled, considering the restrictions of each source. In this instance (Figure 1), the first actor, the "Shipping Team," starts by analyzing the Port of Aveiro's restrictions for the development of the listed lists, ship by ship, to ascertain which list the import fits into to ensure that specific restrictions are observed and met while considering the constraints of each source. From this point on, if the constraints are satisfied, we go to the following phase, which is to examine the Prio Supply and Prio Bio limitations. When these restrictions are acknowledged, the ship under investigation is added to the corresponding Target List Supply and Target List Bio lists. The choice is excluded, and that ship is eliminated when any factor does not adhere to the constraints that have been set forth. We may go on to the next phase after examining all the ships and creating the Target Lists.

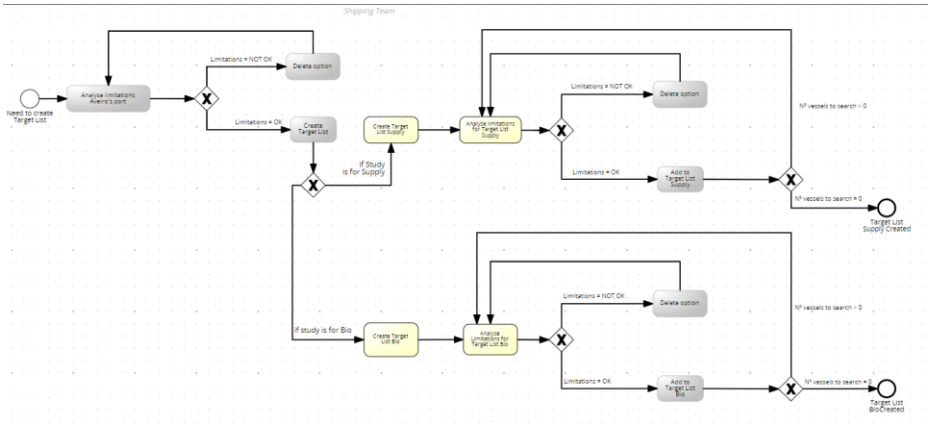


Figure 3 Create Target List

After obtaining the Target List, the next step in the decision-making process is to analyze and study the information related to each ship on the list. This task is performed by "Ana Cruz," who uses the Vortexa® platform to extract the necessary data.

The data extracted from the platform is analyzed to identify ships that meet the specific requirements for the transaction. This includes studying the historical data related to each ship, such as its voyage history, loading and discharge history, and any potential disruptions that could impact the shipment. The information is then used to select the optimal ship for the transaction.

It is worth noting that the selection process is highly dependent on the specific needs and limitations of the transaction. For example, if the shipment is time-sensitive, the decision may be based on the ship's estimated time of arrival (ETA) at the port of discharge. If the shipment requires special handling, such as the need for refrigerated storage, the decision may be based on the ship's cargo-handling capabilities.

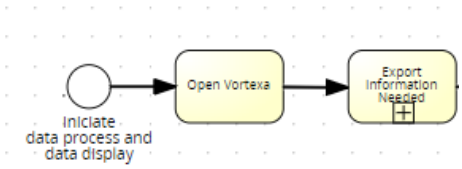


Figure 4 Data process and Data display

This subprocess involves selecting three different features of the Vortexa® platform: "Map", "Live", and "Flow". In each of these, the respective detailed information should be exported. Here is a more detailed description for each feature.

For the "Map" dashboard, the information that should be exported is the status of the ship being "Ballast", and also for other cases, those with cargo status of "In Transit" and "Discharging".

In the "Live" feature, the following information should be exported, with each case separated: origin and destination as Portugal, the same for Spain, and movements in transit between China and Europe.

Finally, with the "Flow" feature, information should be collected from January 2022 onwards, to create a historical comparison with what is currently happening. In this case, we will export information (once again, each case separately) related to situations where the origin and destination are Portugal, as well as the same for Spain and for ships on the "Target List Supply" and "Target List Bio". This is shown in the following figure (Figure 3).

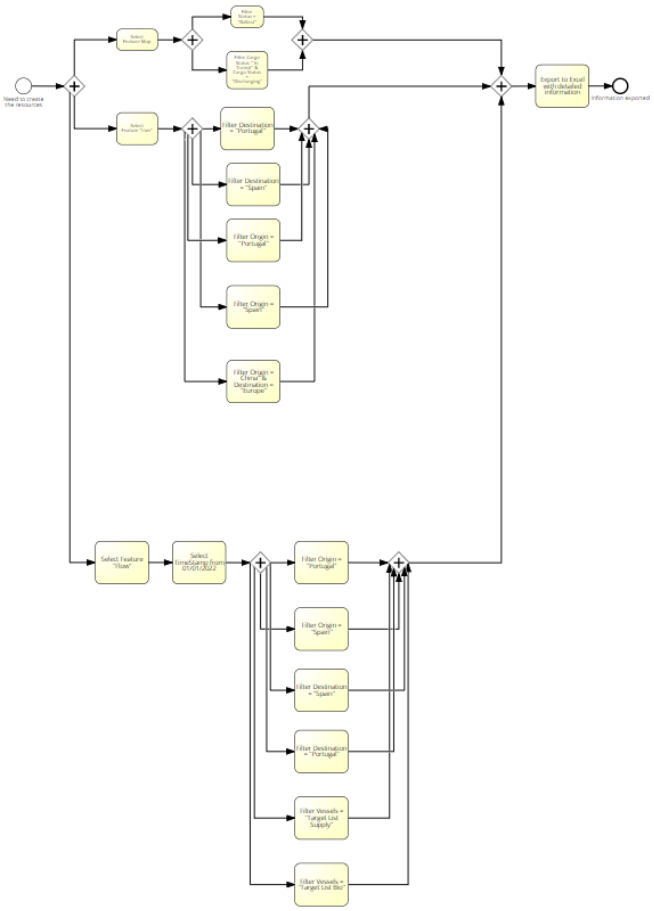


Figure 5 Create the resources

With all the information exported, another subprocess follows, responsible for creating the necessary resources for the study, analysis, and treatment of the data. At this point, it is essential to consider whether the data is being processed for the first time or not. If it is the first time, all notepads for each of the situations to be studied and analyzed must first be opened. The required notepads are as follows: "Target List Supply," "Target List Bio," "Target List Supply History," "Target List Bio History," "Portugal Import Live," "Portugal Exports Live," "Portugal Imports History," "Portugal Exports History," "Spain Imports History," "Spain Exports History," and "China Europe Live." The exported information should be pasted into the respective notepad.

Next, three new Microsoft Excel files should be created. One of them will be titled "TKMC" and will include information from the CSVs of "Target List Supply History" and "Target List Bio History." Two sheets will appear, respectively, and in each sheet, the columns indicating the number of routes in the ARA and Russia zones should be added. In this same file, the current location information of the corresponding ships in each of the lists should also be added. To do this, another subprocess must be entered to retrieve this location. For this case, another platform, in this case, Reuters®, must be opened, the interactive map must be searched, and each ship belonging to the indicated lists must be searched for. After retrieving the corresponding code for each ship, the "TKMC" Excel is opened again, and another sheet is created with the respective location.

Another document will correspond to the "NAVIOS COMUNS" Excel, which will have the historical information of Portuguese imports and exports and Spanish exports. Here, in each of the tables, two new columns with the indication of the corresponding route and its

frequency should be created. Finally, a new Excel "Arbitragem" emerges. For this, Reuters® must be consulted again, but in this case, it is enough to open the respective Excel, create a formula that takes as inputs the historical quotation of "Used Cooking Oil (UCO)" in China and ARA, "Used Cooking Oil with Methyl Ester (UCOME)" in China and ARA, "Freight UCO CHINA - ARA," and "Freight UCOME CHINA - ARA." Next, columns with the UCOME and UCO differentials should be created using the following formulas:

$$Arbitrage\ UCOME\ =\ UCOME\ ARA\ -\ (UCOME\ CHINA\ +\ FREIGHT\ CHINA\ -\ ARA)$$

$$Arbitrage\ UCO\ =\ UCO\ ARA\ -\ (UCO\ CHINA\ +\ FREIGHT\ CHINA\ -\ ARA)$$

Later, once we have all the necessary information, we will import all the CSVs and Excel files into Microsoft Power Bi. Here, we will create 15 different dashboards in order to have all the necessary resources, as can be seen in Figure 4.

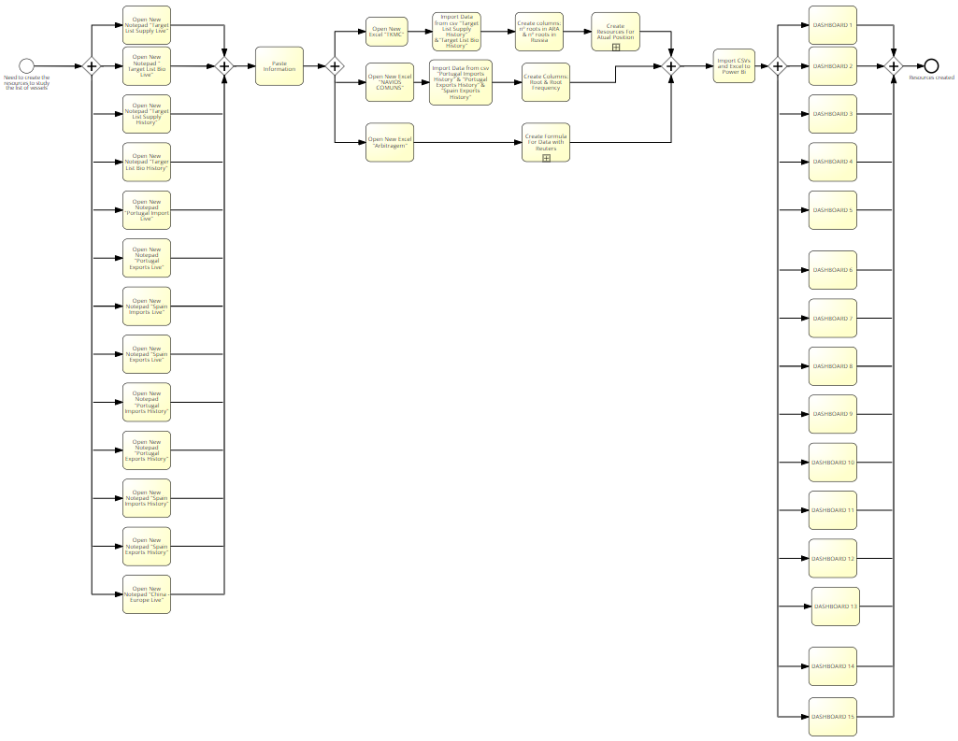


Figure 6 Create the Resources to Study Vessels List

If it is not the first time, just update the information by opening each notepad and updating the information to be later updated in Power Bi. Then, to update the data obtained from the Reuters® platform, just open the corresponding file and connect to the platform (figure 5-6).

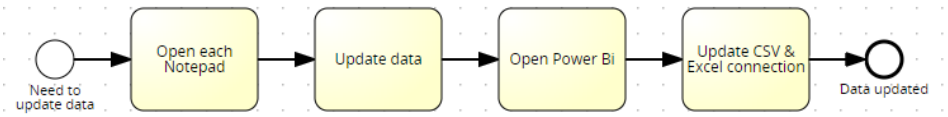


Figure 7 Update Data

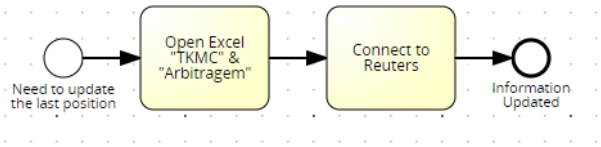


Figure 8 Update the last position

At the end of this phase, it is expected to have built a solid and reliable database that can be used to support the platform and all the functionalities derived from it. In the final phase, the "Shipping Team" actor must select the respective dashboard, either filter the time window in the "Target List Supply" and "Target List Bio" dashboards to extract which ships will be available for inter-company business or obtain information from the respective dashboards to increase knowledge of all the factors to be taken into account to make the decision. Subsequently, the negotiation phase follows, and the process ends when the decision is made (Figure 7).

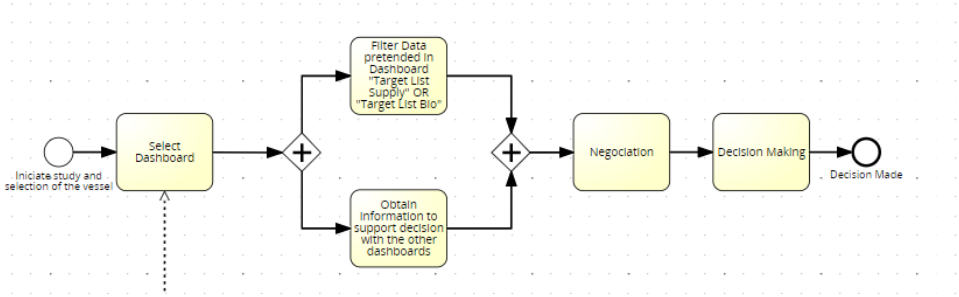


Figure 9 Study and Selection of the vessel

Note that the entire model is presented in Annex I without subdivisions for general analysis.

5.2. Objectives and Methodology Used: Trading Knowledge Management Control (TKMC) platform

5.2.1. Objectives TKMC

The TKMC framework was developed and created to cover the informational vacuum that existed in the firm regarding international marine movements. Increasing organizational knowledge and getting a competitive edge through a technology-based framework that distributes information in a simple, appealing, and succinct way are essential priorities in this age of instant information access. By offering customers an intuitive experience through a user-friendly and aesthetically pleasing interface, the TKMC framework has been created to answer this requirement and encourage users to explore and seek out more information. The clear display of the facts makes it simple to grasp and promotes the ability to make well-informed choices. Additionally, the TKMC framework piques users' interests and motivates them to look for more information so they may make wise judgments. To take advantage of market possibilities, particularly those that are uncommon or transitory, the technology-based framework piques curiosity and inspires a desire to learn more by presenting information in an engaging and intuitive way. Making strategic decisions is made possible by identifying important patterns and insights through trend analysis throughout time. The business will use TKMC to take advantage of the information at hand and achieve a competitive edge. The

organization will be better able to spot market possibilities, foresee trends, and take proactive action with greater organizational knowledge and analytical skills.

5.2.2. Methodology TKMC

Establishing a structured strategy with clearly defined procedures that would enable accomplishing the intended final result perfectly was essential to ensuring the proposal's effective realization. Five key steps have been identified to help in this process: Gap identification involved identifying the area where organizational knowledge was lacking; development of TKMC focused on complete construction and data processing for the desired output; usability testing and focus groups evaluated the solution in real-world settings and gathered feedback; and finally, the final version of TKMC, incorporating improvements. These created procedures ensured a methodical and planned approach, preventing failures and guaranteeing the proposal's successful implementation.

Figure 10 Methodology TKMC

It was essential to create a detailed plan to accomplish the suggested goal. Meeting Pedro Monteiro, the Director of Operations and Shipping, in a casual interview setting was the first step in filling up the knowledge gap. Since Pedro Monteiro is the team member in charge of dealing directly with the negotiating process for intercompany commercial transactions, this decision was made. It was feasible to comprehend the procedure for compiling a list of ships most likely to engage in intercompany transactions better during this chat. Understanding the subtleties of this procedure, including ship selection and the negotiating stage, was the aim. This information made it feasible to decide which information kinds were relevant and prioritized, as well as the best ways to deliver the information. Along with the foregoing, this interview offered insightful information on the requirements and preferences for the display of pertinent data, outlining the essential data components for making informed judgments and how they should be arranged and prioritized.

The next stage in the creation of the TKMC framework came after the interview with Pedro Monteiro: building a simple prototype. The goal was to arrange concepts and create a preliminary design for the technology-based framework, allowing the developer to test Power BI functions and investigate various customization requirements and options. An early design was formed through this iterative approach, and a graphic representation of the user interface and interactions that would be included in the technology-based framework's finished version was created. It was also feasible to determine which characteristics best matched the demands and goals of the TKMC framework. This involved developing dashboards, filters, dynamic tables, interactive charts, and interactive charts to enable users to see and evaluate the data quickly and easily.

The development phase then entailed several crucial processes to turn conceptions and ideas into reality. Prior to importing and transforming the data to create a model that is adequate, understandable, and appropriate for analysis and visualization, it is crucial to determine the relevant data sources. To give accurate and pertinent insights to technology-

based framework users, it is essential to make sure the data is clean, consistent, and well-structured. Next, several Power BI dashboards and graphic components were used to start creating the visualizations. To portray the data in an understandable and straightforward way, this entails developing charts, tables, maps, and other visual components. Users may efficiently explore and engage with the data by using the visualizations' usability, attractiveness, and interactivity, which are crucial factors. Organizing the dashboards and merging various visualizations to offer a full perspective of the data and enable deeper analysis are other tasks included in this phase. Finally, by connecting the Power BI platform to Power Automate, dynamic filters were added, and automatic alerts were set up. By adding more functionality, broadening the options for data analysis, and streamlining activities, automation helps.

It is essential to carry out usability testing and acquire user input prior to the project's final stage. Five coworkers were requested to try the technology-based framework in this situation and offer their feedback and recommendations for improvement via usability testing and a focus group. Usability testing made it possible to find potential navigational problems, problems with functional comprehension, and other user experience-related problems. Participants were given tasks to do on the technology-based framework, and they were encouraged to voice their ideas and remarks as they went. We learned a lot about the technology-based framework's usability, found areas of misunderstanding, and got suggestions to improve the design and interaction. The focus group also gave room for more in-depth conversations regarding the technology-based framework. Participants had the opportunity to explore possible options for technology-based framework development in the future, offer recommendations for improvement, and express their overall views of the technology-based framework. These talks assisted in identifying informational gaps or needs that may be filled in by future technology-based framework iterations. The focus group and usability testing input and improvement suggestions were crucial in shaping the project's outcome.

The focus group and usability testing input and enhancement suggestions were analyzed before the TKMC framework's final version could be developed. This phase saw the completion of all specified changes, ensuring that the technology-based framework was user-friendly and up to snuff. The changes made mostly concentrated on font size alterations and information retrieval in particular situations. These changes seek to improve the technology-based framework's efficiency and usability while also improving the user experience. The technology-based framework's final iteration was also created with the idea of future work in mind. To expand the amount of information transmitted through the technology-based framework, preparations and considerations were made for the project's continuance. Strategies were established to include new data, enhance current features, and deliver even more thorough and pertinent insights based on the ideas and needs indicated by the collaborators. The technology-based framework's final version is the result of an iterative development process in which user input was important to ongoing evolution and enhancement.

Finding the ideal prospects for a business agreement can be challenging because it is sometimes difficult to find reliable and current information about these ships. It is helpful to have access to tools and resources that allow the collection and analysis of data about the concerned ships to get over these challenges. One such tool is the Vortexa® platform, which offers up-to-date details on ship movements throughout the globe, including information on destinations, sources, cargoes, and much more. To analyze economic, political, and financial facts that may have an impact on ship movement and, subsequently, inter-company

transactions, the Reuters® platform is a significant resource. Moreover, Reuters® will be employed in this scenario to give real-time position data for the chosen ships.

Key questions about the ships, such as "When will they be available for business?" "Where are they currently located?" "How often do they visit the ARA region?" and "Where have they been recently?" can be addressed by building a specific dashboard for the Target List based on this information and data. The Shipping Team can swiftly choose the best ships for their operations thanks to this knowledge, saving them both time and money. This strategy can also lessen the possibility of fruitless talks or delays in the negotiating process.

Therefore, the goal was to create an interactive technology-based framework that suited the age of instantaneous information; therefore, all additional data was processed to enable speedy, visual conclusion-drawing. Dashboards were introduced to support and promote the decision to charter a ship in addition to giving information contained and addressed for the Target Lists. The ability to swiftly recognize singular situations, special highlights, and pathways with low frequency is another area of significant interest. Therefore, all information was processed to make it possible to reply to each of these circumstances in a dramatic and aesthetically appealing dashboard. Given the market in which Prio excels, these scenarios specifically include routes with a frequency of one, routes connected to biodiesel goods, and, in addition to these points, constantly being able to compare numbers for the current year with the prior year.

Because Prio is a trusted name in the Iberian market for fuels and energy, it was chosen to incorporate dashboards for Portugal and Spain. The technology-based framework must thus for a more in-depth study of the data pertaining to these nations so that better decisions may be made. The fuels and energy markets in Portugal and Spain have several unique characteristics and difficulties that must be considered, including the substantial influence on the supply and demand of goods in each nation as well as other elements like infrastructure and market rivalry. The technology-based framework allows for a deeper analysis of these markets by including dashboards specifically for Portugal and Spain. This enables a more customized and informed decision-making process regarding issues like the supply and demand of fuels and energy, market competition, and pertinent governmental policies, with information arranged to suit the specificities of these countries. For these cases, the dashboards had the names "LIVE PTARRIVAL," "LIVE PT DEPARTURE," "PT IMPORT," "PT EXPORT," "SPAIN IMPORT," "SPAIN IMPORT BIOS," and "SPAIN EXPORT." One of the features of the built interactive technology-based framework is the dashboard for the case of imports of biofuel in Spain. A dashboard specifically designed for this sector will enable Prio to keep a close eye on biofuel shipments into Spain and immediately spot lucrative possibilities and unusual situations. The business may manage its fleet more effectively and quickly with the use of thorough and aesthetically pleasing data by selecting routes based on accurate and up-to-date information. By doing this, Prio can differentiate itself in a cutthroat market and keep its reputation as a cutting-edge business in the biofuels industry. Finally, a dashboard specifically designed for that situation named "TRANSITO CHINA - EUROPA" was established since China is a market for biofuels that is quite competitive. With this comprehensive and eye-catching data, Prio can manage its fleet with knowledge and agility, picking routes based on accurate and current data and instantly seeing commercial possibilities and unusual instances. Additionally, the dashboards make it simple to compare current numbers to those from the prior year, allowing the business to assess its performance and make the required corrections to maximize its performance in the biofuels market.

