MESTRADO EM ESTRATÉGIA DE INVESTIMENTO E INTERNACIONALIZAÇÃO

The potential of Logistics 4.0 technologies: A case study through Business Intelligence

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ABSTRACT

The growing competitiveness and the importance of data availability for organizations have created a demand for intelligent information systems capable of analyzing data to support strategy and decision-making. Organizations are generating more and more data due to new technologies associated with Industry 4.0 and Logistics 4.0, making it essential to transform this data into relevant information to streamline decision-making processes. This study aims to understand the importance of Business Intelligence (BI) and how its functionalities should be adapted according to a company's strategy and objectives to optimize decision-making processes. A case study was conducted in a Portuguese company using the Delphi method with 61 participants—employees who use the company's integrated BI tool daily. The participants were presented with a questionnaire via the online platform Welphi, requiring qualitative responses to various statements based on the literature review and the results of semi-structured meetings with the company. The study aimed to identify areas where employees believe more investment/development is needed to optimize processes and improve the use of the BI tool in the future. The results indicate that BI is a crucial technology when aligned with a company's objectives and needs, highlighting the necessity of top management's involvement in optimizing the BI tool. Encouraging employees to use the BI tool emerged as a significant factor, underscoring the importance of leadership in innovative projects to achieve greater competitive advantage for the company.

Keywords: Logistics 4.0; Business Intelligence; Delphi method; Decision-making; Case study.

RESUMO

A crescente competitividade e a importância da disponibilidade de dados para as organizações criaram uma procura por sistemas de informação inteligentes capazes de analisar dados para apoiar a estratégia e a tomada de decisões. As organizações estão a gerar mais dados devido às novas tecnologias associadas à Indústria 4.0 e à Logística 4.0, tornando essencial transformar esses dados em informação relevante para agilizar a tomada de decisões. Este estudo tem como objetivo compreender a importância do *Business Intelligence* (BI) e como as suas funcionalidades deverão ser adaptadas de acordo com a estratégia e os objetivos de uma empresa para otimizar os processos de tomada de decisão. Foi realizado um estudo de caso numa empresa portuguesa utilizando o método *Delphi* com 61 participantes – colaboradores que utilizam diariamente a ferramenta integrada de BI da empresa. Foi apresentado aos participantes um questionário por meio da plataforma online *Welphi*, exigindo respostas qualitativas a diversas afirmações baseadas na revisão da literatura e nos resultados de reuniões semiestruturadas com a empresa. O estudo teve como objetivo identificar áreas onde os colaboradores acreditam que é necessário mais investimento/ desenvolvimento para otimizar processos e melhorar a utilização da ferramenta de BI no futuro. Os resultados indicam que o BI é uma tecnologia crucial quando alinhada com os objetivos e necessidades de uma empresa, destacando a necessidade do envolvimento da gestão de topo na otimização da ferramenta de BI. O incentivo ao uso da ferramenta de BI aos colaboradores surgiu como um fator significativo, ressaltando a importância da liderança em projetos inovadores na obtenção de maior vantagem competitiva para a empresa.

Palavras-chave: Logística 4.0; *Business Intelligence*; Método *Delphi*; Tomada de decisão; Estudo de caso.

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LIST OF ABBREVIATIONS

AI - Artificial Intelligence

BDA - Big Data Analytics

BI - Business Intelligence

EU - European Union

I4.0 - Industry 4.0

IT - Information Technology

KPI - Key Performance Indicator

L4.0 - Logistics 4.0

CHAPTER 1

INTRODUCTION

This chapter will outline the rationale behind selecting this topic for discussion. It will be analyzing the problem in the context of current events and prevailing trends. The study's objective and problem formulation will be explained, along with the identification of the research question. Lastly, the structure of this work will be detailed.

1.1 Background of study

In the contemporary era, businesses are transitioning from manual practices to digitalization, aiming to address business challenges, intricacies, and issues related to accessibility. Digital transformation enables companies to integrate automated systems and information technology to enhance operational processes and streamline efficiency. Digital technologies offer capabilities for managing data, optimizing business operations, and minimizing human errors, thereby facilitating the execution of multiple tasks in reduced timeframes (Acioli *et al.*, 2021).

According to Atumonye (2022), within the logistics sector, Industry 4.0 (I4.0) technologies assume a pivotal role, enabling logistics companies to transition from manual operations to automation and digitalization. This shift enhances performance and market capabilities, offering a spectrum of advantages, including heightened operational efficiency and the evolution of innovative business models, products, and services.

Leveraging these technologies facilitates the development of automated systems and remote access controls by logistics companies, streamlining the effectiveness of accessing and processing logistics operations (Schumacher *et al.,* 2016). Considering the rapid adoption and adaptation pace observed in today's market towards emerging technologies, companies are striving to stay abreast of technological advancements. In line with this notion, managers have recognized the necessity for technological system implementations to align seamlessly with organizational planning, objectives, and strategies (Luftman, 2000). Consequently, recent years have witnessed several information systems projects aimed at aligning Information Technology (IT) with the company's overarching strategy.

These information systems projects yield specific data, enabling organizations to derive value, particularly through Business Intelligence (BI) initiatives. Such projects have the

potential to enhance decision-making quality and overall value generation. Nonetheless, undertaking these projects involves significant investments in both systems and resources for organizations (Fernandes, 2017). As investments levels rise, it becomes imperative to grasp the prospective benefits and distinct value that these information systems will truly deliver to organizations in the foreseeable future.

1.2 Motivation

1.2.1 Nowadays

In today's society, data and information play pivotal roles in guiding corporate decision-making processes. With intense business competition and a growing emphasis on success and resource optimization, companies are compelled to continually enhance their performance (Porter and Millar, 1985). This sought-after data and information serve as the bedrock for generating insights, mitigating risks, devising investment strategies, reducing expenses, streamlining processes, and other initiatives aimed at bolstering a company's competitive edge (Sonda, 2024). Most executives recognize the ongoing "information revolution" and acknowledge its significance, as their investment of time and capital in information technology continues to escalate. Consequently, they seek assurances that these investments will yield returns. According to Rodrigues (2017), IT has evolved into a key player, transcending its traditional support role to become a source of knowledge and competitive advantage. Its impact extends to both operational and strategic levels, enabling a deeper understanding of the business environment and its dynamics. BI systems, closely linked with IT, exemplify this trend.

BI systems function as analytical tools that scrutinize databases to aid managerial decision-making processes. By facilitating data processing and analysis, these systems empower managers to formulate effective strategies (Potter, 2024). As noted by Angeloni *et al.* (2006), BI offers a holistic view of the business, organizing data in a tangible manner and transforming it into actionable insights. This enables cross-referencing of data, diverse visualization techniques, and thorough analysis of business performance.

According to Agiu *et al.* (2014), analysts express optimism about the future, foreseeing a surge in BI system users in the forthcoming years, driven by the growing clarity of its benefits.

1.2.2 Tendencies

According to the latest projections from Gartner, Inc., as shown in Table 1, global spending on IT is anticipated to reach $5 trillion in 2024, marking a 6.8% rise from the previous year. This growth rate is lower than the 8% forecasted in the previous quarter. IT services are poised to experience significant growth in 2024, emerging as the largest segment of IT spending for the first time.

It is projected that spending on IT services will surge by 8.7% in 2024, reaching a total of $1.5 trillion. This increase is primarily attributed to enterprises investing in projects aimed at enhancing organizational efficiency and optimization.

Table 1. Worldwide IT spending forecast (millions of USD) source: Gartner 2024

	2023 spending ($)	2023 growth (%)	2024 spending ($)	2024 growth (%)
Data center systems	243,063	7.1	261,332	7.5
Devices	699,791	-8.7	732,287	4.6
Software	913,334	12.4	1,029,421	12.7
IT services	1,381,832	5.8	1,501,365	8.7
Communications services	1,440,827	1.5	1,473,314	2.3
Overall IT	**4,678,847**	**3.3**	**4,997,719**	**6.8**

However, despite the substantial investments, there is no assurance of success. The success of a project is not solely dependent on the systems or technology employed but rather on factors such as implementation, adoption, and effective utilization.

A report by the Standish Group in 2014 revealed that 31.1% of information systems projects in surveyed companies are terminated before completion. Additionally, nearly 50% of ongoing projects exceed their budget, with the final costs averaging around double the initial estimates.

1.3 Aim and problem formulation

Enterprises across all sectors of logistical and supply chain operations are swiftly embracing fundamental I4.0 technologies, including but not limited to Big Data, Cloud Computing, and BI. These technologies find application across various domains such as processing and scheduling, supply chain management and production, as well as delivery

and returns, offering the promise of enhancing logistics processes by enhancing efficiency, reducing lead times, and optimizing workflow (Roshid *et al.*, 2024). Through harnessing the interconnected nature of I4.0, it becomes feasible to implement novel systems infused with real-time data, thereby intelligently supporting decision-making processes.

In the contemporary landscape, a substantial volume of data generated within enterprises remains unutilized and consequently dissipates. BI emerges as, and will continue to serve as, the cornerstone underpinning I4.0 by harnessing data and information for informed decision-making (Faber, 2024). Within this context, it becomes imperative to scrutinize whether the adoption of BI genuinely confers any competitive edge upon a company. Therefore, this study will be integrated into a realistic situation of a large Portuguese business group in the area of distributions and logistics.

1.4 Research question

As discussed, in today's rapidly evolving business landscape, the ability to make informed and data-driven decisions is crucial for maintaining a competitive edge. BI technologies have emerged, enabling organizations to transform vast amounts of data into actionable insights.

This study explores the impact of BI technologies on competitive advantage, focusing on a leading logistics operator in the Portuguese national market.

The central research question guiding this study is: What impacts does BI have on competitive advantage in a logistics company?

This question aims to uncover how BI technologies can enhance an organization's strategic position by optimizing decision-making processes, improving operational efficiencies, and fostering innovation. To answer this research question comprehensively, three key objectives were established. First, verify whether the logistics company in question is strategically aligned with its previously defined goals and objectives. By assessing the alignment, the study aims to determine how well the BI technologies integrates with the company's overall strategy and supports its competitive positioning. Secondly, it is aimed to understand the extent to which the BI technologies are being

utilized as well as the challenges faced in the present as a way of enhance them in the future.

The third objective is to identify the critical areas for improvement and development within the BI too to optimize processes and enhance decision-making, thereby increasing the company's competitive advantage through BI technologies.

The insights gained from the participants' responses will help identify key areas for improvement and development, thereby offering actionable recommendations for the company to enhance its strategic positioning through effective BI technology.

1.5 Structure of the document

The document is structured into several key chapters, each focusing on different aspects of the study. This structure ensures a comprehensive exploration of the research topic, systematically addressing each component from theoretical foundations to practical implementation and analysis.

The Chapter 1 introduces the topic, providing the rationale behind the study. It includes background of study where it contextualizes the study within current events and trends, problem analysis in which discusses current problems, tendencies and aim and problem formulation where it is defined the study's objectives and formulates the problem. This chapter also presents the central research question and outlines the structure of the document.

