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Supply Chain Market Study on Business Intelligence Technologies

- With an emphasis on Big Data Management in Ocean Freight Transportation

Master's thesis in the International Master's Program - MSc Maritime Management

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Abstract

In the last two decades, with the developing technology, data science and the useful tools of data science have started to be used more frequently in the business world. The benefits of BI tools such as real-time visibility, track and trace, route optimization, rate benchmarking and forecasting in processing acquired data could not be overlooked among these developments. Especially in the shipping industry, the need for these BI tools has increased considerably to determine the unpredictable freight prices, customer demand amounts, and the direction of trade flow. This thesis shows, it was concluded that BI tools are very useful for decision-making, increasing efficiency, visualization, and optimization for the transportation industry. Obtaining information based on a quantitative approach was supported with the qualitative approach through the survey, in this context, the importance of Business Intelligence was emphasized for how Big Data can be used and to extract the necessary data from it. In line with the findings obtained, the use of Big Data and the place of Business Intelligence were evaluated throughout this research, while the supply chain, which has an impact on every aspect of our lives, benefits from the cutting-edge developments.

Keywords: Business Intelligence, Big Data, shipping, Big Data Management, data, maritime transportation, supply chain industry, Advantage of BI, Disadvantage of BI.

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List of Abbreviations

BDM – Big Data Management

BI – Business Intelligence

DM – Data Mart

DW – Data Warehouse

EMEA – Europe, Middle East, and Africa

IOT – Internet of Things

IT – Information Technology

MAD – Maritime Analytics Dashboard

OLAP – Online Analytical Processing

RFID – Radio Frequency Identification

RQ – Research Question

SCM – Supply Chain Management

USB – Universal Serial Bus

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Chapter 1: Introduction

This chapter brings background information about innovative technologies to support supply chain and ocean freight transportation sourcing processes. Firstly, the background identifies which innovative technologies are focused on with supporting reasons. Secondly, the purpose of the thesis is presented along with research questions to obtain the objectives of the theory. Finally, the limitations are implied and presented.

1.1 Background

In the last two decades, our daily lives have become more digital through the full integration of the internet, the rapid development of information technologies, and Industry 4.0, which is considered the new industrial revolution (Barreto et al., 2017). This digital transformation affected the supply chain significantly, especially the ocean freight market; it led companies to take advantage of new technologies and become more competitive in an ever-expanding market (Radivojević & Milosavljević, 2019). Among these available innovative technologies, Big Data, and Business Intelligence (BI) have crucial roles in data-driven decision-making for the supply chain (Munim et al., 2020). BI has been a critical field for over two decades, applying data analytics to build the foundational knowledge to support business decision-making. The "Big Data" trend has occurred in the last five years and has become a core element of BI research (Liang & Liu, 2018). Besides, when it comes to the supply chain, the aim is to have a customer-oriented structure with the efficient optimization services which the BI applications can provide; it is easier to ensure more accurate service delivery by expressing the systems and techniques of optimization decisions in the logistics market within better management methodologies and ways of using data (Nwaubani, 2011).

Corporations depend on ever-evolving ways to extract accurate information through Big Data for BI to support making more consistent and efficient decisions (Jin & Kim, 2018). Both Big Data and BI concepts have a significant role in logistics operations. Still, the main difference between them is that Big Data has data sets that play functional roles within organizations with vast amounts; at the same time, BI enables these data for analytical purposes to make more informed business decisions within the data pool (Debortoli et al., 2014). If the explanation is too detailed, Big Data is a field that aims to manage large amounts of data coming from supply chain stakeholders (e.g., suppliers, shippers, and customers) (İyigün, 2019). Big Data is valid

when the data volume is too large for general data management applications to take place (Davenport et al., 2012). Supply chain stakeholders have a high amount of information about their customers, emissions, freight rates, transport volumes, and route distances. Still, the density of this gathered information turned out to be too much to analyze manually with human power (Mahdavinejad et al., 2018). IT-Interfaces concepts such as BI applications and technology developments have been able to assist as systems that support filtering these data and obtaining the desired information accurately (Ereth & Eckerson, 2018). Additionally, in the fluid market of the supply chain, ocean freight has a bigger volume than other transportation types. Due to the high number of stakeholders in maritime transport network, which includes so many stakeholders, large-scale planning problems are experienced at the operational, tactical, and strategical levels (Sanchez-Gonzalez et al., 2019). In particular, the high-volume carrying capacity of the transport network, the immense level of structural complexity, and the fact that some variables have a significant impact on the performance of operations have made the need for data in optimizing logistics processes vitally important (Wang et al., 2016).

Many scientific projects and papers are published on available innovative technologies, concepts, and models for maritime transportation and the supply chain market, such as cloud logistics, automation, blockchain, 3D printing, or RFID technologies. (Sanchez-Gonzalez et al., 2019). However, few scientific papers address the significant role of BI in shipping and the advantages of IT applications in BI systems. Thus, further research and studies are required to use efficient data collection, management, and processing in maritime transport. Such as technology challenges, struggles due to competitive conditions, and logistics companies leveraging opportunities from data management through the BI systems. It is essential to use such systems because they also lead companies to make better business decisions through their accessing, analyzing, and visualizing data. In addition, few studies have been published on Big Data and BI Systems' compatible working structures in the supply chain. The basis of this thesis is identifying usage areas of Big Data and BI technologies for IT in the ocean freight market.

1.2 Research purpose and research questions

The purpose of this MSc thesis is to explore BI tools and their features for IT used by supply chain stakeholders. Based on existing data the thesis aims to provide summarized functionalities for creating reports for an improved understanding of shipping data and how shipping customers can benefit from them in the global transportation market to support their operations, make resourcing decisions, and benchmark between different service providers. While utilizing from BI tools, thesis aims to discover the relationship between BI tools and Big Data Management, their way of working and anticipate the opportunities and challenges in these circumstances.

- RQ1: What are the available innovative BI features for IT technologies in the maritime transportation market in the last two decades?
- RQ2: What are the opportunities and challenges in implementing Big Data Management systems within maritime transportation?
- RQ3: How do Big Data and BI technologies work compatible with each other and be used together in the supply chain market?

1.3 Limitations

The thesis has several limitations that could be addressed in future research. Firstly, the thesis will be limited to a specific innovation method, it will include BI technologies scope for the maritime shipping and supply chain industry. Since the BI systems cooperate with data, carrier or supplier companies are unwilling to share their data. Therefore, access to the IT system's data will be limited. In addition, the thesis will be limited only to the scope of container transportation, as it will focus on maritime transport and its place in the supply chain market. Moreover, the lack of previous studies, depending on the scope of the research topic of the thesis, reveals a limitation; however, since specific individuals and institutions will carry out the research, the necessary data will need to be carried out within a particular interval of time and the scope of sectors. The container shipping industry is a global business, and it has broad commercial capacity among the continents and regions, the research will rely on data, and this data will be captured mainly in Europe, the Middle East, Africa, and EMEA regions. In addition, the thesis will be limited to case study research which includes the plan, design, preparation, data collection, analysis, and reporting. Using systems that benefit from BI by

collecting data based on observations and researching in line with the collected data. In addition, the limitation is that the study only includes a company in the automotive industry and the survey and interviews were conducted with 10 senior and manager-level of employees. Thanks to having a chance to work in Automotive Industry during the thesis work, I will be able to search internally from the service customer perspective. However, the research will be limited to the Automotive Industry, therefore, my stakeholders will be limited to the supplier and manufacturer side; future works may be required to investigate carriers as a stakeholder. Finally, the thesis time scope is limited between February to June, and the research mainly focuses on innovative technologies at this time slot.

