POLITECNICO DI TORINO

Master of Science Thesis

CONSTRUCTION OF A NEW WAREHOUSE IN A TRANSPORTATION AND LOGISTICS COMPANY

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ABSTRACT

The present thesis investigates the domain of data governance and its implications within the context of a transportation company. It specifically explores the employment of logistics planning optimization software and its potential influence on decision-making processes concerning the establishment of a new warehouse facility in Udine. By implementing data governance principles and utilizing logistics planning optimization software, the study aims to evaluate the viability and prospective advantages of this investment. Through the examination of historical data, identification of patterns, and simulation of various scenarios, the research intends to provide valuable insights into the potential impact of the new warehouse facility on the company's operations, efficiency, and profitability. The outcomes of this study can inform transportation companies about the advantages of data-driven decision-making and the adoption of logistics planning optimization software. Furthermore, this research contributes to the existing body of knowledge on data governance by demonstrating its practical application in a real-world scenario.

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INTRODUCTION

This thesis delves into a topic of great relevance to the transportation and logistics sector: the construction of a warehouse through the utilization of optimization and logistics planning software based on the principles of data governance.

We live in an era where the speed and efficiency of logistical operations have become crucial to the success of businesses. Particularly, transportation companies face complex challenges such as fleet management, coordination of delivery times, and resource control. In such a dynamic context, the use of advanced technologies becomes indispensable in effectively tackling these challenges.

The warehouse represents a focal point in organizing a company's transportation and logistics activities. Its proper design and management can have a significant impact on operational efficiency, cost reduction, and customer satisfaction. Many companies encounter difficulties in optimizing delivery routes due to factors such as customer opening hours, traffic, road conditions, and unexpected delays. Therefore, it is crucial to consider all constraints and evaluate alternative options to determine the best solution. IT support can enhance the outcomes of delivery round optimization, which is why Arcese has made the decision to invest in PTV. This optimization and logistics planning software serve as the key tool for implementing data governance in the context of depot construction. Through this software, historical and real-time data can be analysed, various scenarios and constraints can be considered, and optimal plans and solutions can be generated. Consequently, the transportation company can make smarter decisions, optimize resource utilization, and enhance overall productivity.

The current global context has emphasized the importance of IT technology and the exponential growth of data volume. This reflects the increasing need for broader information within organizations and the technologies responsible for their creation. This has led to a need for multi-field reflection on IT control and management methods to ensure technology use represents a solid basis for achieving set objectives. This is especially fundamental within the sector of the transports, which deals with an infinite series of data relating to trips and shipments.

Effective data governance is essential to provide value to all team members across the organization by allowing them to define business terminology, KPIs, rules, policies, and more so everyone in the organization speaks the same language. This shared language provides a common understanding and enables the same, consistent, and trusted information to be leveraged. In a dynamic world where data changes continuously, quick, and safe access to up-to-date information is necessary to ensure its correspondence to the present value of the entity represented.

This thesis endeavours to shed light on the importance of leveraging advanced software solutions for transport optimization in the context of warehouse expansion within the Arcese company. By exploring the multifaceted benefits and potential outcomes of such implementation, this study aims to contribute to the growing body of knowledge in the field and equip transportation companies with the necessary understanding and tools to navigate the complexities of modern logistics, maximize efficiency, and achieve sustainable growth. At the end of the thesis there will be also a part connected to the total investment required for the project; this part will analyze in detail all the several cost which the firm will incurred if it decides to implement the realization of this new warehouse.

CHAPTER 1

WHAT IS THE DATA GOVERNANCE?

1.1. DEFINITION OF DATA GOVERNANCE

Data Governance is an extremely complex theme which refers to a set of processes, roles, policies, standards, and metrics aimed at ensuring the effective and efficient use of information, which enables an organization to achieve the set objectives. It is responsible for ensuring that the information is clean and reliable, well documented, easy to find and access, safe, compliant, and confidential. Thus, it is the overall management of the availability, usability, integrity, and security of the data used in an organization. Effective data governance helps organizations make better use of their data and reduces the risk of errors, breaches, and other issues that can damage an organization's reputation and bottom line. It typically involves inputs from stakeholders across the organization, including IT, legal, compliance, and business leaders. [1]

There are several definitions of Data Governance released by authoritative sources:

- According to DAMA, the International Data Management Association, born thirty years ago in Los Angeles and now spread all over the world through its over fifty national associations, Data Governance is the "exercise of authority and control over data management in terms of planning, execution and monitoring [2]." This definition highlights the idea that data governance is a formalized process that is carried out at the enterprise level which involves the exercise of control and direction over the management of data assets. The DAMA definition also emphasizes that data governance is a continuous process that ensures data is used effectively and in compliance with relevant laws and regulations.
- Gartner defines it as "the mapping of decision rights and the subsequent creation of a framework of responsibilities to ensure the adoption of appropriate behaviors in the evaluation, production, consumption and control of data and related analysis practices [3]."
  This definition highlights the idea that data governance involves making decisions and exerting control over data-related matters within an organization. Gartner also emphasizes that it is a cross-functional process that involves collaboration among different departments and stakeholders. The goal is to ensure that information is accurate, consistent, and accessible to those who need it while also protecting data privacy and security.
- Forrester qualifies it as "the process by which an organization formalizes its fiduciary duty to manage critical data assets to its success [4]". He emphasizes the importance of the governance for organizations looking to make the most of their data assets and stay compliant in an ever-changing regulatory landscape. This definition also highlights the role of ensuring data quality and compliance with regulations such as GDPR and CCPA.

Data is the largest asset in a company and with increasing digitalization, every company has access to a huge volume of information**.** Nowadays, in fact, in the dynamic and highly competitive business environment, companies deal with an incredible amount of customer data. If the information is used properly to better understand the market and the target audience, the business can

only be more successful. All companies make data decisions, regardless of industry or size, and the use of corporate data governance is a key enabler for value creation, risk management and business process improvement. As volumes and types of information become strategic for businesses, data governance is constantly changing [5].

Data governance also defines who may take what actions, on what data, in what situations and using what methods. Key business dynamics highlight the information that should be properly controlled in the strategy and the expected benefits of implementation. It also establishes the policies and processes through which information is standardized, collected, stored, analyzed, shared, and used, as well as traceability. This explains why it can be defined as the ability to handle data as an actual asset. To do this, it is necessary to follow certain rules, a data governance framework, to ensure that the information is properly oriented towards the set objectives of the firm.

Of course, the success of an accurate management will fail if not supported by the quality of the data. The availability of an organization's data only becomes a valuable asset when it can be used as a whole, beyond limited and partial use by individual areas, functions and business units. In other words, it needs to create value and just like managing any other asset - for example a warehouse, a machine, an innovative service, or more generally any other element that has value for the company - data needs some basic rules so that they can produce an economic value. A well-designed data governance framework covers strategic, tactical, and operational roles and responsibilities [6].

Another primary goal of data governance is to "break down the organization's data silos," which usually form when individual business lines deploy and use systems and applications that do not communicate with a data architecture designed for integration, centralized management, and cross distribution. Data silos, also called information silos, are pockets of information stored in different information systems or subsystems that do not connect with each another. If your company is collecting and storing a lot of data in different locations, there's a good chance you have a data silo. When you can't link the data from one system to the other, each is an individual "silo" [7].

Thus, Data Governance aims at harmonizing the data life cycle through defined and shared processes that involve the participation of stakeholders from the various business units which of course need to follow some rules. Therefore, there are three integral pillars of data governance:

1. **PROCESSES:** refer to the steps and procedures that organizations follow to manage their data effectively and efficiently. This includes data quality control, data privacy, data security, data archiving, and data access management, among others.
2. **PEOPLE:** refer to the individuals or teams responsible for managing and maintaining the organization's data. This includes data owners, data stewards, data custodians, and data administrators, who are responsible for ensuring that the data is accurate, secure, and accessible to authorized users.
3. **RULES:** refer to the policies and regulations that organizations must follow when handling and using data. This includes data privacy laws, such as the General Data Protection Regulation (GDPR) and the California Consumer Privacy Act (CCPA), as well as industry-specific regulations, such as those for financial services and healthcare.

To guarantee the success of the data governance, all three components must work together to ensure that is managed in a consistent, efficient, and secure manner that aligns with the organization's goals and objectives [8].

1.2. DATA GOVERNANCE CHALLENGES

It is inevitable that companies run challenges with managing their data and these can include problems related to data accessibility, accuracy, and protection. The relevance of data governance is obvious. Nevertheless, despite its advantages, many companies are afraid to implement these programs – either because of the assumed complexity or due to general uncertainty.

There are several challenges that organizations may face implementing and maintaining data governance. These are not the same for all organizations but there are several that seem to appear more often than others:

- **Lack of data leadership:** data Leadership is a challenge facing many organizations. Gartner says that organizations that lack a clear leader or governing body for their data and analytics initiatives face significant risks which include fragmented decision-making, conflicting priorities, limited resources and accountability, and a general lack of strategic direction. In other words, the lack of leadership for data and analytics initiatives can lead to inefficiencies and risks, such as poor data quality, lack of privacy and security, and difficulties which explain why organizations are slowly embracing that they need people to be responsible for their data, beyond the technology required to leverage and protect the data. That is the reason why the Chief Data Officer (CDO) is working its way up to the level of prominence reserved in the past for the Chief Information Officer (CIO) [9].

- **Recognizing the pain caused by data:** this challenge in data refers to the difficulty of understanding and recognizing the problems caused by poor data management. This leads to the underestimation of data problems because without a clear understanding of the situation, organizations may underestimate the need for data governance initiatives leading to inadequate investment too. It may also be difficult to gain support and buy-in for data governance initiatives or organizations may miss opportunities to improve data quality, reduce costs, and increase efficiency. To overcome this challenge, there is the need to raise awareness of the problems caused by poor data management, including the impact on quality, privacy, security, and efficiency. The best way to overcome this challenge is to highlight the costs and risks associated building support for governance initiatives and secure the resources needed to address the challenges [9].

- **Senior management support, sponsorship, and understanding:** this challenge refers to the difficulty of obtaining support and commitment from senior leaders for data governance initiatives. Lack of senior management support can also lead to conflicting priorities and inconsistent policies as well as difficulties in making decisions about data which can impact the overall quality and reliability or the ability of the organization to effectively use information to support business goals and objectives. Organizations may struggle to build a culture of data

governance which can limit the ability of the organization to effectively manage and govern it over the long-term. To overcome this challenge, organizations need to educate and engage senior leaders on the importance and benefits of this field. This may include highlighting the impact on data quality, privacy, security, and efficiency, as well as the potential return on investment. By gaining senior management support and sponsorship, organizations can secure the resources and commitment needed to address the challenges [9].

- **People think IT owns the data:** it refers to a common perception that data management and governance is primarily the responsibility of the IT department. This can result in confusion and misalignment between IT and other business units because when data governance is seen as solely the responsibility of IT, other business units may be less likely to engage and provide input, leading to a lack of buy-in and support for data governance initiatives. To solve this issue, it is needed to:

    - Involve business stakeholders in data governance processes clearly defining roles and responsibilities for data management.
    - Communicate the importance of data ownership to the entire organization.
    - Foster a data-driven culture where information is seen as a shared asset.
    - Implement data management policies and procedures that align with the organization's goals.

  By implementing these steps, the organization can shift from viewing information as belonging to IT to viewing data as a valuable asset owned by the entire organization. While IT provides the technology infrastructure, the business needs to define and enforce processes and workflows to get the maximum business benefit from it [9].

- **Lack of data documentation:** at the core of good data management there is documentation which introduces data, provides a detailed description of their key attributes, and contextualizes them. Documentation should describe what anyone did and why he made those choices and can be written at many "levels" in many forms. Together, all the documentation associated with a research project should answer a series of important questions such as: "What is the context of data collection?", "How did you generate / collect the data?", or "In what form are the information?". To solve this challenge, it is necessary to implement policies which require documentation for all data management processes using tools that automatically document flows, data lineage, and metadata. It is also fundamental to encourage collaboration between business stakeholders and IT to ensure that documentation is accurate and up to date establishing standards for the format and content to ensure consistency and ease of use. This could be possible of course only by providing training for all stakeholders on documentation's importance and how to effectively maintain it [9].

- **Limited resources:** it refers to the constraints on time, budget, and personnel that organizations face when implementing and maintaining a data governance program. This can make it difficult

for organizations to fully implement effective data governance processes and maintain the quality of their data because of the lack of dedicated personnel or lack of funds to invest in technology or tools or limited time to devote to data governance initiatives. To overcome this challenge, there are different actions that companies do such as prioritize initiatives focusing on the most critical or involve stakeholders engaging business stakeholders in the governance efforts to leverage their expertise and support. Other solutions could be the use of automate repetitive tasks or simplify processes to minimize the time and resources required to implement them or outsource or the outsourcing. By implementing these steps, an organization can effectively manage its data governance program with limited resources and still achieve its goals [10].

- **Data silos and inconsistent implementations**: data silos present a significant obstacle to effective data governance because when information is owned and stored differently by various teams, it becomes difficult to maintain consistent standards. Silos arise for many reasons such as: the fast pace of data collection, constant turnover of data technologies, corporate cultures, or internal friction but typically arise when different departments do not share information with each other. Data silos lead to a set of problems such as inconsistent information because of stored in different locations or wasted resources determined by duplication of efforts for the collection of the same data. Other connected problems are for example the limited view of data which lead to wrong decisions or reduced user experience. The key to overcome all these problems is to adopt a centralized approach to data management and to foster a culture that prioritizes quality so that organizations can ensure that all teams are following the same guidelines. It is important to note that data governance is not a one-time project, but a continual effort and thus, a shift in organizational culture is necessary to prioritize and maintain the value of quality data [10].

- **Data integration:** integrating data from different sources and systems can be a technical and operational challenge like selecting the right governance tool and integrating it with existing systems. Data integration is an important aspect of governance, as it involves combining information from different sources and systems into a single, unified view. This is necessary for organizations to gain a comprehensive understanding, make informed decisions, and support their business goals. But it can be a complex and challenging process, as it requires dealing with different formats, structures, and levels of quality from various sources. There are various methods and technologies available to support integration, such as extract, transform, load (ETL) processes, data warehousing, and data federation. To effectively integrate it from different sources and systems in governance, organizations need to establish clear goals and objectives, define the data integration requirements and constraints, and put in place a robust integration strategy. A successful effort requires collaboration between different teams and departments, including data management, data analytics, and IT with the board that should also have a role in overseeing the integration effort and ensuring that the processes align with the organization's overall policies and goals.[11]

- **Data privacy:** data privacy is a major concern in data governance, as it involves the protection of personal and sensitive information from unauthorized access and use. This can include information such as name, address, social security number, medical records, financial data, and

more. In recent years, privacy has become a critical issue due to the increasing amount of data being collected and stored by organizations, as well as the rise of cyber threats and breaches. To address these concerns, many countries have enacted data privacy laws, such as the European Union's General Data Protection Regulation (GDPR) and California Consumer Privacy Act (CCPA), which regulate the collection, storage, and use of personal information. Data governance policies and processes must be implemented to ensure that personal info is handled in a responsible and secure manner, in compliance with relevant laws and regulations. This can include measures such as encrypting sensitive data, implementing access controls, regularly monitoring, and auditing data usage, and having a process in place to respond to privacy incidents. Overall, the challenge of privacy lies in balancing the need to collect, store, and use personal information for legitimate business purposes with the need to protect the privacy rights of individual [12].

1.3. DATA GOVERNANCE AND DATA MANAGEMENT

It is necessary to point out that data governance could be confused with the term data management.

To make a distinction, the DAMA defines the data management, “the development, execution and supervision of plans, policies, programs and practices that control, protect, deliver and enhance the value of data and information assets” [13]

Data Governance and Data Management are interdependent and complement each other in ensuring the optimal utilization of information within an organization. Neither can substitute the other, as they both play crucial roles in the successful management of an organization's data assets. The main purpose of Data Governance is to provide overall strategic direction for Data Management, which focuses on the day-to-day management and maintenance of the organization's data assets. Thus, data governance refers to the overall management of the availability, usability, integrity, and security of the information employed in an organization, bringing together nine other disciplines such as data architecture management, data quality management, Meta Data management, exc. [14].

Data Governance:

- focuses on establishing policies, standards, and guidelines for data management
- addresses the legal, regulatory, and ethical requirements surrounding data, defines roles and responsibilities for data management
- ensures data is accurate, complete, consistent, and reliable
- evaluates and prioritizes data-related projects and initiatives.
- establishes data quality metrics and monitors data quality levels.

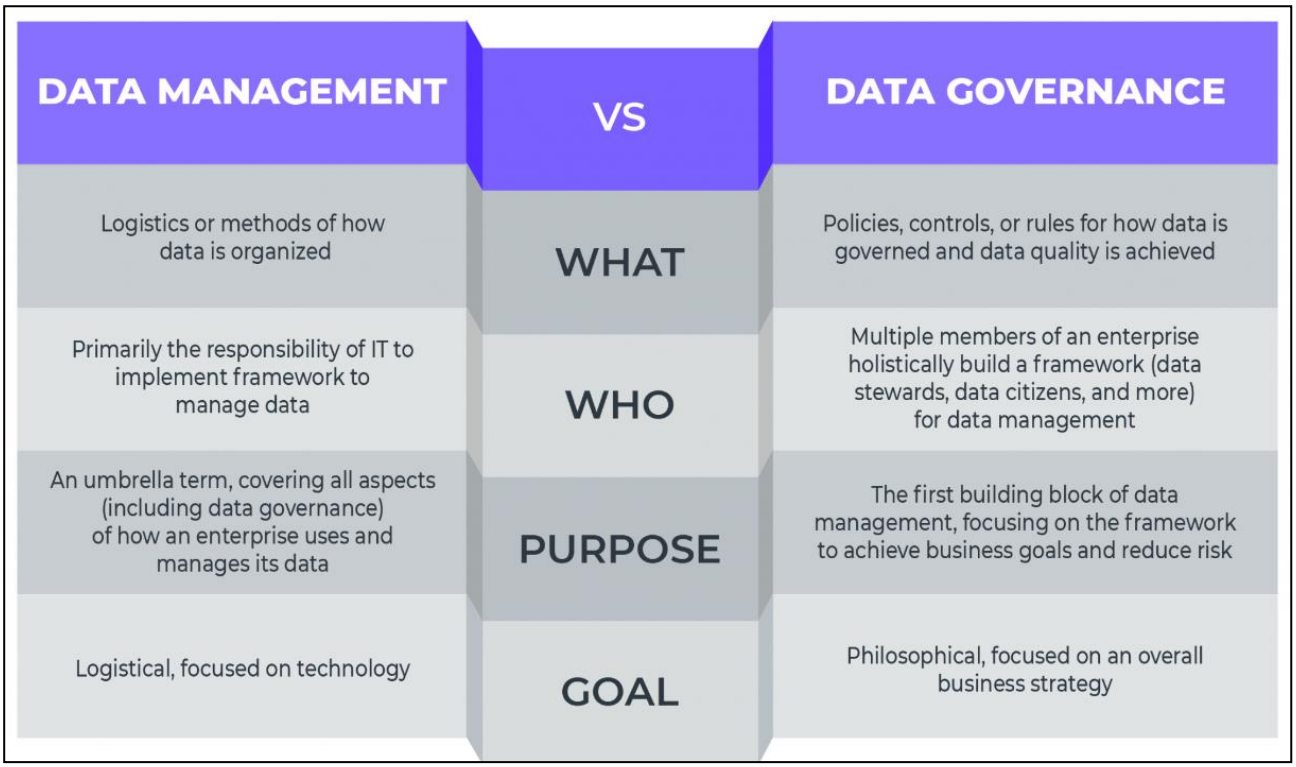
Data Management

- deals with the technical and operational aspects of managing data
- includes processes for acquiring, validating, storing, protecting, and delivering information, manages the lifecycle of data, from creation to deletion.

- Supports the information needs of the organization's various departments and functions.
- Enables effective use of data for analysis, reporting, and decision-making.

The distinction between management and governance lies in that the former deals with the operational aspects of data handling, while the latter concerns the strategic direction for data utilization. Data Governance encompasses a comprehensive approach, which involves the involvement and agreement of all the stakeholders within the organization. It encompasses the people, procedures, and technology needed for efficient data management, with the goal of ensuring the availability of high-quality data throughout its lifecycle and ensuring that it aligns with the organization's objectives [15].

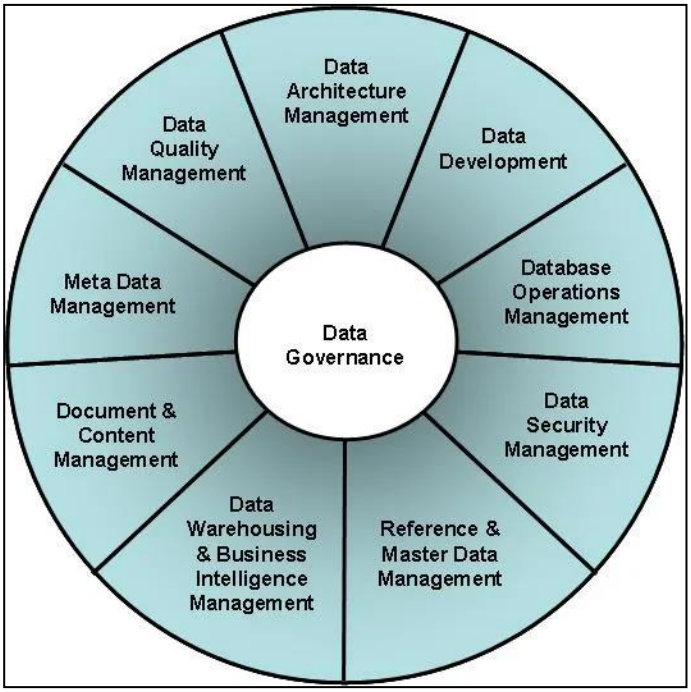
Figure 1. Data Management vs Data Governance [13]



Data management encompasses a range of practices, procedures, processes, systems and concepts that enable an organization to oversee its resources. Thus, the role of data management spans a given data asset's entire lifecycle from its original creation point to its final retirement.

Data Management covers ten disciplines, with Data Governance at the core.

Figure 2. The main disciplines of Data Management [16]



1.3.1. MASTER DATA MANAGEMENT

Gartner, leading research, and advisory company in the information technology industry, defines Master Data Management (MDM) as "a technology-enabled discipline in which business and IT work together to ensure the uniformity, accuracy, stewardship, semantic consistency, and accountability of the enterprise's official shared master data assets [17]". In other words, MDM refers to the processes, governance, policies, standards, and tools that are used to manage and maintain the "golden record" or authoritative version of an organization's core business data, such as customer, product, and vendor information. The goal of MDM is to provide a single, unified view of the organization's critical data to support effective decision-making and ensure consistency across the enterprise. Organizations then use MDM to eliminate the costly and perpetual debate about "which information is correct", which can lead to a paucity in decision-making and information business. MDM targets the essential entities of an organization and aims at enhancing the quality of that data. The objective is to determine which data should be considered as "master data" and is relied upon across the organization. As these entities are used and shared throughout the enterprise, MDM strives to bring together disparate views of these entities into a unified and consistent perspective. Master Data refers to the critical and fundamental data elements of an organization that are used to support business processes and decision-making. It includes information about core business entities such as customers, products, suppliers, employees, and others. It is considered authoritative, meaning it is the single source of truth for these entities across the enterprise, it is typically shared by multiple systems and business units, and it is used as a reference for day-to-day operations and strategic decision-making. Therefore, it is the fundamental data that is essential to running operations within a business or business units, otherwise, there would be no way to uniformly compare information across systems. However, all master data is not created equal. The type

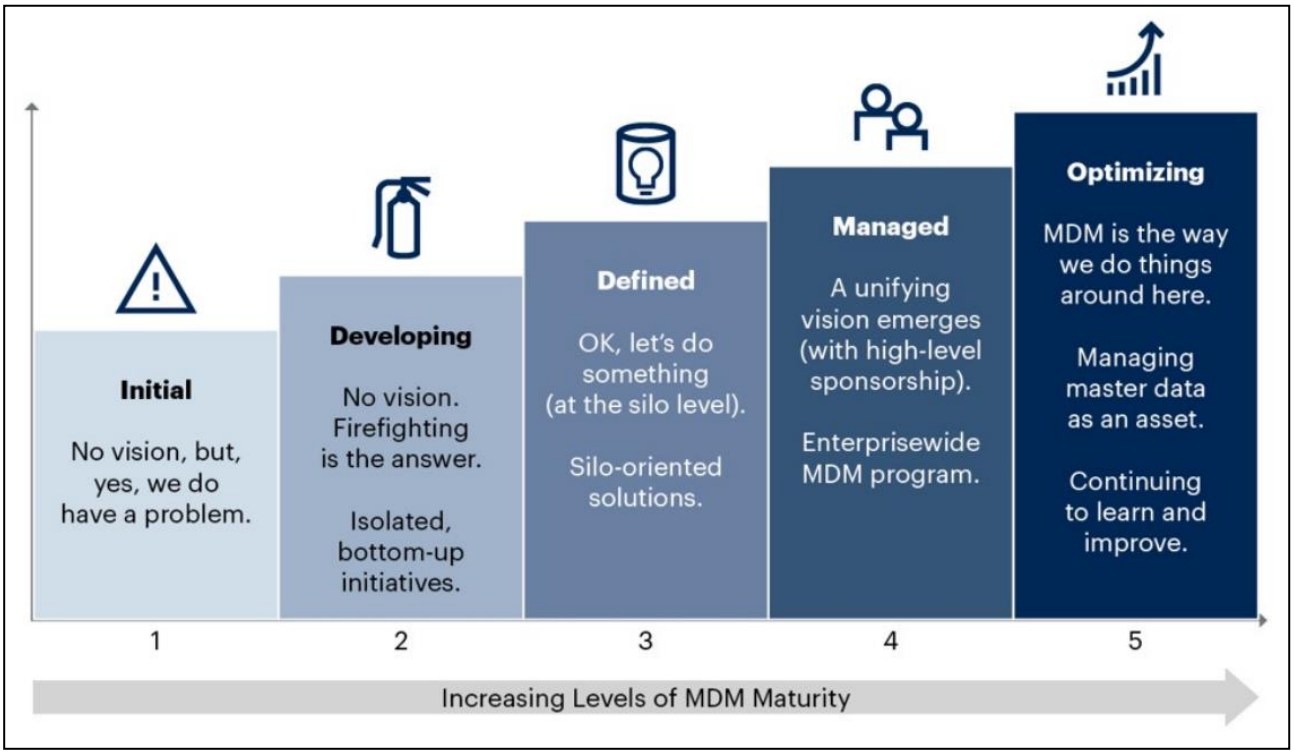
of info that is designated as master data can vary by industry. Even within different business entities in the same industry, master data examples may be discrete or not have much in common.[18]

Organizations continue to approach MDM programs through a technology lens in isolation but without consideration of organizational impact and in the absence of business engagement, so that MDM programs will fail. MDM adds value to the business everywhere, but it is needed to connect all the activities directly to the business outcomes and priorities and maintain the cleanliness of a data. This is, in fact, more of an organizational challenge than a technical one because building a Master Data system should not be considered as an IT project, but as a project of constant business improvement.

In any case, an MDM is the core of broader data governance and cannot be said to be truly effective without adequate data governance. For example, a data governance program will define master data models (i.e., definition of a customer, product, etc.), describe data retention policies, and define roles and responsibilities at the level for creation, maintenance, and access. It also ensures that the company has the most complete and accurate information possible on key entities such as customers, suppliers, etc. Because these entities are shared throughout the organization, master data management aims to reconcile fragmented views of those entities into a single common view — a discipline that goes beyond simple data management [19].

MDM programs are vital to achieve digital business success but are also complex and disruptive. Gartner's MDM Maturity Model gives data and analytics leaders a framework to measure and assess their organization's MDM capabilities, create an MDM vision, and establish a roadmap to reach it.

Figure 3. Gartner's MDM Maturity Model [20]



1.3.2. DATA QUALITY MANAGEMENT

Data quality management is a critical component of the overall data management process, and data quality improvement efforts are often closely tied to data governance programs that aim to ensure that information is formatted and used consistently in the whole organization. Gartner defines it as "the degree to which data meets the needs of the business and supports accurate and effective decision making". Therefore, it represents the basis for preparing an effective Data Governance strategy which, in turn, enables the transformation process of a company towards a data-driven model, the only one capable of maintaining a competitive company in the next future.