Making significant decisions early on is essential when creating a new technology-based framework, including selecting the software that will be used. The technology-based framework's functioning, design, and user experience may be significantly impacted by this

choice. It was required to choose between using Power BI or Microsoft Power Apps to construct the new technology-based framework in question.

Since it can read text boxes and the information typed in them, Microsoft Power Apps was first picked. However, the technology-based framework was finally created in Power BI after carefully weighing the available choices.

Power BI was selected in large part because to its agility, adaptability, and intuitiveness with relation to design and user experience. Power BI seems to be more adaptable and able to meet a wider range of needs when compared to Power Apps.

The benefits and drawbacks of both choices were examined in a meeting with market analyst Alexandre Cruz while considering the potential and long-term goals of the technology-based framework. To reconcile present demands with potential future expectations and opportunities—which might include brand-new features and functions as well as various design and user experience requirements—this was important.

Power BI, which is extremely customizable and can relate to other data analysis tools like Excel, is better suited for data analysis and report development. Users can easily access the information since it is arranged into dashboards, making it easy to view what they need. Due to the dashboards' extensive customization options, customers may design customized representations to suit their requirements. It provides a wide range of data visualizations, such as graphs, tables, maps, and more, enabling users to design unique representations that meet their unique requirements and objectives.

However, Microsoft Power Apps have fewer visualization possibilities, which can restrict the technology-based framework's adaptability and customizability. It is also feasible to create the technology-based framework using a mobile strategy, even though that is not its primary goal, so that when a need to utilize it on a mobile device occurs, it is modified appropriately rather than in online format. Microsoft Power Apps' capability is more heavily geared toward workflow creation, which might not be as useful for technology-based frameworks that want to offer analysis and reporting.

Note that no sort of text box was thought to be essential for the technology-based framework's ultimate output throughout the brainstorming process. As a result, Power BI was selected due to the developer's higher expertise and workflow simplicity. The decision was made that Power BI would be the technology-based framework's future at this first stage, even though Microsoft Power Apps had several benefits, such as the capacity to read text boxes and values. It is important to keep in mind, nevertheless, that the selection of software may be highly influenced by the unique requirements of each project. For instance, Microsoft Power Apps can be the best option if the only thing being developed is a mobile application.

This choice made it possible to create a flexible, adaptable, and user-friendly technology-based framework that could cater to users' demands for design and data analysis. To satisfy certain goals and requirements, each project may call for a distinct software solution, thus it's crucial to keep this in mind.

The methods that were utilized to develop the TKMC platform will be further explained in the following sections. These explanations are meant to provide a thorough understanding of every stage of the procedure, from gathering requirements to creating the platform's final version. The platform's final version will also be covered in detail, along with information on the design of the data structure, data preparation, creation of visualizations and dashboards, application of sophisticated features and integrations, usability testing, and feedback collection.

5.2.3. Knowledge Acquisition and Interview Insights

Making a Target List is crucial for operations management decision-making, such as when loading and unloading ships at the Port of Aveiro or catering to the unique demands of Prio Supply and Prio Bio charterers. To guarantee that the information about the ships is true and practical, this list should be restricted to a group of ships that satisfy the standards of the port and charterers.

It will be possible to identify better business prospects for the charterers and ensure a solid information base on the movements of the ships by filtering the information and the time range. To guarantee that loading and unloading are completed effectively, safely, on schedule, and in accordance with all applicable safety standards and laws, this is essential.

Pedro Monteiro, Director of Shipping and Operations, was questioned to get this information and to better comprehend the situation. The purpose of this interview was to glean insightful information from his specialist knowledge and thorough understanding of logistics and transportation processes.

In addition, Pedro Monteiro indicated that “the Target List must be continuously revised in light of fresh details on the ships and port operations as well as the requirements of the charterers”. To guarantee that the list is consistently updated and that port operations are carried out effectively and securely, cooperation between the Port of Aveiro, charterers, and brokers is essential.

It should be noted that the role of the last party—the broker—is to act as a go-between for shipowners and charterers. The Director of Shipping and Operations told that “brokers are specialist individuals who work in the marine transport industry and they have access to confidential market data, including shipping routes, prices, and vessel availability”, which they may use to help with decision-making in the port management and ship loading and unloading operations. Their major job is to assist both shipowners and charterers in finding suitable boats that suit their demands and financial constraints. In addition, brokers can represent their customers in contract negotiations and pricing negotiations, and they can offer knowledgeable guidance on marine transportation-related concerns. Brokers are essential actors in the shipping industry as a result.

The selection of boats for the list of probable candidates for Prio Supply and Prio Bio is closely related to the restrictions of the Port of Aveiro, as was already indicated. These primarily determine the physical composition of the vessel and the kind of cargo it can carry. The optimum quantity to be received in the case of Prio Supply, which can accept the maximum permitted, will be established by the restrictions of the Port of Aveiro. The cargo capacity for Prio Bio, on the other hand, is typically lower than the maximum capacity permitted by the port due to the volume of business. The vessel's history, including its effectiveness and safety, as well as its availability over the necessary period, should also be considered. Finally, it is critical to note that there may be exceptions to port restrictions; however, they must be examined individually, in collaboration with port authorities, to ensure that the security and effectiveness of port operations are not jeopardized. Finally, Pedro Monteiro added that “to guarantee safe, effective, and value-added port operations, vessel selection should be done carefully while taking the port's constraints and charterers' demands into account”.

5.2.4. Examining the Initial Prototype's Possibility and Functionality

A prototype for the TKMC framework was created when the information gap was located, and its breadth was comprehended. The necessity for an initial menu to access various material was identified in the prototype. The hexadecimal code for the Prio logo (0,128,149) was also used to define a base design that uses shadow effects on visuals, a white background without transparency, a light gray color as the background for each dashboard page, and a highlighted title with a blue shadow. The first menu had sections for the Target List, Spanish, Portuguese, and arbitral motions, as well as an additional information area. A visual aerial view map displaying the nations of origin of Portuguese imports was added throughout the menu in addition to these sections. With the aid of this map, the users can quickly locate nations of interest and get a geographical overview of trade flows. The prototype's design and layout decisions were designed to provide a pleasing visual experience and make it easier to navigate the technology-based framework's various content. The technology-based framework is more appealing and user-friendly for users because to the consistent design and distinctive visual features, which also help to define the TKMC's visual brand.

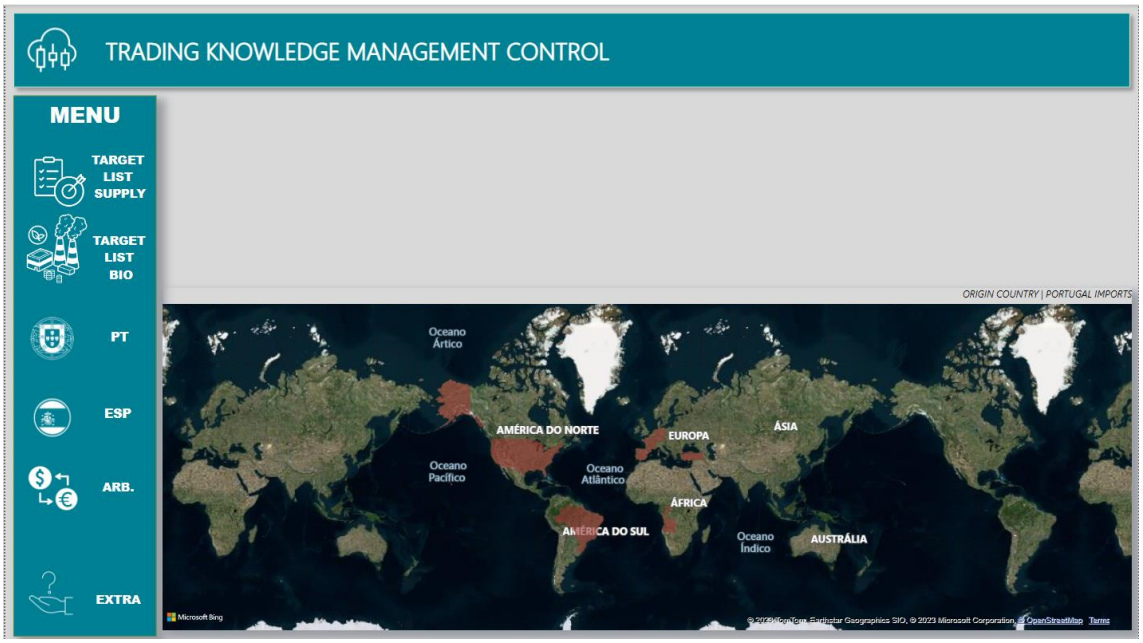


Figure 11 Prototype Main Page

Two dashboards were created in addition to the basic menu for Spanish imports and Portuguese transit movements. There were seven images on the dashboard for Portuguese transit movements:

- A graphic map showing the red-hued paths that were found.
- A vertical bar graph containing information on the product and amount imported showing the volume of product arrivals over the course of the current week.
- Two horizontal bar charts showing amounts related with the destination ports (in this example, just Portuguese ports) and quantities associated with the origin nations in descending order.
- A pie chart illustrating the imported goods.
- Two instructive cards, the top one displaying the overall volume related to the instance being investigated, for as when a variable is filtered to investigate movements in crude oil imports, and the below card displaying the overall number of imports for that week, unaffected by any filtering. The lower card stays in place.

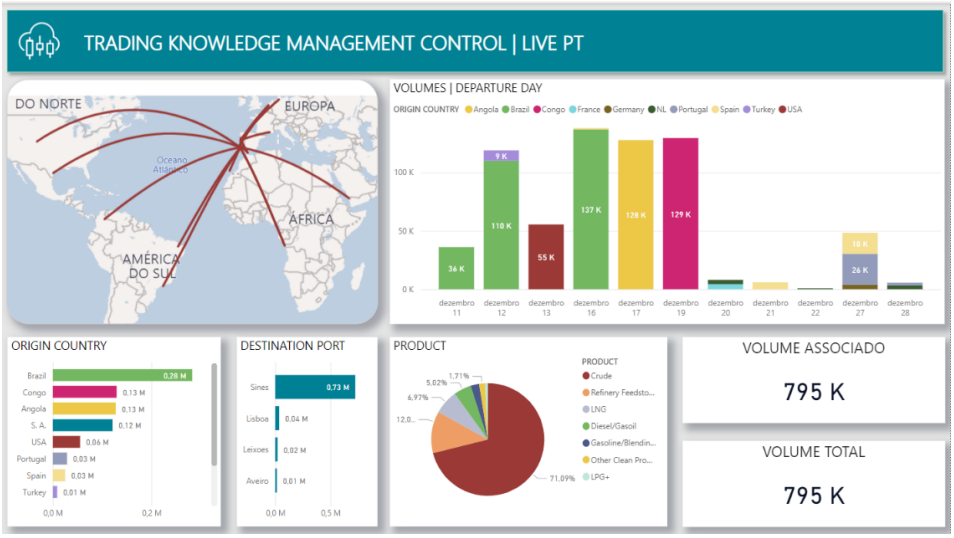


Figure 12 Prototype Live PT Dashboard

Finally, a dashboard for Spanish imports was developed. In this instance, the dashboard has seven graphics total:

- Two aerial view visual maps with yellow bubbles denoting the destinations that are scaled to the corresponding values. The name of the relevant nation is displayed in the upper-left corner. The other map has the same style, but the destination ports are represented by red bubbles
- A yellow horizontal bar chart showing the total quantities associated with the countries of origin and a red horizontal bar chart showing the total quantities associated with the destination ports are two horizontal bar charts that show the quantities associated with the same information that is shown in the maps.
- Two educational cards that individually show the year-to-date totals for 2022 and 2023. The 2023 card also has a color-coded function that changes from red to green depending on whether the year-to-date amount for 2023 has surpassed that of 2022.
- Finally, there is a vertical bar chart showing the temporal distribution of imported biodiesel cargoes to Spain from January 2022 to May 2023, together with the product type and related monthly volumes.

Figure 13 Prototype Spain Movements Dashboard

The prototype was modified, including the inclusion of new information, after discussions about the intended interface, strategy, and information arrangement. The basic layout, which included the opening menu and the title on each dashboard, was mainly kept and just slightly altered. However, in order to give a smoother and more aesthetically pleasant experience, the aerial view map was changed to grayscale tones. The emphasis on biodiesel imports and the chronological representation of Portuguese arrivals were left alone, but the inclusion of a chart showing Portuguese transit movements' destination ports was reexamined because there haven't been any notable changes to the situation recently. However, the Spanish movements were.

5.2.5. Trading Knowledge Management Control | Development

In this topic, we looked at the developed dashboards and the full data processing procedure needed to construct a framework that is technology-based. This framework's goal is to make it possible to quickly extract data and insights and to sign up for alerts for circumstances. The dashboards are control panels that are visually intuitive and made to present information in a clear and straightforward way. The steps in the data processing process were gathering, cleaning, transforming, and integrating the data. The relational model shown in Annex II reflects all relevant relationships, offering consistency and a full perspective of the data.

5.2.5.1. Menu

A menu that incorporates all these options and so offers users a quick and simple navigation experience has been built with the goal of enhancing the organization, division, development, and search time of dashboards. Through buttons connected with each of the five areas of this menu—Target List Supply, Target List Bio, Portuguese Movements, Spanish Movements, and Extra Information—users are intended to be directed to pertinent dashboards. Along with the unique buttons for each dashboard, a map highlighting the nations Portugal imports from has been added to the main menu. This is a desirable and practical substitute for immediately giving consumers information that is both pertinent and aesthetically appealing. With the primary goal of assisting users in better understanding market trends and spotting potential business possibilities, the map was developed to give a broad picture of Portuguese import activity. The focus on nations that export to Portugal might also be particularly intriguing since it offers a clear picture of the commercial ties between Portugal and other nations, which encourages company development. Finally, using a map as a visual element in the technology-based framework's main menu is a successful technique to grab customers' attention and offer helpful information in a clear and simple manner. The tool offers insightful information straight away by emphasizing the nations that export to Portugal, enabling additional hypotheses to be examined with the goal of making better judgments.

Figure 14 TKMC Main Menu

Figure 15 TKMC Sub Menu

Based on their relative importance to the technology-based framework and status as one of its key goals, the Target List Supply and Target List Bio portions were separated. Users are taken to a new page after choosing the Portuguese or Spanish Movements buttons, where they can select between Live Movements and Historical Movements. In both cases, this directs them to the respective dashboard.

Figure 16 TKMC Type Movements Sub Menu

The technology-based framework in question benefits from having a primary menu since it enables users to easily access the dashboards they want and learn how to utilize the technology-based framework. It is also simpler to access pertinent data and less frustrating for users to deal with it when there are unique buttons for each dashboard, such as Target List Supply and Target List Bio. This also helps users learn how to navigate the site naturally. As a result, the dashboard menu is a crucial tool for technology-based framework optimization, improving the technology-based framework's effectiveness and user-friendliness. Users have a powerful tool to enhance the organization, division, development, and search time of dashboards by adopting the menu in the technology-based framework, leading to a smoother and more user-friendly navigation experience.

5.2.5.2. Target List | Supply & Bio

As previously mentioned, the Target List, whether from Prio Supply or Prio Bio, includes the ideal vessels, considering the limitations of the Port of Aveiro, as well as meeting the specific needs of the charterers Prio Supply and Prio Bio.

Therefore, the dashboards associated with the Target Lists have the main objective of identifying the availability of vessels for negotiation, providing information on their current location, recent voyages, and the number of voyages in the ARA and Russia regions.

Firstly, it was necessary to separate the content in the "Map_Ballast" table that included arrival dates and destinations from the content that did not have this information, to distinguish between vessels in ballast and vessels in transit. After this separation, the information that had both destination and arrival date was added to the "IN TRANSIT_DISCHARGING_TARGETLISTSUPPLY" table.

To achieve this objective, it was necessary to create a Calendar table that was used throughout the development of the technology-based framework, not only for the dashboards associated with the Target List.

The creation of the Calendar table allowed for a visual data segmentation, in which the desired date limit for the trading window could be selected. The formula used for this purpose is provided below, with the decision made to identify the earliest historical date as the limit, while the final date remains automatic to avoid update issues and the need for modification, for example, when transitioning to a new year:

$$CALENDÁRIO = CALENDAR(DATE(2022{,}01{,}01), DATE(YEAR(TODAY(\ \ )), 12{,}31))$$

Therefore, a data segmentation visual was implemented to select the maximum date for the negotiation phase of the inter-company business.

To achieve the objective of providing the available days upon selecting a date, it was necessary to define the interpretation of when a vessel is considered available. For this purpose, a new column called "FIRST AVAILABILITY" was created, which adds one day to the vessel's arrival date, as it is only available from that day onwards. Thus, a new column was created using the following formula:

$$PRIMEIRA\ DISPONIBILIDADE = Date.AddDays\ ([DESTINATION\ ETA], 1)$$

After creating the "FIRST AVAILABILITY" column, another visual element was added, in this case, a table, and the data for "Vessel Name" and "FIRST AVAILABILITY" were included. A filter was applied to ensure that the "DESTINATION ETA" is not equal to zero, to exclude cases where the arrival date is not yet available.

Separating vessels in transit from those in ballast into different tables is an important practice for efficient and organized management of maritime transportation. While vessels in transit are loaded with cargo and actively sailing, vessels in ballast are empty, without cargo on board, usually returning to their place of origin or searching for new cargoes. By separating these two categories of vessels into distinct tables, it is possible to obtain specific information about each group, which facilitates logistics planning, enables better resource allocation, and avoids unnecessary delays in commodity movements. Additionally, separating them into different tables allows for more accurate data analysis, which can lead to valuable insights for optimizing the efficiency and profitability of maritime operations.

Furthermore, vessels in ballast that do not have a destination or arrival date do not depend on the filtered negotiation window. Hence, another table was created with data for "Vessel Name," "Capacity (cbm)," and "Latest Product," without any filters, derived from the base table created after the earlier mentioned data separation.

To provide additional information to support decision-making regarding the selection of vessel(s) for the negotiation phase, a table indicating the vessels' recent voyages was added. For this purpose, the following data was included: "PRIMARY VESSEL NAME," "ORIGIN COUNTRY," "DESTINATION COUNTRY," and "ARRIVAL DATE."

The ARA region is one of the busiest and strategically located areas in Europe, with the ports of Amsterdam, Rotterdam, and Antwerp playing a crucial role in global trade. These ports serve as major entry and exit points for a variety of goods, spanning multiple industrial sectors. Understanding the number of routes in the ARA region allows companies and logistics operators to comprehend the extent of connectivity and available options for cargo movement in the region, which is crucial for efficient route planning, resource allocation, and optimization of goods flow. Additionally, understanding the routes in the ARA region enables the identification of business opportunities, such as detecting growing markets, diversifying portfolios, and analyzing competition.

Political situations and international sanctions can impact maritime routes and trade, as is the case with Russia. It is important to consider these factors when analyzing maritime routes in the region. Sanctions can affect commercial activities and influence logistical decisions, including maritime transportation. In the context of the war with Ukraine and the sanctions imposed by the European Union, closely monitoring changes in maritime routes and understanding the impact of these events on international trade is crucial. Restrictions and bans imposed on commercial activities can affect transportation options and the availability of specific routes. Therefore, to obtain this information, a horizontal bar chart was included, identifying the number of voyages in the ARA and Russia zones, highlighted in yellow and red, respectively. Note that a new column with a particular formula had to be added to be included in the filter bar so that the appropriate and available ships would show up in this graph when the correct time frame was entered. The 'is not blank' filter option was utilized with the following formula, which was entered there.

DD = CALCULATE(FIRSTNONBLANK('IN TRANSIT_DISCHARGING_TARGETLISTBIO'[PRIMEIRA DISPONIBILIDADE BIO],1),FILTER(ALL('IN TRANSIT_DISCHARGING_TARGETLISTBIO'),'IN TRANSIT_DISCHARGING_TARGETLISTBIO'[IMO]=HISTORICO_TARGETBIO2[PRIMARY VESSEL IMO]))

To track the current position of the vessel, a map was added, indicating its current location, with the size of the bubbles being proportional. Unlike all the information presented so far, this data is collected through the Reuters® technology-based framework, as explained in the process explanation.

Subsequently, in addition to the necessary actions to place the indicated visuals in their respective dashboards, the next step was to create relationships between them to make the dashboard interactive.

Therefore, based on the Calendar table, a one-to-many ("1 - *") relationship was established between all the tables involved, connecting the Date column in the Calendar table with the Arrival Date columns in the remaining tables ("IN TRANSIT_DISCHARGING_TARGETLISTSUPLLY"; "HISTORICO_TARGET1"), as a date in the Calendar table can appear multiple times in the other tables. Additionally, the "IN TRANSIT_DISCHARGING_TARGETLISTSUPLLY" table was also connected to the "ACTUAL_POSITION" table in a many-to-many ("* - *") relationship since there are many available vessels, each with a location. Finally, to link live movements with historical movements, the "IMO" column in the "IN TRANSIT_DISCHARGING_TARGETLISTSUPLLY" table was connected to the "PRIMARY VESSEL IMO" column in the "HISTORICO_TARGET1" table in a many-to-many ("* - *") relationship, as multiple records in one table are related to multiple records in the other table.