Literature Review is described in Chapter 2. This chapter reviews existing literature and provides a theoretical foundation for the study. It covers introductions of I4.0 and Logistics 4.0 (L4.0), discusses the impact of I4.0 on logistics operations and provide an overview of big data analytics. It also details the characteristics, types, benefits, and barriers of BI.

Methodology can be found in Chapter 3. This chapter explains the research methods used in the study and includes describes how data was collected and provides a detailed explanation of the Delphi method and its characteristics.

Chapter 4 presents the case study and incorporate a description of the online platform used for the Delphi method (Welphi platform), provides an overview of the company involved in the study, details the implementation process and explains in a more detail how was the criteria for the selection of experts. Further details on the questionnaire

development will also be provide. Additional there will be Analyzed the results from the Delphi rounds.

Finally, the Chapter 5 conclusions are reported and summarizes the findings of the study, discusses its limitations, and suggests areas for future research is also included.

CHAPTER 2

LITERATURE REVIEW

The primary aim of this chapter is initially to provide an understanding of I4.0 and, subsequently, L4.0, along with their associated technologies. It will briefly discuss the significance of these technologies in enhancing logistical operations' efficiency. Later, the chapter will delve into the concept of BI, detailing its characteristics, the types of analysis it offers, and the benefits and challenges associated with this technology.

2.1 Industry 4.0

Following the introduction of the term ‘’Industry 4.0’’ in 2011 by a team comprising individuals from diverse sectors, including business, politics and academia, the digital revolution this term entails has garnered increasing interest from companies across diverse industries (Tubis and Grzybowska, 2022).

This fourth industrial revolution, referred to as “Industry 4.0,” is distinguished by the integration of industrial systems using the Internet of Things (IoT), real-time data management and analysis, automated machinery, along with other technologies (Hasnan and Yusoff, 2018). Bag *et al.* (2021) indicated that I4.0 technology emphasizes digitalization, allowing companies to leverage emerging technologies and automated systems. It facilitates the integration of internet networks and communication technologies with business operations, enabling manual tasks to be automated through advanced systems and technologies. In this digital age, logistics companies offer online services through web servers and applications, where digital technologies effectively address data management and accessibility issues (Cichosz *et al.,* 2020).

On a worldwide scale, numerous nations have initiated their respective approaches such as the US National Network for Manufacturing Innovation, China’s Made in China 2025, Japan’s New Robot Strategy, with the aim of bolstering their manufacturing sectors through the utilization of technological advancements. Portugal is no exception, with the I4.0 encompasses a comprehensive package of 60 initiatives comprising both public and private efforts, projected to influence over 50,000 businesses within Portugal. During the initial phase, this strategy will facilitate the upskilling and training of over 20,000 individuals in digital competencies. As a part of the I4.0 measures, a substantial

investment of up to 4.5 billion euros is anticipated to infused into the economy over the upcoming four years (Portugal.Gov.PT, 2017).

According to Esmaeilian *et al.* (2020), leveraging the capabilities of I4.0 technologies, a smart production network can attain real-time monitoring, agile communication, autonomous functionality, and seamless material flow. Technological progress has opened doors to fresh prospects and innovative business models, enabling the creation of value propositions raging from personalized customizations to service innovations.

Besides, the survival and growth of businesses rely on the indispensability of digital skills. Digital skills have become essential for both businesses and the workforce, shifting from being considered 'optional' to being deemed 'critical', according to Digital Economy and Society Index 2022 (DESI 2022) report, the digital decade proposal underscores, among various aspects, the significance of digitally transforming both businesses and public services.

According to DESI 2022 report, in 2021, 26% of European Union (EU) citizens possessed digital skills that exceeded the basic level, as they demonstrated proficiency across all five categories of the Digital Skills Indicator (DSI). The possession of skills beyond the basic level is crucial not only for enhancing competitiveness in the job market but also for facilitating the adoption of digital solutions in the business sector.

At the present, based on Tubis and Grzybowska (2022), I4.0 encompasses not just factories but also the comprehensive digital transformation of industrial and costumer markets, spanning from the rise of intelligent manufacturing to the digitization of entire value delivery channels. Consequently, the pursuit of digitization strategies has also catalyzed the evolution of other production-related systems, notably Logistics 4.0 (L4.0). Hofmann and Rüsch (2017), assert that I4.0 offers a chance for enhanced efficiency in logistics management. They highlight the potential of product and service connectivity via the Internet or other network applications, like Blockchain technology, to facilitate decentralized control of value chains. The authors also note that digital connectivity provides opportunities for improving automated production and self-optimized delivery of goods and services, eliminating the need for direct human involvement.

The digital technologies introduced by the fourth industrial revolution enhance responsiveness during demand fluctuations, boost flexibility in the presence of capacity constraints, reduce lead times through additive manufacturing, and concurrently strengthen inventory control. This underscores the profound influence of I4.0 on industrial logistics (Ivanov *et al.,* 2019). Nevertheless, while I4.0 builds upon the

foundations of previous industrial revolutions, its distinctive advantage lies in achieving the utmost levels of digitalization, automation, virtualization, and decentralization across all sectors as it matures (Culot *et al.,* 2020).

During the initial phase of conceptual development, researchers primarily concentrated on aspects associated with digitizing production processes. Hence, to as the 'smart factory', alternatively known as the digital or intelligent factory. Researchers are also keenly exploring the potential application of I4.0 technology in production-related operations and its potential extension to the overall supply chain, and Maintenance 4.0 (Tubis and Grzybowska, 2022). I4.0 technologies present prospects for enhancing the economic efficiency, environmental sustainability, and social contributions of the logistics sector. According to Hamdi and Abouabdellah (2022), as companies embark on the transition to I4.0, they will undergo the digitization of all processes, spanning planning, supply manufacturing, delivery and returns. This transformation is poised to positively influence logistics processes by enhancing flows, optimizing operations, and reducing lead times.

2.2 The Influence of I4.0 Technology on the efficiency of Logistics Operations

I4.0 technology harbors the potential to introduce automated systems, empowering logistics enterprises to streamline operations and equip management with adept problem-solving tools. According to Cimini *et al.* (2019), the logistics sector exhibits a propensity to adopt digital technologies and systems adept at addressing business challenges effectively. Comparative to traditional methodologies, technological advancements and automated systems mitigate the intricacies inherent in logistic operations, offering analytical prowess and streamlined data management and processing capabilities. Leveraging information technologies and communication networks, logistics entities streamline business processes and automate logistic and supply chain operations (Feng and Ye, 2021).

Dachs *et al.* (2019) emphasize the pivotal role of logistic performance within the industry, necessitating robust systems and programs to navigate logistical complexities. Over the past four years, I4.0 technologies have catalyzed a paradigm shift towards automation and digitalization in logistics, presenting enhanced facilities for both consumers and logistics firms (Efthymiou and Ponis, 2021). I4.0's advent marks a substantial stride in

the digital transformation of the logistics sector, furnishing innovative solutions to bolster productivity and optimize operational efficiency.

The inherent digital transformation particularly bolsters responsiveness to demand fluctuations and enhances flexibility within supply chain and logistic operations. Information systems adeptly process and evaluate data storage, scrutinizing business processes through advanced computing tools and systems (Enrique *et al.,* 2022). I4.0 technology fosters the development of communication and IT infrastructure, transitioning manual operations and programs towards digitalization, thus minimizing communication gaps. Optimization of logistic processes necessitates advanced technologies and systems, a demand aptly met by I4.0 innovations, enabling companies to devise effective optimization systems for streamlined supply chain and inventory control activities (Krishnan *et al.,* 2024).

The rapid evolution of IT and I4.0 technologies engender digital logistics and supply chain systems, facilitating personalized products and services for consumers. Furthermore, I4.0 technology facilitates adaptation to user requirements, diminishing the need for supplementary resources and systems, thereby addressing financial and expense-related concerns (Dalmarco *et al.,* 2019). A pivotal feature of I4.0 technology lies in its capacity to enable logistics companies to establish effective communication systems, fostering seamless interaction with management and consumers, while delivering real-time updates on supply chain and product distribution.

Tracking stands out as a salient feature afforded by I4.0 technology, facilitating logistics companies in monitoring product updates and supply chain activities, thereby enabling informed decision-making and adeptly addressing consumer inquiries (Althabatah *et al.*, 2023). To bolster accuracy and efficacy in decision-making, I4.0 technology provides analytical programs and tools, equipping management with access to real-time supply chain and logistic data, thus enhancing consumer assistance.

I4.0 technology facilitates the creation of automated and remote access control systems within logistics companies, facilitating the collection, analysis, integration, and interpretation of high-quality data, with a focus on consumer satisfaction and efficiency-related issues (Elbasani *et al.,* 2019). Automated systems prove invaluable for managing warehouse products and tracking deliveries to consumers, while positively impacting operational performance by providing advanced technologies and communication systems, effectively minimizing communication gaps and expediting access to pertinent information.

L4.0 epitomizes the dawn of a novel era in logistics management, harnessing digital advancements. Presently, the logistics sector finds itself amidst a profound metamorphosis, as L4.0 revolutionizes erstwhile manual and conventional logistics practices into modern, innovative operations. This paradigm shift poses a dual dynamic of challenges and prospects for organizations (Szymańska *et al.,* 2017).

Embracing a data-centric approach to logistics emerges as imperative. As the volume of data generated by logistics operations burgeons, organizations must possess the wherewithal to decipher and leverage this data for informed decision-making. This mandates investments in BI systems and processes, alongside the cultivation of requisite skills and expertise to wield them efficaciously (Karki, 2024).

Furthermore, the deployment of BI systems empowers organizations to attain enhanced visibility into their logistics operations, facilitating the identification of inefficiencies and empowering data-driven decision-making to enhance performance. According to Cichosz, (2020), L4.0 heralds a transformative tide in the logistics industry, heralding both challenges and opportunities for organizations. To seize upon these opportunities, organizations must be primed to invest in novel technologies and methodologies, while espousing a data-centric approach to logistics.

2.3 Logistics 4.0

To understand what L4.0 means it's important to understand its basics. To Strandhagen *et al.* (2017), logistics involves overseeing the coordination of material and information streams within enterprises. Specifically, it involves overseeing the transportation and storage of materials, as well as the associated data. The objective is to deliver final products to customers with the highest level of service and quality while minimizing expenses. Key components of a logistics supply chain comprise procurement, manufacturing, distribution, and reverse logistics (Strandhagen *et al.*, 2017). There's growing demand for logistics operations to enhance their sustainability efforts in response to the broader sustainability imperative. Publications regarding L4.0 began to surface in 2015, which was four years following the introduction of the term '' Industry 4.0'' at the 2011 Hannover Fair (Rauch *et al.,* 2020).