High-quality data is essential for effective decision-making and data-driven insights and requires continuous monitoring and improvement of data management processes and technology. Gartner also emphasizes the importance of understanding the context and business requirements for data designing data quality management processes and technology solutions accordingly.

Data Quality tools intervene on the information catalog by providing a series of automation features such as:

- data profiling
- integration of formats
- data validation
- data correction
- monitoring of the rules associated with the data
- identification and mapping of sensitive information for compliance purposes
- customized “preview” of the data based on specific requests
- controlled access to datasets
- integrated reports

Information is not free from errors and must meet requirements. Therefore, when defining quality, you need to define constraints, determine how to set them, and determine the obedience to them (that is, the level of fault tolerance). Data Quality is the degree to which data meets the requirements associated with it and the purposes for which they are used.

In summary, data quality enables effective analyzes of data from multiple sources, allowing a company to optimize products, improve customer service, increase revenue, reduce expenses, and make more aware tactical and strategic decisions. Planning business actions necessarily requires a strong focus on data quality and their modeling: the more enterprise data is contextualized, the greater the opportunities to carry out analyzes capable of producing actions that generate business value.

Being able to define a metric to measure data quality is a fundamental condition for starting a positive recursive process. The metrics for measuring the quality of a system or a company can be defined by correlating the business objectives with the various categories of error that can be associated with the information such as missing or incorrect data, unreasonable values, or inconsistent formatting. Metrics can be traced back to these six pillars: accuracy, completeness, consistency, timeliness, uniqueness, validity [21].

1. **Accuracy**

Accuracy measures the number and types of errors in a dataset. Monitoring this metric answers the basic question: “is the data behavior within expected limits?” There can be many types of inaccuracies in a dataset, including an anomalous value or string, an inconsistent relationship between columns or rows in a database, inaccurate data entries that make it difficult (if not impossible) to use in business systems or for analytics. To measure accuracy, the data needs to be compared to a reference dataset. Accuracy is typically measured as a percentage of errors out of the total number of records and a lower percentage indicates higher data quality.

2. **Completeness**

The completeness metric measures the number of records with incomplete data referring to the availability of all relevant data to satisfy user requirements. It is important that all critical fields in a record are fully populated, in fact, this measure is tracked by identifying records with blank fields and typically expressed as a percentage of the total number of records. Actually, in some contexts it might even be acceptable for some fields to be empty (let's think for example a field that requires optional feedback from a user). A null value in this type of field should therefore not be included in the metric that will serve to measure the completeness of the data.

3. **Consistency**

Consistency measures how well individual data points pulled from two or more datasets synchronize with each other. If two data points conflict, that means something is inconsistent. The inconsistency can have several causes such as data entered incorrectly in one or more sources, data entered in a different way in one or more sources, exc.

4. **Timeliness**

The metric of Timeliness, also known as Currency, assesses the freshness of the data in a database. Data that is more recent is often more accurate and relevant, as circumstances can change over time. Using outdated information can also increase the chance of errors being compounded as it passes through the system, as all intermediate data storage will contain outdated information. The timeliness of data is monitored using timestamps, which allows for the differentiation between current and older data, and can then prompt the review, update, or archiving of older information.

5. **Uniqueness**

The uniqueness metric tracks duplicate data because in a data quality process, it is important to identify duplicates and merge or eliminate them so as not to have useless replicated datasets. Identifying and removing or merging these duplicate records is a key part of forming an effective Single Customer View (SCV) which gives you a complete version of the truth of your customer.

6. **Validity**

Validity measures the compliance of data with standards, whether they are defined by internal policies (for example the date format with "day/month/year" and not other non-compliant orders) or by specific regulations (for example in the field of security and data protection).

1.3.3. METADATA MANAGEMENT

Data Governance is focused on the overall management of data as a corporate asset, while Metadata Management is focused on the management of metadata to support the effective use of data. While they are related, they are distinct concepts and serve different purposes in the context of data management.

Metadata refers to data that provides information about other data. It describes the characteristics of data elements and their relationships, including context, structure, quality, and usage information. In the context of databases and data management, metadata is often used to describe the schema or structure of a database, including table and column definitions, relationships, and constraints. Metadata can also describe the data itself, such as data type, length, format, and ownership. The purpose of metadata is to provide context and information making it easier to understand, manage, and use. This can help improve data discovery, data quality, and data governance, as well as facilitate data sharing and reuse. Having metadata is an enabling factor for governance, as it allows users to derive value from the available information. Someone chooses to call metadata "data about data," but that is only part of the picture. Some consider metadata as "what identifies information."

The context metadata conveys is both business as well as technical, which helps you understand the data and use it appropriately.

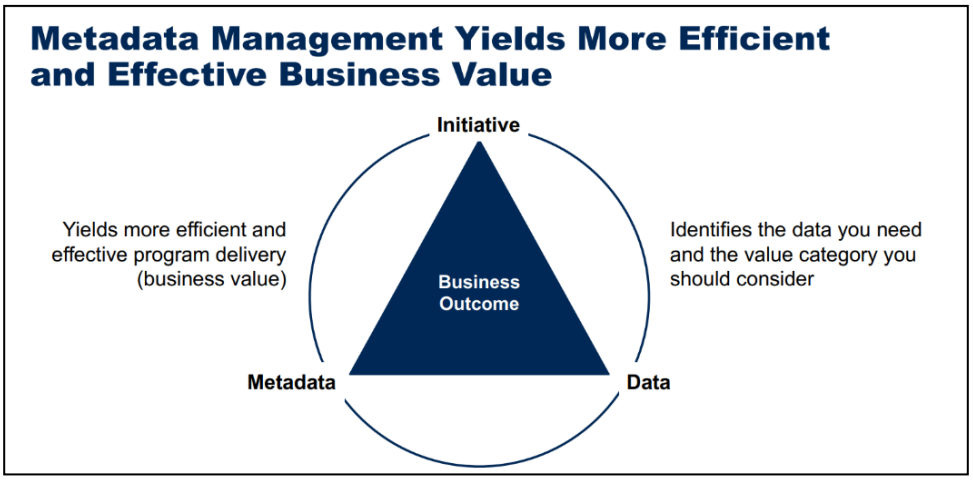
- **Technical Metadata**: provides information on the format and structure of the data, such as data models, data lineage or access permissions.
- **Business Metadata**: defines everyday business terms, such as table and column definitions, business rules, data sharing rules and data quality rules

Metadata management is important for several reasons:

- **Improving data understanding**: Metadata provides a clear and detailed understanding of the structure, content, context, and usage of data, making it easier to manage and use
- **Enhancing data quality**: by providing information about the data itself, metadata can help to identify and correct issues with data quality, completeness, and consistency.
- **Supporting data governance**: Metadata management helps to ensure that data is governed in a consistent and controlled manner, making it easier to meet regulatory and compliance requirements.
- **Facilitating data sharing and reuse**: by providing a common understanding of data, metadata management enables information to be shared and reused effectively across the organization, reducing duplication, and improving consistency.
- **Increasing data discovery**: it makes easier for users to find and access the data they need, reducing the time and effort required.

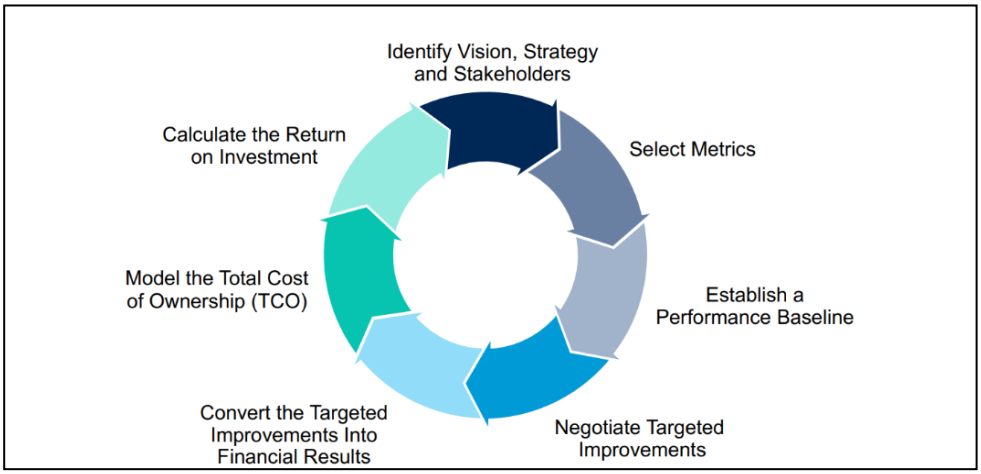
Therefore, Metadata management is important because you can leverage metadata in understanding, aggregating, grouping, and sorting info for use tracing back many data quality problems to metadata. In addition to compliance aspects, data classification and metadata management enable the effective implementation of attribute-based access control models (e.g., ABAC) and data quality processes aligned with business requirements.[22]

Figure 4. Business Outcome of Metadata Management [3]



The requirement for metadata management is a result of the rapid adoption of a data-focused approach by businesses. They create and utilize massive amounts of data and with metadata management, a clear and comprehensive understanding is provided for both data production and consumption, ensuring that data becomes a valuable asset for the organization. Business metadata is essential for creating a corporate glossary and standardizing terms, definitions, metrics, and KPIs.

Figure 5. Metadata Management to Enable Transformational Data [3]



This is a process which is not sequential but a continuous back-and-forth.

Metadata management technologies are essential for organizing and classifying metadata, which enables users to easily search, access, and comprehend it. The latest metadata management tools, such as modern data catalogues, use machine learning algorithms to identify and gather metadata automatically, overcoming organizational obstacles such as missing data and limited knowledge about information systems. This leads to improved metadata organization, categorization, and user understanding.

1.4. THE IMPORTANCE OF DATA GOVERNANCE

It is well known that companies with a good level of management, knowledge, ability to use their data are much more likely to grow than companies that continue to operate "in silos", with non-integrated data and lack of coordination among functions and people. As we already said, the main objective of data governance is to eliminate the existence of data silos within an organization. These silos often form as a result of various business units implementing their own transaction processing systems independently, without a centralized plan or an enterprise data architecture. Data governance standardizes information across these systems by bringing together stakeholders from various business units to work collaboratively towards this goal.
Data Governance favors the mapping and management of data to ensure transversal visibility and widespread knowledge, enabling the sharing of insights that emerge. It leads to the creation of a data-based culture, the adoption of good practices in the treatment and usage which over time lead to better decisions and benefits that become increasingly tangible [2].

The implementation of a Data Governance Framework therefore allows to obtain numerous benefits, such as:

- **Better business decisions**: it gives decision makers access to clean, trusted data enabling them to make consistent and confident decisions. By improving the quality and availability of data, data governance can support better, more informed decision-making, which can ultimately drive better business outcomes.
- **Increased workforce efficiency**: with standardized information available across the organization, teams can avoid duplication of efforts. Because everyone benefits from the data framework, it is possible to establish policies and procedures for data collection, storage, and use which can help ensure that data is consistent, accurate, and easily accessible to those who need it. This can save time and reduce the risk of errors, leading to more efficient and effective work processes.
- **Data Monetization**: with data governance, businesses can unleash the power of the valuable data they collect and generate. Effective governance can help organizations better leverage their data as a strategic asset, which can lead to new revenue streams and business opportunities. For example, by improving the accuracy and consistency of customer data, organizations can more effectively target and personalize their marketing efforts, which can drive increased sales and customer engagement.
- **Avoid data breaches**: with stringent data protection regulations, many organizations find it difficult to control the flow of information and often they violate data protection regulations. By implementing governance practices, organizations can ensure that sensitive data is properly managed and protected, reducing the risk of unauthorized access and breaches. For example, it can help establish clear roles and responsibilities for data management, as well as policies and procedures for data storage, access, and transfer. This can help reduce the risk of breaches by reducing the risk of human error or malicious intent. Additionally, data governance can help ensure that data is properly encrypted and stored in secure locations, reducing the risk of data breaches from cyberattacks and other external threats

- **Improved data quality**: it can improve data quality by establishing clear policies, procedures, and standards for collecting, storing, and using data. This helps to ensure that data is accurate, consistent, and relevant, which reduces the risk of errors and misinterpretation. High-quality data is essential for delivering excellent customer service and satisfying customer needs.
- **Greater transparency and verifiability**: determining the creation of a single 360-degree view of company-wide information aimed at creating a common corporate language and consequent reduction of misunderstandings, as well as simplification of communication activities.

Effective data governance brings value to all team members across the organization. Data governance unifies the organization through a common language by establishing a set of defined terms, KPIs, rules, and policies enabling seamless communication and understanding among team members from different departments. This shared language promotes consistency and trust in the information used also facilitating teamwork and cooperation allowing all members of the organization to use the same terminology and work with the same data. Additionally, clear definition of roles and responsibilities simplifies data processes and ensures smooth collaboration by organizing, documenting, and assessing the quality of its information assets which brings context and clarity to an organization's data and through the definition of terminology, implementation of controls, assignment of responsibilities, and other means, it ensures that all team members have the necessary understanding to confidently use, access and extract insights from the data.

After the COVID-19 pandemic, with many employees continuing to work from home, the handling of sensitive data from remote locations has become a concern. Poor governance in this situation can result in harm to the company's reputation and incur financial penalties. A 2021 study by Mordor Intelligence projects that the data governance market will grow at a compound annual rate of 21.44% from 2021 to 2026, reaching a value of USD 5.28 billion by 2026.

Given that not all organizations have defined and implemented a data governance program in a structured and planned way, why is it assumed that in the current context it is essential to consider a path of this type? If we desire to make a comparison in the automotive field, an organization that uses data in its work is like a car that uses fuel to move to reach a destination. Traveling without safety, monitoring and assistance systems such as ABS, lane control, emergency braking, blind spot control, etc., it would be possible, but very risky. Scott Taylor, Meta Consulting, says that “With bad data, we are keeping making bad decisions. We just don’t realize they’re bad decisions until later”. Whether it's a brief data-driven journey, or a long digital transformation journey, it is unusual to know the road and the steps to take well; therefore, it is very important to have a clear direction, the data strategy, and to have a good navigator, i.e., the technologies to support Data Governance [23].

When there is no data governance, looking at the three pillars’ processes, people, and rules, if they are not balanced, that could result in serious issues. The absence of a Data Governance framework could trigger several common organizational problems:

- Inconsistent definitions leading to challenges in cross-functional understanding
- Policies and rules being created without consideration for corporate strategy or even conflicting with it

- Data management solely being the responsibility of Information Technology, resulting in a lack of business involvement and division between functions
- Increased difficulties in managing business processes
- Inadequate technological integration leading to widespread duplicated data and persistent "data silo" issues
- Poor data leading to flawed decision-making.
- Errors in data mapping: data governance provides a comprehensive understanding of information location in relation to key entities, essential for data integration. Like a GPS that maps out a physical landscape and aids navigation in unknown surroundings, data governance makes data assets actionable and easier to tie to business outcomes.

Without effective data governance, inconsistencies in different systems across an organization might not resolved, for example, customer names may be listed differently in sales, logistics and customer service systems. That could complicate data integration efforts and create data integrity issues that affect the accuracy of business intelligence (BI), enterprise reporting and analytics applications. In addition, data errors might not be identified and fixed, further affecting BI and analytics accuracy [24].

1.5. IMPLEMENTATION OF THE FRAMEWORK

A fundamental step for Data Governance is the definition of a data governance framework, i.e., a set of rules, procedures, processes, and roles aimed at increasing the value of data within a business organization. This enables businesses to make informed decisions about how to manage data and ultimately derive value from it, while minimizing cost and complexity, establishing priorities, and of course complying with regulatory, legal, and state requirements. A data governance framework might be seen as a "recipe" that can be taken and replicated in every organization. In general, a framework is a scheme, a model that allows to graphically represent the fundamental pillars, processes, main dimensions of the application or intervention in a simple but effective way.

There is no ideal framework that fits all organizations, it is essential to design a framework tailored to every single organization, which is as simple and understandable as possible. Typically, to design a framework, some fundamental pillars must be taken into consideration: policies, processes, organizational structure (roles and responsibilities) and supporting tools and technologies.

Building a data governance framework can seem like a daunting task, especially when it comes to make the first moves. However, when all the various elements find their place in the complex data governance mosaic, its application enables better business strategies and supports any compliance tools in a systematic way [25]. The construction of the framework must be tackled gradually, as it presupposes a series of well-defined checkpoints:

- standards and formats must be set up correctly.
- it is necessary to identify the structured and unstructured data that must be protected.
- the various types of data need tags and metadata to streamline searches.
- dataset management roles need to be created and specific responsibilities assigned.
- accurate metrics must be established to quantify the effectiveness of the mechanism.

- it is advisable to incorporate elements of automation in the data governance framework.
- constant monitoring systems should be in place to identify improvements.

1.5.1. THE NECESSARY STEPS OF THE PROCESS

The sheer volume of data, the disparate systems, the many people involved in creating and consuming the data all make data governance a challenging task. It is best to take data governance one step at a time [26].

- **STEP 1: DO THE GROUNDWORK FOR THE DATA GOVERNANCE**

As a starting point it is essential to start from the basics by answering the following questions:

- **WHY?**

An organization should first define the vision and mission of its data governance plan by defining the various objectives: increase revenue, improve decision-making or transparency. It should also establish how to measure the success of the program. A clear vision helps employees and other stakeholders to see how this data governance initiative will impact their daily work lives and how it will help them. Everyone in the team must understand the "why" to be on the same page.

- **WHO?**

Assigning roles and responsibilities is a crucial step. This step defines who will be primarily responsible for the different tasks involved in implementing the data governance framework. Often, organizations take a three-tier approach to building teams. The steering committee, the data governance office, and the data governance working group are three main components of this approach. Multiple teams working cooperatively throughout the organization are essential for implementation.

- **WHERE?**

One of the most important aspects of a governance program is to have proper and complete control of data. Therefore, the "where" in a governance framework defines where the critical information resides in the systems. It is necessary starting with an analysis of the organization's current data assets. Massive volumes of data flow in and out of organizations every day, thus, trying to bring all this data under the control of the governance structure may not be a good idea. Then it is required to choose some specific data resources to include in the schema.

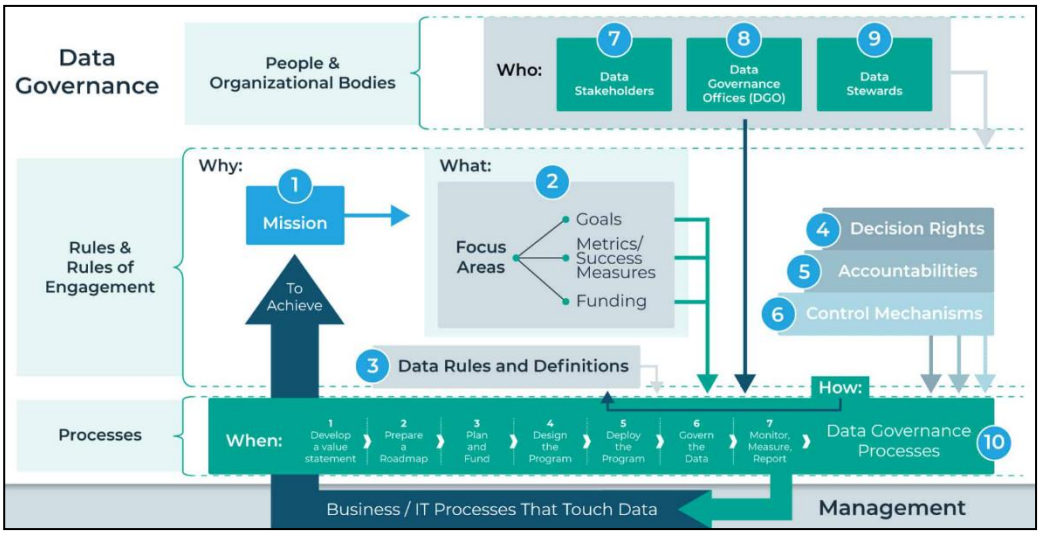
- **WHEN?**

"When" helps teams in various ways. First, it allows companies to ensure compliance with regulations like PCI DSS and HIPAA by defining the retention period for the data and secondly, it also helps the team control how frequently they should conduct audits.

- **WHAT?**

It outlines the type of data that falls under the governance program defining the type of data that needs to be regulated, filtered, and protected. All in all, it is the data around which the entire data governance policy needs to be established. It is needed defining acceptable data formats and draft data workflows and policies for the entire organization.

Figure 6. Data Governance Framework [3]



- **STEP 2: IMPLEMENTATION OF THE DATA GOVERNANCE PLAN**

  - ❖ Step 1: Ensuring data availability.

Data governance teams need to ensure that specific data assets are available. In large organizations, data is scattered across different information silos such as customer support systems, business management applications, sales records, and even partner systems. All of this data needs to be readily available in one place. Organizations may need to design an integration mechanism for these distributed data assets.

  - ❖ Step 2: Ensuring data integrity for data governance implementation.

Clean, standardized, and trusted data resources are the crucial component of the data governance framework. To find the definition of clean, trusted data, start by asking the teams that consume data daily. It is needed to ask which data format makes the most sense to them and based on their input, undertake a multi-step data improvement workflow as follows:

• **Profiling**: only certain parts of a data asset are useful for business decisions. For example, a client's location may be relevant, but gender is not. It's necessary to begin defining the critical components of a data asset and then delete all the unimportant ones.

• **Analyze and standardize**: one of the biggest challenges is the diversity of formats. Ranging from naming conventions to data attributes, there can be several disparities. The data governance structure must include the technology to analyze and standardize the information. It can consist of adding data tags, normalizing attributes, and standardizing naming conventions.

• **Enrich data:** data governance teams must work to enrich data assets. This can involve combining two or more pieces of data in one place and it also involves augmenting the data with complementary information and metadata.

- **STEP 3: ENFORCE ACCOUNTABILITY AND ADHERENCE TO DATA POLICIES**

Data governance efforts aren't limited to just members of data governance teams. For a data governance plan to be successful, the entire organization must contribute to it. Each specific data resource should have an owner who is responsible for his integrity. These owners, with the help of policies and workflows, should ensure that their data asset always maintains high quality. This step also requires a shift in the organization's data culture to embrace governance which is not just a one-time project but a continuous process.

- **STEP 4: CONTINUOUS FEEDBACK AND MONITORING**

Data Governance systems and workflows need continuous monitoring and feedback. This is crucial because the data governance structure is a hybrid system involving people and technology. While technology needs updates and bug fixes, people need constant motivation and reminders. The feedback system is vital for assessing whether efforts meet success criteria and goals. If not, it indicates that some adjustments are needed in the framework.

Implementing a data governance framework is an iterative process. It can only be improved through continuous monitoring and feedback [27]

1.5.2. WHO IS PART OF THE PROGRAM?

- **EXECUTIVE SPONSOR:** without executive-level sponsorship, data governance programs often lack the funding and resources needed to get off the ground. They simply remain at the initiative level or, at best, materialize in separate pockets at the project level. Having a data governance sponsor, however, at an executive level, isn't just about green lighting the program and telling them “I support it!”. Ideally, their role should also include the following [28]:

  - **Championing the program**

    The sponsor needs to show their support of the program throughout the organization. Prior to getting the program off the ground, they need to help advocate for it in order to secure buy-in throughout the organization, gain support from fellow executives and/or upper management, and ultimately help secure the necessary resources. Also putting their stamp of approval and green lighting the program sends a strong message, but this message should be constantly reiterated and communicated. This is particularly important when the program is first getting off the ground and it still requires organization-wide adoption and awareness. They should be clearly visible within the organization as the driving force supporting the program.

  - **Creating responsibility**

    The role of the sponsor during program planning is to create two important roles. The first is the role of a Chief Data Officer, but in smaller organizations this can be a Data Governance Manager, Director, or Lead. Usually, together with this lead, the role of a data governance council is then created and any subsequent roles, such as the data stewardship ones, are the responsibility of the lead and/or council. After these 2 roles are created, the sponsor needs to make sure that both are effectively conducting their leadership responsibilities.

- **Clarifying priorities**

The data governance program lead can sometimes be on the ground level and ensure the program's scope is met and its plan is properly executed, but they often need a level of guidance from the program sponsor. The program sponsor can help clarifying business priorities and goals as well as the organization's business roadmap and strategic objectives. This will ensure that the data governance's deliverables are tied to the business priorities and help identifying when priorities change. As a result, issues and challenges can pop-up which affect the alignment of the program with the business. In the end, it is the sponsor that owns the vision for the program and needs to provide clear leadership and direction throughout its duration to make sure issues are appropriately overcome and goals met.

Data governance sponsorship is important and ideally the sponsor continues to provide their support long after the kick-off. Their involvement is most important in the planning and launching phases to secure the needed resources and consensus from the organization, as well as creating the roles of the council and the program lead. Though, their active involvement it is also needed to ensure the program is kept on track and still meeting the needs of the business.

- **DATA GOVERNANCE COUNCIL OR COMMITEE:** according to the McKinsey Global Data Transformation survey of the 2019, companies spend an average of 30% of productive time on non-value-added tasks because of poor data quality and availability. A data governance council strategizes and steers the enterprise-wide data governance program to enable data quality and regulatory compliance. This is a high-level team that leads and oversees data governance efforts. The committee must include at least one stakeholder from all top-level organizations within a company, so often includes senior executives in logistics, finance, marketing, sales, or manufacturing. Thus, it involves the leadership who have the authority to allocate the budget, create policies, and push projects up the priority list. It ensures that:

  - Trusted data is delivered across the enterprise.
  - The availability, usability, and integrity of data are managed continuously.
  - Data is used effectively.
  - Data is not misused.
  - Policies and standards are defined and implemented.
  - Procedures for data security and privacy regulation compliance are established.

The data governance council also oversees the prioritization of data issues raised by data stewards and reviews of the data governance program. The structure will depend on many different factors, such as the organization's industry, its business goals, the complexity of the data it holds, and regional regulations. Members need to be responsive, open to communication and must be motivated and fully invested in the program to inspire others to participate. Top-level support drives the data governance program while the data stakeholders creating value ensure its success. For smooth functioning of the council, ensure that roles are easily transferred in case of any non-availability, and all the council members collaboratively contribute with their own specific skills. Data governance is essential for unlocking the value of data effectively to power trusted business decisions and the data governance council offers guidance on the data governance strategy,

ensuring the focus on the program's success, and handles conflict resolution. Driving the organization-wide data governance program, the council also provides the foundation for data quality improvement initiatives [29].

- **DATA GOVERNANCE TEAM:** this middle management committee provides guidance to data governance efforts. This team works with IT and Business to draft data standardization policies, data governance workflow and processes, to address technology challenges related to implement data governance. In a typical enterprise, here are some folks who might make up a Data Governance Team:

  - ❖ Manager, Master Data Governance: leads the design, implementation and continued maintenance of Master Data Control and governance across the corporation.
  - ❖ Solution and Data Governance Architect: provides oversight for solution designs and implementations.
  - ❖ Data Analyst: uses analytics to determine trends and review information.
  - ❖ Data Strategist*:* develops and executes trend-pattern analytics plans.
  - ❖ Compliance specialist: ensure adherence to required standards (legal, defence, medical, privacy).

  One of the most important aspects of assigning and fulfilling the roles is having a well-documented description of the roles, the expectations and how the roles interact. [30]

- **CHIEF DATA OFFICER:** the CDO has senior-most responsibility for the organization's strategic use of data, so the enterprise can perform more efficiently, boost productivity, better engage with customers, employees, and other stakeholders, improve existing revenue streams, and create new ones, and develop new business opportunities. He must understand the business and be able to communicate with management, but he must also possess characteristics of leadership, empathy, and dialogue with the operatives. He needs to promote data literacy and culture within the company (bottom-up and top-down). Its main mission is to enhance the data asset, supporting the transition from a tangible to an intangible data asset. The CDO must have a technical background, but also have business and human resources skills, to simultaneously drive the transformation process and collaboration throughout the company. Despite being a middle-top management, the CDO, acts as a bridge transferring digital strategies to the various company branches, testing new tools, and developing the digital skills of people within the company [31].