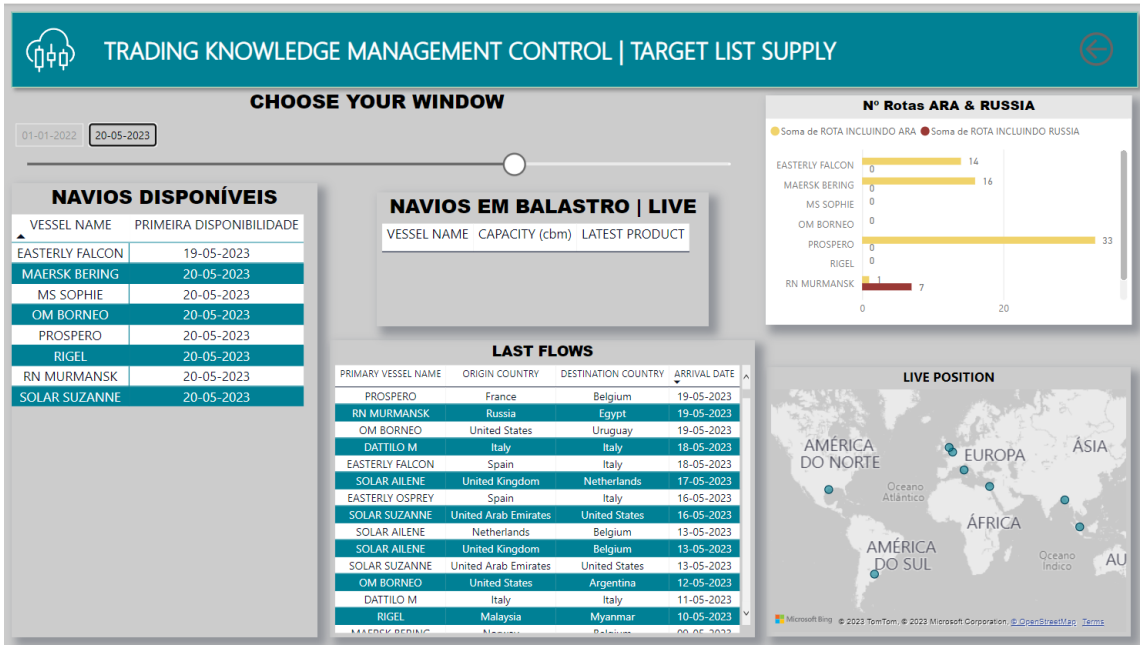


Figure 17 TKMC Target List Supply

In this way, the obtained output will be as follows:

Firstly, the users need to select the deadline for negotiation. In the "Available Vessels" table, the vessels with an arrival date before the specified date will appear. In the "Ballast Vessels | Live" table and the "ARA & RUSSIA Route Count" table, the filtered set of vessels with their respective number of routes in ARA and Russia will also be displayed.
Subsequently, in the table indicating the available vessels and their first availability, if a vessel from that list is selected, only the latest trips of that vessel will appear in the "Latest Movements" table, and the current location will be specific to that vessel.

Here's an example to reinforce the statements:

For the date May 19th, there were 8 available vessels, and in addition, no vessels in ballast. Among the 8 available vessels, let's focus on the vessel "MAERSK BELFAST." It was found that one of its recent routes had originated from Norway and had a destination in Belgium, with an arrival date of May 9th, 2023. As of the extraction date of the information, this vessel was located near United Kingdom. Additionally, it has 16 routes in the ARA region and 0 routes in Russia. The connections created during data processing are shown in the graphic below, making it possible to view all the aforementioned information and make it easily retrievable.

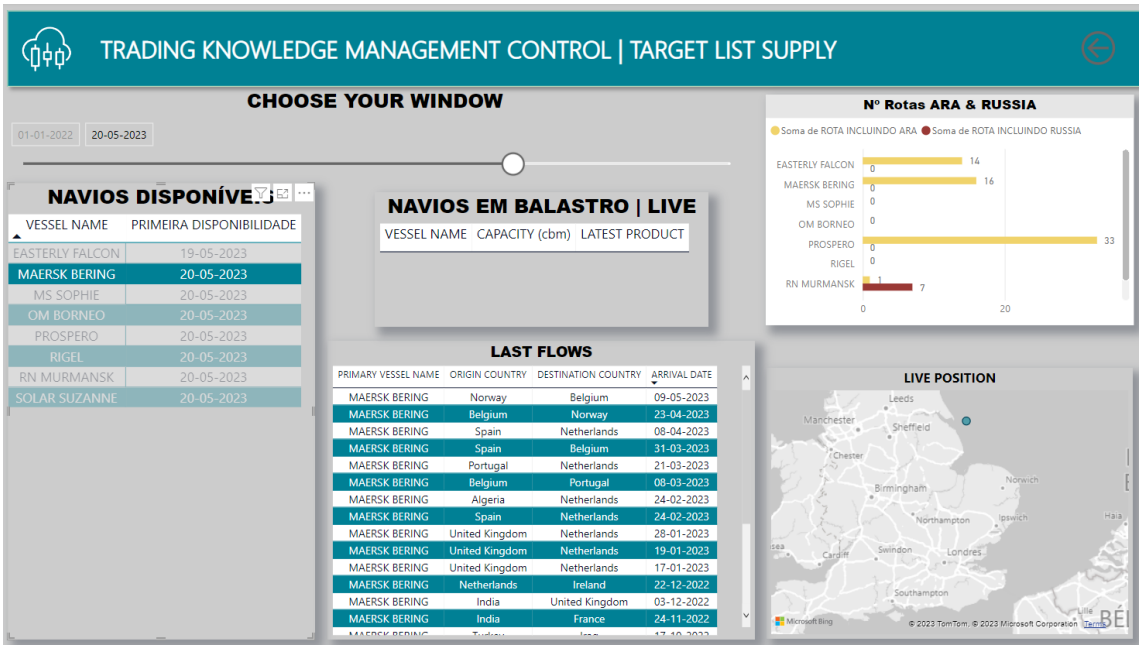


Figure 18 TKMC Target List Bio

5.2.5.3. Portugal Case

Four dashboards have been developed to monitor Portugal's transit and historical routes since 2022. These dashboards provide detailed information about associated movements and can map the latest market trends as well as highlighting rare occurrences. With this information at hand, users can make informed decisions on how to optimize their businesses and ensure they stay one step ahead of the competition.

In the initial menu, there is a button specifically dedicated to Portugal-related cases. By selecting this button, users can choose between two options: Live Movements or Historical Movements, and then further specify whether they are interested in arrivals or departures.

5.2.5.3.1. Live

International trade, the logistics of moving commodities, and a nation's economic progress all rely heavily on maritime routes. For a variety of stakeholders, including shipowners, marine transport firms, port authorities, and importers and exporters, understanding the movements of maritime channels is crucial. Current details on vessels in transit, port calls, itineraries, and projected arrival times may be found by monitoring the movements of maritime routes. This knowledge is useful for logistical planning because it enables businesses to plan their operations appropriately, make the most use of their resources, and avoid unnecessary delays. This monitoring also enables port authorities and marine security organizations to spot possible safety or environmental problems and guarantee adherence to maritime legislation.

Users may follow the most recent market trends and changes by accessing information about real-time transit activities to Portugal in the Live Movement - Arrivals to Portugal dashboard. Users may observe real-time information on product arrivals in Portugal by choosing the Live Movement - Arrivals to Portugal option. The dashboard gives granular information on the sorts of imported goods, their countries of origin, arrival quantities, and their final destinations.

The dashboard displays significant trends and patterns in Portugal's commercial arrivals using simple charts and visuals. Users may locate the industries with the highest levels of activity, the leading nations of product origin, seasonal fluctuations, and other pertinent indicators. The dashboard also displays noteworthy, unique, or rare commercial arrivals. This may include noteworthy occurrences like substantial product shipments, significant shifts in the sources or quantities of imports, or any other information deemed pertinent and helpful to users.

Users may maximize their enterprises by making well-informed decisions based on this information. They can see market possibilities, foresee changes in consumer demand for certain goods, modify company plans, and make sure they stay one step ahead of the competition. The dashboard has been created with a new graphic named "Gantt Chart By MAQ Software" to satisfy the necessary highlights and offer a chronological perspective of movements in Portugal. The developer selected this visualization from a range of alternatives because it effectively and succinctly conveys the pertinent information. “ORIGIN COUNTRY" has been selected as the category in this graphic, and it is automatically presented on the chart's left side. The word "PRODUCT" is used in the legend to indicate the related items. The data is filtered to only include movements with departure ("DEPARTURE DATE") and arrival ("ARRIVAL DATE") dates within the chosen range to delimit the time.

The "PRIMARY VESSEL NAME" connected to the route has been included as an additional feature in the form of a Tooltip, in addition to the fundamental data. Each horizontal bar in the Gantt Chart therefore reflects the length of the journey, the item being transported, and its place of origin. It's vital to emphasize that the temporal placement is also provided, allowing users to quickly determine where each action is situated within the specified timeframe.

Three horizontal bar charts have been added to the Gantt Chart to show the quantity related to each nation of origin. These graphs are intended to offer a structured perspective

that is arranged by quantities related to various product groupings. The items have been grouped into three sections for easier organization:

1. Crude, VGO, and Fuel Oil (Dirty Petroleum Products - DPP)

2. Biodiesel, Gasoline, Diesel/Gasoil, and Other Clean Products (Clean Petroleum Products - CPP)

3. LNG and LPG+ (Gas)

A more detailed and segmented study of each type of product is possible thanks to this division into three sections. It makes it easier to compare the nations of origin of each product category directly. In order to prevent information overload, it draws users' attention to the most pertinent information for each category. It enables users to concentrate on information that is crucial to their field of interest or expertise. The dashboard gives viewers a thorough and in-depth perspective of the movements in Portugal using this mix of visual data, emphasizing the timeline of movements, goods, sources, and associated amounts. This makes it possible to conduct fruitful analysis and make wise decisions.

To make the dashboard more practical and user-friendly, more visual components have been included in addition to the previously described visualization.

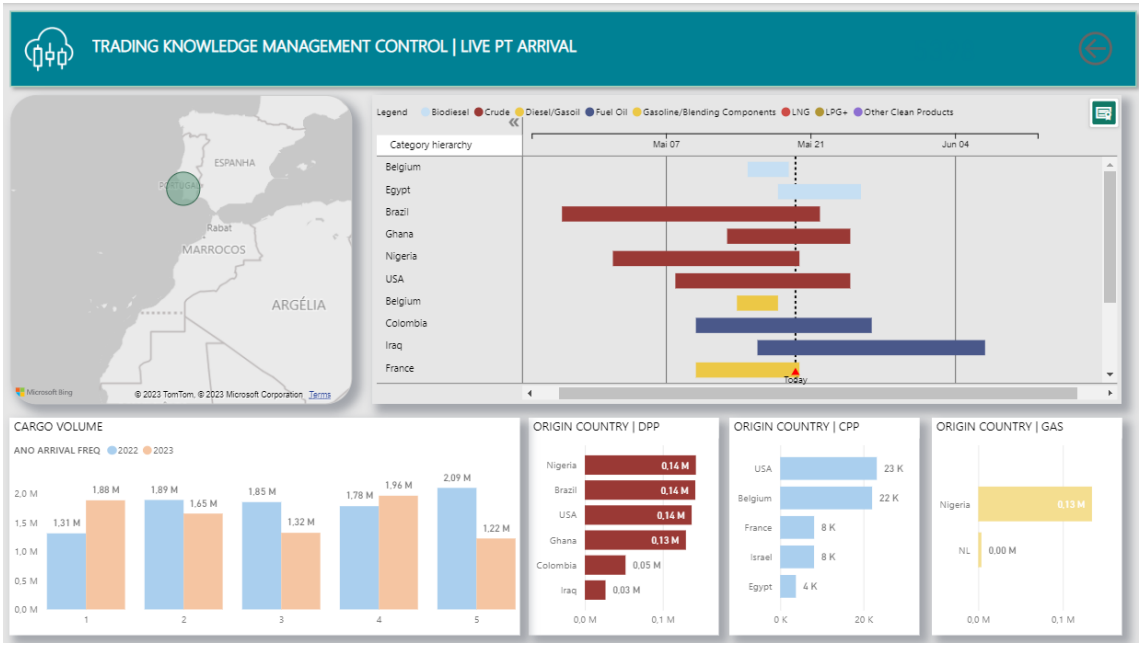


Figure 19 TKMC Portugal Live Arrival Movements

A map showing the movement's destination ports was one of the enhancements. The size of each country's bubble on this map corresponds to the total amount that country is represented by. This geographic depiction makes it simple and quick to comprehend where items come from and how much is involved in each nation. It enables users to compare various geographic locations and visually identify nations with larger quantities of migrations.

A map showing the movement's destination ports was one of the enhancements. The size of each country's bubble on this map corresponds to the total amount that country is

represented by. This geographic depiction makes it simple and quick to comprehend where items come from and how much is involved in each nation. It enables users to compare various geographic locations and visually identify nations with larger quantities of migrations.

Additionally, the technology-based framework employed a consistent color scheme, which is notably apparent in the charts comparing the monthly quantities between 2022 and 2023, where light blue relates to 2022 and bright orange with 2023. The technology-based framework's standardized color scheme makes it easier to distinguish between various years visually and helps users grasp the information given. This allows users to see trends or changes in the data quickly, which improves understanding of the studies conducted.

It was essential to add a column named "MONTH AUX" and a separate hierarchy for month and year to the "Calendar" table to guarantee that the chart includes the current month for both the 2022 and 2023 data.

The "MONTH AUX" column formula will be utilized as a filter in the aforementioned picture. The filter that is now being used, "MONTH AUX" = 0, makes sure that the month that is displayed is always equal to or earlier than the current month. This ensures that consumers only view data from the most recent month, giving them a current and useful perspective on time.

With the intention of sorting the bar chart's depiction first by month and subsequently by year, the hierarchy for month and year was included. The identification of the current month and the viewing of the associated values for the years 2022 and 2023 are made easier by this ordering. The following formulae were used to develop this hierarchy:

$$Mes = MONTH('CALENDÁRIO'[DATE])$$

$$Ano = YEAR('CALENDÁRIO'[DATE])$$

These extra elements, such the map with country names and the vertical bar chart for monthly quantities, improve the user experience and provide the data a more thorough and aesthetically pleasing explanation. This dashboard turns into a helpful tool for customers to track commercial operations in transit and make educated decisions about their enterprises in Portugal thanks to a straightforward design and strong visual components. The next stage was to establish the required connections to make the dashboard interactive after the associated dashboards had the correct graphics implemented. In this instance, links between the included tables and the "CALENDRIO" table have to be established. Two tables were present, each with a distinct function. The first table details incoming motions, while the second table provides pertinent prior information for the given image.

Common fields, which in this instance, like the previous ones, was the Date field in both databases, were probably discovered to construct links between these tables and the "CALENDRIO" table. By creating these connections, the data from various tables could be meaningfully connected and correlated, allowing dashboard users to interact with the visuals more thoroughly and explore the data in greater detail, allowing them to analyze the data in a more dynamic and personalized way.

When gathering data in the illustrated case:

In this instance, it is evident that four ships are delivering crude oil to Portugal. For instance, the ship "ARCHANGEL" travels with 130,000 tons of crude oil from Ghana to Sines. From a volume standpoint, the whole value gained in 2022 was eclipsed in the months of

January and April, and by the month of May, more than half of the value for 2022 had already been reached.

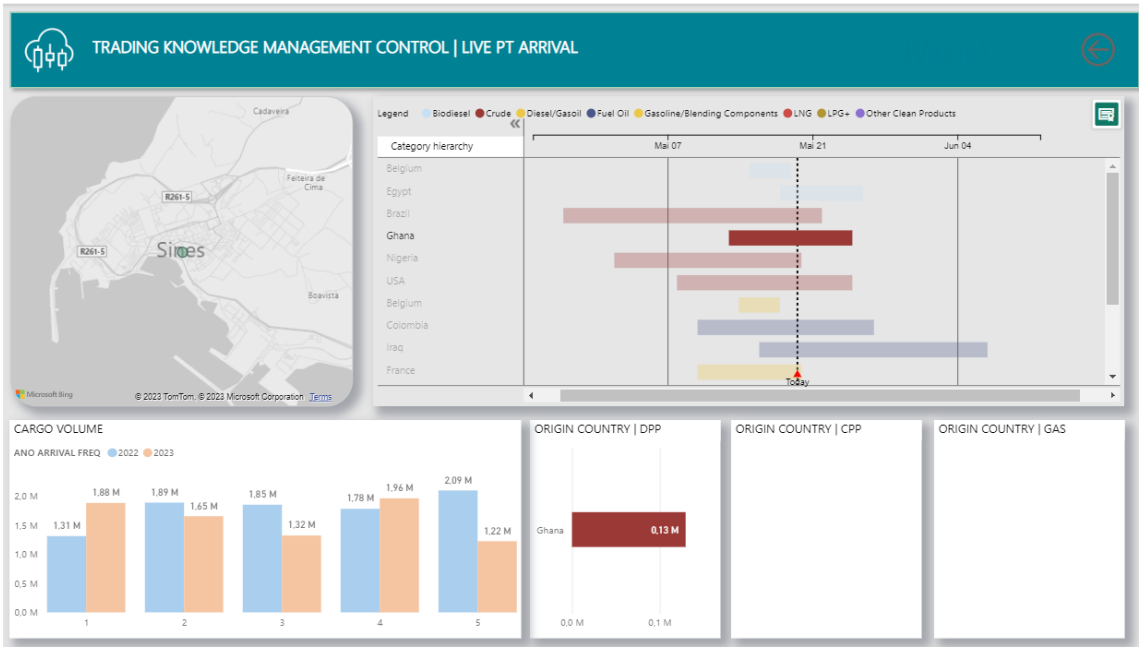


Figure 20 TKMC Portugal Live Arrival Movements - Example

There are certain parallels and changes between the Portugal departures dashboard's design and data processing compared to the arrival's dashboard. Regarding the similarities, some of the factors employed in the design and data processing of both dashboards are the same. For instance, both dashboards used the "DEPARTURE DATE" and "ARRIVAL DATE" data for the timeline display. This uniformity in the use of comparable variables encourages comprehension and comparison of the Portuguese departure and arrival movements. However, there are also obvious variations in how the two dashboards handle data. For example, the "DESTINATION COUNTRY" data was used in the departure's dashboard of the timeline graphic in place of the "ORIGIN COUNTRY" field. Since Portugal is always the origin country in this scenario, the distinction shows the necessity to emphasize the destinations for departures.

The fact that Portugal does not export crude oil means that this information is not pertinent for the departure's dashboard, which is another significant distinction to note. The nations receiving the biomass-derived products (BIOS) became the focus instead. This modification to the data reflects the nature of Portuguese exports and the significance of providing users of dashboards with accurate and useful information.

It may be deduced that there are 4 ships bringing Diesel/Gasoil from Portugal in the scenario provided during the information extraction. For instance, the ship "MAERSK AEGEAN" is traveling from Sines to France over a certain path. Similar to the conclusion made for arrivals in Portugal, the broad view on volumes shows that the months of January and April have individually surpassed the total value attained in 2022. Half of the value from 2022 will not have been attained by May.

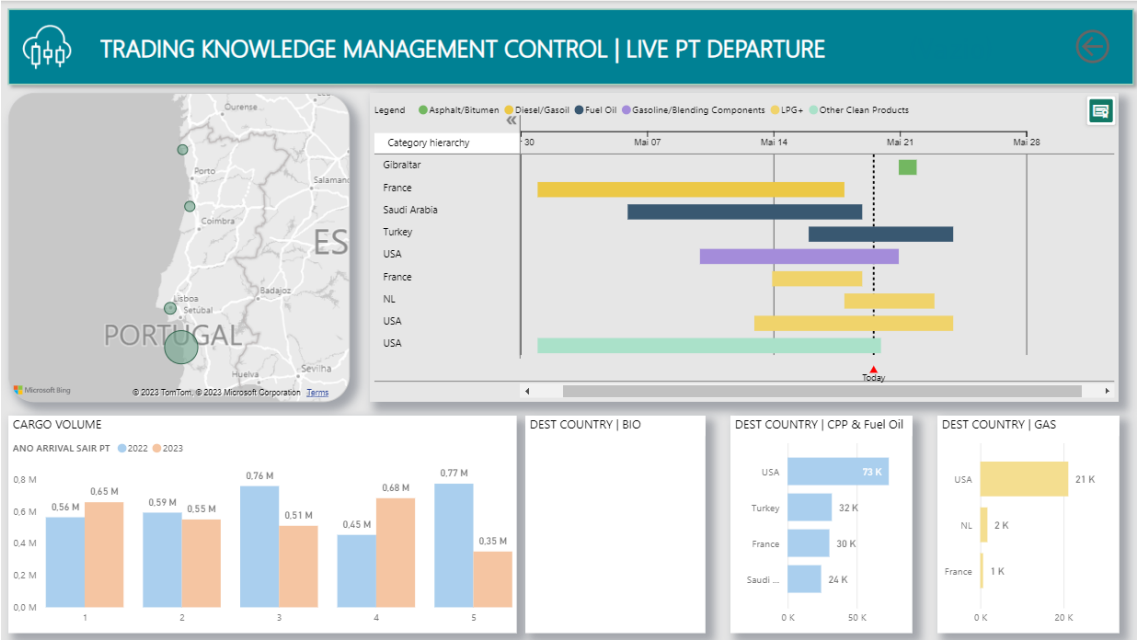


Figure 21 TKMC Portugal Departure Movements

Alarms were introduced to the dashboard using Power Automate and Power BI in the context of dashboard construction. These alarms were set up to inform the developer anytime the import or export value of biodiesel (in each corresponding dashboard) was more than zero, emphasizing that fact. This approach is quite helpful in that it offers a proactive notification mechanism, enabling the developer to be alerted right away whenever transactions involving biodiesel take place (Microsoft, 2023.). It is possible to continually watch the dashboard data and receive instant notifications when certain events take place by establishing the alarms in this way. Power BI and Power Automate may be used to create automated workflows based on predetermined circumstances (Microsoft, 2023). The defined condition in this instance was that the volume of imported or exported biodiesel was larger than zero. When this requirement is satisfied, the automated flow is activated, sending the developer an email that highlights that information. This alert capability has several advantages since it enables immediate and quick responses to key biodiesel-related occurrences. When the developer receives the emails that were highlighted, they may then take the necessary measures, such as conducting more research or speaking with the right stakeholders. This proactive warning strategy also ensures effective decision-making and early detection of possibilities or challenges connected to Portugal's biodiesel trade.