Chapter 2: Frame of Reference

2.1 Business Intelligence (BI)

BI is the progress and methods that enable to process of raw data and capture it clearer and practically (Negash & Gray, 2008). In the period when the digital transformation in all sectors increased rapidly, BI applications also affected the transportation sector (Nwaubani, 2011) and the adoption of BI applications has already begun in many shipping companies (Mathrani, 2008).

Today, the decision-making processes of institutions in the changing competitive business environment have become very difficult; resource planning systems or other business applications are used to ensure that data related to business processes are recorded by handling daily operations, in this case, BI systems are used for the collected data to produce solutions that support decision-making (Elena, 2011). In addition, BI systems lead to making the desired analysis in transforming complex data into significant and usable information for the business, shortening the decision-making process, speeding up, reducing risks, and thus providing a solid, reliable, and clear decision-making basis (Bogza & Zaharie, 2008).

Within the scope of BI, the core components are reporting, multi-functional analysis progress, logical solutions, data mining, business performance management, complex event analysis, benchmarking a business progress through other performance measures or the best of this business process, predictive and rule-based logical solutions (Balaceanu, 2007). BI applications identify and analyze business requirements, implement BI technical solutions, create central or distributed data warehouses, manage data in the data warehouses then analyze the data and report on it (Elena, 2011). It can keep successive criteria, such as financial results by identifying the customer, production, and human resources criteria that assure financial success (Elbashir et al., 2008). Analyzing data in detail enables to make correct strategic and logical decisions (Teimoury et al., 2017).

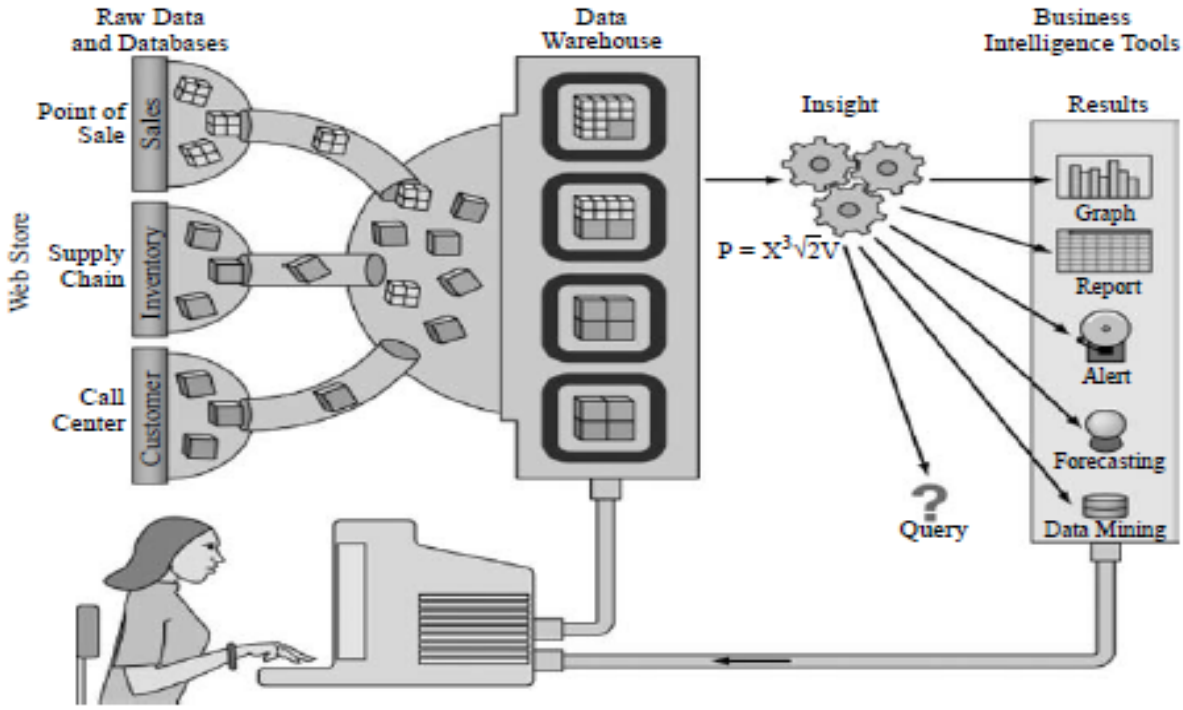

Figure 1: A basic understanding of BI for shipping (Adopted from: Sahay & Ranjan, 2008, p. 31).

2.1.1 BI Components

BI components are groups that create a fully integrated system that works to ensure the shipping organizations survive by responding to environmental pressures (Al-Ma', 2013). BI tools function as a new middleware among transactional applications and decision support applications, thus helping to tailor business operations efficiently and by making the right decisions (Sugirtha et al., 2015). Main tools included in BI consist of Data Warehouse and Mart; Data sourcing; On-Line Analytical Processes; Data Mining.

Data Warehouse and Data Mart

Data Warehouse (DW) and Data Mart (DM) are considered different from each other; however, some studies consider both are the same (Al-Ma', 2013). DW is one of the significant components of BI, and it is a created technology and infrastructure to provide corporate information flow (Sugirtha et al., 2015). DW offers the storage, integration, classification, and protection of information using different technologies (Sugirtha et al., 2015). It may also include operational data, defined as *"an updateable integrated dataset used for organization-wide tactical decision-making in a given subject area* (Gardner, 1998, p?)". Because of data warehouse tools, customers in the supply chain obtain the service of storing and protecting any

data for various usage purposes such as mobile applications, websites, restoration and backup, and extensive data analysis through data storage sites (Gardner, 1998).

DM is a small-size partition warehouse (Theodoratos et al., 1997). DM is a subset of the data warehouse; it is the data warehouse of the departments whose data is needed on a small scale, the operation has its own data mart, marketing has theirs, finance and sales are too, and so on (Sugirtha et al., 2015). It contains data reserved for and belonging to certain users of the organization (Balaceanu, 2007). Similar to DW, DM leads shipping customers to strategize based on stored analyses to forecasts, benchmarks and receive accurate information (Llave, 2017). The critical difference is that creating a DM is predicated on a specific need for a particular grouping and configuration of select data, there can be several DMs inside an organization, and it supports s specific part of business, processes, or units (Sugirtha et al., 2015).

Data Sourcing

In its simplest terms, the data source is the location where the data used comes from (Calantone & Vickery K., 2010). Historical data can be data from the internet or marketplace, operational databases, or information from the current data warehouse environment (Sugirtha et al., 2015). In addition, data stores that can be found on many different platforms may contain structured information such as tables, statistics, plain text files, images, or ratios (Sugirtha et al., 2015).

On-Line Analytical Processes

Online analytical processes (OLAP) are a category of tools that allows users to analyze data from multiple database systems at the same time, the main purpose of these systems is to analyze data, not process it (Balaceanu, 2007). Users want to use some of the relevant data, navigate the database, analyze the data in different filters and get accurate results (Chaudhuri Surajit & Umeshwar Dayal, n.d.). It provides a tool to analyze any data in OLAP data cups and flexibly interact with the mining engine based on intermediate mining results (Han, 1999).