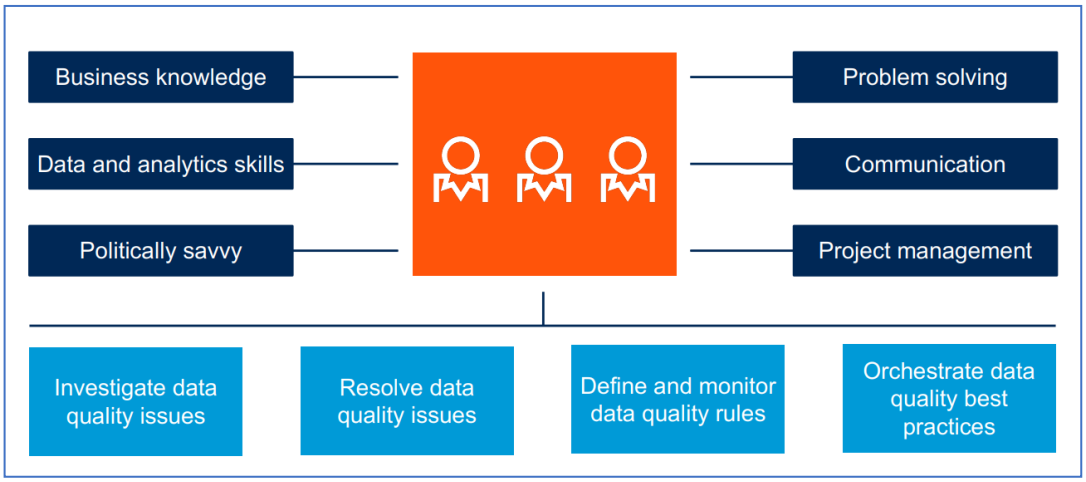
- **DATA STEWARD:** Data stewards ensure that business users have consistent access to high-quality data. They are the bridge between business and IT, and their core function is to enable collaboration and data democratization. Moreover, they help organizations comply with the ever-changing regulations by assessing the data governance policy, processes, and implementation. The responsibilities of data stewards vary depending on their organizations and role. However, some of their primary responsibilities include:

  - ➢ Creating data assets: data stewards own data asset creation, policies, and security.

- Ensuring data quality: data stewards help standardize data definitions, rules, and descriptions providing context to data assets. They also work with the rest of the data governance team to evaluate, manage, and monitor data quality throughout the organization.
- Protecting the data assets: this is crucial in establishing data security protocols that align with the organization's data governance goals, policies, standards, and compliance requirements. They also assess potential threats to information security and consult with the IT team to alleviate them.
- Defining access policies: this tells which users can access specific data assets helping set them up so that the right users have access to all the data they need instantly.
- Optimizing workflows and communications: data stewards help data users — technical and business — search, discover, trust, and use the data they need. That's why they play a crucial role in data collaboration and sharing.

Data steward works according to the recommendations of the data governance office. This group usually includes data owners, a data quality manager, data stewards, data architects, and analysts. Data governance is truly a huge undertaking that requires cooperation between various [32].

Figure 7. Data Steward skills and responsibilities [3]



- **DATA ADMIN**: they are data administrators which oversee the implementation of the entire data governance program and serve as the escalation points for resolving all data-related conflicts. Functionally, a data admin is responsible for processing and transforming data into the best data models. Roles and responsibilities are:

  - Ensure the usefulness of data: this includes overseeing data transformations, monitoring data flow within the organization, and designing data models. It also requires planning, implementing, and maintaining data repositories such as databases, warehouses, and lakes.
  - Enable data analytics for decision-making: this involves handling all training and onboarding requirements for technical and business users.

- Ensure data integrity: this requires tracking data lineage throughout the organization to make sure that it is credible, relevant, and updated.

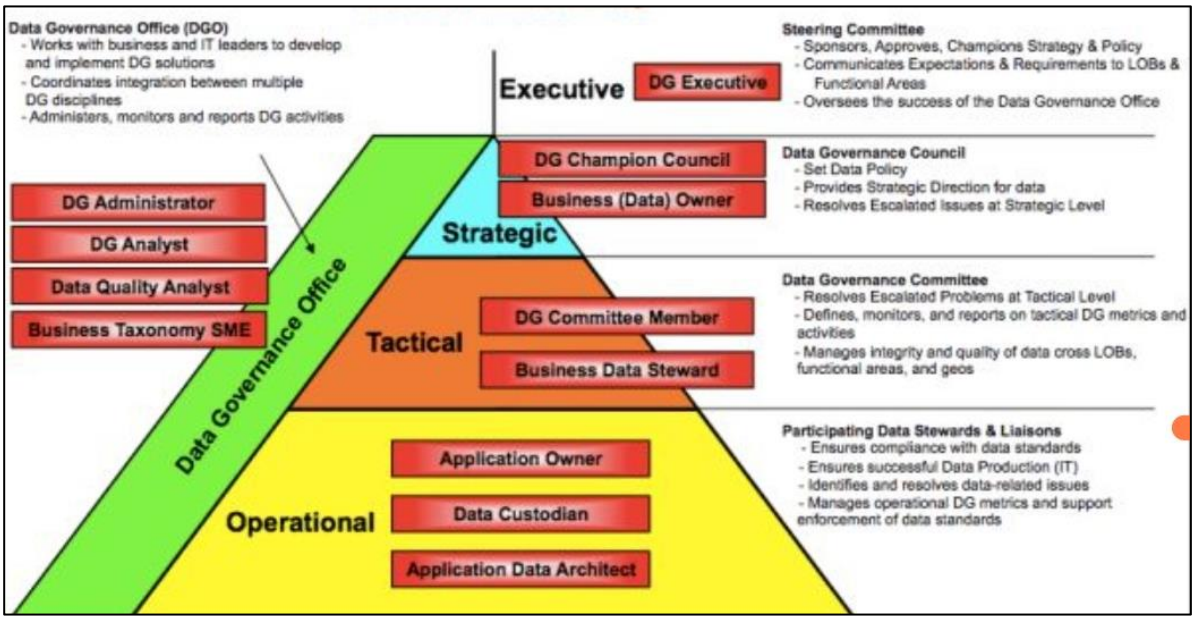
Depending on the organization, data admins may also be responsible for database administration tasks, such as maintaining the data dictionary, choosing the right tools — software and hardware — and monitoring database performance [33].

- **DATA OWNERS:** are responsible for ensuring that data quality doesn't degrade ad it flows through a business' supply chain, all regulatory requirements are met, and data is used appropriately according to policies and procedures. In some instances, people are averse to the term "data owner," as they believe no one person owns the data and, in that case, it can be called a "data custodian" instead. There's no difference between a data steward and a data custodian for most businesses. However, with the growing sophistication of data governance, a separation between the two is beginning to occur. Unlike data stewards, the role of a data custodian is more to the technical side [33]. Some of their responsibilities include:

  - Controlling data access: data custodians authorize and control access to data. They're responsible for managing the technical aspects of setting up and implementing permission controls.
  - Collaborating with data stewards: they identify data stewards for each information asset or domain. They also work with data stewards to fix any data quality or integrity issues.
  - Overseeing data storage: data custodians handle the technical aspects of information storage, versioning master data, and setting up system backups and a disaster recovery plan. They also handle staffing requirements for data governance teams.

- **DATA USERS:** they must follow all established guidelines and policies outlined by management and report any data abnormalities they uncover to the appropriate data owner. Data governance roles are not complete without including the data user. A data user is anyone within the organization who extracts value from data. Data users include marketers, researchers, executives, business managers, senior executives, and more. Data users are often not considered in a data governance framework, but they play a key role in the success of an organization's data governance framework. Without data users, data governance wouldn't be effective. All the other data governance roles — data admins, data stewards, and data custodians — exist to help data users with data-driven decision-making [33].

Figure 8. Data Governance Body [34]



1.5.2. WHY EVERY FIRM NEEDS HIS OWN GOVERNANCE?

It's crucial to understand that what may work for a small or medium-sized business may not work for a larger enterprise. If a data governance framework is too restrictive it can push employees to use tools that are not designed for advanced analysis, such as spreadsheets, which do not integrate the same protections of more sophisticated platforms, thus risking data breaches.

Data governance must therefore be appropriate for the business and accepted by the business. Every firm needs its own data governance because data is a critical business asset that can impact an organization's bottom line, reputation, and regulatory compliance. Having effective data governance in place helps ensure that data is properly managed, protected, and used to support the business goals and objectives. Management should take care of this, showing that they are the first to believe in the value of data and in data governance. It is required to define a program, lead its design, monitor its progress, and have an internal advocate role. This is complex and has a dual aspect: it is both restrictive and enabling and finding the balance may not be easy because it may not be easily accepted in the company. That's why it's critical to provide ongoing education so business users and data analysts become familiar with data usage rules, privacy mandates, and their responsibility to help maintain data sets. And it is precisely when the organization effectively adopts data governance that can transform data into effective business tools.

Data governance is not simply a correct management of internal and external data: it is needed by companies to work correctly, comply with regulations, and avoid that a hole in IT security is not registered due to unstructured and confusing data.

The creation of a data governance framework requires a lot of precise work, but once established it increases efficiency, streamlines internal procedures, and contributes to creating a corporate environment where employees at all levels know how to handle data from the moment it is first entered into the database and how to find new information in the correct way. An intelligently and effectively organized

data governance can save time and, as a result, money. Analysts, data scientists, and decision-making managers should be as autonomous as possible in using information for their work: they must be able to easily find out what data is available in the company, know how to access it, understand its meaning and content, understand where the data comes from, and identify its level of reliability. Data users can also play the role of "producers" of enriched and reworked data sets, which could become part of the organization's heritage to be reused or shared with colleagues from different areas or functions. This scenario can become a reality when a modern data platform is combined with processes and technologies that allow cataloguing the data assets (database tables, views, files, reports, etc.) by enriching them with metadata, essential information for end-users [35].

From this initial overview, it becomes clear that Data Governance does not only involve the adoption of technological tools, but it is a wide ecosystem that combines the review of processes, the definition of procedures and standards (formats, naming conventions, etc.), the identification of methodologies and best practices, training activities, and facilitation of change and collaboration.

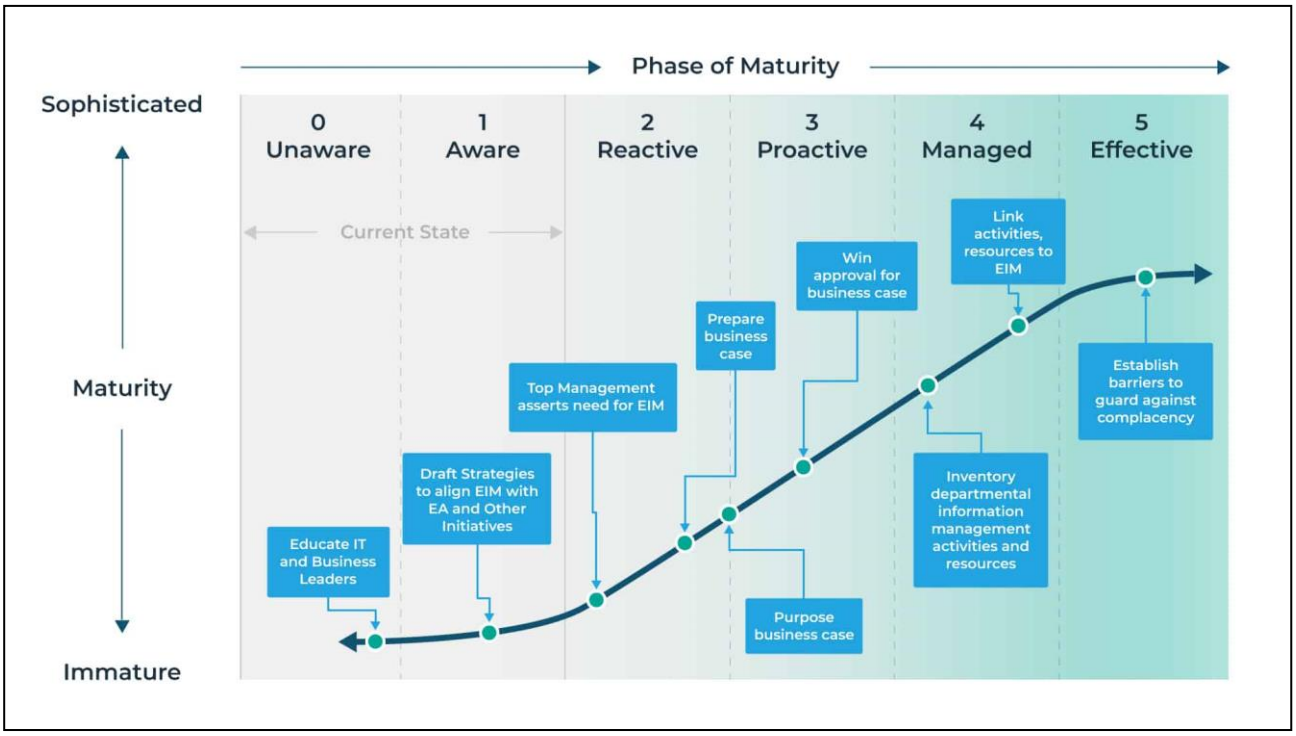
Assessing your organization against a data governance maturity model can aid in creating a roadmap and communicating the current and future state of the data governance initiative. An example of a maturity model is the Enterprise Information Management maturity model from Gartner. Organizations typically start a data governance program at lower stages of a maturity model.

- **Phase 0: Unaware** - at this stage, someone could be one of the few in the organization who recognizes the importance of data governance and its impact on better business outcomes. His task is to create awareness and secure buy-in from stakeholders by demonstrating small wins
- **Phase 1: Aware** - in this phase, the need for policies and standards is acknowledged, and a tailored data governance framework to address specific pain points can be launched.
- **Phases 2 and 3: Reactive & Proactive** - in these phases, a more comprehensive data governance framework can be established, covering all aspects of data governance, and encompassing the entire organization. A Data Governance Office or Team should align with business outcomes
- **Phases 4 and 5: Managed & Effective** - in the managed and effective phases, data governance becomes an integral part of the business operations

The maturity model is a historical record of a company's progress in data governance, compiled from a maturity assessment that compares performance against established goals and benchmarks over a given period. It helps determine where you have been and where you are headed.

There is no one-size-fits-all approach to the maturity model. It is better to find an existing model that closely fits your company's needs and adjust if necessary. Changing the size of the shoe (model) is easier than changing the size of your foot (company) [35].

Figure 9. Enterprise Information Management model [3]



1.5.3. DATA GOVERNANCE AND GDPR

Data Governance is usually connected to GDPR. It is, in fact, an excellent ally to respond to the needs of government regulations, such as the European General Data Protection Regulation (GDPR) and other current regulations. GDPR is the result of a long legislative process, which began in 2010 with the proposal to reform the legislation on the protection of personal data drawn up by the European Commission, the Regulation became applicable from 25 May 2018 after a transition period of two years, which allowed recipients to implement what is necessary to comply. Nevertheless, many companies are still unprepared.

The GDPR aims to:

- Align legislation with new technologies and establish a uniform European regulatory framework
- Increase penalties for administrative violations, with the amount dependent on the specific violation
- Adopt "privacy by design" and ensure appropriate security measures, impact assessments, and breach reporting
- Strictly regulate the selection and appointment of data processors and sub-processors
- Require the appointment of a Data Protection Officer in certain cases
- Clarify rules for information and consent
- Expand the rights of individuals regarding their data
- Establish stringent criteria for transferring data outside of the EU.

The GDPR, designed by the European Union to regulate the handling of customer and employee data, imposes strict rules on organizations to ensure responsible use of data. Companies doing business with EU citizens must be well-versed in the GDPR mandates, including creating a strong data governance program to guarantee compliance.

The governance of data aligns with two critical concepts central to understanding the GDPR: the risk-based approach and the accountability of the data owner. These principles are often emphasized by experts as key to comprehending the new General Data Protection Regulation.

The risk-based approach, which should guide all decisions related to personal data processing by the owner, is influenced by the 2015 OECD Recommendation on digital risk management. This recommendation updates the 2002 OECD Guidelines on network and IT security and places a strong emphasis on risk governance through active risk management. This approach is considered the best solution to address issues arising from improper data management, such as data breaches or violations of personal data, as defined by the GDPR.

This risk governance, according to the OECD, will necessarily have to go through a risk analysis that can help to understand the actual suitability of the measures already adopted in one's own situation and, if these measures are insufficient, what are the measures to be implemented to achieve a sufficient level of contrast to the conceivable risks. Risk management must follow a cyclical pattern that allows for ongoing assessment of risk levels and the implementation of necessary countermeasures if levels change due to various factors. Since risk can never be completely delated, data governance must always include a continuity plan outlining measures for preventing, detecting, responding to, and recovering from potential risks. These risk governance activities, which are part of a holistic approach to the management of possible security issues, will require the participation of all actors in the process, no longer allowing a total delegation to certain subjects to study and implement risk containment measures itself, but also requesting the involvement of all the other figures, especially top management, so that the approach to risk and its management become a heritage shared by all [36].

A further field of application of the principles of data governance is certainly to be identified in relation to the principle of accountability of the owner, which is rightly indicated by many as another of the innovative and fundamental interpretations of the Regulation. This principle creates a system of accountability for owners, who must be involved in defining processes and implementing measures and procedures. Additionally, owners must be able to show the basis for their decisions and demonstrate their implementation.

It can therefore be considered that the first objective of accountability is the formalization of choices that are entrusted to the owner so that he can implement governance procedures tailored to his own concrete reality. This reading of the principle, however, also has the advantage of transferring the principles contained in the legislation into concrete policies, personalizing them on the reality in which they will operationally fall. The implementation of a data governance, therefore, from the point of view of the European legislator, will necessarily pass through a preliminary phase of study and identification of the typical characteristics of its structure, delineation of the processes that supervise the management of data throughout their life cycle (collection, treatment, transfer, securing and destruction of the data itself), formalization of these

processes and the procedures that will have to verify their implementation and, finally, the adoption of corrective systems in the event that these processes are non-adherent or unsuitable with respect to the reference.

Knowing the different types of customer information they gather, where it is stored, who holds ownership, who has access and at what level, how it is secured, and what procedures are in place for deletion are some of the elements that companies must include in their Data Governance program. For instance, ensuring the "right to be forgotten" by deleting all personal information about the user upon request can be difficult without a solid data governance plan in place.

Data Governance refers to the policies and processes that define the appropriate use of data as it flows in and out of an organization: not a mere technological factor, but a wide-ranging discipline that includes people, processes, strategies, guidelines, and tools. Each initiative aims to ensure that organizations maintain high standards throughout the data lifecycle: from their creation to long-term archiving to disposal, in full compliance with internal company policies and external regulations.

Recently, the European Parliament also approved the Data Governance Act (DGA) with the aim of creating new rules on the neutrality of data markets, encouraging the re-use of some data held by the public sector and creating European data spaces in strategic sectors. This strategy will then be completed by the Data Act (DA) currently under approval. Its field of action includes Public Administration data produced and acquired pursuant to the Data Governance Act, but also extends to Big Data from the private sector. In summary, it establishes who can use the data how and for what. While the DGA aims to create a space for data sharing within the European market, the Data Act focuses on the use of data for commercial purposes by non-EU companies and individuals [36].

CHAPTER 2

ARCESE S.P.A TRASPORTI AND THE DATA GOVERNANCE

2.1. THE TRANSPORTATION INDUSTRY

In this part of the document, the focus is on the Italian logistics market in order to gain a better understanding of the sector in which the company operates. Many companies are increasingly turning to outsourcing as a tactical and strategic tool to manage their logistical activities, which are often peripheral and poorly managed. By entrusting these activities to specialized logistics companies, client companies can reduce costs and focus on their core business. To ensure effective management of these tasks, it is essential that there is a good working relationship between the client company and the logistics service provider. Focusing solely on logistics activities, these companies can carry out tasks more efficiently and effectively than individual organizations, resulting in excellent performance. Logistics companies are

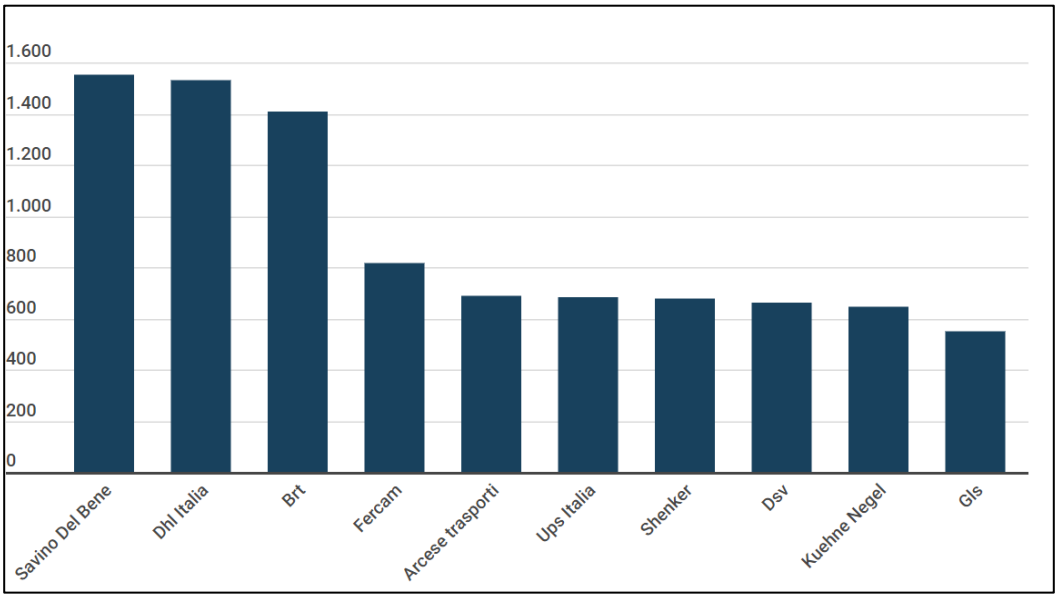
also increasingly prioritizing sustainability and digitalization of processes in order to offer personalized services that meet the specific needs of client companies. Integrated packages for logistics and transport are also being offered to provide comprehensive solutions.

Italy's strategic location at the heart of the Mediterranean has made it an important hub for international trade, with many of the world's major shipping lanes passing through its ports. This has helped to create a thriving logistics industry that offers a range of services, including air, sea, and land transportation, warehousing, and customs clearance Italy's transportation infrastructure is generally well-developed, with a network of highways, railways, and airports connecting the country's major cities and ports. The country also has several free trade zones and special economic zones that offer tax incentives and other benefits to companies operating in the logistics sector.

One area of strength for the sector is the automotive industry, with many major car manufacturers and suppliers basing their European operations in the country. The sector is also increasingly focused on sustainability, with companies investing in eco-friendly transportation solutions and reducing their carbon footprint.

In Italy, there are over 15,000 firms engaged in the logistics and goods transportation industry, generating a revenue of over €70 billion, and growing at an average of 5% annually since the past 5 years. However, the COVID-19 pandemic has caused a decline in the sector, as factories and shops were temporarily shut down. Despite the high level of fragmentation, with small and micro-businesses accounting for 93% of firms with a turnover of less than 10 million euros, the market is dominated by a few large conglomerates. The amount of goods transported by road in the country is significant, 978 million tons and based on the analysis of 2020, Savino Del Bene, the Florentine company, is the leading player in the transportation sector in Italy. With a revenue of €1.55 billion, it tops the list of the top 10 transportation companies in the country. Dhl and Bartolini follow closely behind, with annual revenues of €1.53 billion and €1.41 billion respectively, both demonstrating growth compared to previous years. In fourth place, there is Fercam, boasting a consolidated turnover of approximately €814 million, followed by Arcese Trasporti and Ups Italia, with revenues of €713 million and €687 million respectively. The positions of Dsv and Schenker have switched compared to prior years. Lastly, the last two positions in the ranking of top transportation companies in Italy are held by Kuehne Nagel and Gls Italy [37].

Figure 10. Top sales for transport companies in Italy in 2020 [37]



The Covid-19 pandemic, which officially hit Italy hard starting from March 2020 and whose effects are expected to last for a long time, has generated dramatic consequences on multiple levels: human, health, social, economic, psychological, productive, and not least, transport and logistics. The emergency has forced a downsizing and rethinking of daily travels, placing particular attention on the choices of timing and transportation methods to use, thus bringing to light behaviors of individuals and companies towards mobility and logistics that are different from those adopted before the pandemic. [38]

Diving deeper into the analysis of the transport and logistics sector it is discovered that out of Italian companies involved in the sector:

- 69.9% of the sector's companies deal with Freight Transport
- 13.6% deal with Logistics Services
- 5.8% deal with Import-Export Services
- 5.2% are represented by Couriers and shipments.
- 2.9% concerns Handling
- 2.6% operates in the field of Logistics and warehouse management.

When looking at the territorial concentration, the companies in the logistics and transport sector are primarily found in:

- Lombardia 18,2%
- Campania 10,4%
- Veneto 9,8%
- Emilia-Romagna 9,6%
- Lazio 8,7%

Figure 11. Territorial concentration of companies in the logistics and transport sector [39]

REGIONE	%
North East	**22,8%**
EMILIA-ROMAGNA	9,6%
VENETO	9,8%
FRIULI-VENEZIA GIULIA	1,6%
TRENTINO-ALTO ADIGE	1,9%
North West	**26,6%**
LOMBARDY	18,2%
PIEDMONT	6,3%
VALLE D'AOSTA	0,1%
LIGURIA	2,1%
Center	**18,8%**
LAZIO	8,7%
MARCHE	3,0%
TUSCANY	5,7%
UMBRIA	1,5%
South and Islands	**31,8%**
ABRUZZO	2,1%
BASILICATA	1,0%
CALABRIA	2,8%
CAMPANIA	10,4%
MOLISE	0,6%
PUGLIA	6,1%
SARDINIA	2,2%
SICILY	6,6%

2.1.1. THE CHALLENGES

The supply chain's ability to withstand challenges is constantly under tremendous pressure. The recent technological advancements, changing consumer demands, fluctuating transportation costs, fuel price hikes, driver shortage, and the global pandemic have transformed the logistics industry into a complex arena. Companies must move goods from point A to point B in the face of unpredictable conditions. What are the key issues that logistics and transportation must overcome?

The outbreak of the pandemic has brought about a new reality for logistics and has pushed many businesses to reduce their transportation expenses. This has resulted in some companies cutting back on carriers or negotiating lower rates, but this approach can have a detrimental effect on customer satisfaction as deliveries may arrive late or not at all. For instance, customers who opt for fast delivery services on platforms like Amazon, expect the same level of service from other companies offering similar services. Given the impact of the first wave of Covid-19, it's essential to have a contingency plan in place and to learn from past mistakes. Recognizing the mistakes of the past and being aware of the risks are critical steps towards building a more robust and flexible logistics system for the future. Taking calculated risks, companies can create logistics systems that are able to adapt to changing circumstances and meet the evolving needs of their customers.

To overcome the challenges, the main goal for the industry should be to ensure the use of more sustainable transportation, achieve higher customer satisfaction, and promote economic development:

1. **Increase in shipping costs**: the transportation industry faces a major challenge of reducing the cost of shipping goods. There are a multitude of factors that contribute to the cost of shipping, including fuel prices, labour costs, and the expenses related to maintaining and upgrading transportation infrastructure. The sharp increase in fuel prices has a considerable impact on both consumers and the logistics sector. Technology is playing a crucial role in supporting the logistics industry by reducing the number of shipments and using data analysis to make more informed decisions on route optimization. This helps optimize the logistics budget and reduces fuel consumption by decreasing the number of miles travelled. However, the rising fuel cost also has a substantial effect on consumers, as it leads to higher transportation costs for goods and services, ultimately resulting in inflation and a decrease in the standard of living for many people.