5.2.5.3.2. Historic Data

These historical data, which date back to 2022, provide useful information about the patterns, quantities, and movements of Portuguese marine routes as well as their connections to global markets. Identification of seasonal trends, yearly fluctuations, and long-term patterns are made possible by understanding the past movements of marine routes. Strategic planning, decision-making, and demand forecasting all depend on this data. It is possible to determine the busiest ports, most popular routes, and important trading partners by studying historical data, which offers a thorough picture of the marine commerce landscape. The consequences

of these events on marine commerce may be evaluated by looking at changes in import and export quantities over time, and policies can be modified to accommodate prospective obstacles or opportunities. Historical changes in marine routes also offer useful information for supply chain management and logistics planning. Understanding the patterns of commodities arrival and departure allows for the optimization of ship scheduling, the avoidance of port congestion, and an increase in operational effectiveness. These facts are also essential for deciding on freight rates, negotiating transportation agreements, and making marine transportation-related choices.

To offer a visual depiction of the nations of origin for Portuguese imports, a visual map is included in the dashboard, like prior dashboards. Based on the numbers involved, it is possible to quickly identify the region or zone that directly influences Portugal's imports the most on this map since the size of the regions related to each nation is proportionate to the amount of imported goods. Users may more easily comprehend trade links and the significance of each nation of origin in Portuguese imports with the help of this graphic information.

To spotting patterns, it's critical to be familiar with the four ships that Portuguese imports use the most frequently. The most frequent boats may be used to identify patterns and trends in Portuguese imports, as well as details regarding popular routes, frequent origins, and transferred amounts. The best transport partners and the most effective delivery routes may be chosen with the use of these information to assist businesses plan their import strategy. This identification also makes it possible to keep track of logistical performance indicators like freight capacity and supplier dependability. Companies may spot possible problems and take corrective action by continuously monitoring the operation of these boats, guaranteeing a smooth import flow. Additionally, it facilitates cost analysis since identifying the most common boats helps with a more precise study of import costs, such as freight charges, transit periods, and port taxes. With the use of this data, businesses may evaluate the expenses of various boats and choose providers and routes that are more cost-effective. Finally, it makes risk management easier, which may entail locating ships with a history of issues like delays or product damage. By being aware of this information, businesses may take preventative actions like getting the proper insurance or looking for more dependable transportation options.

Another new picture was the comparison of the frequency between 2022 and 2023 using the top 4 boats with the most routes. Variables related to the vessel's name, frequency, and corresponding year were used to achieve this. The "MEX AUX" variable was further added to the filters to cover values that are less than or equal to zero, for the same reasons as in some of the preceding situations. For the X-axis, the variable "Mes Hierarquia" was also included. A horizontal bar chart showing the least popular routes was introduced with the intention of emphasizing the rarest routes. In this instance, it was discovered that an uncommon route is only connected to one movement every year.

To find market possibilities, diversify suppliers, reduce risks, and investigate niche markets, it is crucial to be aware of the rarest routes in Portuguese imports. First off, the rarest routes might point to areas or nations that can produce distinctive, distinctive, or high-quality goods. Companies can vary their product offerings and satisfy certain customer desires by extending import channels to these locations. Second, depending only on well-known routes might leave a business open to supply interruptions brought on by political unrest, natural disasters, or regional economic woes. Companies can form alliances with new suppliers in

other regions of the world by investigating uncommon routes, which will lessen their over-reliance on a single source of supplies. Thirdly, fewer frequent routes could benefit from increased security, less clogged ports, or less exposure to bad weather. Companies can lower the risk of delivery delays, product loss, or other logistical concerns by diversifying their routes. Last but not least, the most uncommon import channels may lead to niche markets or particular industries where there is a need for distinctive or high-quality goods. Companies may obtain a competitive edge and develop a devoted client base by recognizing these channels and catering to the demands of these specialized markets. This may lead to a distinctive strategic position in the market and more prospects for growth.

An additional column was added, and the Excel formula shown below was used to display the path in "Origin - Destination" format:

$$= CONCATENAR([@[ORIGIN\ COUNTRY]]\ \&\ "\ -\ "\ \&\ [@[DESTINATION\ PORT]])$$

The frequency of the routes was also calculated using an additional column. This is a unique situation because cases where a vessel carrying two cargoes show up as two independent rows when data from the Vortexa® platform is exported. As a result, the computation would be inaccurate if it was only dependent on counting the rows. A formula was made to account for situations in which numerous rows were connected to the same vessel within the same time period in order to remedy this. In such cases, the vessel would only be given a count of 1 in the final computation. In Excel, the following formula was created using this logic:

1. To combine the arrival/departure date with the vessel's IMO number, enter the formula:
   $= CONCATENATE([@[PRIMARY\ VESSEL\ IMO]], "\_", [@[ARRIVAL\ DATE]])"$

2. To determine the frequency outcome:
   $= IF\ (AND\ (COUNTIF\ (\$BH\$1{:}\ BH2, BH2) = 1), 1, 0))$ - The concatenation of "IMO_ARRIVALDATE" and "IMO_DEPARTUREDATE" (for instance, 9215115_45074 - 9215115_45047) appears in the formula above in the column BH.

A pie chart was also provided to show the percentage dispersion of each product's presence in Portugal's imports from the beginning of 2023 until the present. A horizontal bar chart with important terminals and their corresponding volumes for the years 2022 and 2023 was added below this image. It should be noted that filtering was once more used to retrieve data for the months up to the present month using the "MES AUX" variable. The strategic significance of the designated main terminals—*Figueira do Foz, Petrogal, Sovena, Banática*, and OZ—led to their selection. This includes elements like their geographic setting, infrastructure for logistics, or ties to transportation systems.

The export dashboard's highlighted graph focuses on 2023 biodiesel demand trends. This emphasis is especially important because Portuguese corporation Prio has a direct presence in this sector. As one of Portugal's largest producers and distributors of biodiesel, Prio contributes significantly to the nation's exports of the fuel. The dashboard offers useful data on the volume and location of exports for this commodity by emphasizing biodiesel changes in the chart. This makes it possible for users, such as Prio and other participants in the sector, to carefully monitor the effectiveness and development of biodiesel exports into 2023.

Monitoring market trends and patterns connected to biodiesel as well as comprehending the contribution of this sector to the Portuguese economy depend on the visibility of biodiesel movements. Users may use this information to make strategic decisions that are well-informed, such as changing operations, investigating new markets, or seeing chances for development in the biodiesel industry. The graph shows the volume and related biodiesel category (Biodiesel Feedstock, Finished, or Other Biodiesel) for the temporal distribution of biodiesel arrivals in Portugal. The "MES AUX" variable was used to apply filtering to acquire data for months up to the current month, much to the earlier charts.

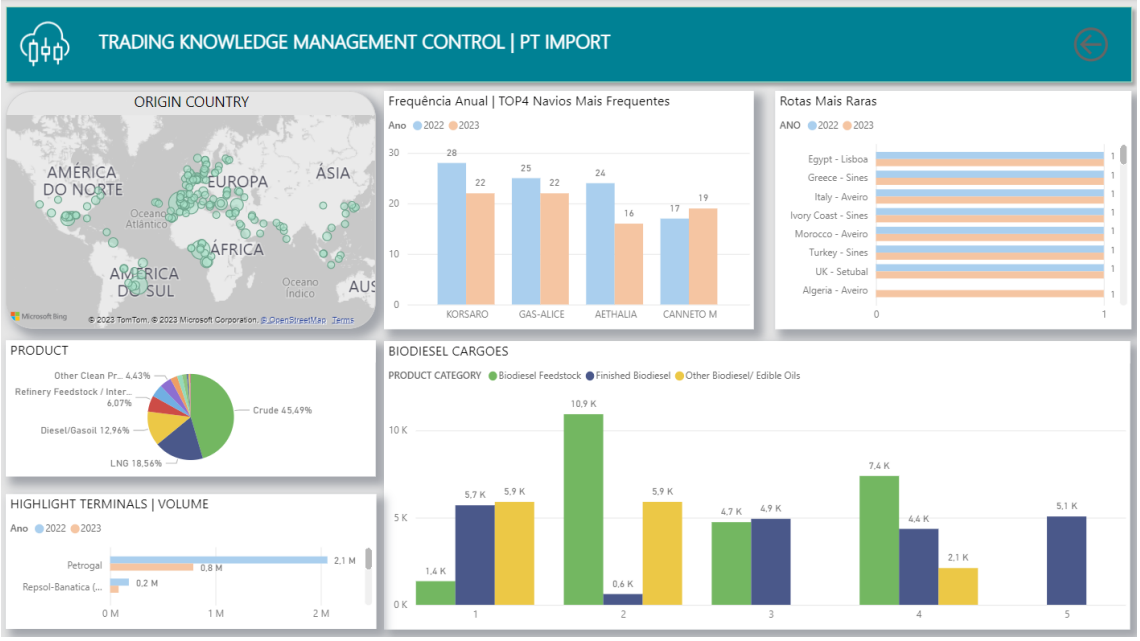


Figure 22 TKMC Historic Portugal Imports

The associations created between the tables in the context of the dashboard's development often took the same course as in the examples earlier. The "Arrival Date" column and the "Date" column in the "Calendário" database were utilized as a common field to create the links between the tables. This date column functioned as a point of intersection for data from other tables, allowing for thorough and logical analysis and visualization. By creating these connections, dashboard users may examine the data more comprehensively and get insightful knowledge by comparing and integrating data from different sources. The continuous usage of the date column in the links between the tables helps to create a seamless dashboard experience and makes it easier to analyze and comprehend the data in a way that is both dynamic and unique to the individual.

Compared to the prior import dashboard, various modifications were made to the export dashboard. One of the most significant adjustments was the addition of a chart indicating biodiesel shipments in place of the chart exhibiting the most frequent ships. This change in emphasis mirrors the export dashboard's main goal, which is to give information on the exported goods rather than the ships that carried them. A new chart that performs a similar function to the biodiesel shipments chart but with a wider range of items has also been added to the export dashboard. Diesel/gasoline, fuel oil, gasoline, jet/kero, LNG, LPG+, and other clean goods are all included in this new graphic. Diesel/gasoline, fuel oil, gasoline,

jet/kero, LNG, LPG+, and other clean goods are all included in this new graphic. This modification was made to give a more thorough and encompassing picture of the exported items, which now includes a range of fuels and allied products. Based on the unique characteristics of the export trade in Portugal, it was decided to add these changes to the export dashboard. In the context of exports, it is critical to highlight a wider range of products that reflect the nation's primary exported goods, even though the focus on biodiesel was significant for importations. Even though the export dashboard saw less changes than the import dashboard, these adjustments were made to satisfy customers' particular requests for export information. The inclusion of many exported items enables a more thorough and in-depth understanding of export operations in Portugal, giving users useful insights to help them decide on their enterprises' and export plans' course of action.

In this instance, it was noted that the biggest amount of completed biodiesel imports, totaling 5700 tons, has occurred in the month of May up to the present.

It was determined that some of the uncommon routes only occurred once in either 2022 or 2023, while other routes only happened once but in both 2022 and 2023.

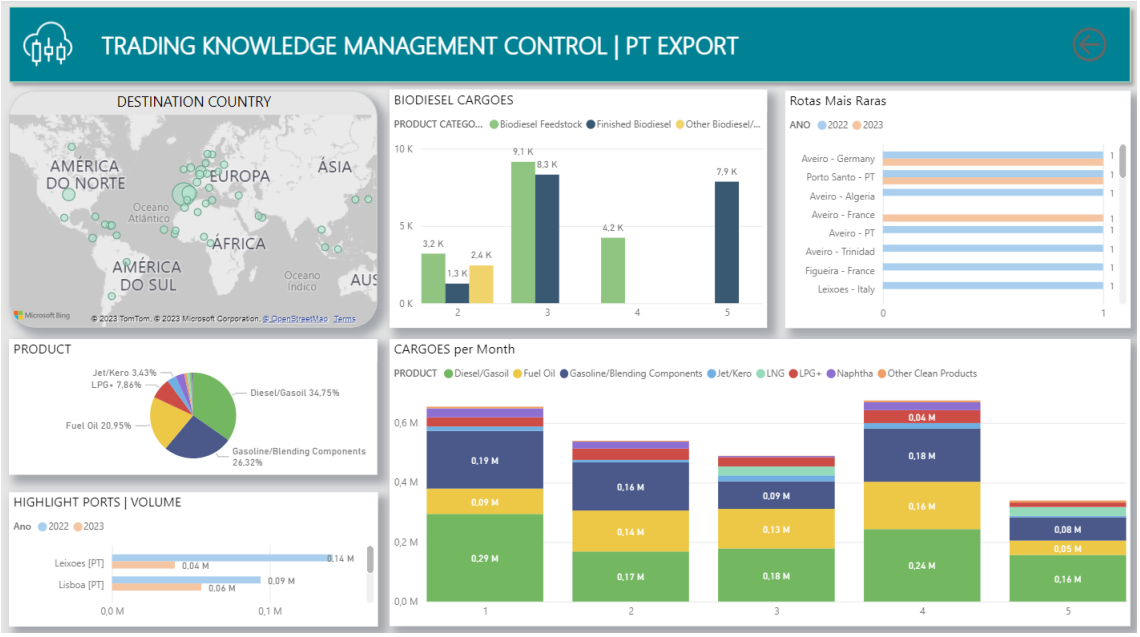


Figure 23 TKMC Historic Portugal Exports

5.2.5.4. Spain Case

One of Portugal's principal commercial partners, Spain significantly affects the nation's exports. It is crucial to know Spanish movements to recognize economic prospects and the dynamics of bilateral trade between the two nations. Users can see the volumes and items shipped to this nation clearly and easily by emphasizing the commercial movements with Spain on the dashboard. This data is useful for identifying demand trends, following market developments, and modifying export tactics to fit the demands and preferences of the Spanish market. Additionally, understanding Spanish movements enables comparisons across various export destinations. Users may evaluate the usefulness of Spain as a target market, compare the export volumes to other nations, and spot any potential obstacles or unique trade

prospects. Forging strong business alliances and expanding Portugal-Spain economic links require an understanding of Spanish trends. Enterprises can investigate options for cooperation and collaboration with Spanish enterprises based on the details of the exported items and the amounts involved, fostering bilateral commerce and fostering mutual economic progress.

5.2.5.4.1. Geral Historic Data

Spain's imports are extremely important in the context of the import dashboard. For the purposes of examining bilateral commerce, determining consumption trends, and making tactical decisions on product sourcing, it is crucial to comprehend import flows from Spain. Users may observe the quantities and items imported from this nation in clear and detail by highlighting Spanish imports in the dashboard. This data is useful for tracking the country of origin of imported goods, evaluating industry-specific reliance on Spain, and seeing possibilities for supplier diversification.

Like the earlier dashboards, a visual map was added to show the nations of origin for Spanish imports. Each country's origin is represented by several yellow bubbles on the map. The concept used here was the same as the separation into three product divisions in the transit movements dashboard. The key visual distinction is that the goods are spread in pie charts in this instance, along with the corresponding percentages that are linked with each product within the specific context, whether it be CPP, DPP, or Gas.

Variables pertaining to the origin countries ("ORIGIN COUNTRY") were positioned on the left side, while variables pertaining to the destination ports ("DESTINATION PORT") were positioned on the right side. The ports with the greatest historical representation can be highlighted thanks to this arrangement. Two educational cards showing the year-to-date total volumes for 2022 and 2023 separately were included to compare and evaluate the variations in decisions. It's important to note that this look didn't alter from the prototype that was created. Finally, a vertical bar chart depicting the most representative and major products—fuel oil, diesel/gasoline, gasoline, LNG, LPG+, and other clean products—was included to accentuate and highlight the temporal quantities of the prominent product shipments in 2023. The "Month Aux" variable was utilized in this visual, as well as the other temporal graphs, as a filter to collect data from the start of the year up through the current month without the need to manually choose and check the filters for each month. The X-axis also included the "Month Hierarchy" variable. Following the same concept of linking tables, the associations generated in the import dashboard were comparable to those in the prior dashboards. The "Arrival Date" value from each dashboard table as well as the "Date" variable from the "Calendar" database were used in this instance to build the linkages. This method of handling table relationships enables meaningful and cogent linkages between information from various sources. It is feasible to aggregate and correlate the data based on corresponding dates by establishing the link between the arrival dates of import movements and the dates in the calendar table. Building accurate and current dashboard representations depends on this connection. Users may interactively explore the data by linking the dates from pertinent tables and tailor their study by filtering the data based on dates, giving them a complete picture of import movements over time.

In this instance, for DPPs, the port of Cartagena has the greatest related percentage, for CPPs, the port of Barcelona, and for Gas, the port of Huelva. In addition, since January, the

price of LNG has been rising gradually. The product was made in the following countries for the specified month of April: United States of America (37.47%), Russia (24.97%), Algeria (15.8%), Nigeria (14.89%), and Oman (6.86%).

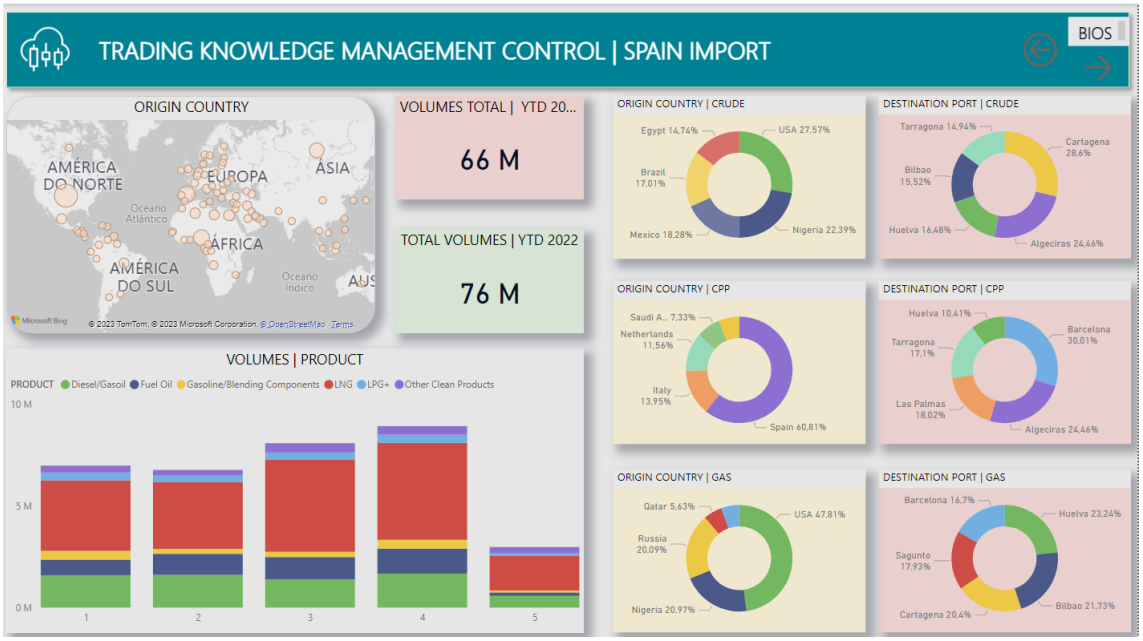


Figure 24 TKMC Historic Spain Imports

The Portugal Export Dashboard's design and relationship framework were used to the Spain Export Dashboard. Due to the similarity of the content and the importance of data display, this choice was decided. The variables that are most closely relevant to this context were chosen since the Spain Export Dashboard's main goal is to show data about Spain's exports. The links between the tables were established using the same reasoning, connecting the "Date" field in the "Calendar" database to the "Arrival Date" variable in each pertinent table. This strategy guarantees consistency and data integrity in the dashboard and permits a comparison of Portugal's and Spain's exports. Users may quickly compare, and contrast trends, quantities, and other pertinent data connected to these two countries' exports by utilizing the same relationships and design. Users benefit from an intuitive experience with this strategy as well because they are already accustomed to the design and features of the Portugal Export Dashboard. By using a uniform style, it makes the Spain Export Dashboard easier to

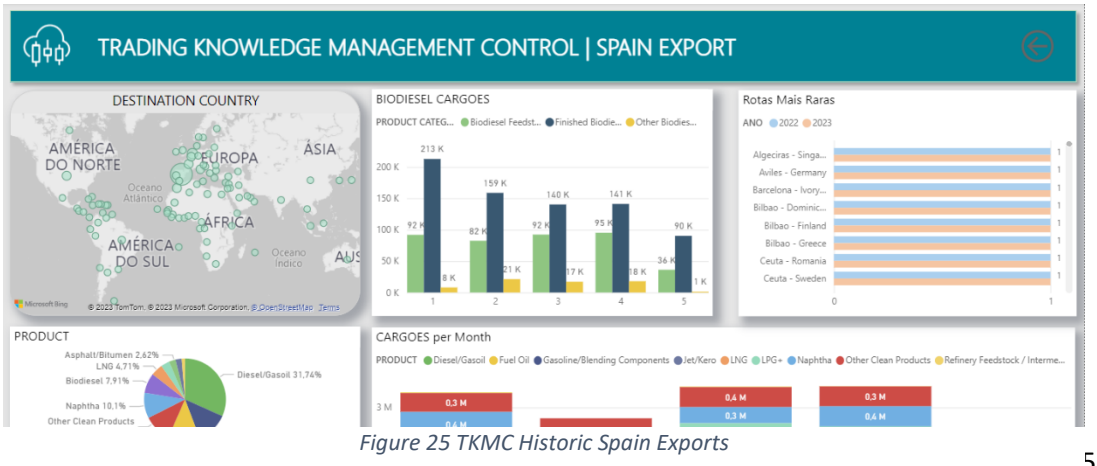


Figure 25 TKMC Historic Spain Exports

comprehend and use, encouraging thorough analysis and well-informed decision-making.