According to Kodym *et al.* (2020), L4.0 entails the seamless integration and networking of transportation systems for trading and production companies, offering decentralized real-time data on logistics networks. To Winkelhaus and Grosse (2019), L4.0 is a system

that facilitates the environmentally-friendly fulfillment of personalized customer requirements while keeping costs stable, bolstering this progress in the industrial and commercial sectors through the utilization of digital technologies. For Strandhagen *et al.* (2017), L4.0 represents a logistics system that facilitates the sustainable and cost-effective fulfillment of evolving market requirements, focusing on customer-centric, personalized, and highly responsive supply chains and logistics powered by emerging digital technologies.

For Strandhagen *et al.* (2017), the emergence of L4.0 as an extension of the I4.0 concept holds significant importance, not only for operational aspects like sustainability, efficiency, and customer responsiveness but also for driving improvements in five fundamental business elements namely data collection and processing, assistance systems, networking and integration, decentralization and service orientation, self-organization and autonomy. For enhancing the overall efficiency and effectiveness of an entire supply chain, the operational processes of logistics service providers concerning L4.0 advancements carry substantial significance (Özaydin, 2016).

Advanced digital technologies are causing a substantial transformation in Logistics processes. Digital innovations like Artificial Intelligence (AI), Blockchain, Cloud Computing, and BI are propelling the shift from executing programmed tasks to achieving a degree of semi-autonomous operation, while facilitating information exchange across a cross-organizational landscape of cyber-physical processes in the industrial progress in L4.0 (Klumpp and Zijm, 2019; Sigov *et al.*, 2022).

L4.0 has a profound impact on pivotal logistics functions including transportation inventory management, material handling, supply chain configuration, and information flow. This transformation drives enhancements in sustainability, traceability, efficiency, and customer responsiveness, effectively converging the physical supply chain dimension with the digital data value chain dimension into the realm of cyber-physical processes (Strandhagen *et al.*, 2017).

As we seen, the concept of L4.0 is relatively recent, and as such, its extent, utility and advantages are still awaiting comprehensive exploration (Choi, 2021). The contemporary challenges facing production and logistics systems encompass the globalization of markets, demographic shifts, shorter product lifecycles, and heightened customer expectations for personalized, sustainable offerings (Dallasega *et al.*, 2022). But even so, the concept of L4.0 is steadily gaining prominence, as evidenced by the escalating number of publications referencing these solutions since 2017 (Tubis and Grzybowska, 2022).

L4.0 represents a significant evolution in supply chain management, driven by advanced technologies and data-driven decision-making, and employs emerging technologies like cyber-physical systems to enhance the operations of conventional logistics. As mentioned by Bag *et al.* (2020), the power of technology and deliberate investments in it greatly influence a company's success in the world of L4.0. As analyzed, Logistics 4.0 signifies the incorporation of cutting-edge technologies and digital advancements into logistics and supply chain operations. This transformation aims to improve efficiency, flexibility, and responsiveness within logistics processes. As logistics systems grow more complex and data-driven, the importance of big data analytics becomes crucial (Roshid *et al.*, 2024).

2.4 Big Data Analytics

The distinctions between big data, Big Data Analytics (BDA), and BI are often blurred and confusing for companies. In general, BI involves a value chain that starts with collecting raw data, converting this data into valuable information, supporting management decision-making, driving business outcomes, and enhancing corporate value according to established guidelines (Larson and Chang, 2016). However, with the advent of ICT and advances in data storage, "raw data" has evolved into "big data." According to Jin and Kim (2018), BI and big data/BDA are no longer separate entities but rather function together as an integrated decision support system. This system encompasses all processes from data collection to management decision-making in business.

BDA involves analyzing extensive and diverse data sets—known as big data—to identify hidden patterns, unknown correlations, market trends, customer preferences, and other valuable business insights (Ikegwu *et al.*, 2022). Within the scope of L4.0, BDA plays a critical role in handling the immense volumes of data produced by interconnected logistics systems, sensors, and devices.

According to Tiwari (2020) the fusion of the necessary engagement of physical goods transportation and the critical reliance on precise, current data within the fast-paced landscape of I4.0 positions logistics as essential part for the seamless integration of digital technologies into business operations. Organizations can harness the advantages of integrated cyber-physical systems only when they synchronize their internal technology implementation with the speed of external stakeholders, such as customers and suppliers, therefore, organizations must proactively invest in emerging technologies to revamp their logistics structures and practices (Gupta *et al.*, 2019; Frank *et al.*, 2019).

According to Santos and Marques (2022), BDA serves to bolster managerial decision-making, notably within the supply chain risk management process. It enables real-time assessment of customer needs and demand. Researches have gauged the efficacy of employing Big Data in the supply chain, unearthing a multitude of benefits, including enhance accessibility, adaptability, compatibility, connectivity, control, and coordination. Furthermore, Dubey *et al.* (2019) demonstrated that the utilization of BDA in the supply chain not only fosters improved visibility but also nurtures trust among all supply chain partners.

Supply Chain decision-makers continually seek strategies to efficiently harness Big Data sources in order to maximize their value (Hrouga and Sbihi, 2023).

Furthermore, globalization, characterized by just-in-time manufacturing and small batch production, serves as catalyst for industrial digitization (Sindhwani *et al.*, 2022).

While its implementation poses challenges, the benefits in terms of cost savings, efficiency and improved customer experiences are substantial. Based on Zhang *et al.* (2021), so far, very few companies have successfully completed this transformation towards L4.0. In order to achieve this, corporate decision-makers must grasp the potential benefits introduced by digital technologies and how they interact with various aspects of logistics processes (Yang *et al.*, 2021). Big Data Analytics is not the only thing that helps in decision making, BI is also connected in the sphere of contemporary data-driven decision-making.

2.5 Business Intelligence

In today's dynamic and fiercely competitive business environment, enterprises must possess the adaptability to address the array of challenges they encounter. These challenges underscore the quest for decision support tools that enable efficient responses to these demands. The abundance of information available today necessitates the adoption of more sophisticated systems.

As articulated by Olszak and Ziemba (2007), BI systems serve as IT solutions tasked with translating data into actionable insights and knowledge, thereby bolstering decision-making, forecasting, strategic planning, and organizational action. Williams and Williams (2007) characterize BI as a fusion of methodologies and technology enabling the organization and analysis of pertinent information across various business cycles, thereby supporting decision-making, action, and facilitating performance enhancement, including

heightened sales, cost reduction, and improved outcomes. Agiu *et al.* (2014) provide a more conceptual definition of BI as the utilization of software, business applications, or external data analysis to facilitate decision-making within a company.

BI entails a gamut of processes primarily focused on two core activities: gathering information from source systems, often in an incipient state, and processing and repurposing this information into valuable insights to support decision-making (Watson and Wixom, 2007). BI encompasses the process of exploring, integrating, aggregating, and conducting multidimensional analysis of information from diverse sources (Olszak and Ziemba, 2007).

2.5.1 Characteristics of BI

For BI to thrive, the entire organizational culture, business processes, and technologies must be meticulously designed and implemented with the aim of enhancing strategic and operational decision-making capacity (Azeem *et al.*, 2021). BI is characterized as both a process and a product. On the one hand, the process involves the methods organizations employ to generate valuable insights or intelligence, crucial for organizational resilience and prosperity. On the other hand, the product encompasses information enabling organizations to anticipate the behaviors of their competitors, suppliers, customers, technologies, acquisitions, markets, products, services, and the broader business environment with a certain level of assurance (Caseiro and Coelho, 2018).

According to Watson and Wixom (2007), BI offers several benefits, including more efficient access to higher-quality data and information, improved analysis and decision-making processes, and support for monitoring Key Performance Indicators (KPIs) and the company's strategy. Moreover, these tools facilitate the creation of dashboards for monitoring indicators, comparing data across different timeframes, and setting objectives, thereby enabling intuitive data analysis.

Olszak and Ziemba (2007) underscore the primary competitive advantages of BI compared to alternative information management systems. These advantages include the capacity of BI tools to integrate disparate and heterogeneous information, analyze vast datasets, and generate comparative reports. Additionally, BI enables simulations and forecasts based on specific assumptions, empowering management to swiftly respond to market dynamics and organizational changes (Ragazou *et al.*, 2023). Large companies' managers prioritize BI projects due to their potential to significantly benefit their

businesses. Currently, BI projects are experiencing notable growth, with the term 'BI' commonly associated with business information collection (Hannula and Pirttimaki, 2003).

2.5.2 Benefits and barriers of BI

Zwass (1992) suggests that BI aims to deliver high-quality, up-to-date, accessible, and dependable information to fulfill user requirements. Wright (1993) and Primak (2008) further argue that leveraging information derived from BI results in revenue generation, cost reduction, and improved management performance, directly contributing to organizational efficiency.

Primak (2008) emphasizes that BI enables the preparation and processing of data, transforming it into actionable information for organizational decision-making, thereby yielding user benefits.

According to Abukari and Jog (2003) and Primak (2008), the advantages of BI adoption include:

- Enhanced information reliability;
- Integration of data from diverse sources;
- Increased decision-makers' agility;
- Simplified information accessibility;
- Enhanced competitive edge;
- Streamlined access control across hierarchical levels;
- Expedited information delivery for strategic decision-making.

Addressing BI challenges, the primary obstacle within organizations is the cultural resistance. Resistance stems from reluctance to alter established work practices, fueled by both entrenched processes and apprehension over job security amid technological changes. Realizing BI benefits necessitates a robust analytical organizational structure, as noted by Carvalho (2019). Abukari and Jog (2003) concur that investing in a BI system poses challenges, demanding organizational support. They argue that most gains are intangible, such as process improvements, complicating return on investment calculations. Primak (2008) underscores the need to overcome these barriers for BI success, stressing the importance of meticulous planning given past failures.

Abukari and Jog (2003) and Primak (2008) also identify barriers hindering BI enhancement:

- Siloed departments impeding data warehouse formation;
- Underestimation of data and information utility;
- Errors in acquiring external data;
- Managerial unfamiliarity with BI;
- High costs associated with BI project implementation.

Conclusively, BI implementation is intricate, influenced by internal and external factors, with organizational responses dictating system success or failure.

2.5.3 Types of BI analysis

BI analyses can be applied across various business cycles. Olszak and Ziemba (2007), along with Williams and Williams (2007), provide examples of analyses feasible with BI-derived information:

- Profitability analysis of products and services: Leveraging historical sales data by product, customer, and geography, alongside forecasted and actual sales figures, allows for the assessment of sales profitability and deviations. This analysis enables companies to evaluate and fine-tune marketing campaigns and sales efforts;
- Customer relationship analysis: Utilizing data on order history, customer lists, and satisfaction surveys facilitates analyses of customer retention levels and the performance of customer support services. Insights gained from these analyses enable actions to enhance customer retention, loyalty, and support services;
- Strategic planning: Modeling various key variables pertinent to organizational development and assessing the company's strategy, mission, and objectives;
- Financial and management control: Drawing from accounting data on income, expenses, customer accounts, and budgets, analyses of budget deviations, accounts receivable aging, and income item evolution can be conducted. These analyses facilitate improvements in budgeting and forecasting processes, focusing on key deviations and identifying aged customer balances to define collection strategies.