2. **Digital transformation:** the digitalization of traditional business strategies and models is a crucial aspect in today's competitive landscape. Therefore, transportation management systems (TMS) are a valuable addition to any transportation business. Not only do TMS offer a suite of tools that modernize outdated similar processes, but they are also designed to be user-friendly and accessible for all departments, from drivers to management. Complex government regulations and unforeseen events, such as Covid-19 and Brexit, have accelerated the digital transformation of government processes, however, the implementation of these changes can be slow and bureaucratic. The pandemic has emphasized the importance of using technology to be more adaptable and flexible and by replacing outdated systems with automated solutions, transportation planners can improve efficiency. [40]

3. **Drivers' shortage:** a recent report from IRU indicates that the driver shortage crisis in Europe is rapidly escalating due to rising transport demand and an aging driver population. By 2026, the gap between retiring and new drivers is projected to increase the rate of unfilled truck driver positions to over 60%. Without efforts to make the driver profession more accessible and appealing, Europe may face a shortage of over two million drivers by 2026, which could affect half of all freight movements. Despite driver salaries being up to five times higher than minimum wages, the report highlights concerning data on the challenges of entering the driver profession, especially for young people, and its lack of appeal, especially for women. IRU Secretary General Umberto de Pretto said, "Europe's driver shortage crisis is accelerating rapidly, posing a major threat to the continent if nothing is done [41]". Huge obstacles are, of course, licence and training costs, and security, particularly for women drivers. This shortage has had a domino effect because while the economy is growing, there is no way to get all the goods where they are needed, the cost of goods increases, and the opposite effect of a strong economy occurs.

4. **Improving cybersecurity**: as the digital economy continues to advance, businesses are relying more heavily on technology and digital tools. Regrettably, cyber criminals and hackers are also taking advantage of these advancements. The transportation industry is not immune to these types of attacks, and in some cases, they may even come from within the organization. Without a robust transportation management system, employees can inadvertently create internal security weaknesses that could lead to cyber-attacks. Additionally, without clear protocols in place, many employees may not follow proper procedures to prevent these attacks from occurring. This has

been a persistent issue in the transportation industry for a long time. While there is no fool proof solution to this problem, a transportation management system can provide a secure and effective tool for companies to incorporate into their operations. TMS platforms are designed for access only by authorized personnel, and the platform can be tailored to a company's specific requirements and security needs. [42]

5. **The Rise of Automation:** the future of the transportation industry will be heavily influenced by automation and AI. These technologies can streamline processes such as order fulfilment, driver tracking, and product monitoring, offering significant benefits to transportation companies. Clients and consumers are also demanding these advanced transportation methods. However, it can be challenging to determine which specific areas of a company would most benefit from automation. A transportation management system (TMS) can provide a solution to this issue by automating all the essential processes within a transportation business. By working closely with a vendor, the specific pain points and tedious tasks can be identified and allocated to the TMS platform, streamlining operations, and improving efficiency. [42]

6. **The growing need for sustainable logistics:** transport and logistics companies (TLCs) are vital to the world's economies, but they account for one-third of the world's CO2 emissions which damage the environment, economy, and society. Consumers and companies now want to know what types of products they are supporting and how they are helping the environment because companies that pollute less have a greater chance of winning contracts and government policies. The need for sustainable logistics in the transportation industry has become increasingly important in recent years, as the world faces a growing demand for goods and services and increasing pressure to reduce the environmental impact of transportation activities. Here are a few reasons why sustainable logistics is important in the transportation industry:

    - Environmental impact: transportation activities, particularly those involving the use of fossil fuels, contribute significantly to air and water pollution, as well as climate change. Sustainable logistics practices aim to reduce the environmental impact of transportation activities and shift towards more environmentally friendly modes of transportation.
    - Resource conservation: sustainable logistics practices aim to conserve natural resources, such as fuel and water, and reduce waste by optimizing routes, reducing packaging, and increasing the use of recycled materials.
    - Economic benefits: it can lead to cost savings by reducing waste, improving efficiency, and conserving resources. This can help increase profitability and competitiveness for businesses in the transportation industry.
    - Social responsibility: the transportation industry has a responsibility to provide safe, efficient, and sustainable transportation services to its customers. Sustainable logistics practices help to meet this responsibility by reducing the environmental impact of transportation activities and promoting sustainable development.
    - Government regulations: governments are increasingly imposing regulations on the transportation industry to reduce the environmental impact of transportation activities and

promote sustainable development. Sustainable logistics practices can help companies comply with these regulations and avoid penalties. [43]

2.1.2. TRANSPORTATION AND LOGISTIC SOLUTIONS

Poor visibility, lack of management, lack of planning and an ineffective transport management system can have consequences for a business including missing deliveries, incurring unnecessary costs, and ultimately losing valuable business. So how is it possible to reduce the risk of these problems occurring and what can your business do to avoid these?

By utilizing route optimization software, companies can significantly decrease their transportation costs. The software uses algorithms to determine the most efficient route for one or multiple destinations, leading to lower fuel consumption and reduced expenses. The transportation and logistics industry are evolving with the integration of advanced technologies, such as artificial intelligence and machine learning, and cloud data into route planning. The global route optimization software market was valued at USD 3,729 million in 2020 and is projected to reach USD 12,416 million by 2030 with a CAGR of 11.56%. The market is segmented into enterprise, deployment, vertical, and regional categories. The increasing traffic congestion in regions negatively impacts the logistics industry, causing increased operating costs, delayed product delivery, decreased customer satisfaction, and disruption to just-in-time business models. Route optimization software takes into account real-time traffic data and other factors to generate precise and efficient routes. It also provides real-time information on the location of vehicles, allowing company managers to monitor driver behaviour. This kind of software utilizes AI and machine learning to cut down on logistics costs while reducing trip time considering limitations such as time constraints, traffic conditions, and weather concerns when planning routes. This software can aid in automating route planning, live vehicle tracking, fuel reduction strategies, and accurate product data to optimize truck efficiency and time-sensitive deliveries. Additionally, it can assist in evaluating progress, modelling the impact of changes in vehicle size, delivery locations, frequencies, and drive hours, allowing for smarter decision-making without additional time and monetary investments."[44]

To tackle the issue of increasing fuel expenses, the transportation industry has explored various ways to address it, such as enhancing fuel efficiency, using alternative fuels, and implementing cost-effective technologies and procedures. The transportation industry heavily depends on liquid hydrocarbons as its energy source. The reason behind this preference is their high energy density per unit volume and ease of use in vehicles such as cars, trucks, buses, trains, airplanes, etc. However, combustion of liquid hydrocarbon fuels leads to emission of massive quantities of CO2 with the associated greenhouse effect. “There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities [45]”. Some of the alternative energy carriers considered for transportation are electricity and hydrogen. Both energy carriers, when produced from a carbon-free primary energy source such as nuclear, solar, wind, etc. or a renewable source such as biomass, have a potential to eliminate net carbon emission by the transportation sector. However, use of either of these carriers is laden with technical and economic challenges. For the transportation sector, probably the biggest challenge is the storage density of the energy [46].

There are measures that can be taken to minimize the negative impact of fuel costs, and steps taken by companies now to decrease the effects of fuel expenses can even bring long-term benefits when prices eventually subside. While demand plays a significant role in oil prices, it is not the only factor influencing them. The global market sets oil prices and they are not regulated by one single country. Other factors such as the source and refining location of the oil and the need for specific processing for different grades also affect prices. The invasion of Ukraine by Russia and subsequent sanctions have damaged global supply chains beyond repair. Even if the conflict ends, it is unlikely that the sanctions will be lifted soon, leading to continued high fuel prices.

To address these high costs, the entire company should be involved in finding a solution, not just the transportation division. Here are some actions that can be taken to reduce the impact of rising fuel costs:

- **Enhancing fuel efficiency:** this involves implementing technologies and procedures that reduce the amount of fuel required to transport goods and people. Measures may include utilizing more aerodynamic vehicles, minimizing idle time, and optimizing routing and scheduling to minimize empty trips.
- **Embracing alternative fuels:** adopting fuels such as electric or natural gas reduces dependence on traditional fossil fuels, despite often being more expensive initially. This approach can offer long-term cost savings and environmental benefits.
- **Implementing a surcharge for incremental fuel costs:** by applying surcharges to new purchases or renegotiating existing agreements, businesses can recoup fuel costs. Customers may resist, but even a small percentage of the surcharge can make a significant difference.
- **Implementing dynamic service pricing:** offering customers the option of slower delivery estimates in exchange for lower costs can decrease fuel consumption. Delaying shipments to consolidate orders or prioritizing slower modes and shorter distances can make the delivery operation more productive and reduce fuel costs and driver hours.
- **Focusing on driver performance:** encouraging drivers to reduce their speed, minimize idling, and remain on well-paved roads can lower fuel consumption.
- **Optimizing vehicle performance:** regular vehicle inspections, engine tuning, and proper tire pressure can lower fuel consumption. Telematics solutions can also monitor vehicle health and driver behaviour, identifying declining vehicle performance early and facilitating driver coaching to reduce fuel consumption.
- **Prioritizing eco-friendly deliveries:** offering delivery options that minimize environmental harm and reduce carbon footprints can make customers happy, benefit the environment, and save on fuel costs. [47]

Although information technology and interconnectivity have enhanced transportation infrastructure efficiency, they have concurrently increased the risk associated with cyber systems. To better understand this issue, a mixed-methods approach was used, which analysed U.S. cyber incident data for transportation systems and conducted interviews with transportation infrastructure managers and insurers. The research sheds light on the nature of cyber risk for transportation infrastructure and offers recommendations for future research to improve cyber risk management and insurance. The findings show a rising trend in the number of transport-related companies affected by cyber incidents and associated costs. Data breaches are the most common incidents, while privacy violations have the highest

average loss per incident. Although some transportation infrastructure systems are implementing cyber risk assessment, mitigation, and security measures, they are generally inadequate, and infrastructure managers do not have the tools to assess and manage cyber risk rigorously. Additionally, limited data and models hinder the accurate modelling of cyber risk for insurance purposes. Even after developing improved tools and modelling, purchasing insurance can be a crucial risk management strategy for transportation infrastructure systems to recover from cyber incidents. According to the U.S. Department of Homeland Security, a single cyber event could potentially cause economic damages of $50 billion, 2,500 immediate deaths, or have a severe impact on U.S. national defence, for over 60 critical infrastructure entities in the U.S. [48]. Cyber losses in transportation systems can be associated with liability from a customer data breach, property damage or theft (e.g., accidents caused by compromise of signalling systems), data damage (e.g., hacking maritime cargo management systems), loss of income due to outages and failure, website defacement, and cyber extortion [49]. Given the variety of possible cyber losses, there are also a variety of approaches to mitigating these losses. Approaches can include design methods which improve system architecture and activities or operational methods that involve changes to business operations. To manage cyber risk, various approaches exist, including countermeasures such as improving system design and operations, investing in the cyber workforce, and utilizing security software. To reduce the risk of cyber-attacks, protective measures such as system compartmentalization, virus detection, firewall implementation, and software encryption are also employed. Institutional measures to manage cyber risk can be structural, involving hardware and software, procedural, involving the management and operation of systems, or responsive. While these protective and institutional measures provide security benefits, businesses must balance them against associated costs and potential productivity losses. It's also essential to recognize that these measures cannot eliminate cyber risk, and the remaining risk needs to be effectively managed. Cyber insurance can complement these measures by transferring the risk to third parties [50].

Digitalization, which encompasses automation, digitized information flows, and artificial intelligence (AI), offers numerous possibilities to enhance efficiency, minimize expenses, and boost service levels in the road freight transport domain. Moreover, digitalization holds the potential to fundamentally transform the industry's business ecosystem. Nonetheless, the road freight transport sector is highly disjointed and features a competitive framework that prioritizes cost reduction, which could impede the pace of technology adoption. Earlier research has pinpointed the probable advantages and hindrances of digitalization in freight transport, such as its effects on sustainability, business models, and implementation. Digitalization creates many changes relevant to the freight transport sector, including, e.g., the circular economy, e-commerce and changed consumer behaviour], new business models and automation. Cooperative Intelligent Transport Systems (C-ITS), for example, can improve traffic flow, reduce fuel costs, and increase efficiency in the transport system [51]. Digitalization not only enables the optimization of current value chains but also the reorganization of the entire value chain. With digitalization and connectivity, multimodal transport can be optimized and efficiency for haulers can be increased. The potential benefits of digitalization, studied by Molero et al. [52] also show barriers to implementation. The main obstacles to unlocking the full potential of freight transport solutions were determined to be the need for standardization and compatibility with existing information and computer technology. Alongside the prospect of automation potentially removing drivers from vehicles, digitalization is expected to alter the role of drivers in the industry. Specifically, by utilizing digitized data and logistics-related documentation, administrative tasks, which currently consume over 5% of a driver's workday, can be streamlined. That is, digitalization and connectivity will change the interface between retailers and customers which will have impacts on freight transport. Moreover, The World

Economic Forum has projected that the implementation of digitalization could lead to a 10-12% decrease in emissions from logistics by 2025, largely attributable to the optimization of the logistics process using crowdsourcing and shared warehouse agreements. It is important to note, however, that the extent to which digitalization positively impacts sustainability is contingent on the specific way it is implemented.

2.2. ARCESE SPA TRASPORTI

Arcese is an Italian transportation company operating since 1966 in the logistics and international transportation of goods by road, rail, sea, and air. The company was founded in 1966 by Eleuterio Arcese in Riva del Garda. Initially a sole proprietorship for third-party transport, in 1981 the company opened to internationalization with the introduction of intermodal transport, integrating road and rail transport.

The acquisition in 1990 of Ventana Cargo (renamed Ventana Serra in 2006), a company specializing in sea and air transport, allowed Arcese to extend its activities worldwide. In 2000 the International Logistics Area was born to offer customers a complete service, complete service of integrated industrial logistics and supply chain management. The birth of this unit is mainly due to the beginning of the management of “Ricambi Italia” of the German car manufacturer Ford and is supported by the construction of a warehouse in Castel San Pietro (Bologna), also used by Volvo Ricambi customers, Italy and Greece.

At the same time, the expansion of the company in Europe continued with the opening of new one’s branches in Belgium, Spain, United Kingdom, France and Sweden and the start of the groupage business, which allows the firm to have daily connections that guarantee a fast, efficient service and complete for its customers. Arcese Spa expands its range of services worldwide integrated logistics, opening new branches in Mexico, China, and Turkey and in 2009 comes created the company SEL, Sport & Event Logistics, for the logistics management of sporting events, meetings, and large promotional events. Finally, to complete the services offered, it specializes in document management and archiving and in the provision of services e-commerce logistics. [53]

Nowadays, Arcese Spa holding is made up of about forty subsidiaries and associated companies and other companies, but the sole director of the holding and of many subsidiaries is the same Eleuterio Arcese, supported by his wife and four children both in the ownership structure and in the highest administrative-management functions. Most of the Arcese Group's customers belong to the automotive sector and for this reason many of the controlled companies are specialized in this field.

The firm is also involved in the social field. For example, during the last years, the company promoted two important initiatives such as: Road to New York - a project that follows the preparation of athletes with Down syndrome, from the beginning of the training to the New York Marathon, promoting sports as a tool of inclusion and personal enhancement, and Discovery Kenya , a project dedicated to children and young people in Kenya and their passion for running as a means to achieve a school education and future opportunities.

The Group's growth strategy in Europe continues in these years thanks to new investments in the network and new facilities. In 2021, logistics activities expanded in Romania and Spain with the expansion of warehouses in Cluj, Barcelona, and Madrid. In 2022, new investments were confirmed in Madrid and France with new warehouses to offer increasingly advanced and integrated solutions.

Thanks to the direct global presence and collaborations with specialized partners on 5 continents, Arcese is the strategic choice for thousands of companies that operate in the most diverse sectors around the world: from automotive to industry, from textiles to fashion, from chemicals to technology combining the clients' knowledge of local markets with decades of experience and expertise in global trade. €93 million in revenue, 2800 employees, 35,000 m2 of warehouse, 70 branches on 5 continents, with the customer at the centre of their actions to offer excellence at every level, a sustainable approach, and an unparalleled customer experience. Value to the people, guided by a leadership that drives cultural transformation to achieve goals worldwide. Digitization and a data-driven approach to accelerate processes and optimize services offered. Drive for growth through expansion of activities and new global opportunities. [54]

The development of intermodal transportation, and the focus on sustainability are two of the Arcese Group's priorities. Over the years, the Arcese Group has continued to invest in the creation of an integrated and flexible European network, as well as in the standardisation of its fleet of semi-trailers suitable for intermodal transport.

The recent order for 300 new semi-trailers compatible with the P400 rail profile confirms the strategic importance of this type of profile for which Arcese is one of the leading logistics operators in Europe. Arcese has been highly regarded in recent years, leading it to now have a fleet of over 3,000 P400 mega intermodal semi-trailers. It is anticipated that the opening of the Ceneri base railway tunnel and the consequent expansion of the railway infrastructure to include trains up to 750 metres long, and with a P400 profile, will facilitate further enhancement of Arcese's services - making them increasingly green and smart.

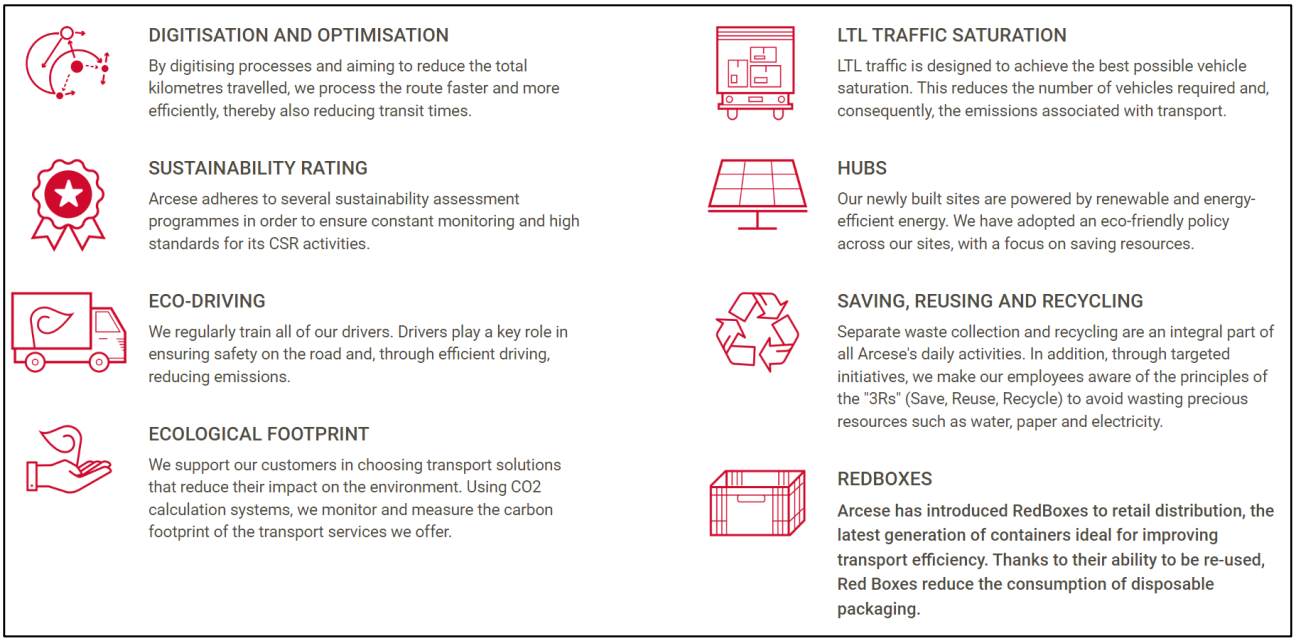
The recent acquisition also consolidates the partnership that began over thirty years ago with Krone and which to date has seen Arcese purchase over 2,500 semi-trailers. Guido Pietro Bertolone, CEO of the Arcese Group, commented, "We continue on our path of innovation and focus on sustainability on a European scale. Our investment and development policy focused on international combined transport represents the future in Europe. Thanks to our ongoing commitment to network development and these new vehicles, we will be able to anticipate market demand for a flexible and sustainable service."

For the Arcese Group, being a socially responsible company means enriching management and strategic decisions with ethical and social considerations, investing in human capital, the environment, and relationships with all stakeholders. In 2018, at the Green Logistics Expo in Padua, the company announced its intention to further reduce CO2 emissions, with the goal of having only Euro 6 and Euro 7 vehicles in its delivery fleet within the next 3 years. At the beginning of 2019, in fact, Arcese expanded the fleet with the new IVECO Stralis NP in a lowered natural gas version, designed to result in a significant reduction in both consumption and pollution. In 2021, the commitment to sustainability continued with the introduction of Bio-LNG vehicles, a renewable gas with high potential for reducing environmental impact, into the fleet. The commitment continued with the introduction of reusable Redbox containers in the distribution services, which reduce the consumption of cardboard. This activity is accompanied by a continuous effort to minimize waste and reduce environmental impact.

Arcese has embarked on a conscious journey, strongly believing in ethical and sustainable business, and implementing a Corporate Social Responsibility (CSR) policy that is realized in the drafting and publication of the Sustainability Report. Sustainable development and quality policy are an integral part

of the company's philosophy. For years, Arcese has been carrying out its commitment to offering an excellent service while fully respecting the communities and environment in which it operates, developing increasingly eco-sustainable transport solutions aimed at reducing the impact generated by its activities. The modern fleet, consisting of 10% Euro5-EEV vehicles, 70% Euro 6 vehicles, and 20% Euro 6 LNG vehicles, represents the most up-to-date and effective tool for reducing CO2 emissions. A well-planned and planned vehicle maintenance program in workshops, combined with the use of the latest industry technologies, helps to maximize efficiency, and minimize consumption throughout the entire fleet looking at intermodal transport as the best solution for reducing CO2 emissions by over 50%. This is the most effective way to reduce the impact generated by activities; that is why, whenever possible, they propose to clients to choose combined road, rail and short-sea transport services.

Figure 12. Environmental and Sustainability activities [54]



Nowadays, Arcese is composed of three business divisions: Road Freight for road and intermodal transport, Air & Sea Freight for sea and air shipments, and Contract Logistics for outsourcing logistics services.

- **Road Freight:** The Arcese Group has developed skills and abilities to create customized solutions for road and intermodal (truck-rail-short sea) transport. The types of transport on road are:
    - International LTL (Less Than Truckload), i.e., a road transport system a partial load which allows the transport of limited quantities of goods agglomerated in a single shipment. Arcese guarantees fast and daily shipments to all Europe with defined transit times.
    - Domestic LTL, which allows to ensure part load and groupage shipments rapid throughout the Italian territory with defined transit times and delivering both in large metropolises than in small urban centres.

- FTL (Full Truck Load), i.e., a vehicle that carries a single load completely full. Arcese offers an efficiently, rapidly, and innovative service, customized for each customer, thanks to its own availability of means that allows to ship goods throughout Europe.

Intermodal transport consists of combining optimally and in different ways the road, rail, and short sea transport of goods, organized in Intermodal Transport Units (UTI), from which they are no longer moved, to avoid damage, up to the point last destination. According to the needs of customers and the distances to be travelled, the three types of transport are organized in such a way as to guarantee their optimization and Arcese in addition it offers weekly departures to the main European destinations.

- **Air and Sea Freight**: Ventana Serra, established in 2006, is the Arcese Group company that deals with transport international by air and by sea, offering customers customized solutions for every need and destination. These two types of transport allow to travel long distances in a short time and to send the goods all over the world, monitoring their shipping status constantly. Ventana Serra also takes care of the management of all the activities customs, both in terms of documentation and continuous assistance to the customer
- **Contract and logistics:** the Arcese Group has developed experience and skills for the optimized management of inbound and outbound logistics activities, ensuring customers, who rely on services of outsourcing logistics, advantages in terms of quality, efficiency, and productivity. Thanks to its warehouses and sites along Europe, the company is able to offer its services to not only Italian but also international customers. The main inbound logistics solutions offered are:

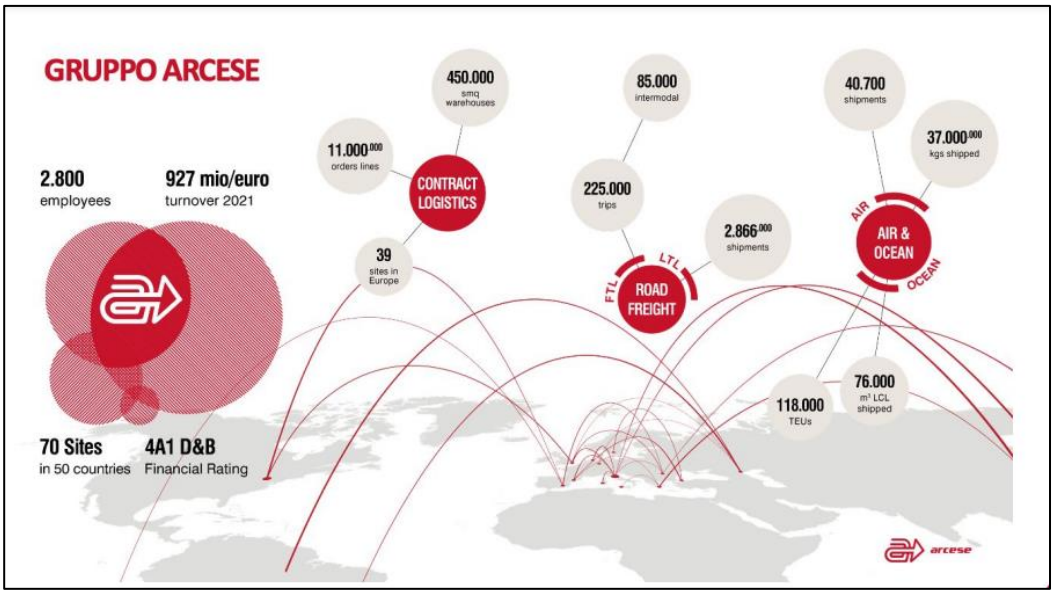
  - Design and optimization of incoming flows and those towards the lines productive
  - Logistics management of collection centers and management of the entire supply chain
  - Management of warehouse logistics and all internal logistics flows production plants, from the receipt and storage of the material, up to the supply of production lines.
  - Value-added activities (kitting and assembly of subgroups).

Among the services offered for outbound logistics, there are:

- Management of warehouse logistics downstream of internal plant production.
- Primary transportation from points of origin to distribution warehouses.
- Management of central distribution warehouses.
- Secondary transport.
- Reverse logistics.
- After sales and customer assistance services.

The Logistics Engineering of the Arcese Group assists customers in planning and management of the entire supply chain, trying to intervene in critical areas and ensure the ability to face the complexity of the new world markets. To assist the expansion of companies around the world, another service offered by the Arcese Group is responsible for the development and management of e-Commerce of the same, from creation of the online store to the storage of goods, from order management to delivery to the final customer. Finally, Arcese has eighteen document and date centers, for the management of all paper and non-paper documents of client companies.

Figure 13. Gruppo Arcese analysis [57]



2.3. DATA GOVERNANCE IN ARCESE

For transportation and logistics companies like Arcese SpA Trasporti, data governance is particularly important due to the high volume of data involved in supply chain management. By implementing strong data governance practices, the company can ensure that their information is accurate and up to date, allowing them to make informed decisions about their operations. This includes tracking shipments, managing inventory, and optimizing routes to improve efficiency and reduce costs.

By ensuring that data is secure and properly managed, the company can also protect against data breaches and ensure compliance with regulatory requirements. In addition to managing data internally, Arcese SpA Trasporti also recognizes the importance of data sharing and collaboration across their supply chain. Through data governance, the company can ensure that data is shared and utilized in a responsible, secure manner, benefiting all stakeholders in the supply chain. In summary, data governance plays a critical role in the operations of Arcese SpA Trasporti, allowing the company to effectively manage and utilize data in a responsible, secure manner. Through effective data governance, the company can make informed decisions, protect against data breaches, and collaborate with partners in their supply chain. The increasingly pervasive nature of data makes it crucial for all employees to learn to “speak data.” data governance also promotes collaboration and innovation by enabling companies to share data with their partners in the supply chain. This can help improve efficiency and reduce costs for all stakeholders, while also promoting innovation and new opportunities for growth. [54]

2021 was a pivotal year for the company. It was a year of continuity and renewal, with Digitalization and Cultural Transformation as its pillars, in line with the strategic objectives of growth and business model excellence.

Figure 14. The pillars of Arcese' strategy [54]

To do this, a crucial attention was dedicated to the Cybersecurity. Arcese protects:

- Personal information and other information entrusted by clients.
- The privacy of employees and third parties.
- The confidentiality of data.