Data Mining

The process of data mining involves analyzing large amounts of data stored in databases and storage devices to discover correlations and patterns (Osman, 2019). The general purpose of data mining is to extract the most relevant information from a given dataset and have that data structured for later use (Osman, 2019). In BI systems, data mining and OLAP often have the same roles, the difference being that OLAP contains a summary and specific results whereas data mining is more detail-oriented (Sugirtha et al., 2015).

2.1.2 Business Intelligence in Supply Chain

Along with the constantly developing and changing market demands, it is critical for the supply chain management systems to keep up with the changing market, so the use of IT tools has become more effective in managing complex supply chains (Auramo et al., 2005). Companies that are part of SCM leverage advanced techniques such as BI tools to forecast and manage their customer demands and provide real-time visibility, track and trace, route optimization, and benchmarking services (Sahay & Ranjan, 2008). By using data analytics in the management of the supply chain, strategic and actionable information about the supply chain network is obtained, and BI is used to extract and process this information (Sahay & Ranjan, 2008). Such BI tools work on real-time data, increasing the quality, automatic information processing avoids manual errors and results with accurate information, and a timeline of the data and aid the decision-making process through to BI (Oliveira & Handfield, 2019). In below table 1, it is possible to see the practical capabilities of BI and its support areas in SCM:

BI practices in supply chain management	BI support in key functional areas of supply chain management
(1) Analysis of current operations in SCM	(1) Development of budgets/business plans
(2) Creation of reports based on SCM needs	(2) Forecasting sales and planning operations
(3) Alignment of business strategy with SCM strategy	(3) Material procurement, logistics and inventory management
(4) Simulation of supply chain scenarios to implement strategic management decisions	(4) Production, quality control, dispatch and return of products
(5) Informing on key metrics within SCM through dynamic on-line queries	(5) Performance and financial management
(6) Data transfer into other platforms (e.g., Excel) for further analyses	

Table 1: The relationship between BI practices and its functional areas (Mathrani, 2008, p. 8).

Implementing BI systems with operative tools is critical in the entire process of the supply chain (Balaceanu, 2007). The success of this management of SCs depends on organizations' willingness to share their data, which is simplified by internet-based technologies (Kehoe & Boughton, 2001). Data sharing, decision-making processes, and common goals between stakeholders and companies working in coordination with each other in the supply chain should be transparent, and efficiency in the reliable processing of data is ensured by the creation of a pooled database (Teimoury et al., 2017). In addition, the data generated in large volumes in the supply chain is obtained from multiple operations, customers, shippers, forwarders, ports, customs, and many other actors performed constantly (Subhashree et al., 2017). This dispersed data obtained often prevents companies from getting valuable and necessary data, all this scattered information sometimes means that valuable information that can be decisive when it comes to knowing the profitability of an operation is often lost due to (Subhashree et al., 2017):

- Complicated reporting processes.
- Data collection difficulty.
- Available information on different platforms.
- Lack of integration of systems with each other.
- Manual update of the information (Subhashree et al., 2017).

The complexity of producing global, reliable, and usable reports often results in the inability to clearly define the costs associated with supply chain operations, BI provides solutions to these problems in the supply chain (Mitrovic, 2017). The primary goal of every business is to make a profit, grow and be sustainable, for this, companies need to make improvements in all conditions, and make new decisions. (Vasić et al., 2015). These purposes can be achieved by the usage of BI. In each new decision to be taken, the current situation should be considered, and then problems, solutions, or goals should be defined (Opone & Olasojumi, 2022). For the actions to be taken and implemented quickly, the raw data must be made useful as soon as possible, even instantaneously, due to BI tools; it becomes possible to cover business opportunities, determine cost reduction methods, optimize prices, determine customer preferences, coordinate supply chain operations, and business activities, and increase communication between all departments in the business (Hočevar & Jaklič, 2010). The advantages of BI are summarized as:

- Allows you to see profitability or cost analysis at the desired level (Elena, 2011; Hočevar & Jaklič, 2010).
- Optimizes business processes (Hočevar & Jaklič, 2010).
- Enables to make the right decisions (Gibson et al., 2011).
- Offers multidimensional reports (Gibson et al., 2011).
- Enables early detection of risks (Elena, 2011).
- Increases information transparency in the company (Gibson et al., 2011).
- Provides a competitive advantage (Elena, 2011).
- Enables the measurement of competition and market share (Hočevar & Jaklič, 2010).
- Creates foresight at the point of investing in new business areas (Hočevar & Jaklič, 2010).
- Shows a guiding effect in renewing the company's vision, mission, and policies (Hočevar & Jaklič, 2010).

2.1.3 Innovative BI Tools for Shipping

Shipping companies must regularly adjust their services to customers' changing needs and expectations (Caschili & Medda, 2012). While these services ensure that the delivery time is on time, they also require that reliability, quality, and prices are correctly included in operations (Caschili & Medda, 2012). Manual work in companies can cause many errors; at this point, BI tools come into play (Lönnqvist & Pirttimäki, 2006). Implementing innovative BI tools in companies helps to generate multiple reports, reducing effort, time, and risk of errors (Lönnqvist & Pirttimäki, 2006).

BI is important for maximizing the impact of every commercial decision, especially in maritime shipping (Sakty, 2013). Choosing the right BI tool allows you to make data-driven decisions in real time, leading to the optimization of various processes through the BI tools' dashboarding service (Gibson et al., 2011).

BI Dashboards

One of the most up-to-date and effective BI tools for managing obtained data in transportation is through Dashboards (Grabińska & Ziora, 2019). The BI dashboard seamlessly displays owned data to users and is a method for visualizing large amounts of data that are often

combined across disparate systems (Konstan et al., 2012). These representations make use of various tables and charts, such as the basic following examples:

- Pie charts, used for combination in percentages (Konstan et al., 2012).
- Stacked bar charts, for both comparison and benchmark (Konstan et al., 2012).
- Line charts are used for updated data frequently and show the current market indexes (Konstan et al., 2012).

Tables can usually be sorted by category or filters according to what information or data you want to focus on, allowing you to display the information based on users' requests among a vast amount of data (Hall, 2003).

A significant amount of data is produced according to the types, values, volumes, departure-arrival ports, or import-export status of the cargoes handled in maritime transport; these data have a high and heterogeneous structure and it's affected constantly by the increasing trade volume in the maritime transport sector (Sakty, 2013). Therefore, data handling techniques and intelligent solutions are required, in this case, the Maritime Analytics Dashboard (MAD) solution emerges (Sakty, 2013). MAD can be considered a means of producing adequate information from a scattered data stack with interactive visualization (Sakty, 2013) (Figure 2).