It's crucial to recognize that the success of BI initiatives hinges not solely on the systems or technology themselves, but rather on their effective implementation, adoption, and utilization. Summing up, this chapter provides a detailed exploration of the critical concepts underpinning the digital transformation of logistics, focusing on Industry 4.0

(I4.0) and its extension into Logistics 4.0 (L4.0). The chapter discusses how these technologies, including Big Data Analytics (BDA) and Business Intelligence (BI), revolutionize logistical operations by enhancing efficiency, responsiveness, and decision-making capabilities. Industry 4.0 introduces advanced digital tools and automation, which Logistics 4.0 leverages to create more integrated, data-driven supply chains. Big Data Analytics plays a crucial role in processing the vast amounts of data generated, while Business Intelligence transforms this data into actionable insights, enabling organizations to optimize their operations and maintain a competitive edge in the rapidly evolving market landscape.

The following chapter will discuss the methodology chosen to conduct this study.

CHAPTER 3

METHODOLOGY

In this section, it will be delineated the research method crafted, developed, and implemented for the specific case scrutinized. The Delphi method will be explained, as well as its characteristics.

3.1 Data and Information gathering

The research initiative commences with data and information gathering pertaining to the current landscape of fundamental concepts, providing an in-depth understanding of prior work and investigations within the field. The literature review primarily revolves around I4.0, L4.0, and BI, with a focus on thoroughly examining articles elucidating the essence of these concepts to gauge the extent of existing research in these domains. Moreover, efforts are directed towards pinpointing technologies deemed essential for the ongoing digital transformation that companies aspire to undertake, discerning those conferring a competitive edge. This exploration aids in comprehending the criteria supporting companies' investment decisions in L4.0 technologies, thereby catalyzing the shaping of the investigative approach and delineating areas ripe for exploration.

Significant emphasis is placed on studies probing the benefits and hurdles associated with BI implementation. Given the existing methodologies such as focus groups, brainstorming sessions, interviews and surveys, the most suitable method to address the research question and achieve the study's objectives was determined to be the Delphi method. This choice was based on the aim of analyzing the strategic impact of BI technologies on a company from a future-oriented perspective. The Delphi method is particularly beneficial in this context as it enables companies to gain insights into what will be most relevant regarding BI technologies in this specific scenario.

Based on this backdrop, it was decided to conduct a case study within a leading logistics operator in the Portuguese national market, considering the versatility of case studies as a method employed by various researchers across disciplines or application areas to develop, challenge, or explain theory, elucidate situations, establish bases for solutions, explore, or describe phenomena (Meirinhos and Osório, 2010).

3.2 Delphi method

The Delphi is characterized as a method that organizes a communication framework enabling a collective of individuals to effectively address intricate issues (Linstone and Turoff, 1975). Through systematic collection and synthesis of informed judgments from experts, this method aims to progressively converge towards a consensus of opinion (Williams and Webb, 1994).

Delphi functions as a technique for distilling, refining, and amalgamating collective opinions and experiences from a cohort of experts. Its primary objective is to solicit the most dependable consensus of opinion from experts via a series of questionnaires interspersed with controlled feedback (Gupta and Clarke, 1996). Consequently, it transcends mere classification or evaluation of information, instead striving to achieve consensus on the problem at hand (Dickson *et al.,* 1984).

In resume, the Delphi method entails soliciting opinions from experts via a questionnaire, with subsequent rounds analyzing and exploring the information received, which can be revised and refined in pursuit of consensus.

This approach was chosen as it enables the aggregation of expert knowledge to formulate more accurate predictions, facilitates the understanding and aggregation of expert consensus without relying solely on qualitative data, and allows respondents to reassess their answers based on previous round results.

3.2.1 Delphi characteristics

The methodology employs a structured approach, albeit indirectly, to swiftly and effectively glean insights from experts who contribute knowledge and insight to the issue at hand, while concurrently fostering learning among panel members. Conversely, it documents facts and viewpoints while sidestepping the pitfalls of face-to-face interaction, such as group conflicts and individual dominance. Embracing a cooperative learning ethos, this method embodies the philosophy that "the whole is greater than the sum of its parts," facilitating collaboration and collective decision-making (Gupta and Clarke, 1996).

Essentially, the technique entails querying a panel of experts about a specific subject in an iterative fashion, maintaining anonymity and confidentiality throughout. With each iteration, the researcher analyzes the panel's responses, subsequently redistributing the questionnaire along with a summary of previous round results containing experts'

perceptions and opinions for consideration, thus repeating the process until a satisfactory level of consensus is reached (Linstone and Turoff, 1975; Williams and Webb, 1994). According to Meyrick (2003), Delphi harnesses the opinions and expertise of specialists in a given field, eliciting considered feedback on expressed opinions and collecting their responses anew, thereby enabling experts to engage with one another's viewpoints through the questionnaire. As for Munaretto *et al.* (2013), its primary characteristics, advantages, and benefits are:

- Anonymity: Fosters interactivity with heightened spontaneity, enabling more open discussions on critical or controversial issues among participants. However, anonymity may lead to incomplete recall or the omission of viewpoints yet to be considered. According to Kayo and Securato (1997), anonymity stands as the pivotal characteristic of the Delphi method, overcoming barriers inherent in face-to-face communication, such as the influence of persuasive individuals, reluctance to express unpopular opinions, and the impact of minority viewpoints. Consequently, anonymity mitigates the effects of personal biases (Grisham, 2009), allowing every participant to contribute their insights while safeguarding against distortions arising from participant interactions (Grisham, 2009).
- Feedback: Prevents deviations from the study's objectives, encourages goal-setting within the group, and facilitates opinion review by participants. However, the success or failure of the method can hinge on feedback, increasing the risk of excluding dissenting viewpoints from analysis. As Marques and Freitas (2018) notes, the feedback process disseminates participants' opinions across questionnaire rounds and presents the collective group opinion, aiding in consensus-building. Controlled feedback aids in reducing disagreement among panel members (Yousuf, 2007), allowing for consensus formation. Linstone and Turoff (2002) emphasize that feedback distinguishes the Delphi method from conventional opinion polling, enabling individuals to refine their judgments based on collective viewpoints.
- Flexibility: Participants receive opinions, comments, and arguments from peers during discussions, prompting reconsideration of their stances. While this foster overcoming communication barriers, the presentation of results and feedback can lead to forced or artificial consensus, where participants passively adopt others' opinions.

- Utilization of Experts: Ensures the formation of reliable concepts, judgments, assessments, and opinions on the subject matter, although it may lead to rapid consensus formation.
- Consensus: Encourages cohesion among expert opinions and identifies reasons for divergence. However, there is a risk of artificially manufacturing consensus.
- Interactivity: Promotes non-hierarchical exchanges, formatting and sharing responses, enhancing response adequacy, and fostering reciprocal learning among respondents. Yet, online interactive rounds are criticized for potentially yielding less elaborate answers despite expediting the process and reducing costs. The synchronization afforded by the internet contradicts the benefit of obtaining more nuanced responses.

In the next chapter, it will be shown how the selection of specialists was and how the questionary was constructed for the case study. Insights about the online platform that was used to implement the Delphi method will also be provide.

CHAPTER 4

CASE STUDY

In this chapter, it will be shown the statements with the highest level of agreement of each dimension and each round. It will be analyzed in general, both with regard to round 1 and round 2, as well as a more in-depth analysis of each statement of each of the dimensions, necessarily covering both rounds in order to register a growth in consensus in specific areas. Data collection in this study was executed through a survey guided by the Welphi tool, which implements the Delphi method which will also be explain.

4.1 Company context

The company chosen for the case study is recognized as the leading logistics operator in the Portuguese national market. It is a large organization with over 2,500 employees and has offices and logistics platforms throughout the Iberian Peninsula.

After establishing the information collection method, it was necessary to define the sample population. The case study company, a leading logistics operator in the Portuguese national market, recently undertook a BI project. Given its focus on logistics and product distribution, the company must respond almost instantaneously to market-generated information and adapt its strategy accordingly. The volatility of prices, suppliers, and customers in today's markets necessitates leveraging collected information to anticipate trends and stay ahead of the competition.

The company operates in the transport and logistics sector and has implemented a project of BI through Power BI tool. Power BI is a powerful business analytics service developed by Microsoft that provides interactive visualizations and business intelligence capabilities with a user-friendly interface that allows end users to create their own reports and dashboards. Fundamentally, Power BI is designed to help organizations make data-driven decisions by providing comprehensive tools for data analysis and visualization. Its main features can go from data connectivity, interactive dashboards or even rich visualizations which offers a variety of visualization options such as charts, graphs, maps, and gauges to represent data effectively. For confidentiality reasons, other characteristics about the company cannot be described.

4. 2 Welphi plataform

In this case study, an online platform called Welphi was used to reach respondents. Various methods exist for contacting users, and online questionnaires are particularly advantageous due to their non-intrusive nature (Wright, 2005). Using the internet can significantly reduce costs and save time since responses are already in electronic format, eliminating the need for manual data entry and the expenses associated with paper (Wright, 2005).

One drawback of online surveys is the potential for low response rates, an issue noted in other studies. However, solutions exist to mitigate this, such as sending periodic reminder emails. A study by Kaplowitz *et al.* (2014) found that web-based questionnaires can achieve higher response rates with follow-up reminders. The Welphi platform facilitates this by allowing reminder emails, which can boost response rates.

Prior to distributing the questionnaire, participants were informed through internal announcements and a detailed Word document outlining the study's topic, methodology, and platform. This document is included in the Appendix List (see appendix A) as well as a document that extracted from Welphi during the implementation of the questionary about the data protection (see appendix B).

The Welphi platform allows for the division of questionnaires into various sections and sub-sections. The study's dimensions scheme for the questionary are detailed below in Figure 1.