All employees are obliged to be familiar with the IT regulations and policies regarding the security and confidentiality of data. A dedicated department manages information security as part of the effort to enforce global rules and ensure information security through the implementation of organizational, technological, and physical security management policies. The Cybersecurity Department periodically conducts internal information security audits/tests and reviews to evaluate how information is handled, working to implement improvements. The internal training process for all employees has been improved and the Helpdesk Service support availability was extended along the day.

This has also been a reaction to what happened last year. On 15 December 2021, in fact, at 5.00 am CET, Arcese has been hit by a cyber-attack which resulted in an unauthorized and unlawful access to Information Systems. The company immediately acted and, in collaboration with an international Kaspersky CSIRT (Computer Security Incident Response Team), started to investigate the event to verify any compromised systems as well as take relevant measures to strengthen the IT systems in partnership with DART (Microsoft Detection and Response Team). The core IT infrastructure has been rebuilt in less than 48 hours in a new domain and in a dedicated environment protected with EDR tool with h24

monitoring, and no data has been lost from the systems (Accounting system, Transport and Logistic management system, etc..).

To prevent and reduce the risk of new cybersecurity incidents, the following actions have been put in place:

- MFA is mandatory for each user connected to our environment.
- Advanced MDR Cybersecurity solution has been implemented to monitor all out infrastructure H24 365/365.
- Multi-Tier architecture has been implemented splitting all the systems in three different segregated layers reducing the potential scope of a cyberattack.

Despite the cyberattack that occurred in December, no notification has been notified to the Italian Guarantee, since no cases of personal data breaches or losses according to the General Data Protection Regulation (GDPR), have been recorded from all the verifications carried out.

2.3.1. THE IMPORTANCE OF DIGITALIZATION

Digitalization and the adoption of new technologies are fundamental assets for the development of any business, in any sector and supply chain. The Covid-19 pandemic has significantly accelerated the transformation programs of many companies because the imperative has been - and will continue to be - to quickly rethink certain processes and strengthen internal and external communication and collaboration infrastructure, optimize efficiency, and increase resilience to respond to market variables. Today, more than ever before, the concepts of flexibility and agility are strategic for every organization, and the possibility of embarking on the transformation journey alongside a reliable technology provider that can be a true "digital enabler" is often a decisive factor for success. Among the various digitalization projects in the logistics and transportation sector, Arcese has decisively focused on digital to implement a fundamental solution for real-time shipment tracking. The daily need was to ensure continuity for employees who monitor daily activities in the field through a proactive system of updates, notifications, and real-time communications. Vodafone Business provides the infrastructure resources of the platform on which a critical component for the company's processes relies, namely the mobile app, which is now used by about 1,500 operators, including Arcese fleet drivers and external transport providers, to be constantly connected with the company regardless of their geographic location, both in Italy and abroad. The developed app also allows the centralized and authenticated management of all communications and interactions of traveling personnel related to scheduled deliveries and enables the digitalization of all processes that were previously managed through the physical passage of paper documents, allowing the operation and delivery of goods in a safer situation and in full compliance with all measures provided to deal with the health emergency. The added value fully responds to the value sought by the company itself, and it is to be accompanied step by step in a "continuous improvement" of the solution, through the continuous evolution of the implemented applications [55]. Guido Pietro Bertolone states that "there are three pillars on which Arcese currently relies: customer value, sustainability, and innovation. Digitalization and technology are essential for the development of any business, particularly for who operate in the logistics sector, as this allows us to remain connected and enable extremely important experiences for customers by providing them with truck and trade, ensuring real-time access to their goods, and thus planning their activity. Digitalization enables the organizational existence of the control tower, which experiences what happens in the field with our resources in real-time, in order to plan, inform the customer if there is a problem, and act proactively [55].”

Thanks to the Cloud and Machine Learning, Arcese's logistics is becoming data driven. With the creation of an enterprise data platform, but especially with the use of advanced analytics and machine learning technologies, the Arcese Group is becoming a true data-driven company, increasing efficiency, and offering its customers an increasingly valuable service. All supported by the Microsoft Azure cloud platform. The vehicles in motion, thanks to a high level of onboard technology, such as remote diagnostics, IoT connection, and GPS devices, are therefore an inexhaustible source of data for Arcese.

Another project that Arcese has recently joined is 'Towards the implementation of the e-CMR system', the initiative launched by Unioncamere with the technical support of Uniontrasporti that aims to digitalize and simplify logistics procedures for road transport. The project, which has now entered the testing phase with the launch of a series of pilots, involves other Italian transport and logistics companies. In September, the e-CMR process will be used by Arcese for several international transports - on a well-defined and controlled traffic perimeter - with the aim of testing its use in the operational context and, thanks to specific KPIs, detecting potential benefits and obstacles or difficulties in its use. With the e-CMR, sender, transporter and consignee can receive real-time notifications on key steps in the transport process (pick-up, transport, delivery) and on the integrity status of the goods, triggering any proactive actions, or enabling the billing process of the transport service as soon as the goods are delivered. Arcese was at the forefront in joining the project: the digitisation of transport documents is in fact a key factor in increasing the competitiveness of the service offered and the quality of supply chain services by enhancing their efficiency. To date, the e-CMR has been ratified in 30 European countries and Italy's goal is to be one of the next. "We expect positive results from this pilot, in addition to raising the awareness of all players in the supply chain, and a boost to the process of ratification of the protocol by the Italian government. Ours is a rapidly changing industry and e-CMR is a key element to support the transformation of our processes driven by the strong push towards digitisation", commented Emanuele Arcese - Road Freight FTL Director and continues "Not only operational efficiency, thanks to more accurate data the digital standard increases transparency and security along the entire supply chain, not forgetting the important implications in terms of sustainability." [54]

In recent years, the IT infrastructure has also undergone significant evolution, first with the creation of a full outsourcing data center and then with a gradual migration to the hybrid cloud, with a predominance of services based on Microsoft Azure. The Group also relies on Dynamics 365 for ERP functionality and CRM tools. As for individual productivity and global collaboration, but with centralized governance, the Microsoft 365 environment has been chosen. "Moving goods from one point to another around the world," says Roberto Mondonico, CIO of Arcese, "following environmental sustainability criteria and offering the customer a whole range of additional services is the real challenge that logistics providers must face, a challenge where digitization plays a fundamental role. We operate in three different segments - land, air and sea, contract logistics - and our goal is to do so by applying the most advanced concepts of intermodality, also through the analysis of information. The most important factor in progress is cultural and human: the transition from a company that relies on gut instinct to a data-driven one can only happen by involving all the people affected by the change and growing the data culture at the same pace [56]."

Logistics operations generate enormous amounts of data, from the position of vehicles to real-time information on routes, from order management to requests for new quotes, which must be processed quickly by calculating the optimal price to win the fierce global competition. Arcese generates 15 million

data per month just to track vehicles and goods and receives thousands of requests for service quotes. These volumes led the company to understand that, to grow even further and remain competitive, it would have to become a data-driven company, and it would have to do so in the best possible way.

Thus, in mid-2020, Arcese created a data management team, which would guide colleagues in the journey towards advanced data usage. With the people found, the IT department began designing the tools. Everything starts, once again, with people and in particular with a close-knit team of specialists from Arcese's IT, Microsoft technicians, and consultants from partner Cluster Reply. End-to-end integration of the entire data flow is designed, from origin to a single corporate data warehouse and beyond, with advanced analysis tools that transform data into information and then into decisions. "In September 2020, we started designing the data factory," says Angelo Varriale, Chief Data Officer of Arcese, "and by December, the first reports were ready, which have now been integrated into interactive dashboards and we are already developing machine learning algorithms; a veritable arsenal available to our specialists. [56]"

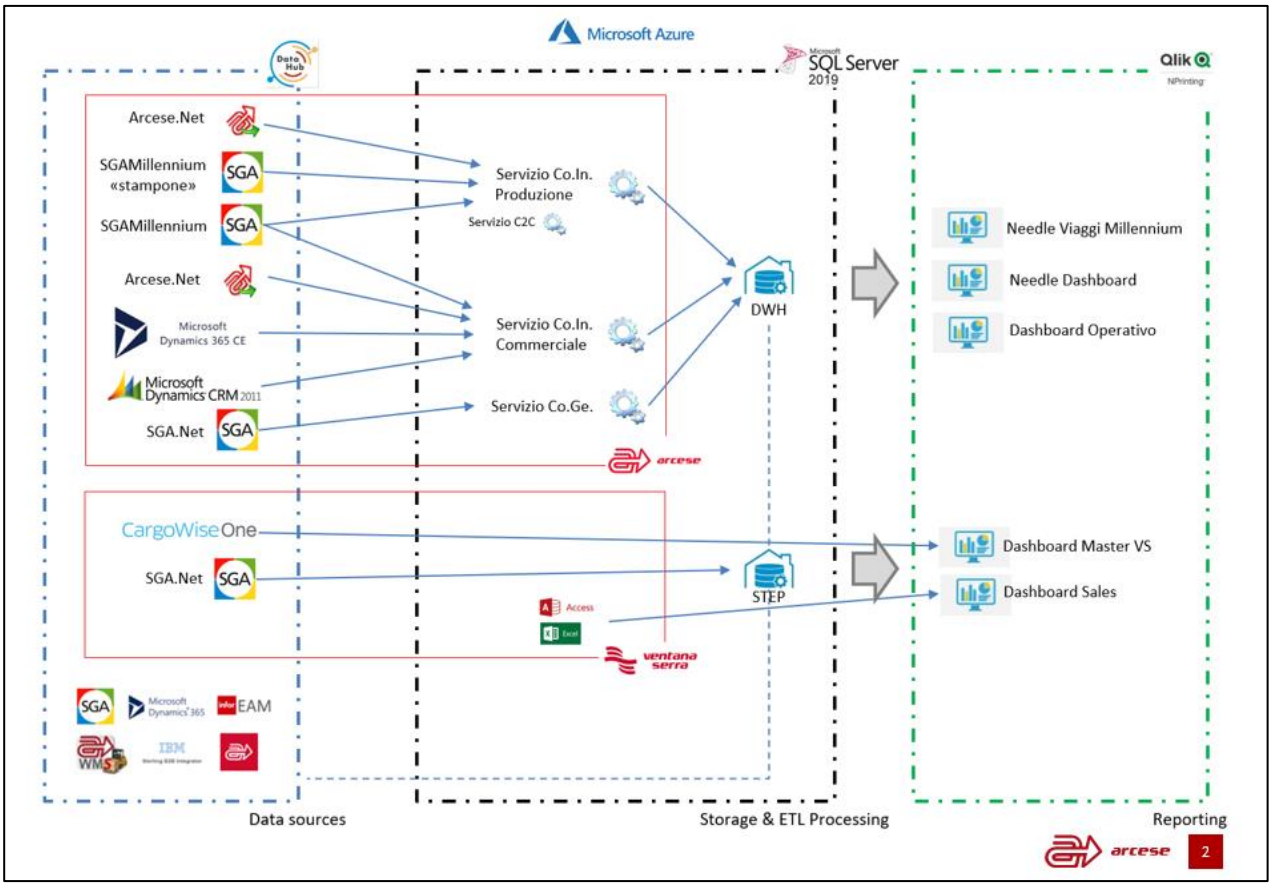
Thanks to the data-driven logistics analysis platform, Arcese can perform large-scale analysis of the big data at its disposal, drawing from a single source of truth and with a better user experience thanks to quick and precise insights. Additionally, strategic data is protected through the highest guarantees of cybersecurity and privacy offered by the cloud. "Artificial intelligence algorithms," explains Varriale, "help us, for example, optimize pricing for the quote requests we receive every day, as well as optimize the logistics flow, allowing us to achieve service levels more in line with customer expectations while minimizing the environmental impact, minimizing the routes taken by empty or partially loaded vehicles." On the machine learning front, the road has just begun together with Cluster Reply and Microsoft, Arcese is carrying out experimental projects for demand forecasting and natural language recognition in emails received by the company, to immediately identify those that require urgent attention. [56].

2.3.2. THE ACTUAL ORGANIZATIONAL MODEL

Nowadays, in Arcese the list of sources which is in the Data Hub is:

- SGA.NET, SGAMillennium, CRM 2011, D365 CE, CW1
- SGAMillennium "stampone": dedicated instance of SGAMillennium used by industrial accounting for cost and revenue calculation. A daily backup and restore of SGAMillennium is performed.
- Arcese.Net: CRMAN functionality, manual active and passive Co.In. (FTL) invoice splitting. Flow coming from D365 FO via FTP integration.

Figure.15. Actual Infrastructure



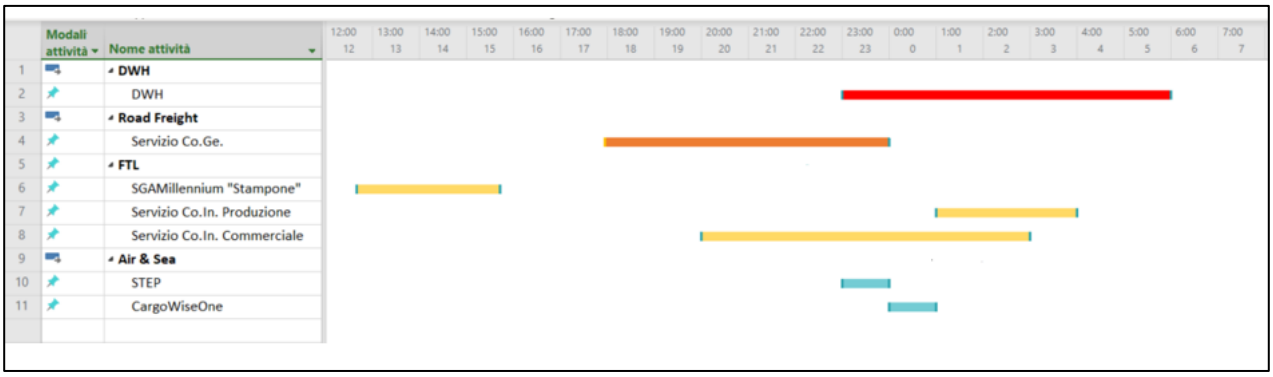
To clarify the process, let's consider a simple shipment. Once a shipment is loaded onto a truck, the operators enter all the information related to it into SGA, which is our Data Sources. Within the various data sources, we find everything we need to uniquely identify that shipment by checking all its characteristics, such as the trips on which that shipment was present, gross weight, taxable weight, volume, sender, recipient, commodity, etc.

Then, there is the list of Windows services for reclassification and redetermination of information. The input of these services, in addition to the sources present in the data hub, is composed of parametric tables in SQL (interface through Arcese.Net) and Excel spreadsheets. The output of these services is stored in a SQL database and becomes a source for the Data Warehouse.

- Co.In. Produzione which determines the costs of the FTL (Full Truck Load).
- Co.In Commerciale which determines the sales of the FTL.
- Co.Ge which determines sales and costs of the LTL (Less Truck Load).

Finally, the data can be viewed through various dashboards, such as "Needle Viaggi Millennium" and "Needle Viaggi". These dashboards are powerful tools that allow users to view data in the way they prefer. By utilizing various visualizations such as graphs, pivots, and other objects, users can analyse data in the most effective way. Additionally, users can extract data in Excel format, enabling them to perform further calculations and make better-informed decisions. This flexibility in data visualization and analysis allows for a deeper understanding of the data and can help drive business decisions.

Figure 16. Back end uploading times



Currently, there is no document describing the information present in the dashboard, both in terms of dimensions and algorithms. The scope of the data that contributes to creating the dashboards is generally related to the Italian instance for Arcese, while for Ventana it is related to the Italy and Mexico company, but it depends on the way a Dashboard is programmed. The DWH is updated once a day and, currently, the calculation of some dimensions is done both at the back-end level (DWH) and at the front-end level (QlikView). QlikView is a business intelligence (BI) software developed by Qlik. It is designed to help organizations analyse, visualize, and explore data to make informed decisions. QlikView allows users to extract data from various sources such as databases, spreadsheets, and other business applications, and combine and associate that data into a single interactive view. Taking data from SGA, users can create customized dashboards, reports, and dynamic charts to analyse data from different perspectives. One of QlikView's main strengths is its data association engine which enables users to freely navigate data and discover hidden relationships without the need to create queries or define rigid database structures in advance. Users can select and click on specific elements within the visualizations to further explore the data and get real-time answers to their questions. QlikView also offers advanced analytics capabilities, such as integration with statistical analysis, machine learning, and data forecasting. This allows users to uncover meaningful trends, patterns, and insights that can help guide business decisions

As already said, the change in the mentality and in the importance given to the Data Governance in Arcese is to assign in to the 2021 which was a pivotal year for the company. Adopting a process modernization and automation strategy, extended to the entire organization, allows to improve existing processes, and prepare for the all-round digital transformation that can become the real differentiating factor on the market. Arcese has understood the importance of assigning more and more value to data, whose total increases day by day. Data care and governance ensure a correct view of management to managers present in the company to make fundamental strategic choices within the company.

After the creation of the Data Governance Team, a trip of continuity and renewal has begun, with digitalization and cultural transformation as pillars, in line with the strategic objectives of growth and business model excellence. The team is composed by three main members: one IT Data Governance Assistant, one Data Governance Specialist and a Data Governance Manager. These roles are strictly connected to other important figures such as the IT Solution and IT Application Specialist which coexist and work in synergy to guarantee the success and the continuous improvement of the data governance and of the systems.

Among the main functions performed by the team of Data Governance, there are:

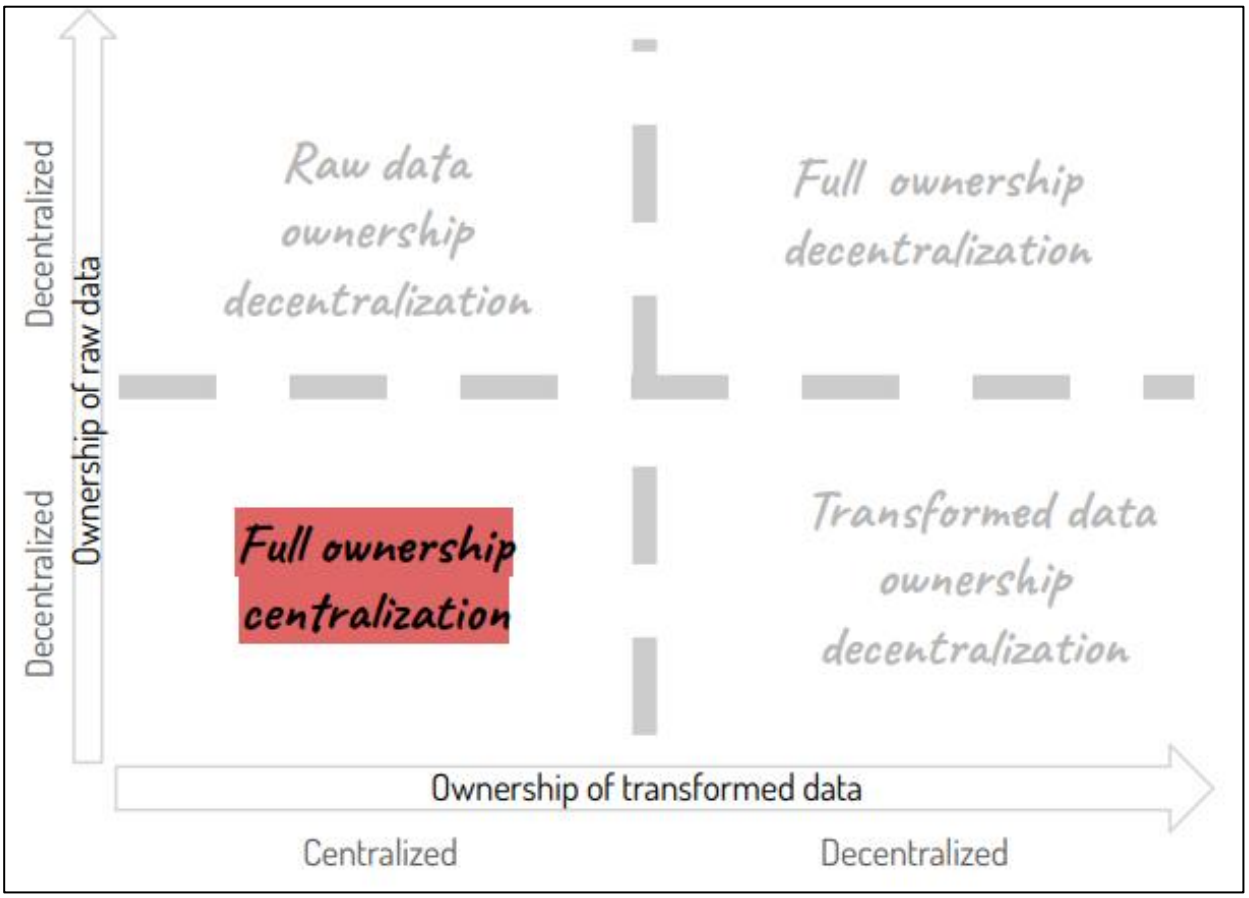
- The definition and creation of operational reporting on the Italian perimeter, through the design of objects for transactional data extraction and the creation of dashboards, in collaboration with the BI development team for monitoring the activities indicated by internal customers, mainly including the Process and Quality departments.
- Extension to the other European subsidiaries, through the mapping of flows, with a view to developing the European network, and with the objective of normalizing and standardizing data.
- Participation in the project for the creation of an information layer including corporate data sources and for the development of advanced reporting, also in relation to the project for reviewing the corporate data governance model and the configuration of the related Tool (Blindata).
- Experiments for the implementation of AI and Machine Learning logics for predictive and prescriptive analyses. One of the most important problems in the firm is to predict the demand of the next days which usually come in the latest hours of the previous day, so the firm is trying to develop something to solve this kind of problems.
- Analysis of data connected to the engineering of transportation and logistics department to help them in making strategical and tactical choices. The two teams work strictly connected because this is one of the main important team which benefits from the success of the data governance. Only a perfect vision of the data, which need to be clean and without errors, can help managers to make strategical choices for the future of the company.
- Use of the software PTV Route Optimiser which is an unrivalled route optimisation software that enables transport planners to build better routes and schedules and boosts fleet utilisation and overall efficiency. This software is used in the firm in a strategical way so that it is possible to make for example basic economic analysis on the different routes that the company need to do every day.

Day after day, the role of data governance in Arcese becomes increasingly important and strategic in order to make fundamental choices for the future of the company. Only through the implementation of a platform that is perfectly shared by both business and IT is it possible to work synergistically towards success and the achievement of the goals set with the creation of the data governance team.

Arcese currently has an organizational model that centralizes the data management, both about raw data and with respect to transformed data. Business users have the option to request new checkouts through the BI Manager tool, but it's always the IT team who manages how these extractions occur as well as the any transformations necessary to go from the raw data to the transformed one. With respect to governance activities, there is no defined and formalized framework.

Centralizing data management can have several advantages, including increased efficiency and consistency in data management practices, better data security and privacy, and improved decision-making capabilities. By having a single entity responsible for managing data, organizations can ensure that data is collected and stored in a standardized and secure manner, which can help to prevent errors and inconsistencies that can arise when data is managed by multiple entities.
However, centralizing data management can also have some drawbacks. For example, it can create bottlenecks in the flow of data within the organization, as all data must be processed and managed by the central entity before it can be accessed by other departments. Additionally, there is a risk of data silos forming, where different departments within the organization may not have access to all the data they need to make informed decisions.

Figure 17. Arcese actual organizational model [57]



CHAPTER 3

PTV ROUTE OPTIMIZER

3.1. DESCRIPTION OF THE TOOL

PTV GmbH (Planung Transport Verkehr) is a German company specialized in providing cutting-edge software solutions and expert consulting services to empower and advance mobility and transportation systems towards a greener and more intelligent future. With a strong global presence, the company serves clients across more than 120 countries of different entities such as policymakers, cities, organizations, industries, and logistics providers.

The cornerstone of PTV's offerings lies in its innovative software, designed to facilitate intelligent traffic management, and optimize transport operations. By leveraging these solutions, decision-makers can make informed choices that not only save valuable time and financial resources but also enhance road safety and environmental sustainability. In fact, PTV's products have gained significant traction

worldwide, with over 2,500 cities relying on their sophisticated capabilities for making data-driven decisions. Located at the epicentre of the renowned technology region of Karlsruhe, Germany, PTV's headquarters serves as a hub for development and innovation. Founded in 1979 as a spin-off from the esteemed Karlsruhe University of Technology (KIT), the company has maintained a steadfast commitment to incorporating the latest advancements in science, technology, and research into its product development cycle. This approach ensures that PTV's solutions remain at the forefront of the industry, providing state-of-the-art features and functionalities. With a dedicated global workforce of approximately 900 employees, PTV Group remains at the forefront of shaping the future of mobility. Focusing on forward-thinking solutions, the company aims to create intelligent and ecologically sustainable transportation systems that benefit individuals and communities worldwide. Through its ongoing pursuit of innovation and commitment to academic rigor, the company continues to drive the development of intelligent mobility solutions for a brighter and greener future. [58]

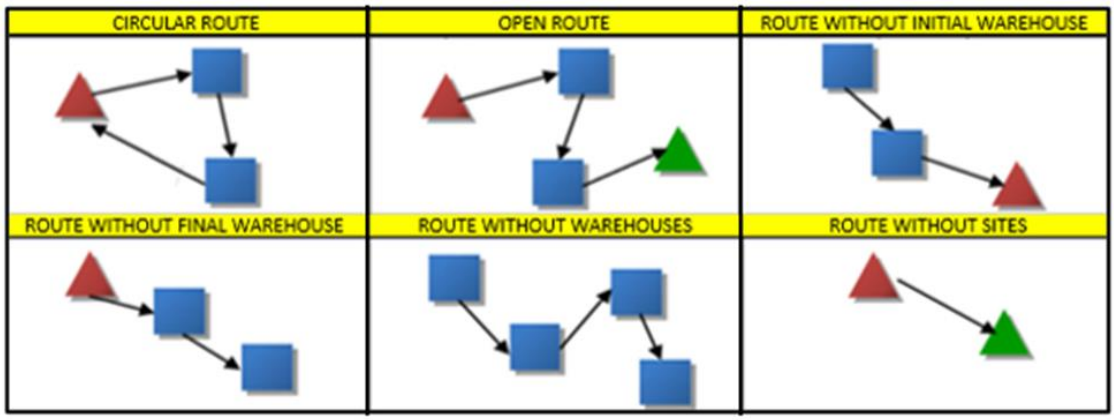
Among the different logistic software offered by the company, Arcese decided to acquire the professional trip planning PTV Smartour, which is now updated to the more recent version PTV Route Optimizer. This software is designed for professional trip planning and calculates the most efficient route by considering all the relevant data that affects the decision-making process. In a logistic company, there are several types of routes that can be employed to transport goods efficiently. The selection of a particular route depends on various factors, including the nature of the cargo, distance, cost considerations, and time constraints. Here are some common types of routes used in logistics:

- **Direct Route**: this is the most straightforward and efficient route from the origin to the destination. It involves transporting goods directly without any detours or stops along the way. Direct routes are typically preferred for time-sensitive shipments or when the distance is relatively short [59].
- **Hub-and-Spoke Route**: in this route system, goods are transported from smaller locations to a central hub or distribution centre. From there, the goods are sorted and then sent out to their respective destinations. Hub-and-spoke routes are often used by courier and package delivery companies to optimize their operations and reduce costs [60].
- **Multi-Stop Route**: a multi-stop route involves making several stops along the way to pick up or drop off goods at different locations. This route is commonly used for trucking and delivery services, where multiple customers or suppliers need to be served within a single trip. Efficient planning and scheduling are essential for optimizing multi-stop routes [61].
- **Intermodal Route**: it involves using multiple modes of transport, such as trains, ships, or planes, to move goods from the origin to the destination. Intermodal routes combine the strengths of different transportation modes to maximize efficiency, cost-effectiveness, and environmental sustainability [62].
- **Reverse Logistics Route**: it is used when goods need to be returned from the destination to the origin or to a different location for various reasons, such as product recalls, repairs, or customer returns. Reverse logistics routes require careful coordination to ensure timely and cost-effective return of goods [63].
- **Milk Run Route**: a milk run is a route that involves picking up goods from multiple suppliers in a specific area, often on a regular schedule, and delivering them to a central location or a customer. Milk run routes are common in industries where multiple suppliers serve a single customer, such as automotive manufacturing. This method of transport got its name from the

dairy industry practice, where one tanker used to collect milk from several dairy farms delivering it to a milk processing company [64].