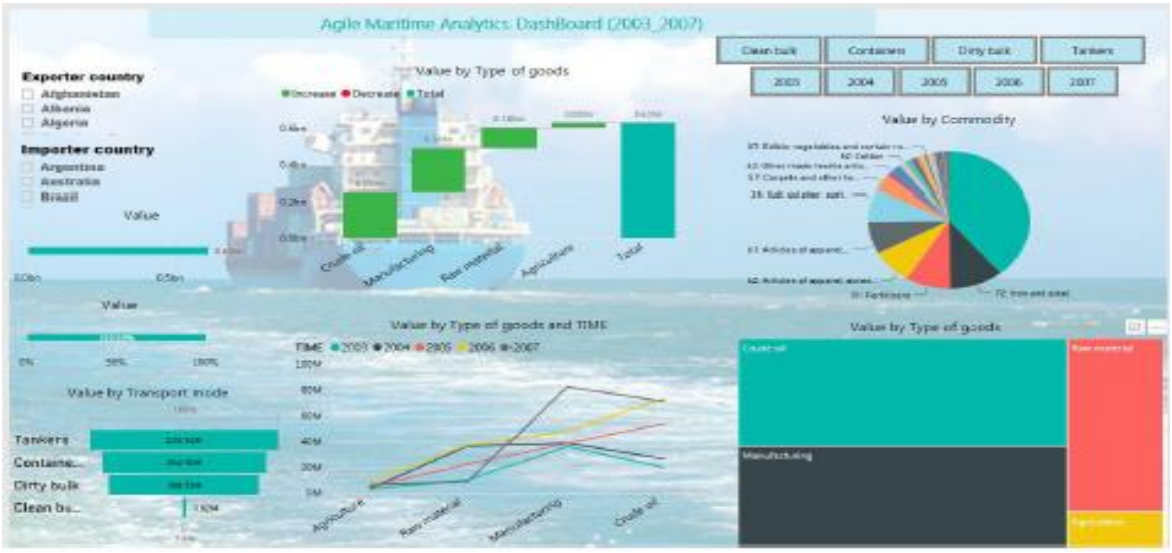

Figure 2: Maritime Analytics Dashboard (Adopted from: Sakty, 2013, p. 11).

BI Reports

BI Reports show why things are happening and how to improve business performance in the future (Arslan et al., 2010). A report often uses multiple data sources to help identify new business and target opportunities (Arslan et al., 2010). For example, because of BI Reports, maritime transport companies can report their cargo handling performance and import-export capacity with instant data, thus guiding the organization to maximize profitability, competition, and customer capacity (Sakty, 2013). With the increasing trade volume, operational systems need more reporting options, for these reports, which are challenging to prepare manually, instant visualization can be provided with the integration of BI systems (Dedić & Stanier, 2017). For instance, the decrease in the business volume in specific periods and the factors that may cause this decrease are important information for decision-makers (Dedić & Stanier, 2017). Reports prepared with business intelligence systems can be quickly delivered to all decision-makers in an electronic environment (Dedić & Stanier, 2017). Since long reports consisting only of text make them difficult to understand, BI reports are enriched with graphs, tables, and summaries (Santhosh Baboo & Prabhu, 2013). Users can also access detailed data from existing reports when they need it (Santhosh Baboo & Prabhu, 2013). Advanced supply and demand forecasting portals can be created by using the data of existing freight movements through BI reports, these forecasts provide a significant reduction in costs by optimizing the stock in freight demand (Srinivasa Rao P & Swarup Saurabh, 2001).

BI Real-Time Visibility

BI Real-Time Visibility is also known as Location Intelligence, it is the ability to map and visualize data in geographic formats (Merrell Paul et al., 2006). Organizations can gain a deeper understanding of business operations by exploring and visualizing datasets based on spatial elements, such as transportation per region, movement through ports or sales by region (Wycislak, 2021). Increasing competition in the transport sector, differentiation in customer needs, and requirements of businesses are changing every day (Shen, 2020). Due to this, companies are working to make better decisions that will respond to today's market conditions by measuring and forecasting (Shen, 2020). Advanced systems such as real-time location systems provide continuous monitoring and asset tracking, providing operational improvement for industries such as transportation, logistics, and manufacturing (Wycislak, 2021). Monitoring data is critical in the transport sector as products are constantly in motion, and real-time collected data brings transparency to processes, increasing efficiency and reducing

commercial risks (Willing et al., 2017). The mandatory monitoring of products at intermediate transit warehouses, port containers, and direct shipment points from production is an important factor triggering the development of this market (Wu et al., 2017). In addition, the increasing competition to serve the entire global population in the last decade creates operational difficulties such as high cargo volumes, data management, container tracking, and security control at seaports all over the world, so real-time location tracking is playing a significant role, especially in maritime transport (Willing et al., 2017).

2.2 Big Data Management

Since technology and the internet have developed, there has been an increase in the production and dissemination of information through creating high amount of data (Almeida & Calistru, 2013). Although data are explained with different definitions in different sources, they are generally unprocessed, ungrouped, uninterpreted, or unanalyzed values that have been collected by various methods (Labrinidis & Jagadish, 2015). While different definitions have been presented, Big Data can be explained in general terms as data sets that cannot be stored, managed, and processed with existing programs, unlike data (Almeida & Calistru, 2013). The concept of Big Data, which is used to describe the type of data, also describes the technology used to analyze, store and process data(Labrinidis & Jagadish, 2015). In the past few years, Big Data has evolved into systems that database experts have classified as relational databases, which contain everything from worksheets to databases in a structured way and that can be used by businesses and that support decision-making by company managers through reporting systems. (Labrinidis & Jagadish, 2015) When describing Big Data, 5V pyramid representation is used to distinguish it from other datasets (Garg, 2017):

Volume: Data volume refers to the largest base of this pyramid, the data flow should be continuous and in large volumes (Garg, 2017). Data volume and speed are growing exponentially, so data needs to be processed and transformed into information in real-time (Journal et al., 2017).

Velocity: The term Velocity refers to the speed at which data is produced, Big Data is not only about the volume of data, but also how fast the data flow (Garg, 2017). Gaining actionable and valuable insights from near real-time data is critical to competitive advantage (Journal et al., 2017).

Variety: Variety refers to the range of sources from which a company can obtain data and the meaningful data within them (Garg, 2017). It includes data such as smartphones, on-premises devices, social media chats, stock data, and data from financial transactions, but the source needs to be relevant specifically to the nature of the business for which the data is collected (Journal et al., 2017).

Veracity: Veracity refers to questions about the quality and accuracy of the data, to achieve clean data, organizations must connect, clean, and transform their data into systems (Garg, 2017). Companies need hierarchies and multiple data connections to keep their data under control (Journal et al., 2017).

Value: Value refers to the ability to extract actionable business insights from within the data pile (Garg, 2017). The value defines how many new members will join the website, how many customers will renew their insurance policies, and how many orders for the products. Businesses need to know who their best customers are and who will stop being customers in a few weeks or months (Journal et al., 2017). In order to gain value from Big Data, companies need to get to know their customers better, and deliver more relevant offers (Parkinson & Bamford, 2016).

2.2.1 Big Data Management in Maritime Transportation - Opportunities

Big Data analytics has an important position in maritime transportation. Most of shipping companies use Big Data technologies to optimize route planning, traffic control, avoid road congestion, and develop their services (Lambrou, 2016). Additionally, in transportation services, revenue management uses Big Data to drive technological innovations, improve logistics and gain a market edge (Lambrou, 2016). When looking at how Big Data is transforming maritime transport, it is possible to see the high amount of produced data (Aktas et al., 2011). In addition, data mining applications have also found a place in maritime transportation within the supply chain, and there are the different types of returns to each sector of data mining applications are evaluated in terms of maritime transport (Şen et al., 2021).