5.2.5.4.2. Spain Bios Import

Due to their importance and considerable influence on the energy and sustainability industries, it is crucial to draw attention to the imports of biodiesel from Spain in a distinct dashboard. Attention may be drawn to this significant area of the renewable energy market by emphasizing the imports of biodiesel from Spain in a particular dashboard. This enables dashboard users to evaluate and comprehend the trends, amounts, and patterns associated with the imports of biodiesel from Spain in greater detail. Additionally, highlighting the imports of biodiesel from Spain in a different dashboard can show the participation of pertinent businesses and institutions in this industry. For instance, if Spain has top producers and exporters of biodiesel, emphasizing their imports might give important insights into their operations and contributions to the global market for renewable energy. The strategic planning and decision-making of stakeholders like energy firms, governments, and investors may also benefit from this approach. It is feasible to spot commercial possibilities, follow market trends, and create strategic alliances with Spanish biodiesel providers by isolating the imports of biodiesel from Spain.

A graphic tool that enables for the comparison of several variables in respect to a central point is the Radar Chart 2.0.2. The examination of the nations of origin and the port of destination is relevant to the application of the import and export dashboard. It is possible to efficiently depict a variety of factors, such as cargo volume, movement frequency, product categories, transportation costs, or any other significant measure for analysis, using the Radar Chart 2.0.2. Users may quickly compare the origin nations or destination ports based on these factors by utilizing the Radar Chart 2.0.2 in the dashboard. The radar-like graphic depiction gives a quick overview of the many dimensions and makes it possible to see patterns, trends, or differences between different nations or ports. When many nations or ports are engaged in imports or exports and it is necessary to swiftly evaluate their performance across several parameters, this visual method is especially helpful. It is simpler to comprehend the unique qualities of each nation or port and their relative location in relation to others thanks to the Radar Chart 2.0.2's concise and intuitive portrayal of data.

As a result, to find out specific information, such as which ports in destination countries the Netherlands exports to, one must click on the corresponding bubble for that nation. As expected from an interactive technology-based framework, all subsequent visuals in the dashboards are then filtered for that situation.

An emphasis is placed on a chart that shows biodiesel shipments from January to the present month while differentiating between the several kinds of biodiesel (biodiesel feedstock, completed biodiesel, and other biodiesel). As was to be expected, in this instance, it was also essential to utilize the "Month Aux" variable as a filter and the "Month Hierarchy" variable as the X-axis.

The linkages between the tables were created similarly to the previous dashboards by comparing the "Arrival Date" variable from each table to the "Date" field in the "Calendar" database. This method makes it possible to properly link and synchronize data between tables, guaranteeing that date information is consistent. By creating these connections, data from several tables may be meaningfully connected, allowing users to examine the information in greater depth and conduct more dynamic, individualized analyses of the data. The dashboard's

usefulness and interactivity depend on the structure of the table connections since it enables users to browse the data based on various time periods and do more in-depth analysis as necessary.

In this case, it is possible to conclude that Indonesia exports to the ports of Castellon De La Plana, Barcelona, Vigo, Ceuta, Huelva, Algeciras, Tarragona, Cartagena, Bilbao, and Cadiz, with the first three having the highest representation, in this case if you want to learn more about imports coming from Indonesia through this dashboard. It is important to note that biodiesel feedstock stood out in terms of time and the corresponding category of biodiesel, and that by May 17th, the total amount had already surpassed all of April.

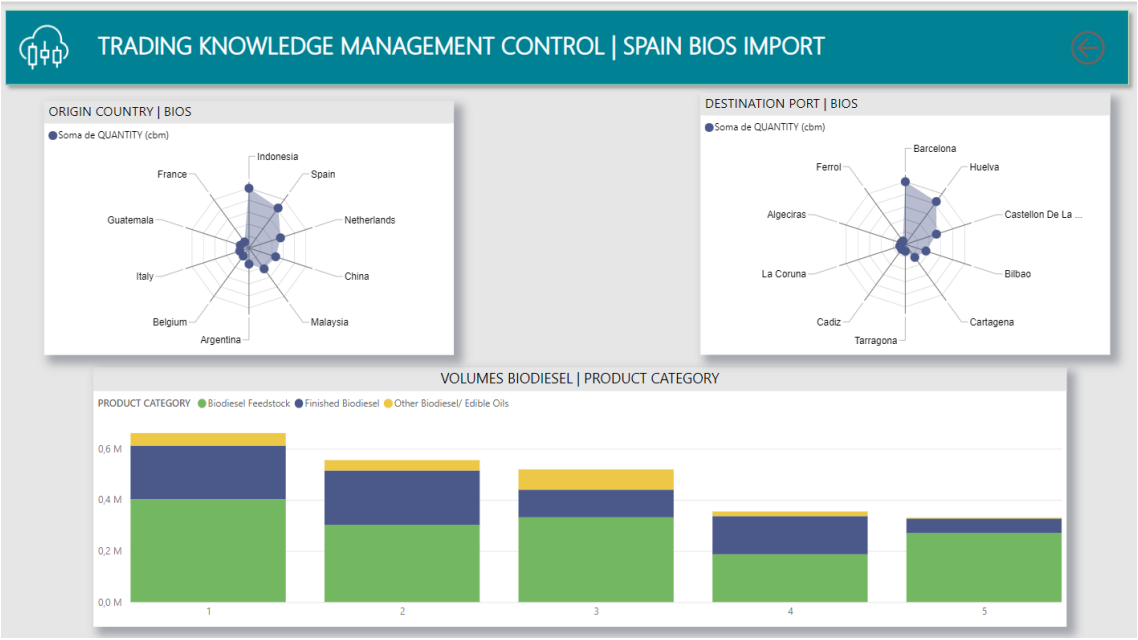


Figure 26 TKMC Historic Spain Biodiesel Imports

5.2.5.5. China – Europe | Extra

Understanding competition and seizing new market possibilities requires the incorporation of more data regarding movements and insights into the pathways between China and Europe. One of the most important commercial routes in the world runs between China and Europe. To get a complete picture of the market and spot prospective business possibilities, it is essential to monitor and examine changes along this route. The dashboard may be customized to include precise information on movements and insights along this route, providing useful insights into the volume, frequency, and properties of carried goods. This aids in comprehending the nature of rivalry along this path and locating market trends that might affect corporate choices. Additionally, thorough understanding of the migration patterns and insights from China to Europe helps businesses to capture untapped market possibilities. Companies can modify their plans, optimize product supply, and look into possible commercial collaborations by recognizing patterns, trends, or special demands along this route.

The transit movements of ships are shown on this dashboard's left side, with an emphasis on biodiesel. A table and a visual map are also present. In contrast to the previous instances, the map shows the destination ports as bubbles that change in size depending on

the size of the ships. The table lists details such the ship's name, nation of origin, port of destination, item, and arrival date.

Arbitrage has been added as a closely watched topic on the right side. The following quotations have been taken from Reuters® and are specifically relevant to the China-ARA route:

- UCO quote in China
- UCOME quote in China
- UCO quote in ARA (Amsterdam-Rotterdam-Antwerp)
- UCOME quote in ARA
- China-ARA freight value
- EUR/USD exchange rate.

Arbitrage refers to the price differential plus transportation expenses, as was previously established. In this instance, an Excel table was made to analyze the necessary data in order to determine the corresponding differentials (UCO and UCOME). Even though there was no quotation, the table still contained the variables that were accessible and the degree of freight. It was considered that in these situations, the most recent quotation applied. If a freight value quote was given on a Friday, it was deemed to be accurate for the whole previous week up to that day. The figure from the preceding Friday was utilized if there was no Friday quotation. The following Excel formulae were created with this end in mind:

$$1 = SE(PROCV('REUTERS\ DB'!C4;'REUTERS\ DB'!\$C\$4:\$J\$492;3;FALSO) = 0;SE(PROCV('REUTERS\ DB'!C5;'REUTERS\ DB'!\$C\$4:\$J\$492;3;FALSO) = 0;SE(PROCV('REUTERS\ DB'!C6;'REUTERS\ DB'!\$C\$4:\$J\$492;3;FALSO) = 0;PROCV('REUTERS\ DB'!C7;'REUTERS\ DB'!\$C\$4:\$J\$492;3;FALSO);$$
$$PROCV('REUTERS\ DB'!C6;'REUTERS\ DB'!\$C\$4:\$J\$492;3;FALSO));$$
$$PROCV('REUTERS\ DB'!C5;'REUTERS\ DB'!\$C\$4:\$J\$492;3;FALSO));$$
$$PROCV('REUTERS\ DB'!C4;'REUTERS\ DB'!\$C\$4:\$J\$492;3;FALSO))$$

$$2 = SE.ERRO(SE(PROCV('REUTERS\ DB'!C7;'REUTERS\ DB'!\$C\$4:\$J\$492;8;FALSO) = 0;SE(PROCV('REUTERS\ DB'!C6;'REUTERS\ DB'!\$C\$4:\$J\$492;8;FALSO) = 0;SE(PROCV('REUTERS\ DB'!C5;'REUTERS\ DB'!\$C\$4:\$J\$492;8;FALSO) = 0;SE(PROCV('REUTERS\ DB'!C4;'REUTERS\ DB'!\$C\$4:\$J\$492;8;FALSO) = 0;PROCV('REUTERS\ DB'!C3;'REUTERS\ DB'!\$C\$4:\$J\$492;8;FALSO);$$
$$PROCV('REUTERS\ DB'!C4;'REUTERS\ DB'!\$C\$4:\$J\$492;8;FALSO));$$
$$PROCV('REUTERS\ DB'!C5;'REUTERS\ DB'!\$C\$4:\$J\$492;8;FALSO));$$
$$PROCV('REUTERS\ DB'!C6;'REUTERS\ DB'!\$C\$4:\$J\$492;8;FALSO));$$
$$PROCV('REUTERS\ DB'!C7;'REUTERS\ DB'!\$C\$4:\$J\$492;8;FALSO));175)$$

A horizontal line with the following two constant values was added to the visual graph:

- To rapidly determine if the arbitrage is open or closed, draw a line at zero.

- A line at 60 was established based on a daily market analysis in which a report from the source "Prima Markets" suggested freight levels recorded at $140. Since the average quoted by Reuters® was based on $200, a $60 differential was made to evaluate the conclusions taking this situation into account

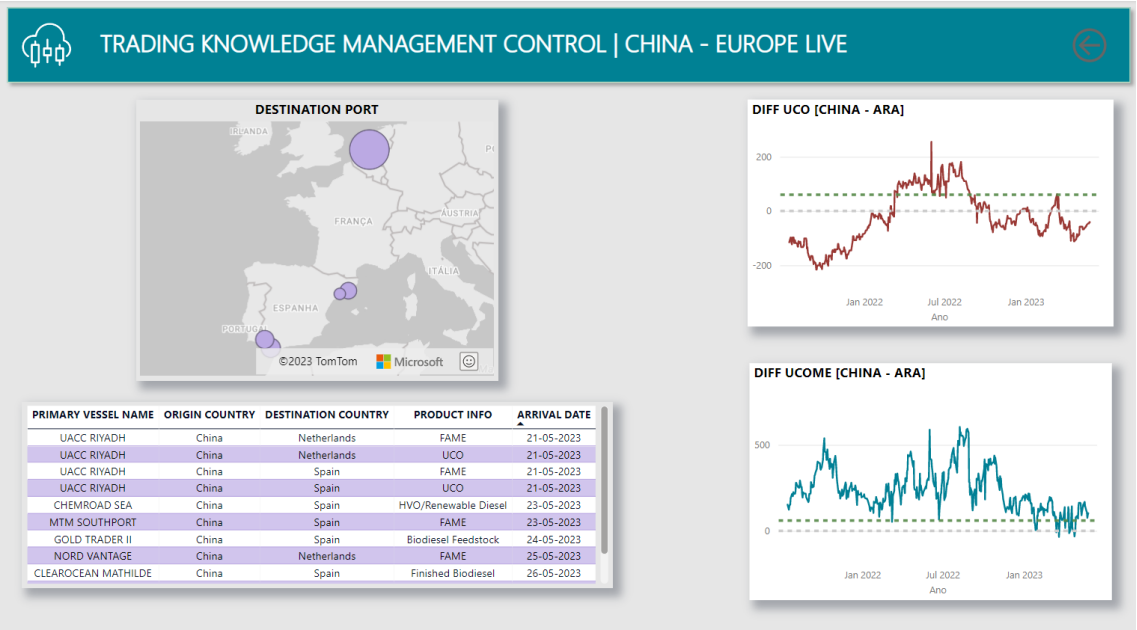


Figure 27 TKMC Extra Information - China to Europe Movements

5.2.6. Usability Tests & Focus Group

The phase of assessment and feedback was undertaken after the development phase. Five team members were requested to conduct a focus group and a usability test for this reason.

The major goal of the usability test is to assess how simple, effective, and satisfied users are when engaging with the TKMC framework. A sample of the target market is recruited for the test, and they use the product to complete certain activities while being monitored and having their interactions recorded. The purpose of the usability test is to determine the product's strengths and shortcomings in terms of usability, as well as to spot any design flaws, navigational issues, or features that could detract from the user experience. Additionally, it's critical to make sure the product delivers on promises, is simple to use, and satisfies consumers' wants and expectations. Users' activities, facial expressions, remarks, and answers to predetermined questions are observed during the usability test to get qualitative and quantitative feedback. The product may be modified and improved upon based on the test findings to make it more user-friendly, effective, and pleasurable to use. Please note that in Annexes III and IV, you can find the respective usability tests and questions used for the focus group.

Ten questions were given to each person to determine how intuitively they understood the technology-based framework and if the perceived attraction matched the original goal. Each question had a developer-set estimated time limit, and participants could

get help if they needed it. It was also essential to grade each task's complexity at the conclusion of the allotted time, with 1 denoting "not easy at all" and 5 denoting "very easy."

It was anticipated that the entire duration would be 287 seconds. The Trading and Risk Management Coordinator, Gonçalo Martins, came the closest to meeting this goal, failing to greatly exceed it either. In terms of extremes, Pedro Monteiro, the operations, and shipping director, had the longest time (533 seconds), while Alexandre Cruz, the market analyst, had the smallest time (191 seconds). It's important to note that the participants' level of Power BI experience and knowledge was evaluated before to the questionnaire's start. Pedro Monteiro barely alluded to the most elementary ideas, whereas Alexandre Cruz displayed the highest level of skill. As a result, it can be assumed that people who are more comfortable with the program would find it simpler and quicker to explore the information and work with the offered images than those who are less familiar, which eventually influences the total time attained.

Nevertheless, despite some cases taking significantly longer than expected, it was found by reviewing the evaluations (using the median values) that, overall, nearly 60% of the task responses were rated as very easy, followed by 23.33% rated as easy, and two cases rated as 3.

Three participants received a median score of 5 when each evaluator's ratings were considered. Operational Manager Joao Gonçalves had a median score of 4.5, while Alexandre Cruz received a score of 4 for the job list.

The analysis of evaluations (using the median of the evaluations) revealed that, in the aggregate of all the tasks and questionnaires, almost 60% of the task responses were rated as very easy, followed by 23.33% rated as easy, and two cases were rated as moderate (3). This is true even though some cases took significantly longer than expected. According to the stated list of duties, three participants had a median rating of 5, the Operational Manager, Joo Gonçalves, received a median rating of 4.5, and Alexandre Cruz received a median rating of 4. Now that each task has been evaluated, it has been determined that, also using the median, tasks 2, 3, 4, 5, and 10 (or half of the tasks) took less time than predicted, while the other tasks took longer than expected. It is important to note that question 7 had the highest time disparity, 17 seconds, between the predicted and actual times. Except for one question, all of the activities had times connected with them that were shorter than anticipated in the instance of Alexandre Cruz, who had the quickest overall time. The sole exception was question 9, which took just two additional seconds than anticipated. All the questions earned a rating of 5, with the exception of questions 3 and 8, which received a rating of 4. It should be emphasized that, as was already indicated, two assessors assigned ratings of 3 in two different situations. When asked why this grade was given, both raters concurred that it was challenging to locate the precise dashboard for Spanish biodiesel import movements, which was the focus of inquiry 8.

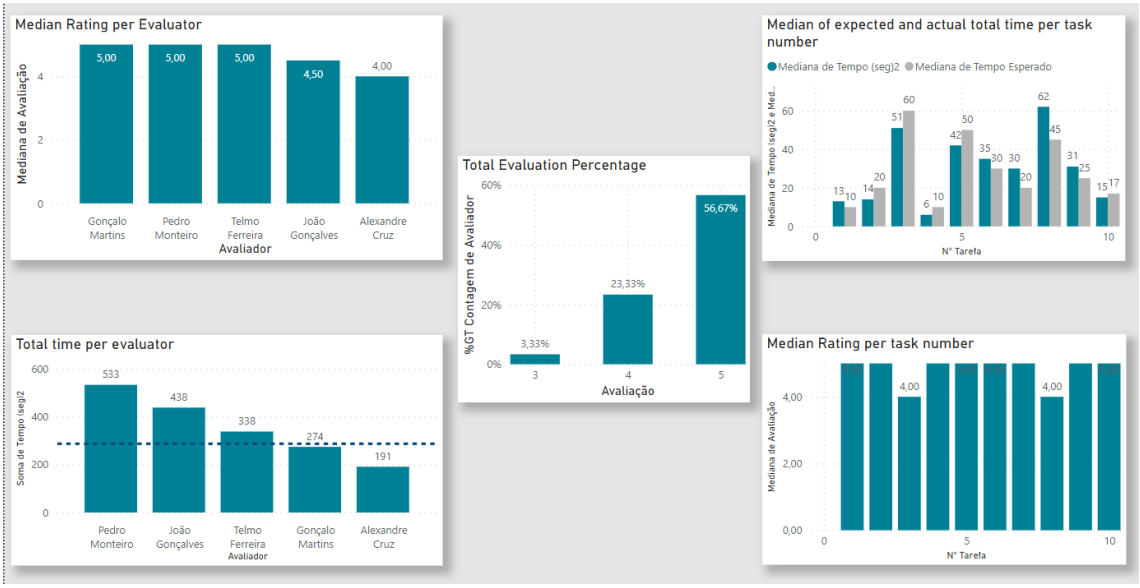


Figure 28 Usability Tests Results Part One

Finally, while analyzing by task number, the evaluator, and the time gained, it is important to note that evaluator Joao Gonçalves spent a lot of time on question 3. He did, however, have one of the quickest times across all assessments for assignment 1. With a response of 2 seconds to question 4, which questioned if they could access Spanish transit movements (the answer was negative, since only historical movements were provided for Spain), Telmo Ferreira, the Head of Emerging Areas and Shipping, set the record for the fastest time.