These are just a few examples of the types of routes that logistic companies can employ. The specific route selection will depend on factors linked to the overall logistics strategy of the company. By utilizing this route optimization software for heavy goods vehicles, Arcese can plan these kinds of routes in the most appropriate and cost-effective way.

Figure 18. Types of Routes [65]



PTV Route Optimizer considers various factors such as traffic conditions, vehicle capacities, delivery time windows, and specific customer requirements to create the most efficient route plans improving efficiency and enhancing customer satisfaction. It can be used for a wide range of applications such as [58]:

- **Scheduling deliveries and optimizing the use of the fleet:** which is an activity whose complexity increases with the volume of orders to be managed. PTV offers a tool that allows for automatic and compliant assignment of orders to available vehicles. By assigning orders to drivers and creating the best possible delivery rounds, the software helps to optimize vehicle routes while considering factors such as distance, transport costs, workload between drivers, and driving and rest time regulations. Without adequate IT support, the transportation optimization process can be very complex, but PTV Route Optimizer simplifies the process by calculating alternative travel solutions and suggesting the right vehicle for each ride. The planner can then evaluate all available options before making the final decision and can also manually intervene and make changes as necessary.

- **Communicating ETA to your customers**: it is possible to communicate the estimated time of arrival (ETA) to customers by utilizing software that tracks vehicle locations and predicts their arrival times. Customers receive real-time updates on their expected delivery times, including any potential delays. The software also allows for the option of notifying customers immediately of any delays or only if they exceed a specified threshold (e.g., 30 minutes). This reduces the amount of time planners need to spend on the phone with customers, keeping them informed of any potential delays.

- **Complying with logistical constraints and customer requests:** PTV Route Optimiser software is capable of taking into account all the planning constraints and preferences to tailor the optimized plans to their unique requirements, such as vehicle loading and unloading times, customer

preferences, vehicle characteristics and equipment, driving and rest times, and opening hours. As customer demands increase and regulations become more complex, transport planning becomes more complicated. It is essential to consider a variety of factors such as limited access to urban areas, increasingly narrow delivery time windows, and pollutant emission restrictions when planning and calculating routes. However, PTV Route Optimiser simplifies the complexity by providing a specific interface that allows planners to consider national regulations, customer requests, and information on the opening of depots and vehicle specifications. When the orders are distributed among drivers and routes are calculated, the software automatically considers all existing constraints to ensure that the proposed plans comply with all the necessary specifications. Some of the common constraints involved in planning and calculating routes include:

- **Time and duration constraints**: frequently, customers impose strict delivery windows and opening hours, leading to drivers waiting in front of closed warehouses and incurring penalties for delays. In addition, national regulations on driving and rest times further complicate delivery scheduling. PTV Route Optimiser simplifies this process by allowing planners to work with ease and in compliance with all constraints. The software memorizes all necessary constraints and automatically considers them when assigning orders to drivers and calculating routes, providing efficient and hassle-free delivery planning.

- **Vehicles fleet**: The choice of the right vehicle for deliveries is becoming increasingly crucial, given the environmental and legal aspects involved. The company's fleet includes trailers, electric trucks, and refrigerated trucks, and not all vehicles are suitable for all types of deliveries. Diesel engines, for example, may be prohibited in some urban areas, while electric trucks and vans have limited range. PTV Route Optimiser simplifies this process by automatically selecting the most suitable vehicle for each order considering all the relevant restrictions.

- **Load, weight, and volume**: Optimizing the loading of vehicles while also considering the unloading sequence can be a challenging task. However, with PTV Route Optimiser, this process is made easier as it considers various factors such as maximum load, linear meters of load, and the number of pallets or roll-containers that can be accommodated on each vehicle. The software also considers the type of load and avoids routes that do not permit the transportation of dangerous goods.

- **Loading and unloading points of the goods**: access to loading or unloading points can often be complicated due to factors such as small ramps or narrow gates, or the requirement for a tail lift. However, with the software, all relevant information can be stored ensuring that the chosen delivery vehicle is suitable for these specific requirements. Additionally, geographical coordinates can be entered into the master data of loading and unloading points, which is particularly useful in cases where only a postal address is not available for these locations. This feature simplifies the work of the drivers and ensures more efficient deliveries.

- **Calculating transport costs in an efficient way**: it provides the necessary tools to calculate transport costs quickly and accurately, which is an essential function during the billing phase. This helps to ensure complete transparency in the billing process.

    - Calculate tolls: PTV Route Optimiser has an integrated toll cost calculation module that is regularly updated with all the applicable rates in many European countries where road taxes are imposed. This feature enables the accurate calculation of the expected costs for each country that the vehicles in the fleet will be passing through. In addition, the software also provides an estimate of the impact that any expected toll rate increases may have on the transport costs.
    - Accurately identify driver costs and reduce expenses: it enables planners to have a comprehensive understanding of all the variables that influence transportation costs. While the distance travelled by drivers is a significant factor, other elements such as traffic can significantly affect driving times. As a result, PTV empowers planners to identify driver expenses and determine the most efficient travel plan.
    - Make the right decisions thanks to the route cost calculation: is it more convenient to manage an order by own means or is it better to entrust it to a small owner? The software assists planners in making informed decisions by incorporating all relevant data and rates related to transport service providers, vehicle profiles, and personnel costs. Using this information, the software calculates the costs for each travel plan, making it easy to determine the profit margins for each order and identify which orders may be better managed externally.

  Having an overview of total costs and being able to evaluate alternative solutions is important for making informed decisions. In Europe, many countries impose taxes on road transit. To help with this, PTV Route Optimiser includes an integrated toll cost calculation module that is regularly updated with all the latest rates. This allows for accurate calculation of expected costs for each country that the fleet's vehicles will be crossing.

- **Exchanging data and information with other platforms**: connecting PTV Route Optimizer to the ERP, TMS system or company telematics platform ensuring fast and complete sharing of data. Only starting from correct data, good results could be obtained: to calculate the best routes and assign each order to the optimal route, it is necessary to provide PTV Route Optimiser with data and information concerning customers, depots, vehicles, and drivers. To ensure efficient data transfer, the software has various interfaces for communication with all common TMS, ERP, CRM, MMS, and telematics systems. When they are integrated with other software solutions, these standard interfaces make configuration work easier avoiding errors in data transfer. In companies, orders are almost always stored in a TMS together with information regarding loading points, customer addresses, etc. Transferring all the data manually into a software, before being able to proceed with the planning of delivery orders, would take a lot of time and would risk making mistakes that would lead to inefficiencies. The solution lies in connecting the TMS in use to the PTV Route Optimiser via standard interfaces and for planners this means a considerable saving of time. Furthermore, an IT support such as the PTV Route Optimiser ensures that the planning is always based on correct and up-to-date data. After planning, the data can be transferred back from the PTV Route Optimiser to the TMS. PTV Route Optimiser is also able to connect with an ERP or a CRM. Why is it so

important? Probably not all information is stored in the TMS. For example, information on opening hours or specific indications on the loading or unloading points of the goods are in an ERP or a CRM. By connecting PTV Route Optimiser to systems, all relevant data for the preparation of a delivery plan can be transferred quickly and error-free. Regardless of the accuracy and precision of the planning carried out by the employees, the delivery plan is only a "good plan" if it is executed consistently. The software has several interfaces for connecting to telematics systems. In this way it is possible to transfer the routes directly to the devices on board the vehicle and, in general, to the telematic system used. This makes it possible to identify the position of the vehicles in the fleet in real time, allowing to compare what has been planned with the actual progress of the journeys. In the event of delays along the way, it is possible to automatically inform the recipients of the goods of the new estimated time for delivery

3.2. THE ARCHITECTURE OF THE SOFTWARE

The architecture of the software is composed of several key components [66]:

- **User Interface**: this component serves as the graphical interface that facilitates user interaction with the software. The user interface (UI) enables users to input essential parameters, including delivery locations, time windows, and vehicle types. It is meticulously designed to be intuitive and user-friendly, employing features such as drag-and-drop functionality and providing real-time feedback on modifications to routes and schedules. The UI accommodates user inputs through web-based forms or by facilitating the upload of data in diverse formats such as Excel or CSV. By providing an intuitive, user-friendly interface with versatile input options and real-time feedback, this component aims to optimize the user experience and foster efficient and effective logistics planning and management within the software system.

- **Optimization Engine**: this core component within the PTV Route Optimizer system assumes the critical role of conducting route optimization calculations. As the optimization engine, it possesses the capability to handle multiple vehicle types while considering a comprehensive range of variables. These variables encompass factors like traffic conditions, road network data, vehicle capacity limitations, and delivery constraints. The primary objective of this component is to determine the most efficient routes that satisfy the specified criteria. To accomplish this, the optimization engine employs advanced algorithms, including Genetic Algorithms and Simulated Annealing. These algorithms are renowned for their effectiveness in solving complex optimization problems. Genetic Algorithms simulate the evolutionary process by iteratively generating and refining solutions based on genetic operators such as mutation and crossover. Simulated Annealing, on the other hand, mimics the annealing process in metallurgy, whereby it gradually cools a material to minimize its energy and achieve a stable state. By adapting these algorithms, the optimization engine generates optimized routes and schedules that minimizing travel time, distance, or other defined objectives.

- **Geocoding and Mapping**: it constitutes a critical component within location-based services, encompassing the conversion of addresses or other location data into precise geographic coordinates, as well as the display of optimized routes on a map. This component leverages a

combination of advanced geocoding services and comprehensive road network data to ensure the accurate conversion of location information. By incorporating an interactive map interface, users are empowered to visualize the optimized routes and exert control over the displayed information, allowing for modifications in accordance with their specific requirements.

- **Data Integration**: PTV, as a comprehensive solution, offers the capability to seamlessly integrate with diverse data sources through Application Programming Interfaces (APIs) or file-based integration. This integration functionality enables businesses to import data from external systems, including telematics, order management, and inventory systems, to optimize routes and schedules based on real-time data. This component within the PTV system is responsible for handling the integration of data from these external systems, ensuring the smooth flow of information for enhanced route planning and scheduling.

- **Reporting and Analytics**: the reporting and analytics component within the route planning and optimization system plays a crucial role in providing businesses with the ability to generate reports and analyse data derived from the entire process. This component offers valuable insights into key performance metrics, including delivery times, vehicle utilization, and route efficiency. By offering both pre-built reports and dashboards, as well as the flexibility to create custom reports tailored to specific business needs, this component empowers businesses to gain a comprehensive understanding of their operations and make data-driven decisions.

Overall, the architecture of PTV Route Optimizer is designed to be flexible and scalable, allowing businesses to customize the software to meet their specific needs and to integrate with existing systems and workflows. The platform is also designed to be highly available and fault-tolerant, with built-in redundancy and failover capabilities. It is a software solution that helps companies to optimize their delivery routes, and it relies on various components in order to function effectively. These are:

- **Database:** PTV Route Optimizer stores all relevant information required for delivery route optimization, such as customer locations, vehicle capacities, delivery time windows, and more. The software uses this data to generate optimized routes based on specific parameters set by the user. The database is crucial to the software's effectiveness, as it provides the foundation for all calculations and optimizations.

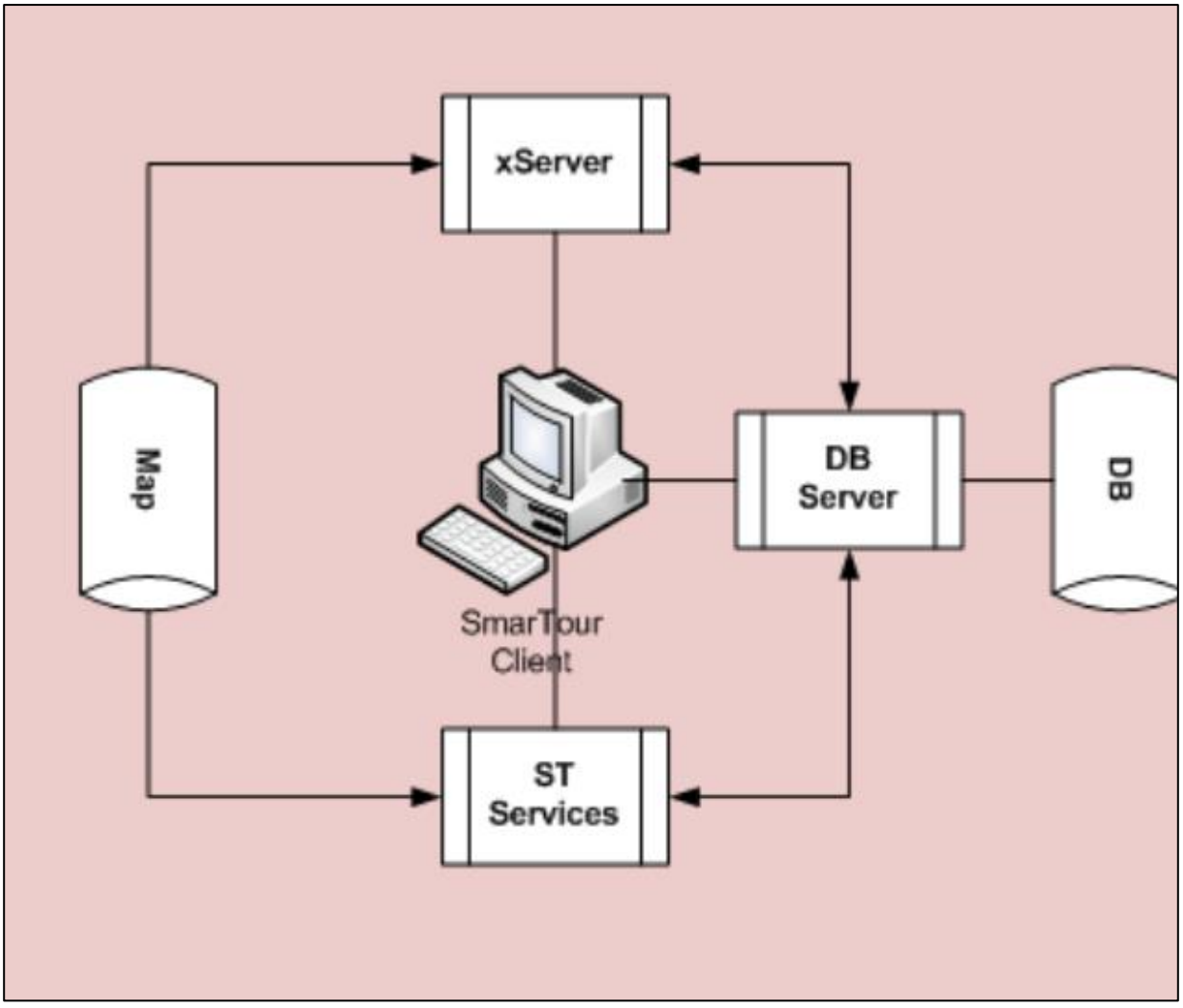
- **Server:** The server processes and analyses the data stored in the database to generate optimized delivery routes. It runs complex algorithms and calculations to determine the most efficient routes based on the data available. The server is also responsible for handling communication between the user interface and the database, ensuring that the data is accurate and up to date.

- **Map:** The map provides a visual representation of the locations where deliveries need to be made. PTV Route Optimizer relies on the map to calculate distances between locations and determine the most efficient routes based on the data provided. The software also uses the map to display optimized routes and provide turn-by-turn directions for drivers.

- **ST services**: Spatial-Temporal (ST) services provide real-time information about traffic, weather, and other factors that may affect the delivery process. PTV can use this information to adjust delivery routes in real-time to account for any unforeseen circumstances that may arise. ST services are essential for the optimization under dynamic conditions and ensuring that drivers can complete their deliveries as efficiently as possible.

In summary, PTV Route Optimizer relies on the database, server, map, and ST services to function effectively. Each component plays a crucial role in optimizing delivery routes and ensuring that drivers can complete their job in the best way. The software relies on the database to store necessary data, the server to process and analyse that data, the map to provide visual representation of the locations, and ST services to provide real-time information that can be used to adjust delivery routes. Without the cooperation among these components, the software would not be able to work effectively.

Figure 19. PTV Architecture [65]



3.3. HOW THE SOFTWARE WORKS?

3.3.1. INPUT

In order to input data into the system, a predefined Excel file must be used, which must be in a specific format that cannot be changed. The file is then imported into the system according to certain standards that cannot be modified, and it must be placed inside a designated folder. PTV Route Optimizer places a high value on data cleanliness, so it's essential to be as precise as possible. This involves removing unnecessary columns that are not required for route planning, as they can cause clutter and make the file more difficult to work with. It's also important to ensure that the data in each column is in the correct format. For instance, date and time columns must be formatted consistently, and numeric columns should not contain text entries. Furthermore, it's necessary to check for and remove any duplicate entries to prevent errors during the route planning process. Additionally, it's important to review the data for any errors or inconsistencies, such as misspellings, missing data, or incorrect information, as these errors can negatively impact the accuracy of the routes generated by PTV Route Optimizer. Finally, it's crucial to ensure that the data is consistent across the entire file, including address formats, unit measurements, and other relevant information.

Figure 20. Import of Data [65]

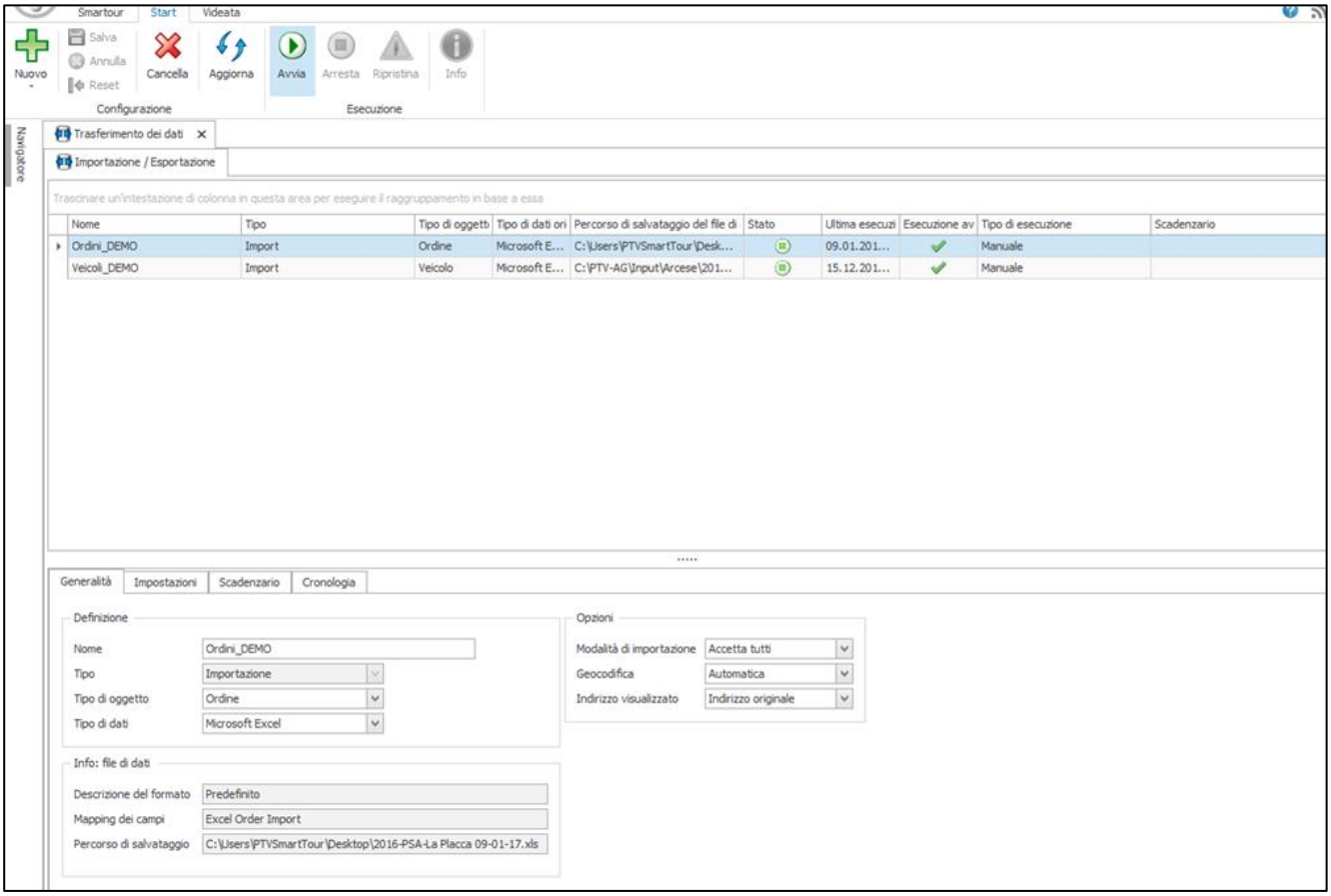
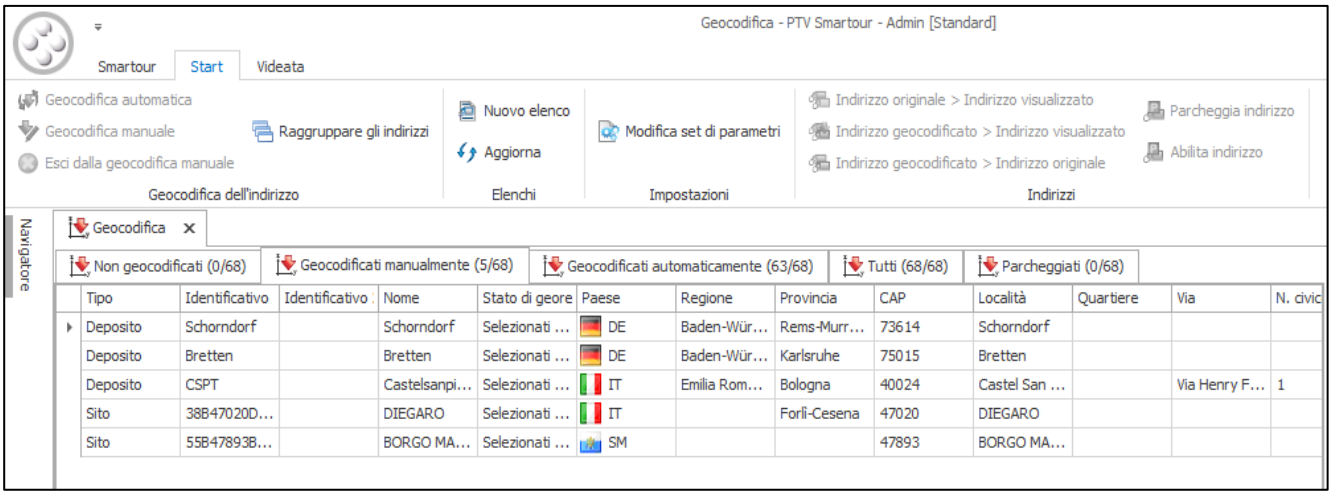
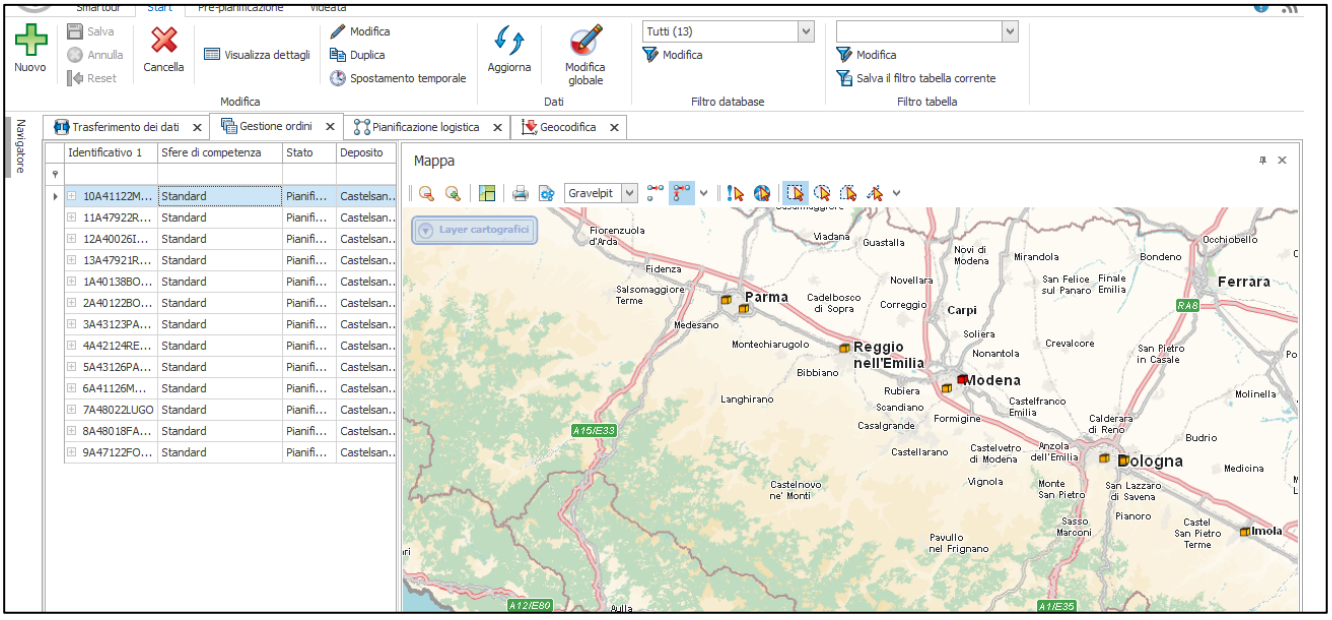


Figure 21. Geocoding of orders



In this image, all orders loaded through data import from Excel are displayed. Adjacent to the orders, a map is shown indicating the planned pickup location, with the selected order highlighted by a red dot.

Figure 22. Encoding of orders



Within this interface, the screen provides a visual representation of the program's ability to accurately encode all the orders. It serves as an indicator of the program's successful processing and mapping of the orders. Specifically, the presence of a value of 0 denotes that there are no orders that have remained unprocessed in terms of geocoding.

However, if there are any orders that have not been geocoded, a course of action is required. These non-geocoded orders necessitate manual intervention, whereby the users or operators must actively select and

engage in the process of geocoding. This manual geocoding involves the determination and assignment of precise geographical coordinates to these orders, ensuring their accurate representation within the system.

The purpose of this manual geocoding process is to rectify any instances where the automated geocoding mechanism may have encountered difficulties or failed to accurately capture the geographic information associated with specific orders. Through manual geocoding, these unprocessed orders can be appropriately mapped and integrated into the system, thereby enabling comprehensive and accurate data representation for subsequent analysis and decision-making.

After planning all the routes, it will be possible to export the document in Excel format. This document will be a summary of the one present on PTV.

3.3.2. PLANNING MANAGEMENT AND LOGISTIC PLANNING

It is crucial to define and establish the daily, weekly, or monthly planning. In the planning process, the user is provided with one or more suggestions for possible alternative transport planning options. Subsequently, it is possible to venture into a designated pre-planning zone where it is intricately possible to outline and define the intended area through meticulous planning. Prior to establishing the specific parameters for each plan, you can engage in comprehensive pre-planning endeavours, carefully crafting and refining these parameters.

Following this, it is needed to proceed to allocate a distinct sphere of competence, ensuring that all essential aspects are thoroughly examined and established within this domain. As an illustration, let's consider the management of a particular geographic area or ZIP Code, which falls under the purview of a designated branch. Consequently, all the diverse shipments and collections within this area are the responsibility and within the jurisdiction of the corresponding warehouse associated with that branch.

The planning management area of PTV Route Optimizer is a crucial component of the software that focuses on streamlining and optimizing the process of planning routes for various transportation operations. It encompasses a range of functionalities and tools designed to assist businesses in efficiently organizing and managing their fleet operations. Within this area, users can define specific planning parameters and constraints, such as vehicle capacities, time windows, driver availability, and delivery priorities. This allows for a customized and tailored approach to route planning that aligns with the unique requirements of each operation.