Track and trace the goods in the container with IOT technology and share the produced data with the stakeholders and determine possible damage, fatigue, and deterioration. Route optimization by examining the historical traffic data and taking the right decisions for the destination of the containers. In addition, forecasting against the peak season problem,

procuring necessary equipment by making forecasts in advance, and avoiding excessive and seasonal price increases by making reservations in advance. Besides that, Big Data Management (BDM) helps to schedule periodic maintenance of ships, containers, and transport equipment while providing efficiency analysis at ports. To optimize of customer's interactions and determine customer's need in advance, BDM provides demand forecasting and shipment predictions (Şen et al., 2021). Optimization of customer interaction and determining customer needs in advance through the demand forecasting and predictive shipments is also part of BGM (Şen et al., 2021). Risk analyses is also important to reduce and avoid the risks, through the BGM, companies can leverage (Şen et al., 2021). In addition, resource allocation can eliminate redundant costs in shipping through analysis of demand, infrastructural capacity, and workforce. Relocation of products provides the ability to move certain products to distribution centers that are closer to customers with high purchasing potential (Şen et al., 2021).

In addition, since Big Data can provide as large-scale data as possible, it also allows for the development of different solutions and approaches for each customer (Tian et al., 2017). Because of this, it will ensure customer loyalty and increases the added value obtained together with the total benefit (Tian et al., 2017). Within the framework of balancing the needs met with resources, it makes it possible to meet higher-level customer needs and demands with lower resource usage (Nikitakos & Lambrou, 2007). Big Data provides a high level of competitiveness in terms of maritime transport activities and the opportunity to manage processes strategically, so a roadmap should be prepared about how this data will be used before Big Data analytics can be used in operations (Alkan et al., 2017). Primarily, decision-makers need to determine the goals they want to achieve and determine what data they will need to reach these goals, therefore necessary to determine in advance what data you need and which of them will need to be selected and processed (Tian et al., 2017).

2.2.2. Big Data Management in Maritime Transport - Challenges

Big Data is used to describe complex datasets that are difficult to process and analyze using traditional data processing methods, so it is challenging to have proper results by using and analyzing Big Data (Labrinidis & Jagadish, 2015). However, Big Data Management is becoming increasingly essential and significantly impacts various industries (Shen, 2020). There are many uncertainties associated with Big Data and many of these uncertainties are

common to all sectors, below, we will address the general issues for using Big Data applications (Jović et al., 2019):

Quality data: When it comes to lox quality data; if the system relies on flawed, inaccurate, or incomplete data, and it's possible to get bad results, a mandatory data validation process that covers every stage of your data quality management process can help ensure the quality of incoming data at different levels (Zaman et al., 2017). In addition to that having a huge volume of data does not the main quality indication (Zaman et al., 2017).

Data consistency: Data consistency depends on how data is collected and analyzed, so the power of analysis is related to data quality and reliability (Zaman et al., 2017). Also, the wrong data reasons for inaccurate forecasts and analyses (Jan, 2017).

Data availability: Analyzes may not be constructive and consistent due to a lack of data integration or poor data management (Koga, 2015). Therefore, it is morel logical to run a data adjustment and ensure that existing data integrations can provide the necessary insights, the integration of new data sources can also eliminate data shortages (Zaman et al., 2017).

Errors related to data flow: High-quality testing and validation of the development lifecycle reduce the number of issues and minimize data processing issues; even when working with high-quality data, analyses can yield inaccurate results (Koga, 2015). In this case, it makes sense to conduct a thorough examination of your system and check whether the implementation of data processing algorithms is error-free (Koga, 2015).

Big data analytics infrastructure and resource usage issues: The problem may be that the system has reached its scalability limit, moreover, the hardware infrastructure may no longer be sufficient (Zaman et al., 2017). The simplest solution here is to upgrade or add more computing resources to the system, which is fine if it helps improve system responsiveness and resources are used appropriately (Zaman et al., 2017).

Stakeholders such as port operation operators, forwarders, ship owners, agents, brokers, logistics, and insurance companies play a role in maritime transportation from raw material to the delivery of the final product (Karakoç et al., 2020). Various business procedures and transportation operations among stakeholders cause a lot of data to be generated (Koga, 2015).

The general problems caused by this in the maritime sector can be summarized in. (Koga, 2015).

Data Transfer and Integration: The lack of communication between carrier and shipper or the desire of the stakeholders not to share their data are the main reasons for this problem (Zaman et al., 2017). In an operation where more than one stakeholder is carried out together, the difference in systems is used is also a problem in terms of data transfer (Aylak et al., 2020). In addition, the failure of the carrier's system to integrate with the shipper or the insufficient technical infrastructure are other factors preventing data transfer (Aylak et al., 2020).

Cybersecurity: Transport companies are facing cyber threats like any other companies. This is an essential issue for any IT system; the safety and security of the data network and data management will become significant for future shipping (Zaman et al., 2017). Threats such as data loss and data theft can cause irreparable damage (Koga, 2015). The use of cloud technology for the e-archive system greatly reduces these risks but does not eliminate them because your cloud technology partner should not give any vulnerabilities (Koga, 2015). Even if the internet connection is very well secured, software infected with a USB inserted into a staff's computer can threaten cyber security.

Data Ownership: The maritime transportation industry can be considered a part of the supply chain (Song & Lee, 2009). Many stakeholders are found within the maritime industry, such as shipowners, operators, customers, port authorities, and classification societies (Karakoç et al., 2020). Shipowners will have access to all data on transport volume and capacities, or classification societies have access to necessary data for security and classification purposes (Koga, 2015). Hence, data ownership is significant for the maritime industry to make decisions and have helpful information (Koga, 2015).

2.3 Business Intelligence and Big Data in Decision Making

BI refers to structured information that enables companies to create constructive forecasts and benchmarks to gain profitability and competitive advantage (Sahay & Ranjan, 2008). On the other hand, although there is no precise definition of Big Data, it can generally be summarized as a large scattered of digital information containing unstructured data (Journal et al., 2017). Big Data analytics supports to collection, process, structuring, and analyze scattered data (Labrinidis & Jagadish, 2015). This enables transport companies to make data-based decisions, increase efficiency with capacity and route optimization, and provide a better service

(Šekularac Ivošević, 2021). In addition, BI supports collecting and analyzing the necessary data in the large data repository and making consistent forecasts and decisions to achieve goals (Balaceanu, 2007). Data analytics include BI for shipping companies to extract results from their data analysis (Elbashir et al., 2008). When companies use data together with advanced statistics and predictive analytics, and when they use models and algorithms to separate the results into actionable language, BI helps them to make the right business decisions based on the collected data (Elbashir et al., 2008). With BI, maritime companies can improve planning and track their performance against their targets (Sahay & Ranjan, 2008). For instance, a maritime company that has been providing liner container transportation services to certain destinations for many years can decide by analyzing the data it has using business intelligence methods, tables and graphs, that it can use its ship with what capacity in which destination, which routes it can use, or which routes it should focus more on (Sahay & Ranjan, 2008). Additionally, with the use of BI applications, companies can analyze market rates according to cargo type or transportation type to identify their pricing strategy through graphs, tables, charts, and statistics (Sakty, 2013).

Chapter 3. Methodology

The purpose of this thesis is to explore BI tools used in the transportation industry. A deductive approach was applied by considering the general principles of BI and Big Data through pros and cons conclusion was reached about the explanations (Gallaire et al., 1984).
Deductive research is a theory process that starts with a fixed and established theory or generalization and then tries to understand whether the theory is applied to specific examples (Hyde, 2000).In this reasoning method, general principles are handled, and conclusions are reached about events one by one. In other words, it is a method that goes from general to specific. The correctness of the conclusion here depends on the correctness of the antecedents (Hyde, 2000). The deduction approach followed in the study was also supported by qualitative and quantitative data.