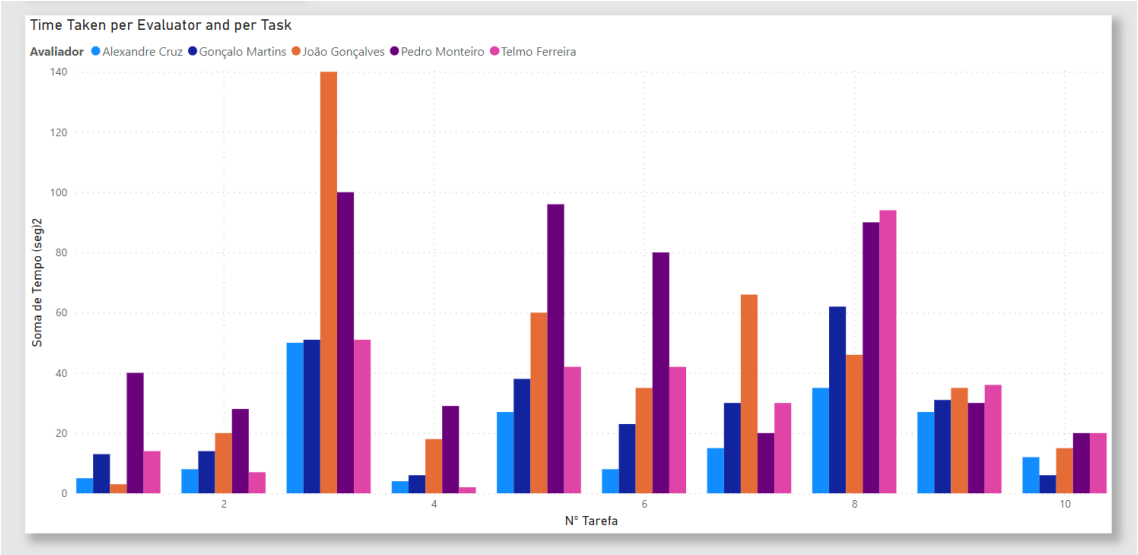


Figure 29 Usability Tests Results Part Two

The fundamental goal of focus groups is to acquire qualitative and in-depth information on participants' views, opinions, attitudes, and experiences about a certain

subject, good, service, or idea. The developer facilitated the focus groups, which were held with the same group of 5 carefully chosen collaborators to promote conversation and stimulate participant participation. Exploring perspectives and ideas, exchanging experiences and thoughts on a specific subject, and gaining a thorough knowledge of participants' motives, beliefs, and values were the main objectives of this sort of evaluation. In-depth examination of complicated topics was another goal of the focus groups, which gave participants a forum for discussion and debate as well as the opportunity to provide rich, in-depth information. The focus groups were also utilized to test theories and notions that would later be put into practice. It was feasible to assess the viability, acceptability, and potential success of future ideas to further improve the technology-based framework in this scenario through conversations and participant input.

They were asked to assess the technology-based framework's utility and usability in their job at this point, as well as its potential effects on their productivity. They were also asked to evaluate the technology-based framework's usability and what it would be like to use it every day, as well as to offer criticism and recommendations for development.

Among the 5 responses, a few circumstances stood out in terms of usefulness. Gonçalo Martins and Telmo Ferreira said it was quite likely that the technology-based framework will boost their respective work productivity in all respects. Pedro Monteiro, on the other hand, said that it was probable that TKMC would be helpful and added that his assessment was based on his experience and that he would be able to say with more certainty once he had used the technology-based framework in his daily job. Being in a field unrelated to the ship business, Alexandre Cruz expressed a "neutral" view on the technology-based framework's use for his work and, subsequently, his productivity.

Regarding the technology-based framework's usability, Pedro Monteiro believed it would be "quite likely" for the technology-based framework to be simple to use and modify. Additionally, the team members concurred that it was "extremely likely" that the technology-based framework would be simple to use in general. The contributors did not voice concerns about missing or inadequately emphasized information since they found the technology-based framework to be user-friendly and free of any obtrusive features, and they were generally pleased with it. These encouraging comments on the technology-based framework's usability show that the precautions taken throughout development were successful in creating a simple and convenient user experience. This encouraging feedback on the technology-based framework's usability and availability of sufficient information highlights the value of including end users in the development process to make sure their needs and preferences are considered. It also shows that efforts to design a friendly and intuitive interface were successful.

Figure 30 Focus Group Results

5.2.7. Trading Knowledge Management Control | Final Version

The TKMC framework's final version takes into consideration all the previously outlined enhancement suggestions made during the assessment process. As a result, the following modifications have been made:

1. Increase in font size for chart titles across all dashboards: The font size for chart titles has been raised across all technology-based framework dashboards to improve readability and facilitate data visualization. Users will be able to quickly recognize important chart components and comprehend the information being displayed as a result.
2. The following is a solution to locate the Spanish biodiesel import dashboard: Finding the precise threshold for imports of Spanish biodiesel proved to be difficult throughout the assessment process. This enhancement will make it simpler and more straightforward to access and use the proper dashboard.
3. Creating a second mobile strategy in addition to the current online strategy: An extra mobile scheme has been designed in addition to the current web scheme to cater to the demands of users accessing the technology-based framework through mobile devices. With this update, customers will have a mobile device-optimized viewing option, making smartphones and tablets more user-friendly and responsive. No matter the device being used, this will improve the technology-based framework's usability and accessibility.

The TKMC framework's usability, accessibility, and general user experience are all intended to be improved by these enhancements. With the intention of satisfying user demands and expectations while delivering a technology-based framework that is more effective and gratifying, the final version features these enhancements.

Concerning the initial suggestion for improvement, a thorough procedure was applied across all dashboards and graphics on the TKMC framework to enlarge the font size of the titles. The goal was to make it easier to grasp the information being given and to increase

visual recognition. The font size for all titles was changed from the basic configuration of 11 to 12 and 14 for titles. The titles are now prominently displayed and can be seen clearly across all dashboards thanks to this adjustment. By enlarging the typeface, readers can read the titles more quickly and easily, which helps them understand the information being provided and quickly find any relevant images. A more effective and user-friendly technology-based framework experience is a result of this development. A similar idea to what was previously used for the Portuguese movement submenus was employed about the second modification, which deals with the identification of the dashboard connected to Spanish biodiesel imports. "General Historic Data" and "Bios Import" are two more submenus choices that were included to help users more easily identify this dashboard. When the user chooses the "General Historic Data" option, a new submenu with choices for import and export that match the current menu structure is presented to them. However, if the "Bios Import" option is selected, the technology-based framework goes immediately to the dashboard for imports of Spanish biodiesel. By better organizing dashboards for various types of data and procedures, this method makes it simpler for users to locate and use the right dashboard. Additionally, it makes it easier for customers to reach the Spanish biodiesel import dashboard without having to go through a series of menus. To improve the user experience on the TKMC framework generally, several adjustments were made to increase usability, make it easier to identify dashboards, and provide users more direct and intuitive access choices.

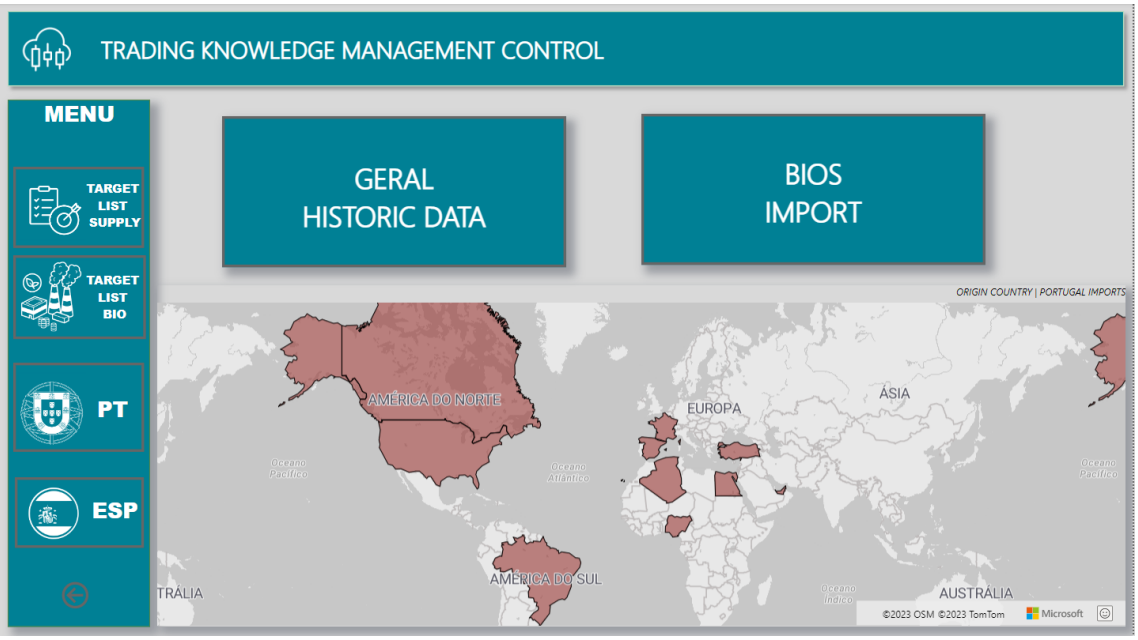


Figure 31 TKMC Sub Menu for Spain Biodiesel Imports

The matching capability in Power BI was used to design the mobile strategy for the TKMC framework, utilizing the tools at hand to accomplish the desired result. Power BI made the procedure easier by enabling the automated split of graphics used in the appropriate dashboard. Additionally, no new processes needed to be developed; instead, the dashboard's pages merely needed to be sized, ordered, and arranged as desired. It was simple to build the mobile strategy because Power BI tools offered the ability to choose the ideal layout. However, there were some restrictions when it came to positioning the buttons for the submenus because initially names weren't assigned for ease of recognition. However, this problem was resolved, and with the implementation of the mobile strategy, any user with

access to the technology-based framework and Microsoft Power BI installed on their mobile device can use and benefit from all of the capabilities offered. Users will have access to the TKMC framework, which enables them to see and interact with the dashboards on their smartphones or tablets in a responsive and user-friendly way. It is also important to note that further warnings and notifications have been added automatically to the technology-based framework and are now sent out anytime an import or export linked to biodiesel happens. Users now have a practical means to keep informed of important occurrences and respond appropriately. The technology-based framework's usability is increased by the addition of the mobile scheme and notifications/alerts in terms of its applicability. The ability for users to access the required data and information quickly and conveniently while on the road will be especially helpful for professionals who frequently travel or work in numerous places and need to make data-driven choices. Here's an example of the application page.

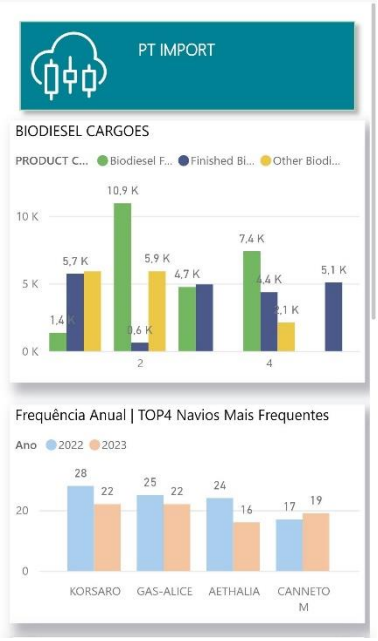


Figure 32 TKMC Movel Application - Example

A QR code on the main menu has been introduced to the TKMC framework in addition to the previously mentioned enhancements. With the help of a suitable smartphone, users may rapidly access the technology-based framework by scanning this QR code. All users will be able to access the technology-based framework quickly and easily in this way. The QR code's presence on the main menu makes it easier for users to access the technology-based framework right away and engage with real-time information without any difficulty. This is especially helpful when data from the technology-based framework is shared or shown in other settings or media. Users may easily and immediately interact with the technology-based framework with the help of the QR code, improving the experience and making it more practical.

It is crucial to stress that all the previously stated enhancement suggestions have been implemented in the final version of the TKMC framework. It is important to understand that the technology-based framework is still being developed and adjusted, though. The technology-based framework must adapt to changing market conditions and shifting monitoring objectives. This indicates that the technology-based framework is always changing, getting better, and adjusting to the requirements of the environment it functions in. The TKMC framework is created as a dynamic and adaptable solution, prepared to respond to future

developments and growing objectives. The technology-based framework will continue to be useful and effective via efforts at ongoing enhancement and flexibility, giving users a trustworthy and current tool for evaluating and monitoring data connected to ship movements and the market.

6. Discussion

To facilitate decision-making and advance organizational knowledge, it was created a technology-based framework with the intention of giving businesses a technical tool (platform) and action plan methods. This unified technology framework attempts to offer businesses a complete solution by giving them access to useful and pertinent data on their performance, market, and competitive landscape.

The technological framework's core concept is to give businesses a tool that combines data, analysis, and strategies into a single environment for the purpose of defining strategies and action plans that will help them make better decisions, carry out strategic actions, and succeed. Th TKMC framework's major objective is to equip businesses with the information they need to make better decisions, enhancing their competitive edge and upholding the sustainability of the economy. With prompt and accessible warnings to identify noteworthy incidents that may have a substantial influence on the company's behavior and positioning, TKMC helps enterprises to have a strong foundation for their decisions. Companies may access a variety of information and expertise that is pertinent to their business thanks to TKMC. This makes it possible to comprehend the market, trends, competition, and other elements that may have an impact on performance and strategy. The technology also makes it easier to find important examples, which enables businesses to find pertinent opportunities or dangers fast. Companies may be better able to alter their company plans and better respond to market developments if they have the capacity to anticipate critical events and act promptly. The development of this framework has greatly benefited users. Access to pertinent information has been facilitated through data visualization, giving users a clear and thorough understanding of the whole market environment in which, they operate. Real-time notifications and alerts have also fundamentally altered the way consumers interact with information since they provide them the capacity to respond quickly, seizing opportunities or averting hazards. Making decisions has become more informed and nimbler thanks to the TKMC framework. Users now have access to clearer and more pertinent information, enhancing their ability to confidently and properly assess the choices accessible to them. They can swiftly spot possibilities in the market, such prospective investments or new customers, and act appropriately. Decision-making, agility, and access to pertinent information have all improved, enabling technology-based framework users to respond more forcefully to market issues. They can foresee trends, spot market inefficiencies, and modify their approaches accordingly. Because of this, TKMC users are in a better position to take full use of their business possibilities and have a greater competitive edge.

The Trading Knowledge Management Control (TKMC) framework’s flexibility and agility are essential to its capacity to respond to changes in the market and tracking priorities. A data analytics technology-based framework like TKMC must be able to adapt to changing needs and offer consumers useful solutions in a dynamic and ever-changing environment. The TKMC framework's adaptable design, which enables continual inclusion of enhancements and modifications to satisfy constantly changing demands, is one of its main features. The technology-based framework is made to be readily updated and improved, whether by adding

new features or making better use of already-existing resources. This makes sure that the technology-based framework is constantly current and in line with industry trends and requirements in terms of ship movements and market needs. Additionally, the TKMC framework is equipped to handle future modifications thanks to a constant process of user input and involvement. Users actively suggest new features and find ways to improve the technology-based framework, allowing it to develop to meet their requirements. Understanding user wants and requirements is the foundation for developing TKMC, as is putting the required improvements in place to satisfy those requests. The TKMC framework's capacity to adjust to changing needs is another crucial factor. It is essential for TKMC to be prepared to meet any future issues and requirements given how quickly technology and the business are advancing. The TKMC framework is also supported by strong and adaptable technologies like Power BI, which provides sophisticated data visualization and analysis capabilities. The technology-based framework can readily interface with other tools and systems because to its strong technological base, ensuring interoperability and the capacity to grow and take on new problems. The TKMC framework's ability to convey information more quickly is due in large part to the utilization of Power Automate. Customized processes that automate real-time information transmission have been made feasible by integrating Power Automate into the TKMC framework. Power Automate has furthermore shown to be quite accessible and adaptable for modifying workflows in accordance with demands, setting up alerts, and emphasizing pertinent information. This makes it possible for organizations to get real-time alerts about crucial occasions, new trends, or key data changes, ensuring that crucial information is quickly recognized and emphasized. The TKMC framework now has access to effective and economical automation thanks to Power Automate, which boosts information transfer speed and lets companies take decisions based on real-time data. This tool's adaptability enables users to modify processes in accordance with their requirements and preferences, greatly enhancing the TKMC framework's adaptability and customization. In conclusion, the TKMC framework's adaptability and flexibility are essential for handling market changes and monitoring objectives. The technology-based framework is prepared to evolve and adapt to new demands through a continual process of user feedback, market trend monitoring, and adoption of cutting-edge technology. The developer behind TKMC is dedicated to giving users a dependable, current solution that satisfies their demands while providing a consistent, high-quality data analytics experience.

The TKMC framework contributes significantly to the fields of ship flows and market data analytics and monitoring, helping to close gaps, present novel ideas, and improve current methods and practices. The technology-based framework's capacity to offer practical and timely information on ship movements and the market is one of its key contributions. Until recently, getting and evaluating data in this industry was a laborious and time-consuming procedure that involved manually gathering data from numerous sources, compiling it, and then doing analysis. By automatically gathering pertinent data, offering powerful analytics, and offering interactive visualizations, TKMC streamlines this process and enables users to make quick decisions based on accurate and up-to-date data. The TKMC framework also fills a void by offering a complete and integrated solution for tracking ship movements and market data. Users may obtain market data, marine transportation statistics, route studies, port information, and more with TKMC since it centralizes information in one place. The development and operation of the TKMC framework heavily rely on the Vortexa® and Reuters® databases. Given the volume of information it offers, as well as Reuters®, Vortexa® has proven

to be essential. Do you require a reference? These databases offer useful and recent data on market performance, trends, pertinent news, and other business-related information. Companies now have access to a wide range of data that is pertinent to their strategies and decision-making thanks to the integration of these databases into the TKMC framework. It is crucial to stress that any modifications to the Reuters® and Vortexa® databases would directly affect the TKMC framework. To maintain the quality and dependability of the information made available on the technology-based framework, it is necessary to consider changes and modifications in these databases. The TKMC framework's data quality and relevance must be continuously maintained through partnership with Vortexa® and Reuters® for businesses to be able to make strategic decisions based on the most up-to-date and accurate market data.

By streamlining processes and saving critical time, this boosts operational effectiveness and efficiency. The TKMC framework is notable for its unique method of offering sophisticated data visualization and analysis capabilities. Users of TKMC may interactively explore data and find hidden insights thanks to features like customized filters, interactive charts, and user-friendly dashboards. This novel method makes it easier to comprehend and evaluate data, giving consumers the ability to decide strategically based on useful information. Additionally, the TKMC framework's capacity to adapt and evolve helps to improve present methods and procedures in the analysis, monitoring, and monitoring of ship movements and market data. To keep TKMC current and relevant, the TKMC framework's developer regularly solicits user input and technology advancements. Therefore, the technology-based framework is always being improved, new features are added, and industry best practices are included.

TKMC encourages the use of business intelligence (BI) to improve decision-making through its functions and features (J. Wang et al., 2022). The technology-based framework enables users to have a complete perspective of the market, recognizing trends, competition, and important variables for the organization by quickly giving information and warnings. This promotes data-driven and insightful decision-making, which enhances competitive advantage, success, and organizational understanding (Syahchari et al., 2020). As the technology-based framework makes it possible to access and share information in digital format, digitization is important to TKMC (Liang et al., 2023). The TKMC framework streamlines business processes and makes it easier to disseminate knowledge by doing away with the need for paper documents and labor-intensive manual procedures (Syahchari et al., 2020). This enables businesses to maximize operational effectiveness, conserve resources, and adapt to the rapidly changing digital world (Zhou, 2022). Companies may benefit from the implementation of BPMN in TKMC since the technology-based framework enables simple and intelligible modeling and documenting of business processes (Salvadorinho & Teixeira, 2021). Companies may find opportunities for improvements, remove bottlenecks, and optimize their operations by mapping workflow and the decision-making processes (Pattanasing et al., 2022). By making it easier to analyze and enhance business processes, TKMC framework serves as a supporting tool. The technology-based framework helps businesses to take advantage of business possibilities and reduce risks by facilitating quick access to pertinent information and encouraging educated decision-making. This supports economic sustainability by enabling businesses to make money and prosper over the long term in accordance with sustainable business practices (Pattanasing et al., 2022). TKMC helps firms to acquire a competitive advantage, enhance operational efficiency, optimize processes, and support sustainable growth by offering a comprehensive solution for knowledge management and decision-making in enterprises (Pattanasing et al., 2022).

Businesses using BPMN (Business Process Model and Notation) as a tool to comprehend their internal structure and how systems and people are interrelated is the recommended framework for organizations looking to accomplish comparable goals (Ramadhani & Mahendrawathi, 2019). Adopting BPMN enables business processes to be mapped and visualized in a clear and straightforward way, highlighting opportunities for optimization. The importance of TKMC framework integration, which entails linking systems and applications inside the company to promote quick and efficient information interchange, reduce rework, and increase productivity, must also be emphasized (Ramadhani & Mahendrawathi, 2019). To fully realize the potential of the business, interoperability across various systems is essential. The business is creating an acceleration ramp toward securing a competitive advantage by adopting this strategy. To achieve beneficial and long-lasting results, it is necessary to combine greater organizational knowledge gained through an awareness of business processes and system interconnectivity with economical sustainability brought about by better planned and more effective decisions (Raut et al., 2019).It is important to emphasize that the technology-based framework established in this context was produced in collaboration with the organization. This indicates that corporate personnel were actively involved from the start through interviews, usability testing, and focus groups. Through a collaborative approach, it was assured that the framework satisfied the organization's unique requirements and offered a tailored solution appropriate for its operational environment. This flexible approach can be used as a base to handle related problems in several additional contexts. This framework can be applied and customized by companies in many industries or sectors by drawing on the collaborative method used throughout its development. The collaborative nature of the approach makes it possible to readily alter and improve the framework to suit the needs of various operational contexts. Because of its adaptability, businesses can take advantage of the best practices and lessons discovered while developing the framework, making it an invaluable tool for achieving desired results in comparable circumstances.