Figure 23. Depot Data Definition [65]

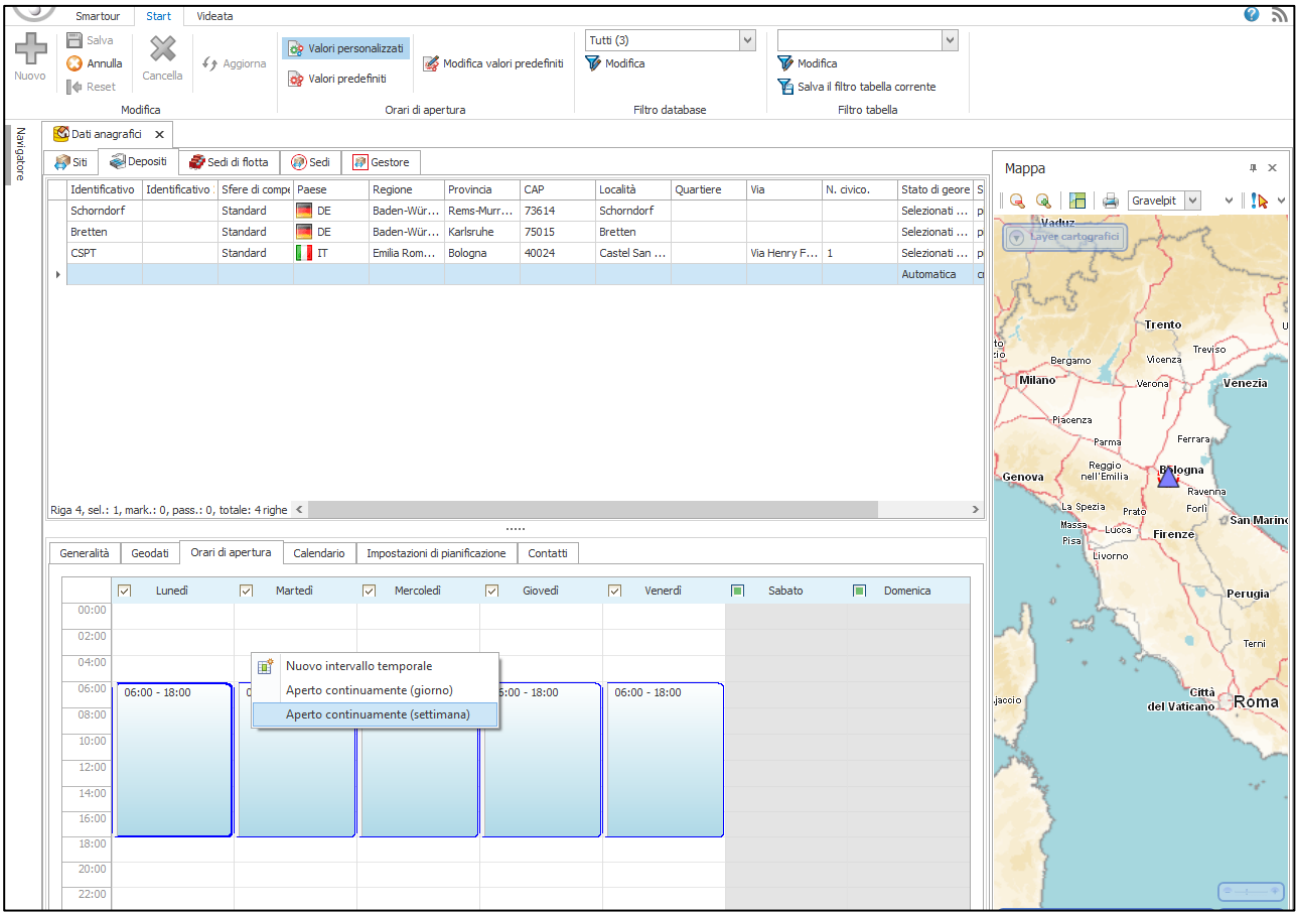


Figure 24. Fleet Capacity Definition [65]

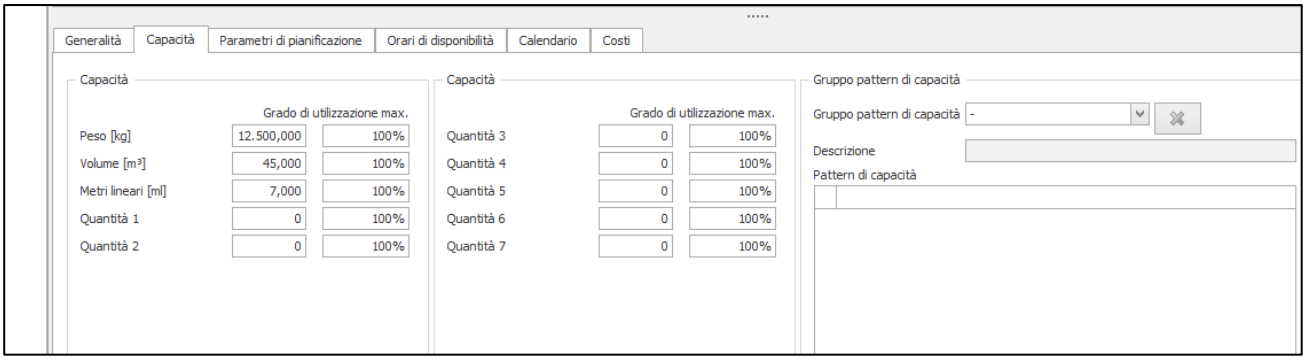
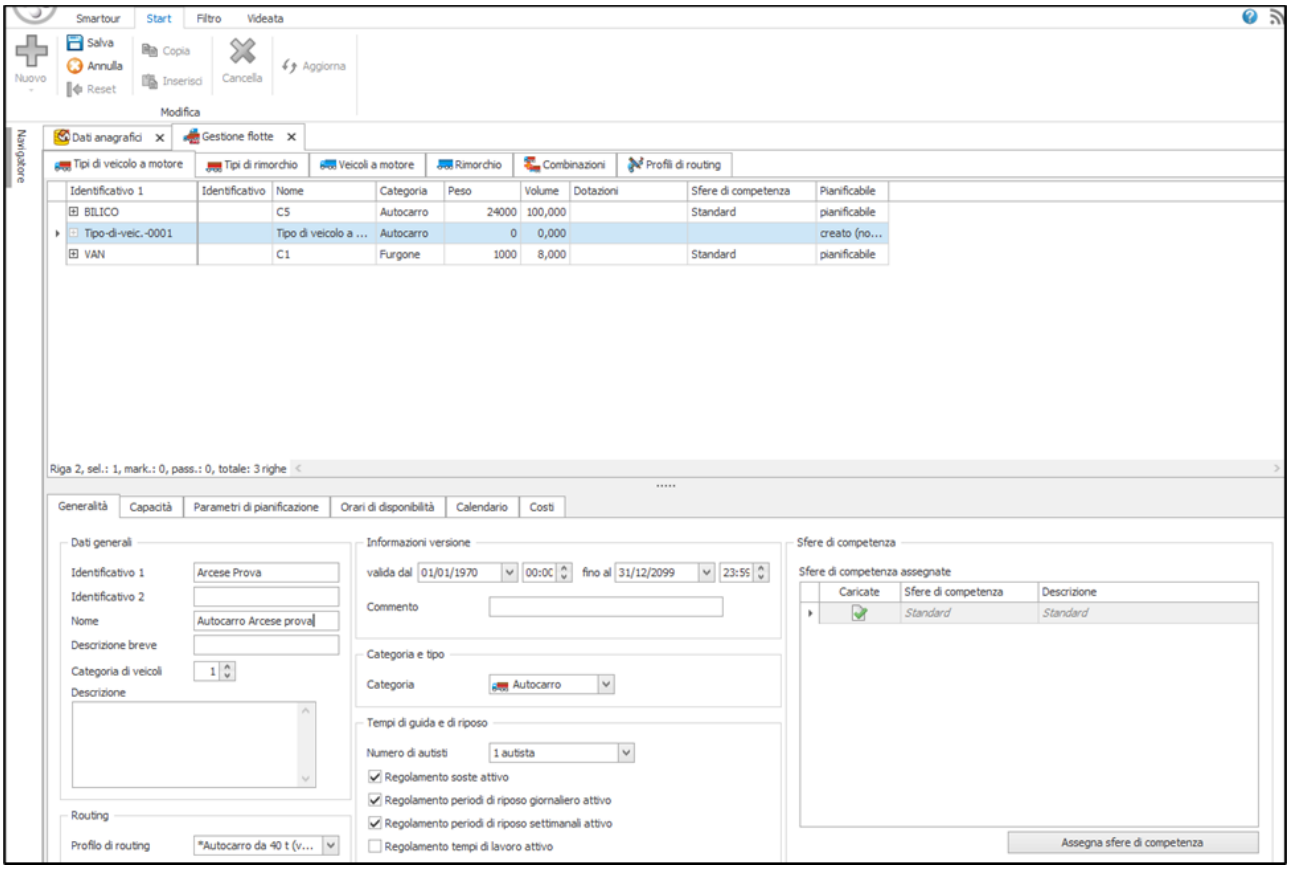
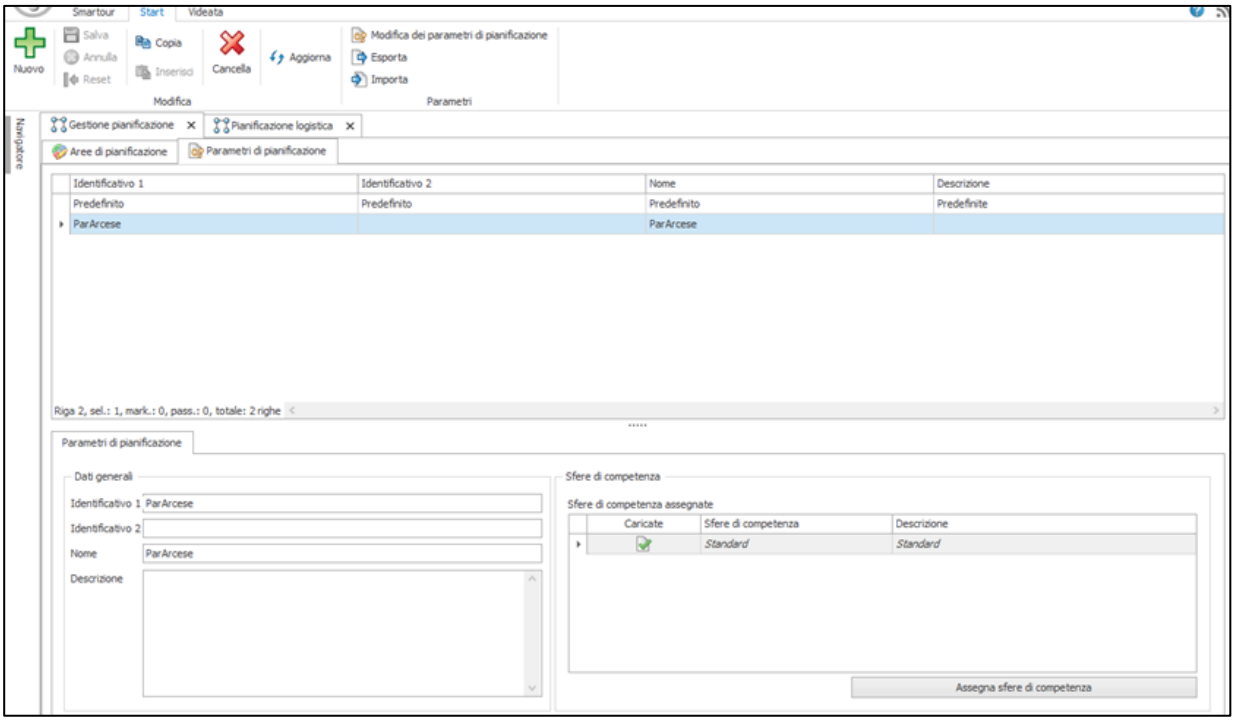


Figure 25. Fleet Management [65]



Additionally, the planning management area offers features to import and integrate relevant data, such as customer addresses, order details, and road network information. This enables the system to generate optimized routes based on the input data, taking into account factors like distance, traffic, and delivery time windows. The software also facilitates scenario planning, allowing users to simulate and compare different planning strategies or what-if scenarios to determine the most efficient and cost-effective options. This feature enables businesses to evaluate the impact of changes in parameters or constraints and make informed decisions regarding their route planning processes.

Figure 26. Planning Management Area [65]

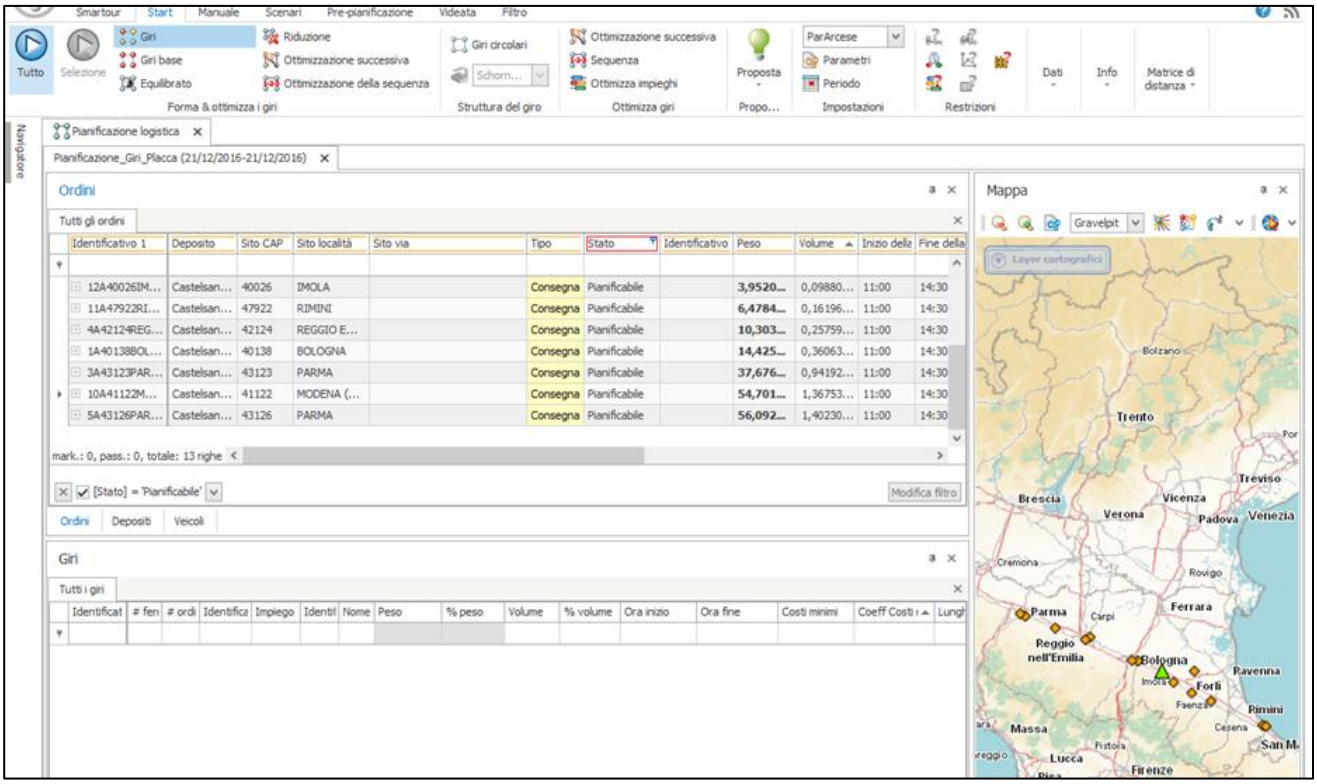


3.3.3. LOGISTIC PLANNING

The logistic planning area within PTV Route Optimizer assumes a pivotal role in optimizing the comprehensive logistics operations of businesses. This area focuses on strategic decision-making, meticulous resource allocation, and long-term planning, all aimed at ensuring a streamlined and effective logistics management framework. The logistic planning area provides users with the ability to define and manage various essential logistical parameters. These encompass critical aspects such as warehouses, depots, and distribution centres, along with their respective capacities. By considering factors such as proximity to customers, transportation costs, and demand patterns, businesses can strategically determine optimal locations for inventory storage and distribution hubs.

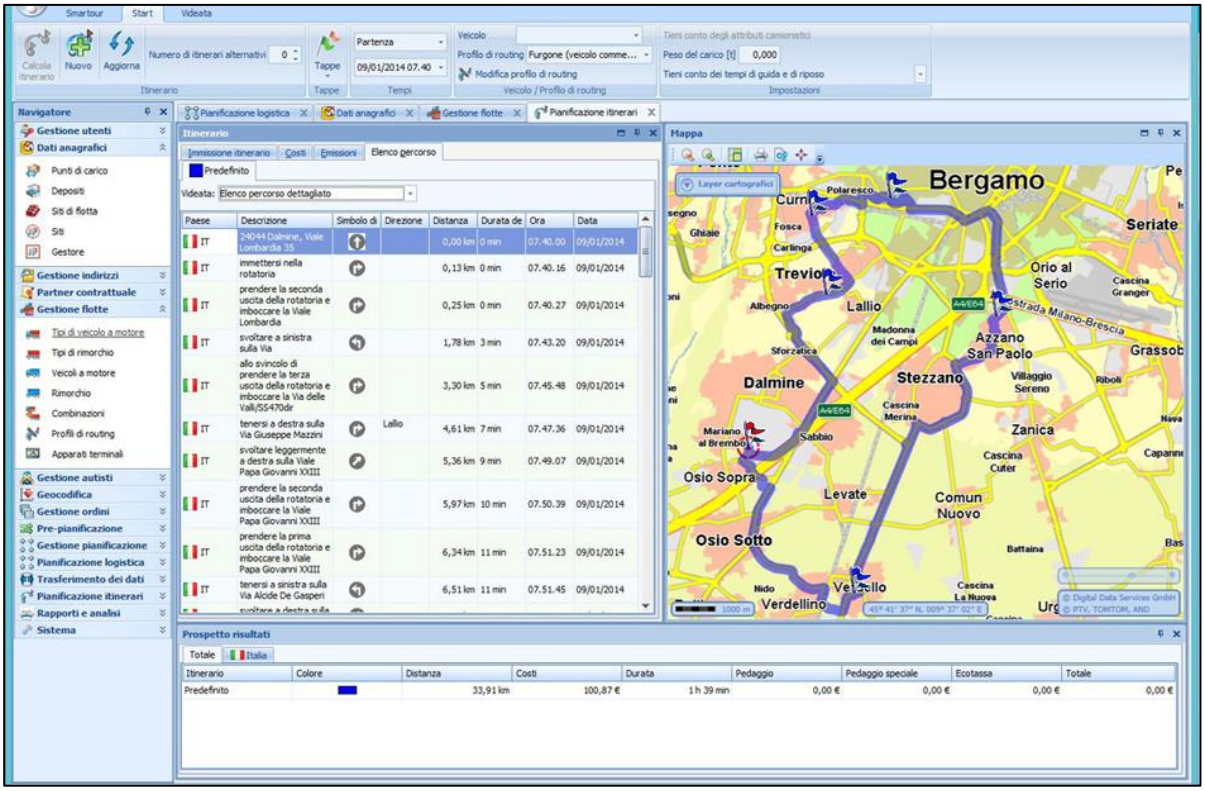
Within the logistic planning area, users are empowered to model intricate logistics networks, encompassing multi-tiered distribution structures, cross-docking operations, and intermodal transportation alternatives. Such modelling capabilities enable organizations to design and evaluate different supply chain configurations, thereby assessing their impact on cost, delivery times, and overall operational performance. The software harnesses advanced algorithms and optimization techniques to tackle complex logistics optimization challenges. By factoring in diverse variables such as transportation costs, vehicle capacities, delivery time windows, and other constraints, the software generates optimal solutions, encompassing routes, load plans, and distribution schedules. Furthermore, the logistic planning area serves as a strategic decision support tool, offering valuable insights and analytics based on key performance indicators (KPIs). Users can effectively monitor and analyse critical metrics such as delivery efficiency, resource utilization, cost per mile, on-time performance, and customer satisfaction. These metrics aid in identifying areas for improvement and enable data-driven decision-making.

Figure 27. Logistic Planning Area [65]



In the realm of logistics planning, plannable routes are visually represented by means of a map, showcasing diverse orders alongside the corresponding selected warehouse locations. Once the planning process is initiated, the system generates and displays the processed routes. This entails a meticulous analysis and computation of the most efficient routes based on factors like distance, time, and constraints. The system presents these routes to the planners, allowing them to review and assess the proposed logistics paths. In cases where there is a significant volume of orders involved, subsequent optimization becomes crucial. This refers to the iterative process of refining and improving the established routes with optimization techniques, such as adjusting the sequence of orders or considering alternative routes, that are employed to minimize costs, reduce travel time, and enhance overall efficiency. Of course, calculated routes can be modified: for example, an additional stop can be added, an alternative route can be calculated, or the direction of travel can be reversed. The route calculation can be customized to consider various requirements, thanks to the possibility of interaction and customization of driving and resting times of drivers.

Figure 28. Planning Routes [65]



3.3.4. COSTS

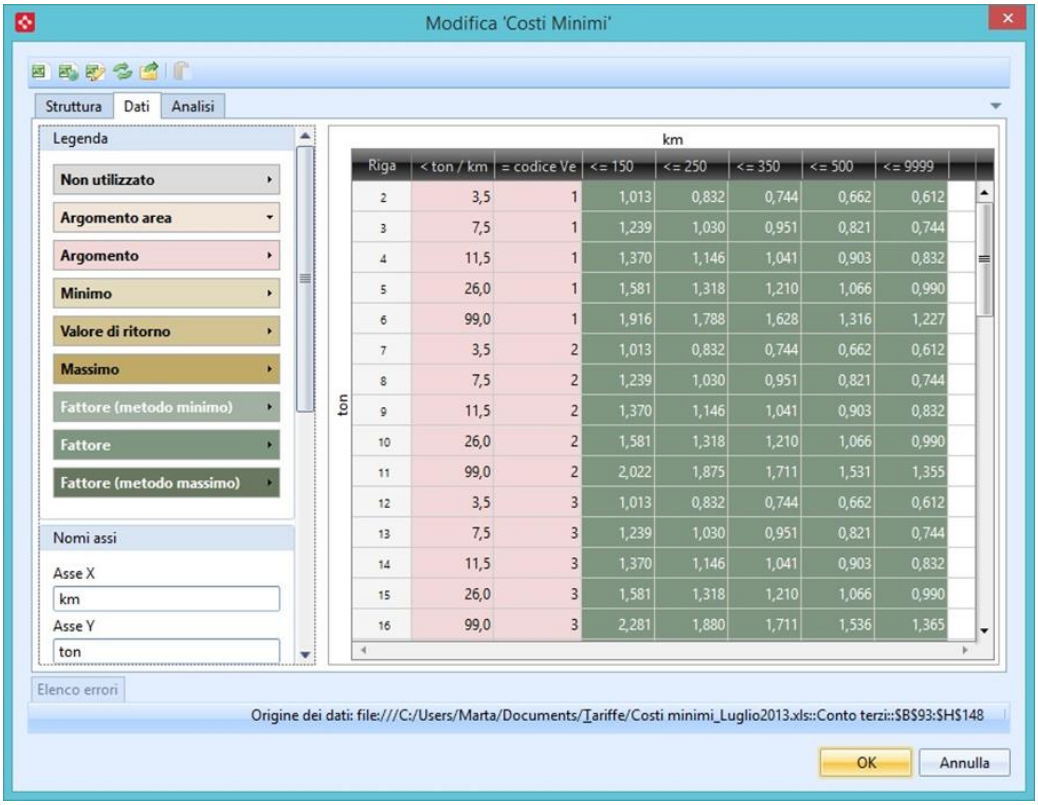
It is possible to create and manage tariff models for each shipper and use them for an accurate calculation of transport costs. The tariffs can be designed to depend on various factors, including the distance travelled, the quantities transported, or more intricate variants incorporating different cost supplements. The methodology employed by PTV Route Optimizer for cost calculation encompasses a range of elements that collectively contribute to an accurate assessment of transportation costs. Key elements considered in the cost calculation process include:

- **Fuel expense:** PTV Route Optimizer considers the characteristics of the vehicles, such as fuel consumption rates, load weights, and the profiles of the planned routes. By considering these factors, the software can estimate the fuel consumption for each leg of the route and calculate the associated fuel expenses. This information is crucial for businesses to assess and manage their fuel costs effectively.
- **Labour costs:** it incorporates various factors related to labour, including driver wages, working hours, and regulatory constraints. By considering driver availability, working time regulations, and labour costs per hour, the software estimates the labour expenses associated with each route. This enables businesses to have a comprehensive understanding of the personnel costs involved in their transportation operations.
- **Vehicle maintenance expenses:** in addition to fuel and labour costs, PTV Route Optimizer takes into account vehicle maintenance expenses. This is achieved by considering factors such

as vehicle depreciation, maintenance schedules, and repair costs. By integrating these factors into the cost calculation process, the software provides an estimate of the anticipated vehicle maintenance expenses for each route. This information is crucial for businesses to manage their fleet maintenance costs effectively and plan for maintenance activities accordingly.

- **Other cost parameters:** other cost parameters such as toll fees, taxes, insurance, and any other relevant expenses are considered to provide a comprehensive view of the overall costs associated with transportation. By considering these additional cost factors, businesses can have a more accurate understanding of their total transportation expenses**.**

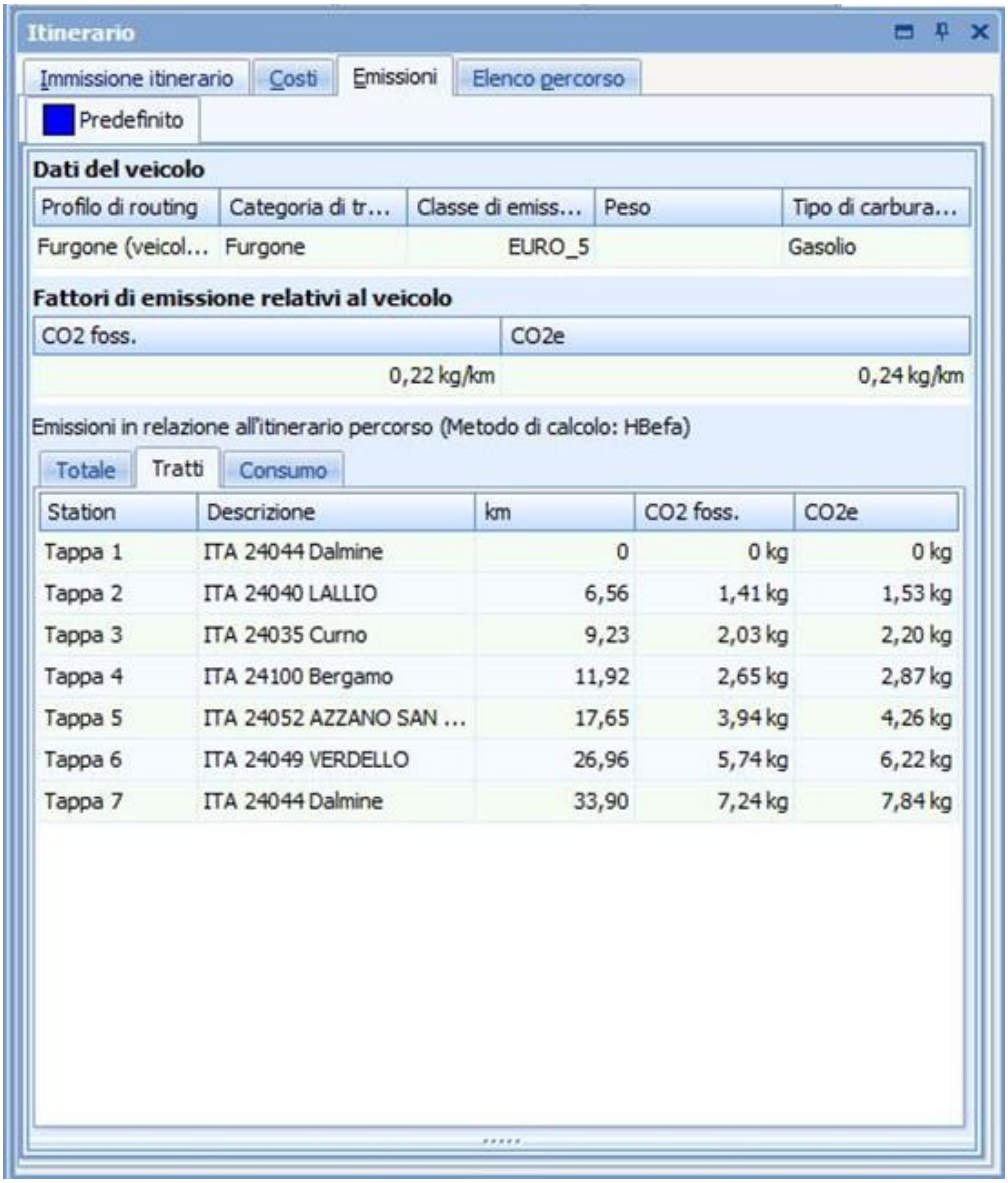
Figure 29. Costs [65]



3.3.5. CO2 EMISSIONS

Calculating CO2 emissions is an essential aspect of transportation planning and optimization, and PTV Route Optimizer incorporates a methodology to estimate and track these emissions. By considering various factors, such as vehicle characteristics, fuel consumption rates, and route distances, the software provides an accurate estimation of CO2. The calculation relies on established emission models and databases that provide comprehensive information on vehicle emissions which consider factors such as vehicle age, engine type, and emission control technologies to generate accurate estimates. The software also incorporates real-time traffic data and road network information to account for traffic conditions and their influence on CO2 emissions. This feature enables businesses to analyse the environmental impact of their transportation activities, set emission reduction targets, and evaluate the effectiveness of their sustainability initiatives.