According to the deductive research approach, a structured literature review was conducted with related research to undertake scope studies to assess the relevance and size of the literature and to delimit the subject area or topic, such studies need to consider interdisciplinary perspectives and alternative ways in which a research topic has been previously addressed (Tranfield et al., 2003). Thereafter a case study was conducted including a survey and interview were implied to get qualitative and quantitative research to support the thesis.

3.1 Data Collection

During the literature review, secondary data were included, and a general conclusion was obtained by analyzing previously published papers and research. The basis of the literature review was clarified with a detailed evaluation and analysis of the existing evidence. Priority data were obtained with subsequent interviews and surveys.

3.2 Literature Review

The literature review was written by identifying keywords that would be related to the thesis, such as BI, Big Data, shipping, Big Data Management, data, and maritime transportation (Denney & Tewksbury, 2013). In this thesis, the literature review was carried out on related studies such as book sections, journal articles, reports, scientific articles, websites, and related thesis works. Databases at Chalmers Library, Google Scholar, Scopus, Elsevier, and Sage Researchmethods were used to access these resources (Dimitrov et al., 2010). For an academic

source to be selected as a citation in the thesis, it must be related to the thesis, have an explanation of the subject, and have been cited by other authors before (Waugh & Ruppel, 2004).

Categorization	Papers Found	Matching Objectives	Final Selection
Business Intelligence	32	29	29
Big Data Management	27	25	23
Integration of BI and Big Data	8	8	6
BI Systems in Logistics	17	17	17
Big Data Management in Maritime Transport	6	6	6
Total	**90**	**85**	**83**

Table 2: Included papers for literature review (Denney & Tewksbury, 2013, p.232).

The literature review was used in the frame of reference chapter to explain BI and Big Data in general terms, their positions in maritime transportation were evaluated, then their structure of working together in maritime transportation was explained (Gallaire et al., 1984). In the first stage of the thesis, BI tools and their innovative features were explained and the place of BI in the transportation sector was explained. Afterward, the pros and cons of Big Data and Big Data for transportation were explained. In the last stage, the similarities, and differences between BI and Big Data were explained, and it was concluded how they are used together in maritime transportation.

3.3 Case Study

In this research, a case study was conducted to collect data on the key advantages and disadvantages of the usage of BI technologies. In addition, the case study supports anticipating the future of BI technologies in maritime transportation, and which features of BI technologies are used by industry professionals. The case study is the most used research technique in social and life sciences (Heale & Twycross, 2018). It is used to make a very large area easily understandable and discoverable (Heale & Twycross, 2018). A case study is a form of study in

which the data obtained from the literature review are collected and analyzed by researching the subject in the context of real life and imposing the results on quantitative methods (Dul & Hak, 2007).

Data collection in the case study was conducted based on a mixed methods approach through the combination of qualitative surveys. The survey was conducted with 10 logistics employees from the automotive industry. The age range of participants is between 30-45 and they are industry professionals with many years of experience in the transport sector. 4 of the employees are in executive positions and 6 of them have senior positions. Especially in logistics purchasing operations, they use BI technologies and Big Data to compare rates, forecast, and create scenarios. Participants answered five open-ended, four closed-ended, and one multiple-choice question. The survey and interview were carried out through the Microsoft Forms application and shared with the participants on May 30, 2022 (Appendix 1). All answers from 10 industry professionals were obtained until June 3, 2022.

3.4 Data Analysis

Primary data were obtained through the qualitative and quantitative approaches with their consistency analysis, and secondary data was obtained by literature review, then all the received data was analyzed with survey and interview results. Close-ended questions were evaluated between one and five in the survey where one stands for strongly disagree, three stands for tentative, and five stands for strongly agree.

The unit of analysis identified in the literature review and used in the survey comprised:

- Decision-making
- Rate forecasting
- Benchmarking
- Finding errors
- Predicting the market position
- CO2 emission calculation
- Traceability / Real-time visibility
- Freight optimization
- Dashboard

Studies conducted on Big Data and BI to date have dealt with both approaches separately from different perspectives. In this research, BI and Big Data were researched together, and the academic literature was handled with a deductive research method based on the evaluation of the results of the literature review. Thus, secondary data is received accordingly to have a general perspective, then based on interviews and surveys with quantitative and qualitative approaches are moved in to achieve primary data, these primary data supported the deductive approach for valid outcomes by automotive industry professionals.

Chapter 4. Results and Analysis

In this chapter, the results are presented from the literature review. This section provides a brief description of the position of BI and BDM in the shipping industry and their compatible working structure. In addition, results from analyzed surveys and questionnaires have been included.

4.1 Business Intelligence Analyses in Shipping

Through rapidly developing information technologies, an increase in the number of research is observed (Bowen, 2009), and the literature review provided the definition of BI, its components, its position in the supply chain, and its innovative features for maritime transportation were mentioned. As a result of the survey and interview, future trends, economic conditions, and accurate information forecasts with BI are used effectively and proactively by providing transportation companies with good information and a competitive advantage in making business decisions. By bringing together the information obtained through BI, shipping operations can quickly adapt to the constantly changing business environment and challenging competitive conditions which were confirmed in the literature.

Results from the literature review, survey, and interview showed that organizations that do not produce BI or benefit from digital solutions continue their classical and conventional works, also closed to change and development. For this reason, companies cannot maintain their market positions in the competitive market and cannot ensure long-term permanency due to the absence of keeping up with innovation. According to the literature review, the increasing costs of shipping companies, decreasing profit margins, and increasingly intense competition force decision-makers to discover innovative solutions. Results from the literature review, BI applications offer loyalty, experience, and satisfaction for the customers. It is a significant occasion to make better decision-making, decrease costs, increase revenues, better productivity, and automate progress. It is imperative that they analyze their market positions, freight prices, future forecasts, and benchmarking well and have digital awareness in the context of sustainable competition in the business. In addition, with results from the surveys, BI-conscious organizations can anticipate the promises, benefits, threats, and potential impacts of emerging new technologies. Literature review results show that BI-conscious managers can analyze the internal and external environmental factors better than their competitors, and they

can make the digital business design of the business and the selection of strategies more successful. In addition, the results of the survey, automotive industry employees were asked what features of BI tools they utilize most, and below is the chart that explains the result.