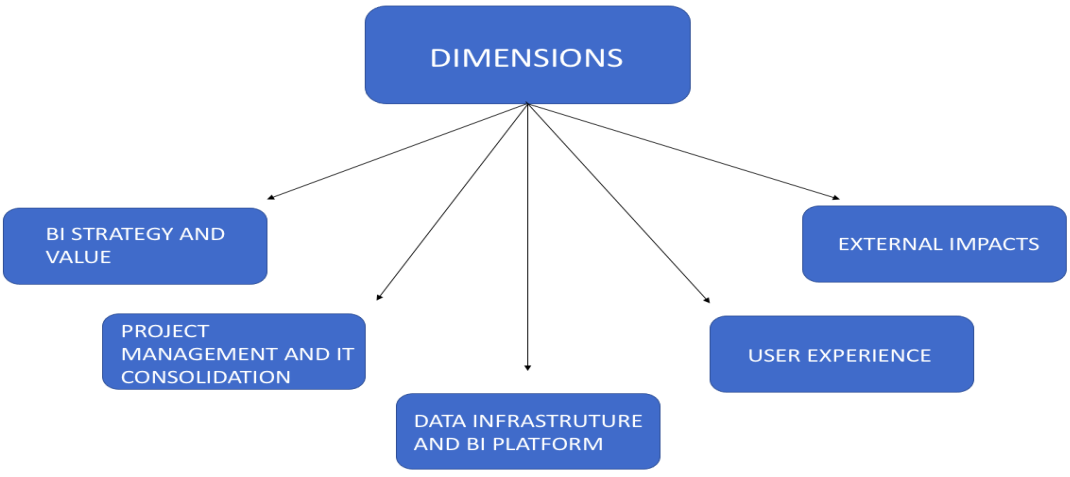

Figure 1. Dimensions of the questionnaire

The platform uses a round system to anonymously compare participants' opinions with their peers, fostering group consensus without face-to-face interaction. Welphi supports

asynchronous, online, participatory, and interactive comparisons of ideas. Anonymity encourages participants to adjust their initial positions based on group feedback, promoting consensus. Participants can respond without creating a profile or logging in. In the appendix section it will be provided the document extracted from Welphi regarding the welcoming page of the questionary (see appendix C).

The tool can be accessed at the user's convenience via a link provided in the initial email, minimizing scheduling conflicts. This platform enables the creation of questionnaires to gather opinions from multiple participants who have busy schedules or are geographically dispersed, as was the case with this company. Given that the company has offices spread across Portugal, it would be challenging to bring all participants together in one location on the same day.

Welphi's distinguishing features include the ability to create questionnaires and rounds, invite participants, set approval and rejection rules, develop response scales, share round results, and generate statistical graphs. One significant advantage is the automatic generation of statistics for result analysis. Welphi also allows the establishment of approval and rejection rules to manage consensus and decide on elements for subsequent rounds. Data can be exported to Excel for further analysis.

4.3 Process of implementation

The next few steps that will be described will be applied in the case study. The implementation of the Delphi method involves several steps, which, according to the consulted literature (Kayo and Securato, 1997; Yousuf, 2007), can be outlined as follows:

- Selection of the expert panel;
- Development of the first questionnaire;
- Initial contact with experts and invitation to join the research;
- Distribution of the first questionnaire;
- Collection of responses to the first questionnaire;
- Qualitative analysis of responses;
- Preparation and distribution of the second questionnaire with feedback;
- Collection and analysis of responses to the second questionnaire;
- Comparative analysis of responses from both rounds.

Each of these steps requires meticulous preparation and implementation, and the entire process should be documented and described. Below, we detail the main characteristics and considerations for each of these steps.

Selection of experts

In the initial phase, it is aimed to determine the number of participants participating in the questionnaire, select these experts, and structure the questionnaire items (Deng *et al.*, 2013). For reasons of confidentiality, sociodemographic data could not be collected.

Five key areas of the company were selected for the study, involving departments such as logistics, transport, finance, innovation, and central services. Participants were chosen from each business area based on their interaction with the BI tool, resulting in a convenience sample. This variety of users from different departments enriches the case study and the subsequent analysis, highlighting the sensitivity of different departments towards the BI tool. Studies indicate that the behavior and relationships between internal organizational components can significantly impact the project's success, as well as stakeholders' perceptions (Henderson and Venkatraman, 1993).

The director indicated that it was possible to provide 180 participants, but it was decided to include only 61 participants. This number was accepted, considering that it is recommended for such studies to have between 10 and several dozen participants (Powell, 2003; Grisham, 2009). According to Skulmoski *et al.* (2007) there are four criteria that define an expert/ participant: possessing knowledge and experience relevant to the subject under investigation, having the capability and willingness to participate, having enough time to commit to Delphi study, and having effective communication skills.

Development of the questionary

To structure the items to be included in the questionnaire, the statements were prepared through a literature review, as well as through semi-structured meetings that took place in April 2024. To avoid the questionnaire stimulating fatigue in participants, the time available to carry out the study and the complexity of the questions, a Delphi questionnaire was created consisting of five dimensions as demonstrated in Figure 1, where within each dimension we have between three and six statements for the experts to reflect and give their opinion, in order to achieve the objectives of this research. The Likert scale, with five levels, used a qualitative scale and whose objective was to specify

the level of agreement with the statements, and it can go from “Strongly disagree”, “Disagree”, “Neither disagree nor agree”, “Agree” to “Strongly agree”.

In all dimensions and for each statement, there was the possibility for participants to write comments to express their opinion on the topic covered from a more detailed perspective, or to provide some additional information. The questionnaire was written in Portuguese to facilitate the response process, taking into account that the company is a Portuguese company and the employees all share their native language (Portuguese), and also because it was unknow the level of English of each participant. If the questionnaire was carried out in English, it could compromise the results of the study due to problems of interpretation or even understanding.

The number of interactions in the traditional Delphi method is conducted in rounds, and while the exact number of rounds is determined by the study’s creator and organizer, studies with only two or three rounds are frequently found in the literature. It was also established that the experts would only answer the questionary twice (two rounds) in order to manage expectations about the duration of the process and to avoid high dropout rate. The first round started on the 29th April of 2024 and ended on 7th May of 2024. The second round started on 8th May of 2024 and ended on the 14th May of 2024.

As mentioned, the questionnaire was divided into dimensions, which were based on areas of study interest of the company to which we apply this case study, as well as based on the literature review. Table 2 seeks to demonstrate the dimensions that incorporate the questionnaire as well as the sources on which their choice was based.

Table 2. Dimensions and sources

Dimension of the questionnaire	Source
BI strategy and value	(Yeoh *et al.*, 2008 and Popovic *et al.*, 2014)
Project management and IT consolidation	(Yeoh *et al.*, 2008)
Data infrastructure and BI platform	(Yeoh *et al.*, 2008)
User experience	(Hung *et al.*, 2016)
External impacts	(Premkumar and Roberts, 1999)

For the first dimension, “BI strategy and value”, the statement "The BI project will create value for the business" was proposed during several semi-structured meetings, reflecting the company's specific requirements. The statements "The level of BI implementation will be close to the business needs", "Employees are aware of the critical success factors for the BI project", (El-Adaileh and Foster, 2019)", ‘’The use of this technology will be

a necessity to compete in the market", "We could lose customers to the competition if we do not adopt these new technologies" (Premkumar and Roberts 1999), and "Managers will strongly support the adoption of these new technologies" (El- Adaileh and Foster, 2019) have been studied and discussed in the literature. Given their established relevance, it was prudent to include these statements for our panel of experts to consider.

For the second dimension, "Project management and IT consolidation", the company needed to gauge employee sensitivity regarding data availability. It was decided to include the following statements: "BI design contributes to a more standardized data architecture" and "The set of indicators that the platform will make available will be appropriate" based on the semi-structured meetings. Additionally, based on the literature review, the statements "BI technology will contribute to the centralization and unification of data" and "Top management will be aware of the benefits of this new technology" (El-Adaileh and Foster, 2019) were included in this dimension.

In the third dimension "Data infrastructure and BI platform", the statements "The Power BI tool will satisfy your data integration needs" and "The BI tool will make information clearer and more accurate" were formulated during one of the semi-structure meetings to assess employees' perspectives in this area. The literature review contributed the statements "BI technology will improve decision-making by providing pertinent and up-to-date information" (Premkumar and Roberts 1999; El-Adaileh and Foster, 2019) and "BI will help management optimize resources and increase productivity" (Premkumar and Roberts 1999).

The fourth dimension, "User experience", include the following statements: "The skills required to use BI technology will be very complex" "Integrating these technologies into our current work practices will be very difficult", (Premkumar and Roberts 1999) and "Top management will actively encourage employees to use new technologies in their daily tasks" (El-Adaileh and Foster, 2019; Premkumar and Roberts, 1999) are statements that have been examined in previous studies, making them relevant for inclusion in our questionnaire.

Of the three statements included in the last dimension, "External impacts", two were sourced from the literature: "Our suppliers will push for the use of this technology as a way of doing business" and "Our customers will push for the use of this technology as a way of doing business" (Premkumar and Roberts 1999). The statement "The data that is expected to be made available will meet the needs of customers and suppliers" was jointly developed by the company and the author during meetings held in April of 2024.

During the course of this document, there will be tables that were extracted from Welphi. Theses tables with the results from each dimension, going from round 1 and round 2 are in Portuguese, so it will be provided in Figure 2 (first and second dimensions) and in Figure 3 (third, fourth and fifth dimensions), with the statements in English and in Portuguese for a better understanding.