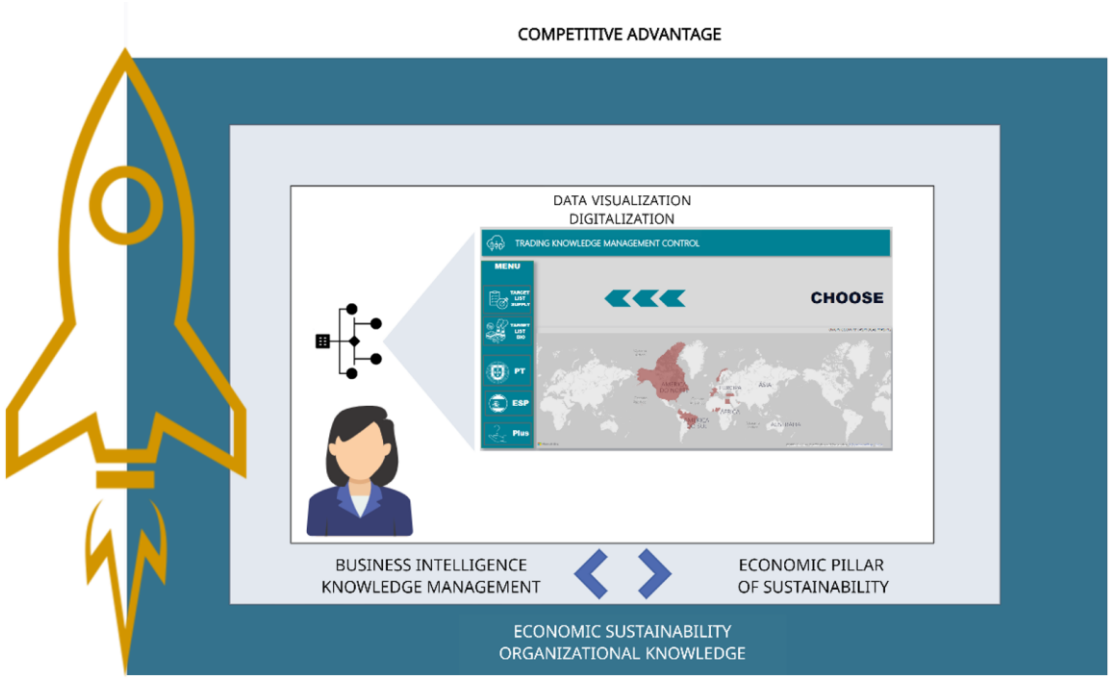


Figure 33 Final TKMC Framework

7. Conclusions

The creation of a post-industrial economy, today's value imperative for the growth of the global economy, is characterized by the identification of knowledge as a key competence, the establishment of an information and communication foundation, and the motorization of the economy, which establishes the importance of innovation and digitalization (Gumba et al., 2021).

As cited in (Mao et al., 2015) also said that there is a long-term causal relationship between IT relatedness and organizational performance, and that intermediary organizational competencies, such knowledge management competency, can moderate this relationship.

Since knowledge is the key resource for streamlining and developing new business processes for the organization, knowledge management might potentially have an impact on how business process management is implemented (Ramadhani & Mahendrawathi, 2019).

A key tool for representing and analyzing processes in the environment of an organization is the business process model (Salvadorinho & Teixeira, 2021). The generated maps make it possible to see how processes and systems are connected, which makes it easier to see gaps and decide which tasks could be automated (Salvadorinho & Teixeira, 2021). With the support of Vortexa®, for example, it was possible to create a more specific list of the vessels to be studied throughout the process as well as the identification of their current location.

In order to establish a technology-based framework that would give warnings, information, and organizational knowledge in order to assist decision-making and boost competitive advantage, a plan was developed from the identification of the problem. It was possible to test the framework and find new opportunities and standout vessels within the analyzed timeframe after data processing, programming, and incorporating the improvements suggested by the evaluation group. Power BI was used to develop the Trading Knowledge Management framework. It is crucial to emphasize that this information was previously not spread widely. It was made possible to resolve this issue by co-creation within this company in the energy sector, with everything being approved by potential users. The framework intends to combine business intelligence and knowledge management, preparing comparable organizations in the researched context for a first step in knowledge management and adaptation to the technology environment. As a result, this approach can be applied to similar businesses. It is important to stress that without theoretical backing, this achievement would not have been feasible. The framework aims to integrate business intelligence with knowledge management, giving comparable businesses a strong platform to start implementing knowledge management strategies and adjusting the rapidly evolving technology environment.

Given the importance and relevance of all the terms developed in this study, it is mandatory to bet on the creation of content and information that brings together the main concepts: knowledge management, competitive advantage, digitalization and the economic pillar of sustainability, given that during the research conducted for the development of section two of this article - literature review - has revealed the little exploration of the relationship of these concepts.

8. Limitations

Multiple restrictions that were discovered throughout the framework's development led to variations in the output of the technical tool. These restrictions will be listed along with the manner they were applied in order of occurrence. The first restriction appeared during the process of identifying ships that met the criteria for being added to the Target List, considering the limitations of the Port of Aveiro and Prio Supply or Prio Bio. Although the characteristics were established in this instance, it was required to develop and analyze the ships independently to export the data from the Vortexa® platform without utilizing the predetermined characteristics. This happened because of a constraint in the Vortexa® platform, which did not offer this option for information filtering and exporting. There would be no need to re-study all the ships anytime the filtered characteristics changed if it were feasible to update the filtered characteristics so that the matching ships would be presented automatically. The inability to export the ships' current locations from the Target List to the technical tool was another restriction found in the Vortexa® platform. The Reuters® platform was utilized to get around this restriction and provide access to this data. To find the ship locations, it was required to use this supplementary source. Thirdly, the ARA zone (Antwerp, Rotterdam, and Amsterdam) was determined to be the best area for conducting business. However, because of how erratic and dynamic the market is, this zone could change over time. Currently, it is not feasible to examine ships that are present in zones other than ARA more often. This restriction results from the market's dynamism and the ongoing requirement to watch over and modify the business zones as circumstances change. Additionally, because Spanish transit movements differ from Portuguese movements and show larger dispersion, they were not considered because they required more research and thorough analysis before being incorporated into the framework. Therefore, to incorporate these motions into the framework, separate research must be done to examine and comprehend them. These restrictions that were brought up throughout the framework's development shed light on the limitations and difficulties that were faced. This awareness aids in identifying areas in need of development and considers potential upgrades and improvements to guarantee the continuous efficacy of the technological instrument.

9. Future Work

To separate the information and allow for the customization of dashboard designs, it is crucial to think about adding trade zone information to the database in addition to the ARA zone in order to ensure efficient future work. Other ships will be able to be added to the Target List in this manner, and the remaining dashboards will contain information that has been filtered to take into consideration all pertinent opportunities and possibilities. To get pertinent warnings when and where they are needed, a study of trends in Spanish transit movements will also be undertaken, including, similarly to what is done with Portuguese movements, the highlights from this research and the corresponding Spanish transit movements. As was already noted, it is imperative that the platform be modified to deliver the

needed information and be in line with the environment in which it functions. In order to update the platform accurately and with the essential, actual, and up-to-date information, frequent contacts will be formed, and evaluation reports will be created for the users. This will allow for improved usage duration, experience, and genuine engagement. The need to maintain a framework that is correct and regularly updated is critical. With this strategy, consumers may have access to trustworthy data and be ready to make judgments based on the dynamic market environment. Finally, to increase the organizational knowledge, it would be interesting to create some methodology to create history and, in turn, study statistics of the trips made by the company itself, with the respective evaluations and feedbacks. Thus, the entire business community would be aware of the actions taken and there would be the possibility to send feedback and keep the communication link active, which is extremely fundamental to achieve the improvement of the performance and positioning of the business entity.

References

Akoka, J., Comyn-Wattiau, I., Prat, N., & Storey, V. C. (2022). Knowledge contributions in design science research: Paths of knowledge types. *Decision Support Systems*. https://doi.org/10.1016/j.dss.2022.113898

Allen, L., Atkinson, J., Jayasundara, D., Cordiner, J., & Moghadam, P. Z. (2021). Data visualization for Industry 4.0: A stepping-stone toward a digital future, bridging the gap between academia and industry. *Patterns*, *2*(5). https://doi.org/10.1016/j.patter.2021.100266

Antunes, R. (2020). Impact of digital transformation on knowledge management in organization. *Advances in Business Related Scientific Research Journal*, *11*(1), 36–47. https://doi.org/10.1145/3560107.3560317

Arevalo, C., Escalona, M. J., Ramos, I., & Domínguez-Muñoz, M. (2016). A metamodel to integrate business processes time perspective in BPMN 2.0. In *Information and Software Technology* (Vol. 77, pp. 17–33). Elsevier B.V. https://doi.org/10.1016/j.infsof.2016.05.004

Arruda, D., & Madhavji, N. H. (2017). The role of big data analytics in corporate decision-making. *DATA 2017 - Proceedings of the 6th International Conference on Data Science, Technology and Applications*, 28–37. https://doi.org/10.5220/0006402300280037

Aslam, J., Saleem, A., Khan, N. T., & Kim, Y. B. (2021). Factors influencing blockchain adoption in supply chain management practices: A study based on the oil industry. *Journal of Innovation and Knowledge*, *6*(2), 124–134. https://doi.org/10.1016/j.jik.2021.01.002

Azizan, S., Ismail, R., Baharum, A., & Hidayah Mat Zain, N. (2022, February 14). Exploring the factors that influence the success of digitalization in an organization's IT department. *2021 6th IEEE International Conference on Recent Advances and Innovations in Engineering, ICRAIE 2021*. https://doi.org/10.1109/ICRAIE52900.2021.9704018

Becker, L. T., & Gould, E. M. (2019). Microsoft Power BI: Extending Excel to Manipulate, Analyze, and Visualize Diverse Data. *Serials Review*, *45*(3), 184–188. https://doi.org/10.1080/00987913.2019.1644891

Brendel, A. B., Lembcke, T. B., Muntermann, J., & Kolbe, L. M. (2021). Toward replication study types for design science research. *Journal of Information Technology*, *36*(3), 198–215. https://doi.org/10.1177/02683962211006429

Cao, G., Duan, Y., & Cadden, T. (2019). The link between information processing capability and competitive advantage mediated through decision-making effectiveness. *International Journal of Information Management*, *44*, 121–131. https://doi.org/10.1016/j.ijinfomgt.2018.10.003

Ching, N. T., Ghobakhloo, M., Iranmanesh, M., Maroufkhani, P., & Asadi, S. (2022). Industry 4.0 applications for sustainable manufacturing: A systematic literature review and a roadmap

to sustainable development. *Journal of Cleaner Production*, *334*. https://doi.org/10.1016/j.jclepro.2021.130133

Cuadrado-Gallego, J. J., Demchenko, Y., Losada, M. A., & Ormandjieva, O. (2021). Classification and analysis of techniques and tools for data visualization teaching. *IEEE Global Engineering Education Conference, EDUCON*, *2021-April*, 1593–1599. https://doi.org/10.1109/EDUCON46332.2021.9453917

Felsberger, A., Qaiser, F. H., Choudhary, A., & Reiner, G. (2022). The impact of Industry 4.0 on the reconciliation of dynamic capabilities: Evidence from the european manufacturing industries. *Production Planning and Control*, *33*(2–3), 277–300. https://doi.org/10.1080/09537287.2020.1810765

Foster, K., Smith, G., Ariyachandra, T., & Frolick, M. N. (2015). Business Intelligence Competency Center: Improving Data and Decisions. *Information Systems Management*, *32*(3), 229–233. https://doi.org/10.1080/10580530.2015.1044343

García-Holgado, A., García-Peñalvo, F. J., Hernández-García, Á., & Llorens-Largo, F. (2015). *Analysis and improvement of knowledge management processes in organizations using the Business Process Model Notation*.

Ghasemi, B., Khalijian, S., Daim, T. U., & Mohammadipirlar, E. (2021). Knowledge management performance measurement based on World-Class Competitive advantages to develop strategic-oriented projects: Case of Iranian oil industry. *Technology in Society*, *67*. https://doi.org/10.1016/j.techsoc.2021.101691

Gibellato, S., Ballestra, L. V., Fiano, F., Graziano, D., & Luca Gregori, G. (2023). The impact of education on the Energy Trilemma Index: A sustainable innovativeness perspective for resilient energy systems. *Applied Energy*, *330*. https://doi.org/10.1016/j.apenergy.2022.120352

Gina, B., & Budree, A. (2020). *A review of literature on critical factors that drive the selection of business intelligence tools*.

González-Ramos, M. I., Guadamillas, F., & Donate, M. J. (2023). The relationship between knowledge management strategies and corporate social responsibility: Effects on innovation capabilities. *Technological Forecasting and Social Change*, *188*. https://doi.org/10.1016/j.techfore.2022.122287

Gumba, K., Uvarova, S., Belyaeva, S., & Vlasenko, V. (2021). Innovations as sustainable competitive advantages in the digital economy: Substantiation and forecasting. *E3S Web of Conferences*, *244*. https://doi.org/10.1051/e3sconf/202124410011

Gupta, A., Kr Singh, R., Kamble, S., & Mishra, R. (2022). Knowledge management in industry 4.0 environment for sustainable competitive advantage: a strategic framework. *Knowledge Management Research & Practice*, 1–15. https://doi.org/10.1080/14778238.2022.2144512

Gupta, A., Poels, G., & Bera, P. (2023). Generating multiple conceptual models from behavior-driven development scenarios. *Data and Knowledge Engineering*, *145*. https://doi.org/10.1016/j.datak.2023.102141

Haryanti, T., Rakhmawati, N. A., Subriadi, A. P., & Tjahyanto, A. (2022). The design science research methodology (DSRM) for self-assessing digital transformation maturity index in

Indonesia. *Proceedings of the 2022 IEEE 7th International Conference on Information Technology and Digital Applications, ICITDA 2022*. https://doi.org/10.1109/ICITDA55840.2022.9971171

Hlupic, V., de Vreede, G. J., & de Vreede, G. J. (2005). Business process modelling using discrete-event simulation: current opportunities and future challenges. *International Journal of Simulation and Process Modelling*, *1*(1–2), 72–81. https://doi.org/10.1504/ijspm.2005.007115

Horvat, D., Kroll, H., & Jäger, A. (2019). Researching the effects of automation and digitalization on manufacturing companies' productivity in the early stage of industry 4.0. *Procedia Manufacturing*, *39*, 886–893. https://doi.org/10.1016/j.promfg.2020.01.401

Isaksson, A. J., Harjunkoski, I., & Sand, G. (2018). The impact of digitalization on the future of control and operations. *Computers and Chemical Engineering*, *114*, 122–129. https://doi.org/10.1016/j.compchemeng.2017.10.037

Islam, M., & Jin, S. (2019). An overview of data visualization. In *2019 International Conference on Information Science and Communications Technologies (ICISCT)*.

Jacob, F., Pez, V., & Volle, P. (2021). Principles, methods, contributions, and limitations of design science research in marketing: Illustrative application to customer journey management. *Recherche et Applications En Marketing*. https://doi.org/10.1177/20515707211032537

Joe Turner, A., Editorial Board, U., Meyer, B., Zurich, E., Rannenberg, K., & Bramer, M. A. (2009). *Leveraging knowledge for innovation in collaborative networks*.

Kabugo, J. C., Jämsä-Jounela, S. L., Schiemann, R., & Binder, C. (2020). Industry 4.0 based process data analytics platform: A waste-to-energy plant case study. *International Journal of Electrical Power and Energy Systems*, *115*. https://doi.org/10.1016/j.ijepes.2019.105508

Kadcha, Y., Legmouz, D., & Hajji, R. (2022). AN INTEGRATED BIM-POWER BI APPROACH FOR DATA EXTRACTION AND VISUALIZATION. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives*, *48*(4/W4-2022), 67–73. https://doi.org/10.5194/isprs-archives-XLVIII-4-W4-2022-67-2022

Kalpič, B., & Bernus, P. (2006). Business process modeling through the knowledge management perspective. *Journal of Knowledge Management*, *10*(3), 40–56. https://doi.org/10.1108/13673270610670849

Khalwadekar, R., & Gogate, U. (2022). Quantitative and Causal Analysis of Techniques of Microsoft Power BI File Optimisation. *5th IEEE International Conference on Advances in Science and Technology, ICAST 2022*, 35–39. https://doi.org/10.1109/ICAST55766.2022.10039578

Khan, I., Hou, F., Irfan, M., Zakari, A., & Le, H. P. (2021). Does energy trilemma a driver of economic growth? The roles of energy use, population growth, and financial development. *Renewable and Sustainable Energy Reviews*, *146*. https://doi.org/10.1016/j.rser.2021.111157

Khan, I., Zakari, A., Dagar, V., & Singh, S. (2022). World energy trilemma and transformative energy developments as determinants of economic growth amid environmental sustainability. *Energy Economics*, *108*. https://doi.org/10.1016/j.eneco.2022.105884

Khatuwal, V. S., & Puri, D. (2022). Business Intelligence Tools for Dashboard Development. *Proceedings of 3rd International Conference on Intelligent Engineering and Management, ICIEM 2022*, 128–131. https://doi.org/10.1109/ICIEM54221.2022.9853086

Kholiya, P. S., Kapoor, A., Rana, M., & Bhushan, M. (2021). Intelligent Process Automation: The future of digital transformation. *Proceedings of the 2021 10th International Conference on System Modeling and Advancement in Research Trends, SMART 2021*, 185–190. https://doi.org/10.1109/SMART52563.2021.9676222

Ko, R. K. L., Lee, S. S. G., & Lee, E. W. (2009). Business process management (BPM) standards: A survey. *Business Process Management Journal*, *15*(5), 744–791. https://doi.org/10.1108/14637150910987937

Kumar, P., Sharma, D., & Pandey, P. (2022). Industry 4.0 (I4.0) Based Virtual Organization Model for the Coordination of Sustainable Textile Supply Chain. In *American Business Review* (Vol. 25, Issue 1, pp. 186–208). Pompea College of Business, University of New Haven. https://doi.org/10.37625/abr.25.1.186-208

Liang, R., Huang, C., Zhang, C., Li, B., Saydam, S., & Canbulat, I. (2023). Exploring the fusion of data visualisation and data analytics in the process of mining digitalisation. *IEEE Access*. https://doi.org/10.1109/ACCESS.2023.3267813

Lig˛ Eza, A., & Potempa, T. (2014). *Artificial intelligence for knowledge management with BPMN and rules*.

Liu, Y., & Feng, C. (2023). Promoting renewable energy through national energy legislation. *Energy Economics*, *118*. https://doi.org/10.1016/j.eneco.2023.106504

Luo, W. W., & Chen, X. Y. (2011). A research on flexible business process management system based on knowledge base and semantic web services. *Proceedings of 2011 International Conference on Electronic and Mechanical Engineering and Information Technology, EMEIT 2011*, *8*, 4289–4292. https://doi.org/10.1109/EMEIT.2011.6023989

Ma, Y., & Li, B. (2022). Effect of digitalization on knowledge transfer from universities to enterprises: Evidence from postdoctoral workstation of Chinese enterprises. *Technology in Society*, *71*. https://doi.org/10.1016/j.techsoc.2022.102102

Maindze, A., Skaf, Z., & Jennions, I. (2019). *Towards an Enhanced Data-and Knowledge Management Capability: A Data Life Cycle Model Proposition for Integrated Vehicle Health Management*.

Mao, H., Liu, S., & Zhang, J. (2015). IT resource and competitive advantage: Role of knowledge management capability and resource commitment. *Proceedings of the Annual Hawaii International Conference on System Sciences*, *2015-March*, 3791–3800. https://doi.org/10.1109/HICSS.2015.456

Marnewick, C., & Marnewick, A. L. (2022). Digitalization of project management: Opportunities in research and practice. *Project Leadership and Society*, *3*, 100061. https://doi.org/10.1016/j.plas.2022.100061

Meski, O., Belkadi, F., Laroche, F., Ladj, A., & Furet, B. (2019). Integrated data and knowledge management as key factor for industry 4.0. *IEEE Engineering Management Review*, *47*(4), 94–100. https://doi.org/10.1109/EMR.2019.2948589

Microsoft. (2023). *Microsoft Power Automate*.

Moghimi, F., & Zheng, C. (2009). A decision-making model to choose business intelligence platforms for organizations. *3rd International Symposium on Intelligent Information Technology Application, IITA 2009*, *2*, 73–77. https://doi.org/10.1109/IITA.2009.408

Moore, J. (2017). Data visualization in support of executive decision making. In *Interdisciplinary Journal of Information, Knowledge, and Management* (Vol. 12). http://www.informingscience.org/Publications/3687

Muskan, Singh, G., Singh, J., & Prabha, C. (2022). Data visualization and its key fundamentals: A comprehensive survey. *7th International Conference on Communication and Electronics Systems, ICCES 2022 - Proceedings*, 1710–1714. https://doi.org/10.1109/ICCES54183.2022.9835803

Object Management Group. (2011). *Business Process Model and Notation (BPMN), Version 2.0*. http://www.omg.org/spec/BPMN/20100501

Oesterreich, T. D., & Teuteberg, F. (2016). Understanding the implications of digitisation and automation in the context of Industry 4.0: A triangulation approach and elements of a research agenda for the construction industry. In *Computers in Industry* (Vol. 83, pp. 121–139). Elsevier B.V. https://doi.org/10.1016/j.compind.2016.09.006

Olszak, C. M. (2022). Business Intelligence Systems for Innovative Development of Organizations. *Procedia Computer Science*, *207*, 1754–1762. https://doi.org/10.1016/j.procs.2022.09.233

Park, S., Bekemeier, B., Flaxman, A., & Schultz, M. (2022). Impact of data visualization on decision-making and its implications for public health practice: A systematic literature review. *Informatics for Health and Social Care*, *47*(2), 175–193. https://doi.org/10.1080/17538157.2021.1982949

Pattanasing, K., Aujirapongpan, S., Dowpiset, K., Chanthawong, A., Jiraphanumes, K., & Hareebin, Y. (2022). Dynamic knowledge management capabilities: An approach to high-performance organization. *HighTech and Innovation Journal*, *3*(3), 243–251. https://doi.org/10.28991/HIJ-2022-03-03-01

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, *24*(3), 45–77. https://doi.org/10.2753/MIS0742-1222240302

Petrović, P. (2022). Economic sustainability of energy conservation policy: improved panel data evidence. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-021-02104-6

Polyvyanyy, A., Ouyang, C., Barros, A., & van der Aalst, W. M. P. (2017). Process querying: Enabling business intelligence through query-based process analytics. *Decision Support Systems*, *100*, 41–56. https://doi.org/10.1016/j.dss.2017.04.011

Pries-Heje, J. R., Baskerville ; Venable, J. ;, Pries-Heje, J. R., & Baskerville, J. (2017). Choosing a design science research methodology. In *Australia Choosing a Design Science Research Methodology* (Vol. 2). APA.