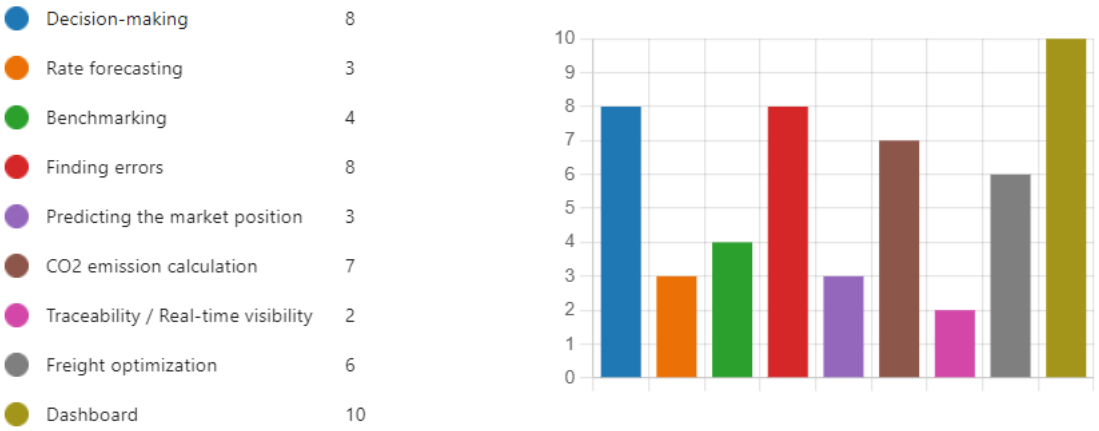

Figure 3: Results of the multiple-choice question

According to the survey answers, dashboard features, freight optimization, benchmarking, decision-making, and finding errors are the most used features of BI tools, and this situation supports the literature review result. The requirement for CO2 emission calculation features via BI tools shows that industry professionals are aware of the importance of sustainability, and they are looking for better solutions to reduce CO2 emissions. Based on the survey, general results showed that Dashboarding is the most used feature of BI tools, literature review also supports that. Due to offering graphs and charts with ratios feature of Dashboarding, it provides better service.

4.2 Key Advantages and Disadvantages of Using BI Tools in Maritime Transport

BI tools' pros and cons are evaluated in the previous literature review. As a result of the literature review, BI tools have advantages such as making the right decision, visualizing data, optimization of business processes, and rate comparison are concluded. Analyzed answers from the survey and interview also supported this. Surveys with employees showed the benefits of BI tools such as visualizing accurate data, supporting decision-making processes, optimizing complex projects, predicting potential developments, analyzing large and scattered data and reducing the workload. These benefits also support published studies. Thus, it is concluded that

BI tools reduce the daily workload of the transportation industry and provide a more efficient working system.

The results from the literature review showed the disadvantages of the BI tools and mentioned the difficulty of data reliability and collection, the difficulty of integrating the systems with each other, the required manual workload, and the complicated reporting processes. According to the interview, the received answers from 10 industry professionals supported the difficulties. Automotive industry workers mentioned in the survey the scattered database, its quality, reliability, and the difficulty of integrating the systems while using BI tools. The consistency of the secondary data and primary data obtained in this way on BI tools draws attention.

4.3 Business Intelligence in Decision Making

According to the literature review, BI systems are among the information systems that are increasingly being used at the level of large organizations and companies today. As a result of the surveys, a benefit of BI systems, which appeal to employees and managers at all levels, is effective decision-making for managers, particularly in the decision-making phase. In addition, according to the multiple-choice question in the survey shows the effect of BI on decision-making. BI technologies enable users to easily understand complex information, analyze this information and make effective decisions.

Based on the results from the literature review, with the BI tool's diverse components such as data mining, data warehouse technologies, and analytical applications, BI systems surpass other software and provide benefits to their users. One of the main benefits of BI systems is decision-making and by making effective decisions, it becomes easier for organizations to reach their goals. According to the literature review, rapid changes and complex situations in the transportation sector have forced businesses to make faster decisions. Therefore, it is important for decision-makers to anticipate the possible consequences of decisions and choose the best alternative. BI generally aims to deliver the right information to the right decision-maker at the right time and in the right format, thereby increasing operational efficiency throughout the enterprise. Surveys and interviews also support that adopting fact-based approaches in the decision-making process provides a competitive advantage to the business and prevents the failures of decisions taken with personal foresight and intuition. In line with the data obtained in this study, it has been concluded that BI plays an important role in making

efficient and effective decisions for users, thanks to its digital features such as a dashboard, report, and real-time visibility in maritime transportation.

4.4 Big Data Management in Maritime Transport

The results from the literature review showed that maritime transportation has a general and comprehensive network from production to supply, which is one of the areas where the need for data is felt most intensely. Whereas in the past shipping activities allowed products to be handled in as much quantity and as little variety as possible, today it can handle more and more diversity of products with higher variety. This situation can create more complex business processes and in addition to making it difficult to plan and organize transportation activities on a systematic axis, it also increases possible risks. According to the literature review, the benefit of Big Data technology in terms of the performance of transportation activities offers a remarkable view. Today, in addition to the intense need for data in the effective execution of transportation activities, the increasing need for the evaluation of the results when the transportation activities are completed and the increase in the logistics business volume also increase the need for big data applications. Based on the literature review, Big Data can be summarized as a data source that collects large-scale data collected from many different sources. On this axis, most of the data in the system consists of unstructured data. According to the interview, various technology companies and internet browsers have designed several systems that make this data structured and therefore usable, which has been a factor that has increased the use of Big Data by individuals as well as businesses and supply chains. It has resulted that Big Data can provide classified and usable data through these systems. For instance, all kinds of information about products ordered in a particular region can be collected and classified according to all kinds of requirements of shipping companies and supply chains. Therefore, an enterprise that plans to invest in shipping activities in the said region can take all its decisions according to these data.

According to the survey, since the Big Data system is an unstructured system, every piece of data in it may not be data that can be used for planning and executing logistics activities. In addition to that, based on the answers from the interview, the quality of the obtained data is important, inconsistent, and wrong data cause the outputs to be completely wrong and cause undesired analyzes to be made, also the data is not always reliable, therefore making sure the data accuracy takes time and it can be difficult to reach the source of the information and

complicated to search across different systems. It is therefore necessary to determine in advance what data you need and which of them will need to be selected and processed. Based on the interview, it is seen that Big Data can meet the data requirements of shipping activities to a large extent and have an opportunity to provide significant improvements to cover almost all shipping operations. However, when each operation is evaluated separately, the benefits and strategic advantages to be provided by Big Data can be better understood.

4.5 Compatible Way of Working for BI and Big Data

It was noticed that while there are many studies related to Big Data and BI separately, there are not many studies that explain the two in the same pattern and include their compatibility with each other, therefore the research questions are shaped around this academic gap.
In the literature, there are studies that explain BI and Big Data, talk about the importance of their application in the shipping sector, approach these subjects from a different perspective, and try to raise awareness of these innovations. In these studies, it was determined that a large amount of data was derived from transportation activities such as freight transportation, shipping, distribution, and storage, and the effects of these data on logistics were analyzed. These analyzes were generally analyzed by examining papers, research, and case studies and looking at the benefits of digital solutions used in companies. The literature review showed that digital innovations developed with data-based BI have a significant and positive effect on the shipping sector. In addition, studies have revealed that supply chain managers need to benefit from large amounts of data when making decisions to increase the availability of the product to customers and reduce costs. As a result of the surveys and interviews, it has emerged that Big Data Management and BI are very beneficial for the shipping industry.

The interview concluded that Big Data is essential for identifying any form of data analysis in a spreadsheet, database, or application to detect trends, identify anomalies, and measure performance. According to the literature review, data analysis is a technical process in which data is extracted, purified, transformed, and systems are set up to manage it. Shipping companies leverage BI to maximize their use of Big Data. BI applications can provide insights for shipping companies and customers to drive product viability, development decisions, progress metrics, and improvements in the right direction. In addition, BI tools enable companies to leverage the benefits of data not only to adopt current sales forecasts and potential future patterns and trends but also to understand their customers' needs at a deeper level.

According to the survey, industry professionals are struggling to determine scattered data in their daily work. In this case, innovative BI tools help them to identify these data and use it efficiently.