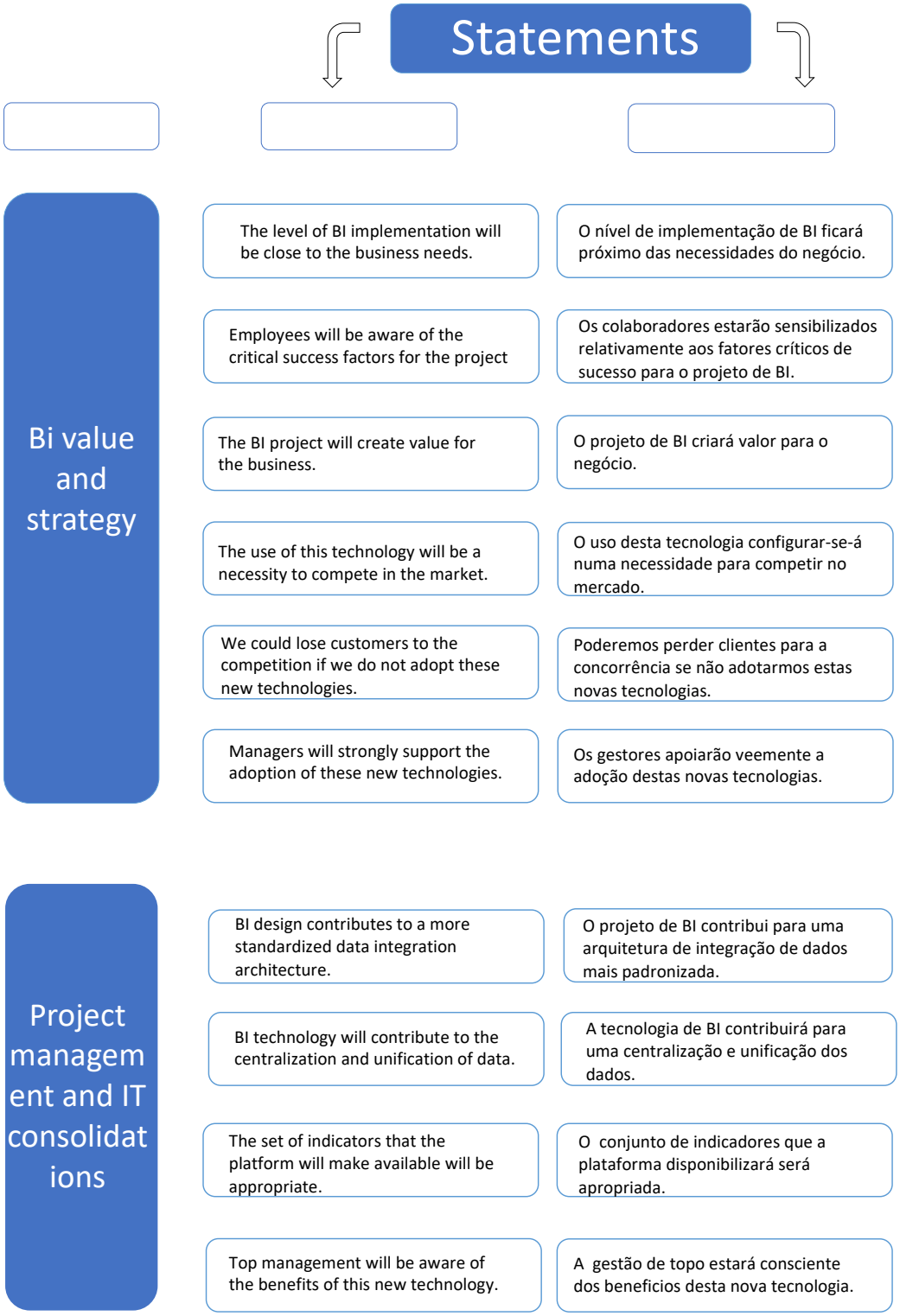

Figure 2. Statements in English and Portuguese from 1st and 2nd dimensions

Figure 3.Statements in English and Portuguese from 3rd, 4th and 5th dimensions

Initial contact with experts and invitation to join the research

The initial contact with the company was made through telephone call, followed by an email to the communications department, explaining the intention to conduct a case study and requesting contact information for someone in the innovation department.
In response, a director from the innovation department suggested a Teams call to better explain the case study process and the requirements. Over the following weeks, several calls were held to finalize details as well as presential meetings, particularly on how participants for the questionnaire would be selected.
Once everything was settled down, the participants receptive an invite through email from Welphi to start the questionary. This document can be found in the appendix section (see appendix D).
The steps regarding the collection of responses to the first questionnaire, qualitative analysis of responses, preparation and distribution of the second questionnaire with feedback, and comparative analysis of responses from both rounds will explain in the next section -Analysis and discussion of results.

4.4 Analysis and discussion of results

Data collection was conducted using the Welphi tool. This tool enabled experts to respond to both rounds of the questionnaire at their convenience, eliminating the need for face-to-face contact and thereby preventing any potential influence on their responses.
As it was mentioned previously, it was used a qualitative scale through five level Likert scale, from “Strongly Disagree” to “Strongly Agree”.
The data collection process included 61 participants from the company selected for the case study. In the first round, 82% of the questionnaires were fully completed (50 out of 61). In the second round, 90% of the questionnaires were fully completed (45 out of 50). Only responses from participants who had fully completed the first round were considered in the second round.
The 50 participants included in the analysis were distributed across various departments as follows:

- Logistics: 31 experts
- Transport: 10 experts

- Finance: 4 experts
- Innovation: 4 experts
- Central Services: 1 expert

This cross-departmental involvement provided a comprehensive view of the business, the project, and all users. The questionnaire focused on analyzing the impact of BI on the company.

4.4.1 Delphi survey: Round 1

In this first round, responses from 50 out of the 61 experts were taken into account.
Table 3 provides a summary for each dimension, highlighting the statement that received the highest percentage of agreement in the first round. The table includes the statement, the level of agreement, and the corresponding percentage. Notably, the "Data infrastructure and BI platform" dimension had two statements with identical agreement levels and percentages, both of which are shown in the table.
In the subsequent subchapter titled Delphi survey: Round 2, this table will feature an additional column indicating the percentage of agreement for these statements in the second round, aiming to determine whether there is an increase in agreement levels.
Although Table 3 only mentions the statements with the highest level of agreement, it is also interesting to emphasize that if we aggregate the results into levels of agree and strongly agree, we will reach percentages of over 80% of consensus in the vast majority of statements.

Table 3. Statements with the highest level of agreement in round one

Dimensions	Statements	Level of agreement	Round 1
BI strategy and value	The use of this technology will be a necessity to compete in the market	Strongly agree	64%
Project management and IT consolidation	BI technology will contribute to the centralization and unification of data	Agree	66%
Data infrastructure and BI platform	The BI tool will make information visualization clear and accurate	Agree	60%
	BI will help and facilitate management to optimize resources and increase productivity	Agree	60%
User experience	Top management will actively encourage employees to use new technologies in their daily tasks	Agree	66%
External impacts	Our suppliers will push for the use of this technology as a way of doing business	Neither disagree nor agree	60%

Next, it will be delving into a more detailed examination of the statements for each dimension.

As observed in Table 4, all statements received responses in the “agree” and “strongly agree” levels, with percentages ranging from 50% to 64%. It is important to highlight that the participants reached a 60% consensus on the statement that, in the future, the company might lose customers to competitors if it does not adopt new technologies. This indicates a general understanding that the continued development and use of new technologies are essential for improving processes to meet customer expectations.

The section allocated for expert comments provides valuable insights for each statement in each dimension. It is worthwhile to review the content provided by the participants. In the second statement, the results were somewhat scattered, with one expert rating the statement as “disagree” and noting that "to date, there has been little internal dissemination about this tool," which may explain the varied responses to this statement. Another comment in this dimension relates to the final statement, where a participant noted that many managers lack the necessary training to use BI tools effectively. This gap in training leads to slower adoption of these technologies and requires a greater effort from the company to promote proper and efficient use. The same participant also mentioned that it is crucial for companies to manage managers' expectations regarding the capabilities of BI tools, ensuring they understand both the benefits and limitations to prevent frustrations and disappointments that could hinder the implementation of effective improvements.

Table 4. Results Round 1, BI value and strategy. Extracted from Welphi platform

	discordo totalmente	discordo	nem discordo nem concordo	concordo	concordo totalmente
O nível de implementação de Business Intelligence ficará próximo das necessidade do negócio.	0%	6%	12%	56%	26%
Os colaboradores estarão sensibilizados relativamente aos fatores críticos de sucesso para o projeto de Business Intelligence.	0%	16%	32%	50%	2%
O projeto de Business Intelligence criará valor para o negócio.	0%	0%	2%	42%	56%
O uso desta tecnologia configurar-se-á numa necessidade estratégica para competir no mercado.	0%	0%	2%	34%	64%
Poderemos perder clientes para a concorrência se não adotarmos estas novas tecnologias.	0%	4%	8%	28%	60%
Os gestores apoiarão veementemente a adoção destas novas tecnologias.	0%	0%	18%	58%	24%

In the realm of project management and IT consolidation (Table 5), it was found that there is consensus on the statements fell within the “agree” range, between 48% and 66%. Participant comments on this topic were also reviewed. Regarding the third statement, one expert marked “agree” but cautioned that the project team should implement BI tools with care, highlighting the need for ongoing collaboration with qualified users and project managers. This collaboration should involve continuous improvement in the definition of indicators and data analysis types, tailored to each area of analysis. Such a process is vital to ensure that the BI tool is configured to maximize value creation for the company.

The participant also highlighted that the project team must be cautious when submitting BI models for approval, as approvers may lack sufficient knowledge about BI, leading to the potential approval of models that do not meet the end users' actual needs. Therefore, it is crucial for the project team to ensure that the models submitted are suitable and effectively address user requirements.

Additionally, the participant stressed the importance of conducting pilot implementation tests and setting longer approval cycles. The team should work with multidisciplinary teams and maintain a high degree of flexibility before standardizing BI models. This approach requires a project team with strong communication skills, a comprehensive understanding of the business, and sufficient time to fine-tune the tool according to the specific needs of the company's departments. This flexibility allows for testing and adjustment of BI models before their final adoption. In summary, the insights underscore the importance of a meticulous and collaborative approach when implementing BI, ensuring that the tool is effective and aligned with the needs of the company and its employees.

There was also a remark regarding the last statement, where an expert pointed out that the BI tool itself does not create an impact; rather, it is the decisions made using the tool that generates value. This participant rated this statement as "agree."

Table 5. Results Round 1, Project management and IT consolidation. Extracted from Welphi platform

	discordo totalmente	discordo	nem discordo nem concordo	concordo	concordo totalmente
O projeto de Business Intelligence contribuirá para uma arquitetura de integração de dados mais padronizada.	0%	0%	4%	58%	38%
A tecnologia de Business Intelligence contribuirá para uma centralização e unificação dos dados.	0%	0%	0%	66%	34%
O conjunto de indicadores que a plataforma disponibilizará será apropriada.	0%	6%	30%	48%	16%
A gestão de topo estará consciente dos benefícios desta nova tecnologia.	0%	2%	16%	50%	32%

Concerning the third dimension, "Data Infrastructure and BI Platform," all statements reached a consensus in the "agree" category, with percentages ranging from 50% to 60% as demonstrated in Table 6. This suggests a good chance of achieving even greater consensus in the second round.

For the first statement, a participant agreed but emphasized the importance of staying abreast of technological advancements. The participant noted that in the future, it might be necessary to move beyond Power BI, as other applications could offer more advanced capabilities for data analysis, including predictive analytics and other tools necessary for the evolution of data usage. This highlights the fast-paced nature of technology development and the potential for new, more effective solutions than current ones like Power BI.

Another participant commented on the second statement, noting that the accuracy of information is directly linked to the quality of the data. He stresses that even with a robust BI tool, if the underlying data is flawed, the reports generated will be inaccurate. The participant marked this statement as "agree." Another participant added that a BI tool can enhance a data-driven management culture, which will require increasingly high-quality data from core systems feeding into the BI tool. This participant strongly agreed with the statement.

Lastly, a participant agreed with the final statement and noted that BI tools allow for detailed analysis of complex supply chains and logistics networks. They can be used to monitor and improve the performance of various links in the chain, providing both micro and macro views quickly, thereby fostering improvements. However, the participant cautioned that while BI is a valuable technology, it should not be seen as a "game-changer" on its own.

Table 6. Results Round 1, Data infrastructure and BI platform. Extracted from Welphi platform

	discordo totalmente	discordo	nem discordo nem concordo	concordo	concordo totalmente
A ferramenta de Power BI satisfará as necessidades de integração de dados.	0%	8%	22%	58%	12%
A ferramenta de Business Intelligence tornará a visualização da informação clara e precisa.	0%	0%	8%	60%	32%
A tecnologia de Business Intelligence facilitará a tomada de decisão fornecendo informações pertinentes e atualizadas.	0%	4%	4%	50%	42%
O Business Intelligence ajudará e facilitará a gestão a conseguir otimizar recursos e aumentar a produtividade.	0%	0%	6%	60%	34%

As demonstrated in table 7, consensus levels exceeding 60% were achieved, suggesting a strong likelihood of even greater agreement in the next round.