Qhal, E. M. A. (2022). Role of Business Intelligence and Knowledge Management in Solving Business Problems. *Tehnicki Glasnik*, *16*(3), 371–378. https://doi.org/10.31803/tg-20220531145604

Qin, X., Luo, Y., Tang, N., & Li, G. (2020). Making data visualization more efficient and effective: A survey. *VLDB Journal*, *29*(1), 93–117. https://doi.org/10.1007/s00778-019-00588-3

Rajaram, A., Olory, C., Leduc, V., Evaristo, G., Coté, K., Isenberg, J., Isenberg, J. S., Dai, D. L., Karamchandani, J., Chen, M. F., Maedler-Kron, C., & Fiset, P. O. (2022). An integrated virtual pathology education platform developed using Microsoft Power Apps and Microsoft Teams. *Journal of Pathology Informatics*, *13*. https://doi.org/10.1016/j.jpi.2022.100117

Ramadan, M., Amer, T., Salah, B., & Ruzayqat, M. (2022). The impact of integration of industry 4.0 and internal organizational forces on sustaining competitive advantages and achieving strategic objectives. *Sustainability (Switzerland)*, *14*(10). https://doi.org/10.3390/su14105841

Ramadhani, F., & Mahendrawathi, E. R. (2019). A conceptual model for the use of social software in business process management and knowledge management. *Procedia Computer Science*, *161*, 1131–1138. https://doi.org/10.1016/j.procs.2019.11.225

Rane, S. B., & Narvel, Y. A. M. (2021). Leveraging the industry 4.0 technologies for improving agility of project procurement management processes. *International Journal of System Assurance Engineering and Management*, *12*(6), 1146–1172. https://doi.org/10.1007/s13198-021-01331-4

Rassameeroj, I., Jomkhamsri, P., & Thaithaweewattana, N. (2022). Student Request System Prototype Using Low-Code Development Platform. *Proceedings - 2022 International Conference on Algorithms, Data Mining, and Information Technology, ADMIT 2022*, 190–195. https://doi.org/10.1109/ADMIT57209.2022.00038

Raut, R. D., Mangla, S. K., Narwane, V. S., Gardas, B. B., Priyadarshinee, P., & Narkhede, B. E. (2019). Linking big data analytics and operational sustainability practices for sustainable business management. *Journal of Cleaner Production*, *224*, 10–24. https://doi.org/10.1016/j.jclepro.2019.03.181

Sai Ramesh, A., Vigneshwar, S., Vickram, S., Manikandan, S., Subbaiya, R., Karmegam, N., & Kim, W. (2023). Artificial intelligence driven hydrogen and battery technologies – A review. *Fuel*, *337*. https://doi.org/10.1016/j.fuel.2022.126862

Sakhnyuk, P. A., Sakhnyuk, T. I., & Korshikova, M. V. (2020). The use of intelligent technologies of Business Intelligence Platforms and Data Science and Machine Learning Platforms for monitoring the socio-economic indicators of the administrative districts of Moscow. *IOP Conference Series: Materials Science and Engineering*, *873*(1). https://doi.org/10.1088/1757-899X/873/1/012015

Salvadorinho, J., & Teixeira, L. (2021). Organizational knowledge in the I4.0 using BPMN: A case study. *Procedia Computer Science*, *181*, 981–988. https://doi.org/10.1016/j.procs.2021.01.266

Sarnikar, S., & Deokar, A. (2010). Knowledge management systems for knowledge-intensive processes: Design approach and an illustrative example. *Proceedings of the Annual Hawaii International Conference on System Sciences*. https://doi.org/10.1109/HICSS.2010.248

Seriño, M. N. V. (2022). Energy security through diversification of non-hydro renewable energy sources in developing countries. *Energy and Environment*, *33*(3), 546–561. https://doi.org/10.1177/0958305X211013452

Shah, T. R. (2022). Can big data analytics help organisations achieve sustainable competitive advantage? A developmental enquiry. *Technology in Society*, *68*. https://doi.org/10.1016/j.techsoc.2021.101801

Shaulska, L., Yurchyshena, L., & Popovskyi, Y. (2021). Using MS Power BI Tools in the University Management System to Deepen the Value Proposition. *2021 11th International Conference on Advanced Computer Information Technologies, ACIT 2021 - Proceedings*, 294–298. https://doi.org/10.1109/ACIT52158.2021.9548447

Shehabat, I. (2020). The role of knowledge management in organizational performance and gaining sustainable competitive advantage. *ACM International Conference Proceeding Series*, 133–139. https://doi.org/10.1145/3399871.3399878

Shen-Hsieh, A., & Schindler, M. (2022). *Data Visualization for Strategic Decision Making*.

Shi, X., & Liao, Z. (2013). The mediating effects of interfirm business process integration and joint teamwork on firm performance in supply chains. *Asia Pacific Journal of Management*, *30*(4), 1243–1264. https://doi.org/10.1007/s10490-012-9308-6

Sofiyabadi, J., Valmohammadi, C., & Asl, A. S. (2022). Impact of knowledge management practices on innovation performance. *IEEE Transactions on Engineering Management*, *69*(6), 3225–3239. https://doi.org/10.1109/TEM.2020.3032233

Solana-González, P., Trigueros-Preciado, S., Pérez González, D., Solana González, P., & Trigueros Preciado, S. (2013). *Strategy of information security in small and medium enterprises, an technology-enterprise approach: Analysis of its relationship with organizational and performance business variables*. https://www.researchgate.net/publication/294581512

Syahchari, D., Saroso, H., Lasmy, Sudrajat, D., & Herlina, M. (2020). *The effect of information technology, strategic leadership and knowledge management on the competitive advantage in the chemical industry*.

Tabares, M. S., Giraldo, L., & Joyanes, L. (2016). Improving the business processes management from the knowledge management. *ACM International Conference Proceeding Series*, *Part F130520*. https://doi.org/10.1145/2925995.2925998

Telukdarie, A. (2019). Business Processes: A critical tool for Industry 4.0 enablement. In *2019 International Conference on Fourth Industrial Revolution (ICFIR)*.

Thomson Reuters. (2012). *THOMSON REUTERS CONTEX*.

Tyndale, P. (2002). *A taxonomy of knowledge management software tools: Origins and applications*. www.elsevier.com/locate/evalprogplan

Valmohammadi, C. (2017). Customer relationship management: Innovation and performance. *International Journal of Innovation Science*, *9*(4), 374–395. https://doi.org/10.1108/IJIS-02-2017-0011

Van Der Walt, A., Gilliland, S., & Smit, I. (2021, August 5). Data Migration in Support of Business Intelligence in a Growing Organization. *IcABCD 2021 - 4th International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems, Proceedings*. https://doi.org/10.1109/icABCD51485.2021.9519357

Vokony, I., Taczi, I., & Szalmane Csete, M. (2022). Agile digitalization evolution in the energy sector, taking into account innovative and disruptive technologies. *Renewable Energy and Power Quality Journal*, *20*, 584–589. https://doi.org/10.24084/repqj20.375

Vortexa. (2022). *Vortexa | Real-Time Energy Cargo Tracking*. https://www.vortexa.com/?gclid=EAIaIQobChMI6fr8s7ae_AIVR7LVCh1BaAkcEAAYASAAEgLOmvD_BwE

Vuchkovski, D., Zalaznik, M., Mitręga, M., & Pfajfar, G. (2023). A look at the future of work: The digital transformation of teams from conventional to virtual. *Journal of Business Research*, *163*. https://doi.org/10.1016/j.jbusres.2023.113912

Wang, F. Y., Yan, A. M., Li, X. Z., & Yang, L. F. (2011). Cloud computing based business intelligence platform and its application in the field of intelligent power consumption. *2011 International Conference on Electronics, Communications and Control, ICECC 2011 - Proceedings*, 3612–3616. https://doi.org/10.1109/ICECC.2011.6066291

Wang, J., Omar, A. H., Alotaibi, F. M., Daradkeh, Y. I., & Althubiti, S. A. (2022). Business intelligence ability to enhance organizational performance and performance evaluation capabilities by improving data mining systems for competitive advantage. *Information Processing and Management*, *59*(6). https://doi.org/10.1016/j.ipm.2022.103075

Wang, X. Y., & Mu, Y. (2009). The using of knowledge visualization tools in e-Science environment - Take concept maps for example. *Proceedings - 2009 IITA International Conference on Control, Automation and Systems Engineering, CASE 2009*, 39–42. https://doi.org/10.1109/CASE.2009.130

World Energy Council. (2022). *World Energy Trilemma Index 2022*. www.worldenergy.org

Wu, W., Liang, Z., & Zhang, Q. (2022). Technological capabilities, technology management and economic performance: the complementary roles of corporate governance and institutional environment. *Journal of Knowledge Management*, *26*(9), 2416–2439. https://doi.org/10.1108/JKM-02-2021-0135

Xu, X., Lu, Y., Vogel-Heuser, B., & Wang, L. (2021). Industry 4.0 and Industry 5.0—Inception, conception and perception. *Journal of Manufacturing Systems*, *61*, 530–535. https://doi.org/10.1016/j.jmsy.2021.10.006

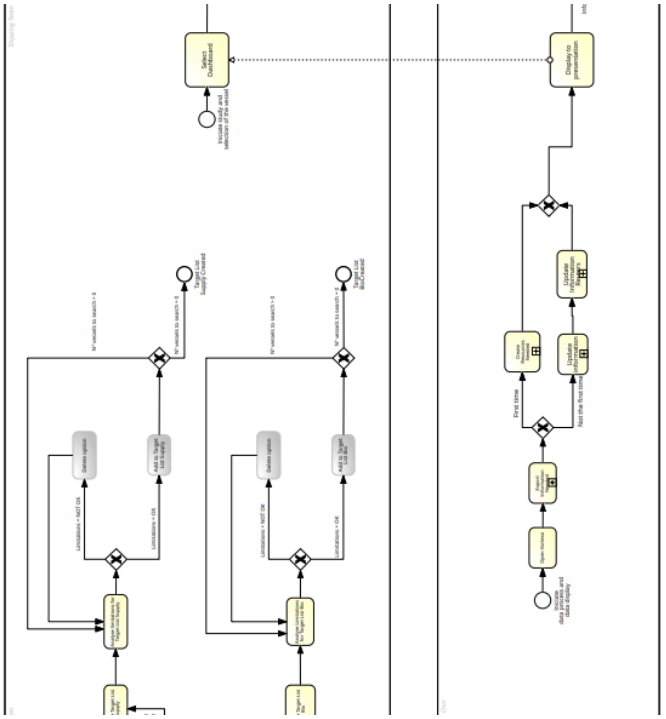
Yang, M., Sulaiman, R., Yin, Y., Mallamaci, V., & Alrabaiah, H. (2022). The effect of business intelligence, organizational learning and innovation on the financial performance of innovative companies located in Science Park. *Information Processing and Management*, *59*(2). https://doi.org/10.1016/j.ipm.2021.102852

Zhou, H. (2022). *A study of technical support for artificial intelligence systems applied to knowledge management systems*. 921–924. https://doi.org/10.1109/icpeca53709.2022.9718930

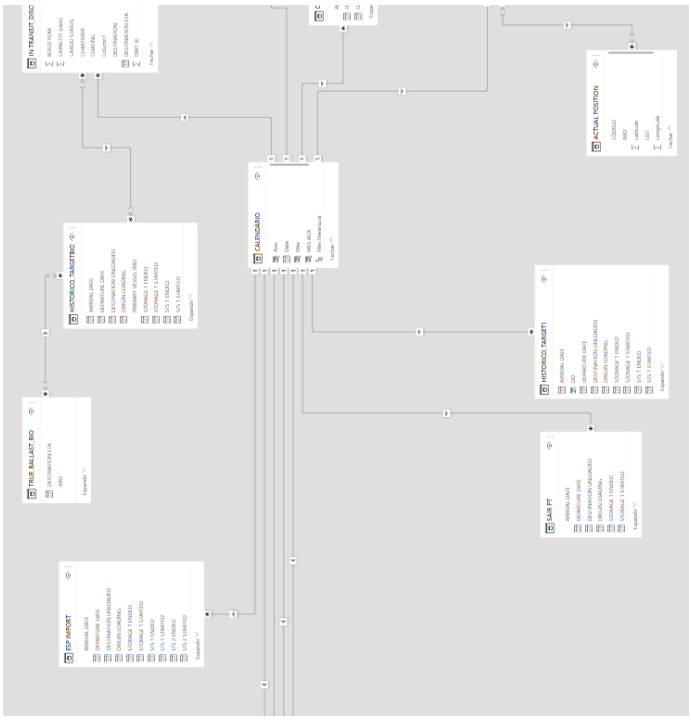
Zulkafli, S. M., Ariffin, M. M., & Zakariya, A. (2022). Data Analytics and Visualization of Remote Healthcare Monitoring System. *2022 6th International Conference on Computing, Communication, Control and Automation, ICCUBEA 2022*. https://doi.org/10.1109/ICCUBEA54992.2022.10010938

Attachments

Annex I



Annex II



Annex III

***TKMC* – TESTE DE USABILIDADE**

TKMC: plataforma desenvolvida com o intuito de facilitar a transição das empresas rumo a um futuro sustentável do ponto de vista do conhecimento e da economia, oferecendo um local único para gerir informações. O processo tem como objetivo oferecer uma solução abrangente para as empresas se manterem informadas e tomarem decisões que apoiem o desenvolvimento económico e sustentável, mantendo as empresas informadas para decidir sobre a gama de oportunidades que atendam às características ideais para realizar negócios interempresariais, o que permitirá à empresa obter uma vantagem competitiva e manter os pilares da sustentabilidade com um foco maior no pilar económico.

São quatro os pontos principais de informação que esta plataforma fornece: Disponibilidade dos navios pertencentes às *Target Lists*, Movimentos Live e Históricos para Portugal, Movimentos Históricos para Espanha e foi colocado um extra de Movimentos Live da China para Europa.

Este teste de usabilidade visa incidir na movimentação ao longo da plataforma em todos os pontos de informação, com o principal objetivo de o usuário saber rapidamente e de forma muito fácil onde obter a informação pretendida. O primeiro ponto, *Target List* (Supply e Bio), tem como objetivo principal identificar a disponibilidade dos navios, para cada um dos casos isoladamente, para negociação suportando com a identificação da sua localização atual, últimas viagens e também o número de viagens na zona de ARA e Rússia. Ao incluir *dashboards* específicos para Portugal e Espanha, a plataforma permite uma análise mais aprofundada desses mercados, possibilitando uma tomada de decisão mais ajustada e informada em relação a questões como a oferta e procura de combustíveis, a concorrência no mercado e as políticas governamentais relevantes, estando a informação disposta ajustada às particularidades desses países.
Assim, o propósito deste estudo é perceber, através do desenvolvimento da plataforma mencionada,qual o grau de usabilidade da ferramenta em questão e quais os aspetos a serem melhorados.

Este documento apresenta uma lista de tarefas a serem executadas, por cada um dos envolventes no protótipo apresentado da plataforma *TKMC*, durante uma sessão de avaliação na presença de um observador. De referir que este teste se destinaa avaliar o sistema usado e não o utilizador, como tal não deverá sentir-se pressionado pelo tempo,tarefa incompleta ou outro fator que o possa desconcentrar. Sempre que for formulada uma questão por parte do observador, deverá responder oralmente. Pode igualmente formular as questões que achar necessárias ao observador. Depois de terminar cada tarefa, deverá assinalar o grau de facilidade da sua execução usando para o efeito a escala numérica apresentada (onde 1 representa o extremo - Nada fácil - e 5 o extremo -Muito fácil).

Número da Tarefa	Descrição	Avaliação				
1	Opta por estudar uma das Target Lists e responde à pergunta: Quais são os navios disponíveis para negociação no dia 17/05?	Nada Fácil 1	2	3	4	Muito Fácil 5
2	No mesmo dashboard, opta por um dos navios disponíveis e indica: - Uma das últimas viagens; - Localização Atual; - NºRotas em ARA	Nada Fácil 1	2	3	4	Muito Fácil 5
3	Volta ao menu inicial e acede aos Movimentos Live - Chegadas a PT Perante a informação disposta há algum tipo de movimentos com Bios a ocorrer neste momento? Se sim, indica toda a informação que consegues obter a partir deste dashboard	Nada Fácil 1	2	3	4	Muito Fácil 5
4	Volta ao menu. Consegues aceder aos movimentos live espanhóis?	Nada Fácil 1	2	3	4	Muito Fácil 5
5	Volta ao menu inicial e acede às importações portuguesas. No mês de maio, diz-me: - Origem; - Destino; - Produto; - Quantidade	Nada Fácil 1	2	3	4	Muito Fácil 5
6	Neste mesmo dashboard, limpa todos os filtros. Indica qual é o TOP3 Produtos Importados associados à Petrogal em 2023	Nada Fácil 1	2	3	4	Muito Fácil 5
7	Volta ao menu inicial e acede às exxportações portuguesas. Que produtos estiveram envolvidos nas exportações de Lisboa em 2023?	Nada Fácil 1	2	3	4	Muito Fácil 5
8	Volta ao menu inicial e acede às importações espanholas, especificamente de bios: Quais sãos os portos de destino que recebem produto da Indonésia? Neste caso, qual é a categoria de biodiesel que se destaca?	Nada Fácil 1	2	3	4	Muito Fácil 5
9	Volta ao menu inicial. Relativamente a exportações espanholas, indica, caso seja verdade: - Quais são as rotas raras associadas aos movimentos com "Other Biodiesel" em Abril 2023?	Nada Fácil 1	2	3	4	Muito Fácil 5
10	Volta ao menu inicial. Indica 2 navios que estão em trânsito China - ARA	Nada Fácil 1	2	3	4	Muito Fácil 5

nnex IV

Focus Group

Primeiramente, agradecer toda a colaboração e envolvimento na realização e concretização desta análise! Estequestionário é anónimo e todos os dados que nele forem descritos serão tratados de forma confidencial (cumprindo as normas do RGPD) e agregada, servindo apenas para o propósito desteestudo. Agradecemos a sua colaboração fundamental para o sucesso deste trabalho e, por isso, solicitamos que responda a cada pergunta expressando a sua posição sincera.

Qual o seu nome:

1) Qual a sua idade:

☐ 20-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ 61-70

2) Qual o seu sexo: ☐ Masculino ☐ Feminino

3) Qual o seu grau de escolaridade:

	Primeiro Ciclo (1º ao 4º ano)
	Segundo Ciclo (5º ao 6º ano)
	Terceiro Ciclo (7º ao 9º ano)
	Ensino Secundário
	Licenciatura
	Mestrado
	Doutoramento

4) Qual a sua função na organização?

Perguntas sobre a plataforma

1) Numa escala de 1-7 em que o 1 representa extremamente provável e o 7 extremamente improvável, classifique as seguintes afirmações acerca da **utilidade** percecionada no sistema:

Afirmação	1 Extremamente provável	2 Bastante provável	3 Ligeiramente provável	4 Neutro	5 Ligeiramente improvável	6 Bastante improvável	7 Extremamente improvável
Utilizar esta plataforma no meu trabalho aumentaria a minha produtividade							
A utilização desta plataforma facilitaria o meu trabalho							
Eu acharia esta plataforma útil no meu trabalho							

2) Numa escala de 1-7 em que o 1 representa extremamente provável e o 7 extremamente improvável, classifique as seguintes afirmações acerca da **facilidade** de utilização percecionada no sistema:

Afirmação	1 - Extremamente provável	2 - Bastante provável	3- Ligeiramente provável	4- Neutro	5- Ligeiramente improvável	6- Bastante improvável	7- Extremamente improvável
Aprender a trabalhar nesta plataforma seria fácil para mim							
Seria fácil conseguir que esta plataforma fizesse o que eu quero fazer							
A minha interação com esta plataforma seria clara e compreensível							
Eu acharia esta plataforma fácil de usar							

3) Numa escala de Likert (1-5) em que o 1 representa discordo totalmente e o 5 concordo totalmente, classifique as seguintes afirmações acerca da utilização do sistema:

Afirmação	1 Discordo totalmente	2 Discordo	3 Neutro	4 Concordo	5 Concordo totalmente
O sistema é agradável de utilizar					
A plataforma era fácil de navegar					
A organização da informação estava intuitiva					
A informação foi fácil de obter					
A linguagem da plataforma era adequada e apropriada					
Este sistema tem algumas características irritantes					
Em termos gerais, fiquei satisfeito com a plataforma					
Houve informação que faltou e que gostaria de ver apresentada					

3) Comentários finais:
(*Nomeadamente, a nível de melhorias de design, apresentação/falta de informação*):

Obrigada pela participação!