According to the literature review, the process of transforming business data into usable information is time-consuming and involves a variety of factors such as data models, data sources, data warehouses, business models, and others. Shipping companies should set relevant goals and parameters to extract valuable insights from Big Data. Decision-makers should have access to and use small, specific data. BI and Big Data are digital tools that do not identify specific data that can help companies make better leadership and management decisions. In conclusion, BI and big data by definition are different, but they can be interoperable and shared.

Chapter 5. Discussion

In this chapter, the results are discussed. The result and analysis and the literature review demonstrate the benefits of BI tools, also the importance of using Big Data, and the harmony between them. In addition, the result shows that using BI tools has also some challenges. In addition, due to the awareness created by this study on the benefits of the use of Big Data and BI in maritime transportation, it is thought that the companies that do not use these innovations in the sector will also use BI, so this study will contribute to the increase in the use of BI in the shipping sector. While performing data analysis, first, information about BI was collected from different research sources. Among these studies, there were purposes and methods of use of BI in different sectors, among which the studies that BI technology was most relevant for the transport sector were compiled, and the relationship between BI and transport was investigated by the document method analysis. Then, the collected data about Big Data were analyzed and finally, the benefits of BI and Big Data for transportation were discussed.

In the supply chain and maritime transportation, there are corporate and large-scale companies, as well as companies that provide small and low-budget services (Mathrani, 2008). It is more possible and convenient for large companies to invest in BI tools that can collect various data and use it efficiently. However, for small service providers, it is difficult to access the necessary data and it can be challenging to allocate a budget to invest in their tools. Therefore, the integration of transport service providers' systems can be very difficult. In addition, the usage of different infrastructures for the system prevents their integration with each other, so it is not always easy to implement BI tools and collect big data. BI challenges are determined by many factors, including diverse data infrastructures, data management challenges, new BI capabilities, and the changing data literacy levels of the workforce. On the one hand, BI solutions must ensure that appropriate data governance and security protections are in place; on the other hand, they need to show how BI can benefit employees, including those who are less data literate. In line with the questions posed to the employees in the survey, answers have been received that the use of BI tools has some disadvantages.

In addition to the above, there are many types of intelligence used in conjunction with Big Data in maritime transportation. However, there is not much academic research on the difference between them or what kind of benefits they provide in which subject within the sector. For

example, terms such as Market Intelligence, Location Intelligence, Transportation Intelligence, or Logistics Intelligence are widely used in the industry. Which of these BIs encompass or which types of intelligence work differently from BI is a debatable thing. This research clarified where Big Data and BI are used in the transportation industry and laid the groundwork for further research in the future. With the development of technology, the working principles of companies are also changing, companies that benefit from technology efficiently are securing their positions in the market, so the importance and processing of data should not be overlooked in the transportation sector.

Chapter 6. Conclusion

Considering the last 20 years' development of businesses together with IT, it is seen that one of the most important concepts is data. This increasing importance of data has also increased the investment in data storage, collection, and processing. The shipping industry has also been affected by the development of data science. Companies have started to use their data to provide better service for their customers, increase their profitability, and make the right decisions. However, among this increasing data pile in the sector, it has become important to develop a common strategy using the available data and to implement these strategies in various fields. At this point, the concept of BI emerges. In this study, we discussed how Big Data and BI are used together in the transportation sector, and their benefits and challenges. It's concluded that BI can be expressed as the whole process of taking the data stored or presented in various environments, from the sources where it is stored, and placing it in a certain area after various processes such as cleaning and transformation and making strategic decisions for the institution by applying analyzes on this result data.

During the theoretical research, it was concluded that the BI that companies use in practice in the supply chain is used to analyze the current operations, prepare visual reports, and see the potential gaps and positions in the market, to determine the strategy while optimizing the freight and price, to prepare the simulation of the situations that may occur by creating scenarios and to scrutinize the necessary data across the platforms. In line with the surveys, managerial practices in the use of BI and Big Data were evaluated by professionals in the industry. The obtained answers provide a response to research question 1 and supported the theory to a significant extent. Industry workers use dashboarding features, benchmarking, decision-making, freight optimization, market position estimation, and price estimation features of BI to filter the scattered data and analyze the necessary data, and they see the benefits of this. Especially with the technology developing in maritime transportation, the benefits of BI for carrier selection, benchmarking, and foreseeing the market position through the dashboard feature, evaluating cargo handling performances, and providing real-time vision for IT technologies cannot be ignored. In the supply chain, maritime transport has a much higher freight volume compared to other transport methods, therefore the data obtained because of operations have more amount. It was concluded that BI and Big Data should work together in maritime transport.

The features and benefits of BI in processing Big Data, it was concluded that Big Data also has benefits for the transportation industry, but also some challenges. Tracking containers, comparing previous price data of freights with current market positions, optimizing route and freight with traffic data, taking precautions against the peak season problem, procuring necessary equipment by making forecasts in advance, and avoiding excessive and seasonal price increases by making reservations. It was concluded that it has benefits such as advance, scheduling of periodic maintenance of ships, containers, and transport equipment, and efficiency analysis at ports. In addition, Big Data enables to optimization of customer interaction and determines customer needs in advance through demand forecasting and predictive shipments, and risk analyses to reduce or minimize the risk. It cannot be ignored that benefiting from Big Data in the scattered data crowd has some difficulties as well as positive effects. It was concluded that there are challenges such as the low quality of the data, data reliability, the technological infrastructure required to access the existing data, and the flow of data between companies' platforms. In this way, research question 2 is answered

Since the subject of the research field is the supply chain and maritime transportation, in this study, the applications of enterprises in the shipping sector for the use of Big Data, the ability of BI to process data together with IT technologies at this point and the benefits it provides to companies have been determined. In this study, we discuss how Big Data works together with BI in the transportation sector and the answer is received for research question 3. In addition, there is not much research on how concepts such as Market Intelligence, Location Intelligence, and Logistics Intelligence used in the sector work together with Big Data, and what benefits they provide to the supply chain suggested to researchers for further investigations. Considering that the logistics processes will be more automated and technology-centered in the future and that the human factor will not be used in these processes partially or completely, it is thought that the impact of these developments, namely the increase in efficiency that will be created by Big Data applications in the operational processes of the logistics sector should be continued.

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Appendix I

Survey:

Which of the following features do you utilize in your daily work through BI tools? (Multiple answers option)
• Decision-making • Rate forecasting • Benchmarking • Finding errors • Predicting the market position • CO2 emission calculation • Traceability / Real-time visibility • Freight optimization • Dashboard

Appendix II

Interview 1:

Questions	**Rate Between 1-5**
Do you believe that investments in BI tools can provide more profits?	1 - 5
Can BI solutions adapt and evolve alongside the supply chain organizations' long-term plans?	1 - 5
Do BI applications (Power BI, Coupa, SAP Systems, etc.) make our daily work easier?	1 - 5
Do you think BI tools have risks in terms of data reliability?	1 - 5

Interview 2:

Nr.	**Open-ended Questions**
1.	What are the key advantages of using the BI systems (Power BI, Coupa, SAP Systems, etc.) in your daily work? (Please mention at least three advantages.)
2.	Mention two disadvantages or improvement areas of using BI systems.
3.	How can BI tools increase supply chain efficiency in terms of decision-making and time-using? (With two short examples)
4.	What do you think about the future of BI applications with decision-making mechanisms in the logistics industry? (Please explain shortly in one sentence.)
5.	How often do you use BI tools in your daily work?