Participants indicate that the skills needed to use this BI technology are not particularly complex. One comment highlight that the tool is user-friendly and intuitive, largely because of its visual nature. However, from the expert's point of view, the more challenging aspects are building the BI system and obtaining accurate data. Generally, BI technology enables end users with minimal training to derive insights. Another comment points out that while data retrieval is straightforward and intuitive, configuring and preparing dashboards is more complex. This is why the participant rated the statement as "agree," in contrast to the majority. Additionally, participants concur that integrating this BI technology into existing work practices will be relatively easy. 66% of experts agree that effective management will support employees in utilizing new technologies in their daily work.

Table 7. Results Round 1, User experience. Extracted from Welphi platform

	discordo totalmente	discordo	nem discordo nem concordo	concordo	concordo totalmente
As competências requeridas para o uso desta tecnologia de Business Intelligence serão muito complexas.	2%	62%	20%	14%	2%
A integração desta tecnologia nas nossas práticas de trabalho correntes será muito difícil.	16%	62%	16%	6%	0%
A gestão de topo incentivará ativamente os funcionários a utilizarem as novas tecnologias nas suas tarefas diárias.	2%	0%	14%	66%	18%

As shown in Table 8, statements exhibit fairly dispersed results, despite consensus levels ranging between 38% and 60%. The first statement, although presenting varied responses from “strongly disagree" to "agree," has a convergent opinion at the "neither agree nor disagree" level, with 60% agreement. One participant rated the statement as "disagree," explaining that in the short term, they view the tool as more beneficial for internal company use rather than from the suppliers' perspective. The second statement demonstrates less consensus among participants, with opinions ranging from "disagree" to "strongly agree," with closely clustered values between 10% and 38%. While the last statement includes two similar but minor values around 4%, they are not particularly significant. However, there is a higher percentage of agreement at the "agree" level, leading to the conclusion that most participants believe the data planned to be provided through the BI technology will meet the needs of customers and suppliers in the future.

Table 8. Results Round 1, External pressure. Extracted from Welphi platform

	discordo totalmente	discordo	nem discordo nem concordo	concordo	concordo totalmente
Os nossos fornecedores pressionarão para o uso desta tecnologia como forma de fazer negócio.	2%	24%	60%	14%	0%
Os nossos clientes pressionarão para o uso desta tecnologia como forma de fazer negócio.	0%	10%	32%	38%	20%
Os dados que estão previstos serem disponibilizados, irão de encontro às necessidades dos clientes e fornecedores.	0%	4%	34%	58%	4%

4.4.2 Delphi survey: Round 2

In the second and final round of this Delphi survey, only the fully completed questionnaires from the first round were considered, resulting in fifty participants for this round. Despite the decrease in participants from the initial round, the dropout rate was low, registered forty-five questionaries fully answered. As expected with the Delphi method, the second round showed greater agreement among the participants' responses, as seen in Table 9. This method is instrumental in fostering consensus among the panel.

Overall, the table highlights the importance of the statements chosen during the survey of the literature review (chapter 4 Section Development of the questionary). A more detailed analysis of each dimension will follow to understand where participant consensus aligns, aiming to guide management on where to focus investments and improvements in the BI technology to optimize processes.

From the analysis of Table 9, it is evident that participants who use the tool daily place significant importance on the dimensions of "Project management and IT consolidation" and "Data infrastructure and BI platform”. The percentage of consensus on these dimensions increased notably from the first to the second round. The high level of agreement on these dimensions among the responses from our chosen organization's sample underscores the importance of aligning the characteristics inherent to project management, IT consolidation, and data infrastructure and BI platforms for the employees.

A closer analysis of the results for each dimension will be conducted, comparing the second-round results with those from the first round.

Table 9. Statements with the highest level of agreement in round one and round two

Dimensions	Statement	Level of agreement	Round 1	Round 2
BI strategy and value	The use of this technology will be a necessity to compete in the market	Strongly agree	64%	73%
Project management and IT consolidation	BI technology will contribute to the centralization and unification of data	Agree	66%	69%
Data infrastructure and BI platform	The BI tool will make information visualization clear and accurate	Agree	60%	69%
	BI will help and facilitate management to optimize resources and increase productivity	Agree	60%	64%
User experience	Top management will actively encourage employees to use new technologies in their daily tasks	Agree	66%	67%
External impacts	Our suppliers will push for the use of this technology as a way of doing business	Neither disagree nor agree	60%	62%

As previous Table 3 highlights that the statement "The use of this technology will be a necessity to compete in the market", which was prominent in Table 10, saw an increase in consensus by 9% from the first to the second round, reaching a total of 73%. In this dimension, all other statements also showed increased consensus levels, except for "Employees will be aware of the critical success factors for the BI project," which saw a 3% decrease, dropping to 47% in the second round from 50% in the first round. This shift

was noted from the "agree" level to "neither agree nor disagree." In the first round, 50% marked "agree" and 32% marked "neither agree nor disagree," while in the second round, 47% marked "agree" and "neither agree nor disagree" rose to 36%. Despite being a minor decrease in consensus perception, this change is intriguing and warrants further investigation.

Table 10. Results Round 2, BI value and strategy. Extracted from Welphi platform

	discordo totalmente	discordo	nem discordo nem concordo	concordo	concordo totalmente
O nível de implementação de Business Intelligence ficará próximo das necessidade do negócio.	0%	4%	9%	64%	22%
Os colaboradores estarão sensibilizados relativamente aos fatores críticos de sucesso para o projeto de Business Intelligence.	0%	16%	36%	47%	2%
O projeto de Business Intelligence criará valor para o negócio.	0%	0%	2%	36%	62%
O uso desta tecnologia configurar-se-á numa necessidade estratégica para competir no mercado.	0%	0%	2%	24%	73%
Poderemos perder clientes para a concorrência se não adotarmos estas novas tecnologias.	0%	2%	4%	24%	69%
Os gestores apoiarão veementemente a adoção destas novas tecnologias.	0%	0%	9%	69%	22%

In the next dimension, all statements showed increased levels of consensus. Notably, while the statement with the highest consensus in round 1 continued to grow in round 2, the statement "Top management will be aware of the benefits of this new technology" recorded the largest increase in consensus, rising by 6%. From one round to the next, we observed a growing agreement on the components of project management and IT consolidation, underscoring the significance of both the selected statements and the dimension itself, as shown in Table 11.

Table 11. Results Round 2, Project management and IT consolidation. Extracted from Welphi platform

	discordo totalmente	discordo	nem discordo nem concordo	concordo	concordo totalmente
O projeto de Business Intelligence contribuirá para uma arquitetura de integração de dados mais padronizada.	0%	0%	4%	62%	33%
A tecnologia de Business Intelligence contribuirá para uma centralização e unificação dos dados.	0%	0%	0%	69%	31%
O conjunto de indicadores que a plataforma disponibilizará será apropriada.	0%	4%	31%	53%	11%
A gestão de topo estará consciente dos benefícios desta nova tecnologia.	0%	2%	11%	56%	31%

In the third dimension, the Delphi method produced greater agreement between participants' responses, as shown in Table 12. It is worth noting that after just one round, there was a notable increase in consensus among participants, influenced by comments from round 1 and the group results. Although all statements had higher agreement, one statement that had high agreement in the first round became the statement with the highest consensus in the second round, with a 9% increase, while another statement had a 4% increase. This suggests that the statements with the greatest consensus reflect the importance that participants attribute to greater alignment of the tool in terms of centralizing and unifying data with the company's objectives to maximize the tool's potential.

Table 12. Results Round 2, Data infrastructure and BI platform. Extracted from Welphi platform

	discordo totalmente	discordo	nem discordo nem concordo	concordo	concordo totalmente
A ferramenta de Power BI satisfará as necessidades de integração de dados.	0%	4%	24%	62%	9%
A ferramenta de Business Intelligence tornará a visualização da informação clara e precisa.	0%	0%	2%	69%	29%
A tecnologia de Business Intelligence facilitará a tomada de decisão fornecendo informações pertinentes e atualizadas.	0%	4%	2%	51%	42%
O Business Intelligence ajudará e facilitará a gestão a conseguir otimizar recursos e aumentar a produtividade.	0%	0%	7%	64%	29%

Like the other dimensions, the "User experience" dimension also showed increased consensus, as seen in Table 13. Participants generally believe that integrating these technologies into their current work practices will be straightforward, considering the tool's intuitive nature, as one participant noted in a comment from round one. This statement saw one of the largest consensuses increases, growing by 11% from one round to the next. While the remaining statements also showed increases, they were less significant, with the first statement rising by just 2% and the last by only 1%. The minimal growth of the last statement highlights an important issue: participants felt there had not been enough promotion of the tool. This is something top management needs to address, as the way the tool was introduced to employees might not have emphasized its importance in optimizing processes, for example. It is crucial for top management to provide clear incentives and proper training to ensure employees understand the benefits and know how to effectively use the technology.

Table 13. Results Round 2, User experience. Extracted from Welphi platform

	discordo totalmente	discordo	nem discordo nem concordo	concordo	concordo totalmente
As competências requeridas para o uso desta tecnologia de Business Intelligence serão muito complexas.	2%	64%	22%	9%	2%
A integração desta tecnologia nas nossas práticas de trabalho correntes será muito difícil.	7%	73%	16%	4%	0%
A gestão de topo incentivará ativamente os funcionários a utilizarem as novas tecnologias nas suas tarefas diárias.	0%	0%	13%	67%	20%

As shown in Table 14, there was only a slight increase in consensus for the first two statements. The last statement remained unchanged in consensus from one round to the next, holding steady at 58 percentage points. Despite the minimal growth in the first two statements, attention should be given to the statement "Our customers will push for the use of this technology as a way of doing business." A comment from round one offers insight into this slight increase: a participant noted that they view the tool primarily for internal use rather than for business transactions with customers. While 40% of participants agree that the tool should be a way to conduct business, top management needs to consider whether the tool is essential for business operations or simply for improving customer relations.

Table 14. Results Round 2, External pressure. Extracted from Welphi platform

	discordo totalmente	discordo	nem discordo nem concordo	concordo	concordo totalmente
Os nossos fornecedores pressionarão para o uso desta tecnologia como forma de fazer negócio.	0%	27%	62%	11%	0%
Os nossos clientes pressionarão para o uso desta tecnologia como forma de fazer negócio.	0%	11%	29%	40%	20%
Os dados que estão previstos serem disponibilizados, irão de encontro às necessidades dos clientes e fornecedores.	0%	4%	33%	58%	4%

The Delphi rounds revealed increasing levels of consensus among the participants. Key findings include the recognition of the strategic necessity of BI for market competition, the importance of data quality for accurate BI outputs, and the need for top management's active involvement in promoting technology adoption.

In round 1 there was responses indicated a range of opinions, highlighting areas requiring further clarification and consensus-building, and in round 2 greater consensus was

achieved, reflecting the Delphi method's effectiveness in aligning participant opinions through iterative feedback and reflection.

The findings suggest that for successful BI technology development, the company must focus on several critical areas such as continuous improvement processes that are essential to keep up with technological advancements and maximize the utility of BI, continue with the top management involvement because active involvement and support from top management are crucial for fostering a culture that values data-driven decision-making and ensures the successful adoption of new technologies and aligning BI initiatives with the company's strategic goals, since it ensure that the technology supports business objectives and drives competitive advantage.

CHAPTER 5

CONCLUSIONS

The study sought to answer how BI impacts competitive advantage in a logistics company, focusing on the development of the BI tool within a leading logistics operator in the Portuguese national market. Using the Delphi method, the study involved a panel of Power BI users to gather diverse insights on the perceived benefits and challenges of BI technologies. The Welphi platform facilitated efficient expert opinion collection. Expert selection ensured informed feedback, covering key dimensions such as project management, IT consolidation, data infrastructure, user experience, and external impact. The analysis provided comprehensive insights into BI development within the company, with main conclusions and implications described subsequently. Additionally, it will be providing some information about the limitations of the study and some indications about the future research.

5.1 Conclusion of the study

This study explored the transformative potential of L4.0 technologies, particularly through the lens of BI, within a leading logistics company in the Portuguese market. By leveraging the Delphi method, the study gathered insights from a panel of experts who actively use the company's BI tools. The findings highlight several key themes and considerations that are essential for organizations aiming to harness the full potential of digital transformation in logistics.

The study confirms that BI is not just a tool but a strategic asset that can significantly enhance a company's competitive advantage. When aligned with an organization's strategic goals, BI facilitates better decision-making by providing timely, accurate, and actionable insights. The research underscores the necessity for BI tools to be seamlessly integrated into the company's operational framework, thereby enabling management to optimize resources, improve productivity, and respond more effectively to market changes.

The successful implementation of BI technologies requires the active involvement and support of top management. This involvement is crucial not only for driving the adoption of new technologies but also for fostering a culture that values data-driven decision-making. The study reveals that when top management actively encourages and supports

the use of BI, it leads to higher levels of adoption and more effective utilization of these tools across the organization.

The rapid pace of technological advancement in the Industry 4.0 era means that companies must be agile and proactive in their approach to technology adoption. The study highlights the importance of continuous improvement processes, emphasizing that companies should regularly reassess their BI tools and be open to adopting newer, more advanced technologies as they become available. This adaptability is crucial for maintaining the relevance and effectiveness of BI in driving business outcomes.

Despite the clear benefits, the study also identifies several challenges associated with BI implementation, including the need for proper training and the potential resistance from employees accustomed to traditional work practices. The ease of use of BI tools, as well as the clarity and accuracy of the data they provide, are critical factors that influence their success. The findings suggest that companies must invest in comprehensive training programs and ensure that the tools are user-friendly and well-integrated into existing workflows.

In conclusion, this study demonstrates that the adoption of Logistics 4.0 technologies, supported by robust BI tools, is essential for companies looking to thrive in the digital age. The strategic use of BI can lead to significant improvements in operational efficiency, decision-making, and overall competitiveness. However, the successful realization of these benefits requires careful planning, ongoing management support, and a commitment to continuous technological adaptation. As companies continue to navigate the complexities of digital transformation, those that effectively integrate BI into their operations will be best positioned to succeed in the increasingly competitive global market.

5.2 Limitations of the study

This study has several limitations that should be acknowledged. As this is a case study, caution should be exercised when generalizing the findings and conclusions of this study, and the confidentiality of sociodemographic data makes it difficult to characterize the company and its employees. Firstly, given more time, it would have been beneficial to conduct the questionnaires in bilanguage (English and Portuguese) since this study is all written in English. Secondly, the online data collection method sometimes resulted in a

low response rate, requiring follow-up emails to prevent high absenteeism. Despite these efforts, as discussed in Chapter 4, there was still a dropout rate between rounds.

Another limitation was the time constraint. To minimize the impact on the company's operations, only two rounds were conducted. However, it would be valuable to perform a similar study with an additional round to potentially increase the level of agreement in certain areas. Connected to this idea, a study of this nature can impact the normal performance of the employees of the company being studied.

5.3 Future research

Future research should expand the sample size to include a more diverse group of experts from other and regions since this company has also offices in Spain. That would enhance the generalizability of the findings. Also, a comparative study across different organizations in the transport and logistics sector could provide a more comprehensive understanding of the implementation and impact of BI technology.

Longitudinal studies that track the adoption and effects of BI technology over an extended period would be valuable. Such studies could capture the dynamic nature of technological advancements and market changes, offering insights into the long-term benefits and challenges of BI implementation.

Additionally, future research could employ mixed methods, combining quantitative surveys with qualitative interviews. This approach would provide a more holistic view, capturing both the measurable impacts and the nuanced experiences of users. In-depth case studies of specific companies that have successfully implemented BI technology could offer detailed best practices and lessons learned.

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APPENDIX

Appendix A - Informative document for Delphi survey

O meu nome é Inês Bernardo e sou aluna do Mestrado de Estratégia de Investimento e Internacionalização no ISG Business & Economic School e encontro-me a realizar a minha tese em Logística 4.0, mais concretamente na tecnologia de Business Intelligence sob Orientação do Prof. Joaquim Vicente.

Irá ser realizado um Estudo de Caso na sua empresa através de um questionário onde se pretenderá analisar o impacto que a tecnologia de Business Intelligence vai ter na sua empresa.

Cada participante irá responder ao mesmo questionário de forma anónima, duas vezes (duas rondas). Na segunda ronda cada participante irá ter acesso não só à sua resposta da ronda anterior, bem como a percentagem de respostas do universo dos restantes participantes de forma a refletir se mantém a sua posição ou se considera que deve alterar a sua resposta em funções dos dados fornecidos.

Neste questionário terá que responder de acordo com o seu grau de concordância, devendo escolher um de cinco níveis. Este questionário irá chegar-lhe via email através da plataforma Welphi.

1ª ronda: 29 abril – 7maio;

2ª ronda: 8 maio – 14 maio.

Todas as informações que irão ser recolhidas são para uso exclusivo da minha tese de mestrado.

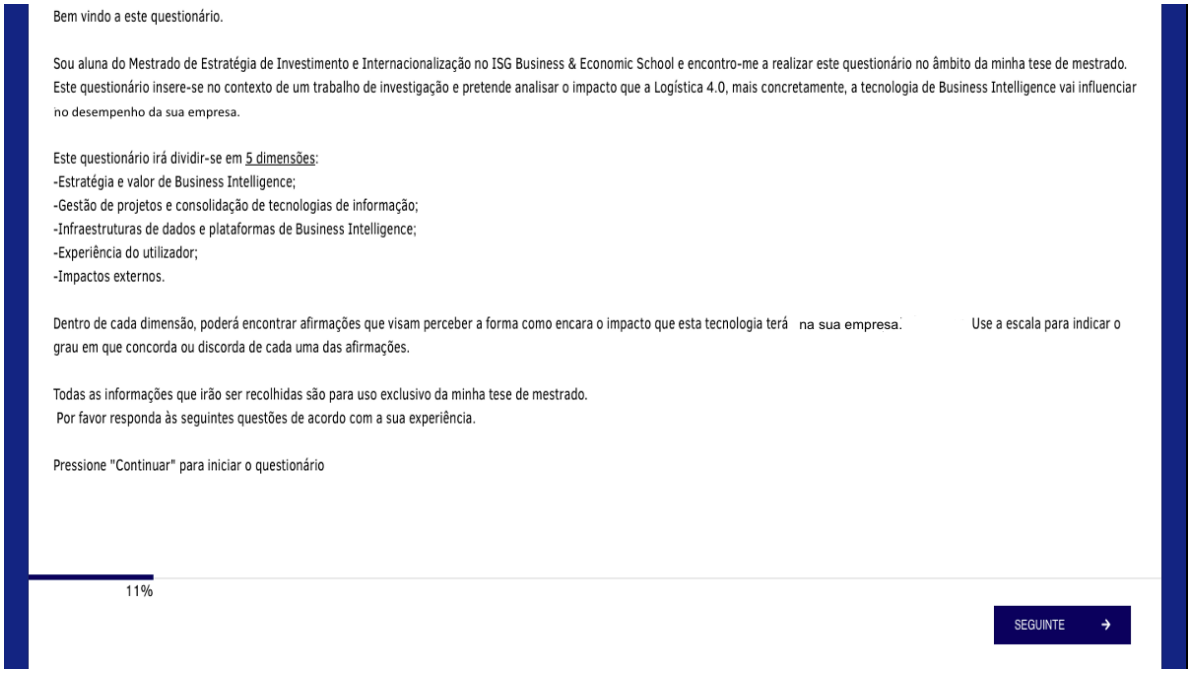
Obrigada pela sua colaboração!

Inês Bernardo

23 abril 2024

Appendix B - Data protection information

Appendix C - Welcoming page of the Delphi questionary



Bem vindo a este questionário.

Sou aluna do Mestrado de Estratégia de Investimento e Internacionalização no ISG Business & Economic School e encontro-me a realizar este questionário no âmbito da minha tese de mestrado. Este questionário insere-se no contexto de um trabalho de investigação e pretende analisar o impacto que a Logística 4.0, mais concretamente, a tecnologia de Business Intelligence vai influenciar no desempenho da sua empresa.

Este questionário irá dividir-se em 5 dimensões:
-Estratégia e valor de Business Intelligence;
-Gestão de projetos e consolidação de tecnologias de informação;
-Infraestruturas de dados e plataformas de Business Intelligence;
-Experiência do utilizador;
-Impactos externos.

Dentro de cada dimensão, poderá encontrar afirmações que visam perceber a forma como encara o impacto que esta tecnologia terá na sua empresa. Use a escala para indicar o grau em que concorda ou discorda de cada uma das afirmações.

Todas as informações que irão ser recolhidas são para uso exclusivo da minha tese de mestrado.
Por favor responda às seguintes questões de acordo com a sua experiência.

Pressione "Continuar" para iniciar o questionário

11%

SEGUINTE →

Appendix D - Invite through email from Welphi platform

Caro participante,

Foi convidado a participar no questionário ‘’Análise estratégica do impacto de *Business Intelligence* na sua empresa’’ na plataforma *Welphi*. O *Welphi* é um sistema de questionários online que implementa o método de *Delphi*, através de rondas em que, além das suas respostas às questões colocadas, é possível introduzir comentários que serão partilhados com os restantes participantes, de forma anónima, de forma a haver troca de argumentos e assim caminhar no sentido de um consenso.

Por favor siga o link abaixo para iniciar a sua resposta ao questionário.

Link de acesso: @url
Quaisquer dúvidas por favor entre em contacto através do seguinte endereço de email: inesdsbernardo@outlook.pt

Obrigada,
Inês Bernardo