Figure 30. CO2 emissions



3.4. THE ADVANTAGES OF THE USE OF PTV IN THE FIRM

The use of PTV Route Optimiser in a firm could be very usefull for several reasons [58]

1. REDUCTION OF LOGISTIC COSTS

The software allows to make the best use of your fleet and ensures that your vehicles are always on the best route. Using PTV Route Optimizer ensures full control of transportation costs, increased efficiency of route scheduling and better utilization of fleet vehicles.

- **Reduction of logistics costs by saving kilometres, fuel and tolls**

Logistics costs are reduced by assigning orders to available vehicles and calculating the best routes for each vehicle in the fleet. The investment in an optimization software pays for itself quickly, especially if the drivers have many delivery orders every day. In fact, the program has algorithms that are able to identify potential for improvement where the planner's experience alone fails to arrive.

"Optimized routes" means that each vehicle reduces the km traveled and therefore consumes less fuel. As a result, CO2 emissions are also reduced. PTV Route Optimizer also automatically calculates toll costs based on the chosen route, thus allowing operators to estimate in advance how much tolls affect the transport order and how much on the total transport costs.

- **Reduction of transport costs thanks to a smarter use of the fleet**

It ensures better assignment of delivery orders to fleet vehicles. Delivery and collection orders can be combined together in the same round to avoid empty journeys – thus optimizing fleet utilization because fewer vehicles are needed to handle orders. Thus, by using the fleet more efficiently, operating costs and transport costs in general are reduced.

- **Less logistics costs thanks to load optimization**

Fleet assets must be used in the best possible way. A truck traveling unloaded, even if only partially, is not exploited to its full potential and still has high operating costs. PTV Route Optimizer calculates the best distribution of orders among the different vehicles in the fleet and ensures maximum productivity. Load optimization reduces logistic costs dysfunctionally.

2. CONTROL OF THE EXECUTION OF ROUNDS AND TRACEABILITY OF DELIVERIES

The software guarantees planners full control over the execution of rounds and the status of deliveries: it is possible to create reports and analyse the performance of the transport service, identifying any problems, shortcomings and potential for improvement. The work of the planner does not end with the preparation of an executive plan because it is needed to check the progress of the laps and understand how it is progressing. Will everything arrive on time? Which drivers can take on new delivery orders? Do any laps need to be changed due to too heavy traffic? Planners must always have a look at the execution of the plan to understand if there are further margins for optimization and if, at a strategic level, there are decisions to be taken into consideration, such as the purchase of new vehicles or the opening of a new deposit. The software is able to:

- **Give view of the rides and delivery status on the map:** the possibility of seeing on a map how the rounds are carried out gives planners a complete and quick view of the status of deliveries. What trips have already been made? What are still ongoing? Is it possible to add a new order to a running ride? Is there enough space to load the goods? The visual support of the map helps planners to answer all these questions effectively.

- **Check available vehicles and drivers:** vehicles and drivers are not always available. And not all means are suitable for all orders. It is not easy to always keep these limitations under control. PTV Route Optimiser provides the right support to manage this complexity: all information

related to schedules, availability, specifications, etc. they are stored in the card corresponding to the vehicle and the software uses them when assigning orders and programming laps.

- **Create performance reports:** how many km did the fleet travel yesterday, in the last week or in the last month? How much fuel was consumed and how many emissions were produced? Which vehicles have been loaded the most? Analyzing the performance of the activities already carried out helps to improve the planning of future activities.

- **Compare the lap plan with real performances:** how reliable is the transport rounds execution plan? Are there any delays that always accumulate along a certain route? Are there customers who always receive their goods late? It is possible to compare the delivery plan with the real performanc checking the execution of the rounds and improving the operational plan of the deliveries.

3. EFFICIENT MANAGEMENT OF LOGISTICS AND TRANSPORTS

Assigning orders to riders manually, for logistics and transportation managers definitely requires too much time. With the support of PTV Route Optimiser, however, orders are automatically distributed to create an optimized plan. The times required to obtain an operational plan of the rounds are considerably reduced and, thanks to the lower workload, the operators can also devote themselves to other tasks. All this translates into optimal management of logistics and transport and more satisfied customers [58].

- **Reduction of the time to program the laps:** logistics and transport management is like Tetris: it has many possible solutions and the pieces can change shape continuously. Having IT support that helps planners to identify the optimal solution that respects all the constraints and manages complexity, allows operators to significantly reduce the time required to obtain an efficient operational plan of the rounds. The algorithms behind PTV Route Optimiser calculate all possible routes and compare them in terms of driving times, distances and costs. Thus the software can quickly establish the operational delivery plan and routes that meet all requirements. Operators can also engage in other logistics and transportation management tasks.

- **Improved customer service:** thanks to PTV Route Optimiser, it is easier to meet customer requests: last minute changes to orders, punctuality and compliance with delivery times, possibility of communicating the arrival time of the goods in real time, automatic notifications in case of delays. PTV Route Optimiser takes all constraints and special customer requests into consideration and creates a truly efficient delivery schedule.

- **Support for thoughtful strategic decisions:** tour planner knows the weak points along the transport chain. But he does not always have time to focus on these issues and implement new solutions. With PTV Route Optimiser operators can save time for tactical and strategic analyses.

4. LEAD TIME AND LOGISTICS

Customer requests are increasingly numerous and complex: orders should always be delivered with the utmost punctuality, at the established time and without affecting the quality of the transport service. Having satisfied customers means having a significant advantage over the competition and PTV Route Optimiser allows to manage all this complexity by:

- **Increasing punctuality and efficiency:** algorithms take into account all constraints and restrictions, including loading and unloading times. The execution plans created with automatic scheduling are reliable, with real delivery times. In addition, it allows you to inform customers in advance of the arrival of goods, so that they can prepare for unloading at the warehouse.

- **Communicating the delay on the expected delivery time:** there can always be delays caused by traffic and accidents along the way. It notifies planners of accumulated delays and allows them to take action to remedy the expected ones and communicate to customers an updated ETA in real time (ETA | estimated time for delivery of goods).

- **Managing delivery orders:** PTV Route Optimiser allows planners to create an operational delivery plan in no time. This means that orders that arrive late or undergo last-minute changes can also be managed and this leads to a greater flexibility in accepting orders and placing them on delivery.

5. GREEN LOGISTICS

Environmental protection is often perceived by companies as too expensive. PTV Route Optimiser helps in saving on transport costs and, at the same time, reducing emissions. The optimization program calculates efficient delivery rounds and schedules the activities of the fleet vehicles. Orders are assigned automatically to optimize the use of vehicles. The calculated routes are always the most efficient and suitable for heavy vehicles. The result: fewer km, reduced fuel consumption and fewer pollutant emissions.

In this way, it is possible to rationalize the use of resources and reduce the company's carbon footprint. Institutions are moving more and more in the direction of giving an important weight to pollution control programs and the reduction of polluting emissions. There will be more and more countries in which emissions reporting will also become mandatory for transport and logistics services. The demand for “green” transport services is also growing among customers. People are often willing to pay higher prices to prioritize environmentally sustainable companies and this is why PTV Route Optimiser, in addition to increasing transport efficiency, allows to calculate CO2 emissions and other pollutants by creating detailed reports.

CHAPTER 4

CONSTRUCTION OF A NEW WAREHOUSE IN UDINE

4.1. REASONS BEHIND THE PROJECT

The present project examines the feasibility of constructing a new facility within Arcese S.p.A Trasporti to enhance operational efficiency and mitigate transportation costs. Specifically, the research endeavors to assess the utilization of a specialized transport optimization software as a means to determine the cost-effectiveness and the presence of volume in order to establish the new facility. The primary objective entails a comprehensive analysis of transportation expenses, product volumes, delivery schedules, and other pertinent factors in order to ascertain the most optimal logistics solution for the organization. The focus of this investigation centers on the construction of a new facility in Udinese, with the intention of streamlining operations and minimizing transportation expenditures.

In recent years, Arcese has encountered several challenges in managing customer orders from the northeastern region of Italy known as the "Triveneto," comprising the regions of Friuli Venezia Giulia, Veneto, and Trentino Alto Adige. Despite the presence of two significant warehouses located in Paese (TV) and in Verona (VN), the increasing demand from customers and the growing number of clients, owing to the high concentration of industries, have necessitated evaluations regarding the potential addition of a new warehouse in that area. The expansion of customer base and the corresponding surge in volumes have strained the existing warehouse capacities, leading to logistical constraints and potential inefficiencies. The proposed warehouse would aim to alleviate the burden on the existing facilities, enhance operational efficiency, and better serve the growing customer demand. The decision to invest in a new warehouse facility in the Triveneto region is underpinned by the desire to maintain Arcese's competitiveness in the market and cater effectively to the evolving needs of its customers. This strategic move reflects the company's commitment to adapt and expand its infrastructure in line with market demands, ensuring customer satisfaction and retention.

Given the substantial investment that such a venture would inevitably entail, including the construction or acquisition of a new facility, the recruitment of dedicated personnel, the realignment of existing routes, and the redistribution of transported volumes among other branches, careful cost considerations were integral to the project. While the initial impact on costs would undoubtedly be negative, over the years, the project is expected to yield several economic advantages in terms of enhanced efficiency, faster transportation, and customer satisfaction.

The initial negative impact on costs is a common phenomenon during the initial stages of such transformative projects. This can be attributed to the upfront investments required for constructing, acquiring or renting the new facility, implementing technology solutions, and integrating the new operations into the existing network. Additionally, the process of relocating existing routes and redistributing volumes among other branches may result in temporary disruptions and associated costs.

It is crucial to allocate sufficient resources and expertise to manage these transitional challenges effectively. However, it is important to recognize that the long-term benefits of the project are anticipated to outweigh the initial costs. By establishing a new facility in the Triveneto region, Arcese improves service capability leading to increase customer loyalty to a larger market share. Over time, the economies of scale and increased operational efficiency resulting from the new facility are expected to generate cost savings and contribute to the overall profitability of Arcese Spa Trasporti.

There are several reasons why Arcese Trasporti consider investing in a warehouse in Udine:

1. **Strategic location**: Friuli Venezia Giulia could be a strategic location for Arcese Trasporti as it allows for easier access to customers and destinations in the region, as well as neighboring areas such as Austria, Slovenia, and Croatia. The geographical position can facilitate operational efficiency and coverage of transportation and logistics operations.
2. **Market development**: Arcese Trasporti foresees an increase in demand for transportation and logistics services in Friuli Venezia Giulia or the surrounding regions, investing in a warehouse in the area would be advantageous to seize these growth opportunities and expand their market presence.
3. **Infrastructure connections**: Friuli Venezia Giulia offers good infrastructure connections, such as roads, highways, ports, or airports, which would benefit Arcese Trasporti's transportation and logistics activities. A well-developed infrastructure can improve operational efficiency and reduce delivery times.
4. **Support for existing customers**: if Arcese Trasporti already has significant customers or business partners in Friuli Venezia Giulia, investing in a warehouse in the area could be advantageous to provide faster and improved service to existing customers and strengthen business relationships.
5. **Growing market**: analyzing the economic growth and development prospects of Friuli Venezia Giulia can help determine if there is increasing demand for transportation and logistics services in the region. Analyzing key sectors of the local economy, such as manufacturing, agriculture, or tourism, can provide a better understanding of potential business opportunities.
6. **Competition and positioning**: evaluating the presence and strength of competitors in Friuli Venezia Giulia can help determine Arcese Trasporti's market positioning. Identifying any competitive advantages, such as innovative technologies, specialized services, or established customer relationships, can provide insight into the possibility of gaining a significant market share.
7. **Logistics infrastructure**: examining the existing logistics infrastructure in the region, such as the availability of warehouses, terminals, intermodal transport networks, or railway connections, can help assess the practicality and convenience of the investment. A well-developed logistics infrastructure can facilitate transportation operations and reduce operating costs.
8. **Sustainability and social responsibility**: considering the aspect of sustainability would be an important factor for Arcese Trasporti. Evaluating regional and local policies on environmental

sustainability, support for clean energy, or market sensitivity to sustainable practices can influence the decision to invest in a warehouse in Friuli Venezia Giulia.

9. **Collaborations and partnerships**: exploring potential collaborations or partnerships with local companies, industry associations, or institutions may offer opportunities for synergy and mutual benefits. Creating strategic collaboration networks would allow Arcese Trasporti to expand its presence and better serve customers in the Friuli Venezia Giulia market.

4.2. DESCRIPTION OF THE PROJECT

The initial phase of the project aims to ascertain the existence of sufficient shipment volumes to substantiate the actual need for a new warehouse in the Triveneto region. To obtain these data, a QlikView object has been utilized, which effectively presents all the pertinent information required for working with PTV. QlikView, as expounded in prior chapters, is an academic and business intelligence platform that furnishes analytical tools and interactive visualizations to facilitate informed decision-making in organizational contexts. The operational staff input the shipment data into the SGA (Warehouse Management System), which is directly linked to QlikView. This system compresses and stores the data in its memory, thereby enabling immediate exploration by multiple users. Data extracted refers to a specif month of the past which is October 2022 that would be used as reference.

Subsequently, the extracted data necessitate meticulous cleaning in order to serve as input for the PTV software. This process demands utmost precision and accuracy, as any inaccuracies may render the software incapable of importing the orders associated with specific rows. Critical elements that require careful scrutiny include addresses and flags indicating delivery or pickup, as these indicators are often prone to incorrect formatting, erroneous data, and punctuation that PTV cannot process effectively.

Figure 31. Data Import

	FLAG_RITIRO_CONSEGNA	SP_COD_SP_UNICA	SP_RITIRO	Filiale produzione	VG_COD_VIAGGIO	VG_DATA_ORA_PARTENZA	STOP UNICO	Indirizzo	Località unica
2	Consegna	10_11_T_2022_TV_59939	2022/TV/22041	TV	10_11_2022_TV_23152	03/10/2022 5.52.00	FERLETTI TIZIANA	LC MATTONAIA 455	SAN DORLIGO DELLA VALLE
3	Consegna	10_11_T_2022_MO_109835	2022/MO/97383	MO	10_11_2022_TV_23160	03/10/2022 6.49.00	AIR MECCANICA SNC DI DANELUZ & C.	VIA EUGENIO RIGO 5	PRATA DI PORDENONE
4	Consegna	10_11_T_2022_TV_59921	2022/TV/21197	TV	10_11_2022_TV_23160	03/10/2022 6.49.00	VIEFFETRADE S.R.L.	VIALE EUROPA. 24/B - Z.I. CAMOL	BRUGNERA
5	Consegna	10_11_T_2022_TV_60102	2022/TV/22063	TV	10_11_2022_TV_23203	03/10/2022 7.13.00	ELECTROLUX PROFESSIONAL S.P.A.	VIALE TREVISO, 15	PORDENONE
6	Consegna	10_11_T_2022_TV_60103	2022/TV/22062	TV	10_11_2022_TV_23203	03/10/2022 7.13.00	ELECTROLUX PROFESSIONAL S.P.A.	VIALE TREVISO, 15	PORDENONE
7	Consegna	10_11_T_2022_TV_59895	-	TV	10_11_2022_TV_23155	03/10/2022 7.29.49	220003_ UDINE_1_ STORE, UDINE 1, RETAIL PARK	PIAZZALE RITA LEVI MONTALCINI 1/1	UDINE
8	Consegna	10_11_T_2022_TV_59533	-	TV	10_11_2022_TV_23155	03/10/2022 7.29.49	220007_UDINE_2_PEPCO_RETAIL	VIA ANTONIO BARDELLI 4	MARTIGNACCO
9	Consegna	10_11_T_2022_BO_492434	2022/BO/98431	BO	10_11_2022_TV_23225	03/10/2022 8.27.58	BIONET SRL	VIA GONARS, 52	UDINE
10	Consegna	10_11_T_2022_MO_110361	2022/MO/97914	MO	10_11_2022_TV_23168	03/10/2022 9.27.49	CASAGRANDE SPA	VIA A.MALIGNANI 1	FONTANAFREDDA
11	Consegna	10_11_T_2022_TV_59877	-	TV	10_11_2022_TV_23168	03/10/2022 9.27.49	PEPCO STORE, GRAN FIUME PORDENONE 1	VIA MAESTRI DEL LAVORO, 42	FIUME VENETO
12	Consegna	10_11_T_2022_TV_59886	-	TV	10_11_2022_TV_23253	03/10/2022 13.20.04	220046_TRIESTE_1_TORRI_D'EUROPA_PEPCO_RETAIL	VIA BARTOLOMEO D'ALVIANO 23	TRIESTE
13	Consegna	10_11_T_2022_BO_495173	-	BO	10_11_2022_TV_23275	04/10/2022 5.56.00	AUTOPIU' S.R.L.	VIA CABOTO, 24	TRIESTE
14	Consegna	10_11_T_2022_BO_495953	-	BO	10_11_2022_TV_23275	04/10/2022 5.56.00	AUTOPIU' S.R.L.	VIA CABOTO, 24	TRIESTE
15	Consegna	10_11_T_2022_BO_495439	-	BO	10_11_2022_TV_23275	04/10/2022 5.56.00	AUTOPIU' S.R.L.	VIA CABOTO, 24	TRIESTE
16	Consegna	10_11_T_2022_BO_495952	-	BO	10_11_2022_TV_23275	04/10/2022 5.56.00	AUTOPIU' S.R.L.	VIA CABOTO, 24	TRIESTE
17	Consegna	10_11_T_2022_BO_495954	-	BO	10_11_2022_TV_23275	04/10/2022 5.56.00	AUTOPIU' S.R.L.	VIA CABOTO, 24	TRIESTE
18	Consegna	10_11_T_2022_BO_495684	-	BO	10_11_2022_TV_23275	04/10/2022 5.56.00	AUTOPIU' SPA	VIA CABOTO 24	TRIESTE
19	Consegna	10_11_T_2022_TV_60226	-	TV	10_11_2022_TV_23275	04/10/2022 5.56.00	BRESSAN ALBERIGO SNC	VIALE VENEZIA 16	GRADISCA D'ISONZO
20	Consegna	10_11_T_2022_TV_60376	2022/TV/22109	TV	10_11_2022_TV_23282	04/10/2022 7.08.00	CAME S.P.A.	VIA CORNIA1/B	SESTO AL REGHENA
21	Consegna	10_11_T_2022_TV_60577	2022/TV/22290	TV	10_11_2022_TV_23278	04/10/2022 7.24.00	220003_ UDINE_1_ STORE, UDINE 1, RETAIL PARK	PIAZZALE RITA LEVI MONTALCINI 1/1	UDINE
22	Consegna	10_11_T_2022_TV_60182	-	TV	10_11_2022_TV_23278	04/10/2022 7.24.00	220003_ UDINE_1_ STORE, UDINE 1, RETAIL PARK	PIAZZALE RITA LEVI MONTALCINI 1/1	UDINE
23	Consegna	10_11_T_2022_TV_60165	-	TV	10_11_2022_TV_23278	04/10/2022 7.24.00	220007_UDINE_2_PEPCO_RETAIL	VIA ANTONIO BARDELLI 4	MARTIGNACCO
24	Consegna	10_11_T_2022_BO_495683	-	BO	10_11_2022_TV_23278	04/10/2022 7.24.00	AUTOPIU S.P.A.	VIA NAZIONALE,49	PRADAMANO
25	Consegna	10_11_T_2022_BO_495666	-	BO	10_11_2022_TV_23278	04/10/2022 7.24.00	AUTOPIU S.P.A.	VIA NAZIONALE,49	PRADAMANO
26	Consegna	10_11_T_2022_BO_495170	-	BO	10_11_2022_TV_23278	04/10/2022 7.24.00	AUTOPIU' S.R.L.	VIA NAZIONALE, 49	PRADAMANO-UDINE
27	Consegna	10_11_T_2022_BO_495949	-	BO	10_11_2022_TV_23278	04/10/2022 7.24.00	AUTOPIU' S.R.L.	VIA NAZIONALE, 49	PRADAMANO-UDINE
28	Consegna	10_11_T_2022_BO_495631	-	BO	10_11_2022_TV_23278	04/10/2022 7.24.00	AUTOPIU' S.R.L.	VIA NAZIONALE, 49	PRADAMANO-UDINE
29	Consegna	10_11_T_2022_BO_495948	-	BO	10_11_2022_TV_23278	04/10/2022 7.24.00	AUTOPIU' S.R.L.	VIA NAZIONALE, 49	PRADAMANO-UDINE

Figure 32. Data Import

PROVINCIA UNICA	SP_MITTENTE	SP_MITTENTE_LOCALITA	SP_MITTENTE_CAP	SP_MITTENTE_PROVINCIA	SP_DESTINATARIO	SP_DESTINATARIO_LOCALITA	SP_DESTINATARIO_CAP	SP_DESTINATARIO_PROVINCIA	DT_MESE_LUNGO
TS	S.I.F.E.A.	LEGNARO	35020	PD	FERLETTI TIZIANA	SAN DORLIGO DELLA VALLE	34018	TS	OTTOBRE
PN	FM SRL	CORREGGIO	42015	RE	AIR MECCANICA SNC DI DANELUZ & C.	PRATA DI PORDENONE	33080	PN	OTTOBRE
PN	IRES MAGAZZINO CESSALTO	CESSALTO	31040	TV	VIEFFETRADE S.R.L.	BRUGNERA	33070	PN	OTTOBRE
PN	METEOR SAS DI FABIO DELL'OGLIO & C.	MARENO DI PIAVE	31010	TV	ELECTROLUX PROFESSIONAL S.P.A.	PORDENONE	33170	PN	OTTOBRE
PN	METEOR SAS DI FABIO DELL'OGLIO & C.	MARENO DI PIAVE	31010	TV	ELECTROLUX PROFESSIONAL S.P.A.	PORDENONE	33170	PN	OTTOBRE
UD	ARCESE TREVISO	PADERNELLO	31038	TV	220003_ UDINE_1_ STORE, UDINE 1, RETAIL PARK	UDINE	33100	UD	OTTOBRE
UD	ARCESE TREVISO	PADERNELLO	31038	TV	220007_UDINE_2_PEPCO_RETAIL	MARTIGNACCO	33035	UD	OTTOBRE
UD	RAGAZZINI	FAENZA	48018	RA	BIONET SRL	UDINE	33100	UD	OTTOBRE
PN	DANA BREVINI SPA (B6) - WINCHES UNIT PLANT	REGGIO EMILIA	42124	RE	CASAGRANDE SPA	FONTANAFREDDA	33074	PN	OTTOBRE
PN	ARCESE TREVISO	PADERNELLO	31038	TV	PEPCO STORE, GRAN FIUME PORDENONE 1	FIUME VENETO	33080	PN	OTTOBRE
TS	ARCESE TREVISO	PADERNELLO	31038	TV	220046_TRIESTE_1_TORRI_D'EUROPA_PEPCO_RETAIL	TRIESTE	34144	TS	OTTOBRE
TS	FORD ITALIA C/O ARCESE LOGISTICS	CASTEL SAN PIETRO TERME	40024	BO	AUTOPIU' S.R.L.	TRIESTE	34147	TS	OTTOBRE
TS	FORD ITALIA C/O ARCESE LOGISTICS	CASTEL SAN PIETRO TERME	40024	BO	AUTOPIU' S.R.L.	TRIESTE	34147	TS	OTTOBRE
TS	FORD ITALIA C/O ARCESE LOGISTICS	CASTEL SAN PIETRO TERME	40024	BO	AUTOPIU' S.R.L.	TRIESTE	34147	TS	OTTOBRE
TS	FORD ITALIA C/O ARCESE LOGISTICS	CASTEL SAN PIETRO TERME	40024	BO	AUTOPIU' S.R.L.	TRIESTE	34147	TS	OTTOBRE
TS	FORD ITALIA C/O ARCESE LOGISTICS	CASTEL SAN PIETRO TERME	40024	BO	AUTOPIU' S.R.L.	TRIESTE	34147	TS	OTTOBRE
TS	JAGUAR LAND ROVER C/O KUEHNE NAGEL	BENTIVOGLIO	40010	BO	AUTOPIU' SPA	TRIESTE	34147	TS	OTTOBRE
GO	NOVELLINI S.P.A.	ROMANORE	46030	MN	BRESSAN ALBERIGO SNC	GRADISCA D'ISONZO	34072	GO	OTTOBRE
PN	TIYAN - HR SRL	MUGGIA	34015	TS	CAME S.P.A.	SESTO AL REGHENA	33079	PN	OTTOBRE
UD	220009_MESTRE_VE_PEPCO_RETAIL	VENEZIA	30100	VE	220003_ UDINE_1_ STORE, UDINE 1, RETAIL PARK	UDINE	33100	UD	OTTOBRE
UD	ARCESE TREVISO	PADERNELLO	31038	TV	220003_ UDINE_1_ STORE, UDINE 1, RETAIL PARK	UDINE	33100	UD	OTTOBRE
UD	ARCESE TREVISO	PADERNELLO	31038	TV	220007_UDINE_2_PEPCO_RETAIL	MARTIGNACCO	33035	UD	OTTOBRE
UD	JAGUAR LAND ROVER C/O KUEHNE NAGEL	BENTIVOGLIO	40010	BO	AUTOPIU S.P.A.	PRADAMANO	33040	UD	OTTOBRE
UD	JAGUAR LAND ROVER C/O KUEHNE NAGEL	BENTIVOGLIO	40010	BO	AUTOPIU S.P.A.	PRADAMANO	33040	UD	OTTOBRE
UD	FORD ITALIA C/O ARCESE LOGISTICS	CASTEL SAN PIETRO TERME	40024	BO	AUTOPIU' S.R.L.	PRADAMANO-UDINE	33040	UD	OTTOBRE
UD	FORD ITALIA C/O ARCESE LOGISTICS	CASTEL SAN PIETRO TERME	40024	BO	AUTOPIU' S.R.L.	PRADAMANO-UDINE	33040	UD	OTTOBRE
UD	FORD ITALIA C/O ARCESE LOGISTICS	CASTEL SAN PIETRO TERME	40024	BO	AUTOPIU' S.R.L.	PRADAMANO-UDINE	33040	UD	OTTOBRE
UD	FORD ITALIA C/O ARCESE LOGISTICS	CASTEL SAN PIETRO TERME	40024	BO	AUTOPIU' S.R.L.	PRADAMANO-UDINE	33040	UD	OTTOBRE

Figure 33. Data Import

DT_ANNO	General cargo/ricambi	VG_VETTORE	Nr Sped	Colli	Tax Weight	Peso lordo in quintali	Gross Weight	Volume	Tot. Sales	Costo netto operativo	Tot. Costs	Gross Profit	MG%	C.Nolo	C.Rit	C.Con	C.Acc.	C.Mag.	Costi Stimati	% Stimati
2022	General Cargo	2F SRL	1	4	1,00	1,00	1,00	0,13	€ 0,00	€ 2,07	€ 3,47	-€ 3,47	-	€ 0,00	€ 0,00	€ 2,07	€ 0,00	€ 1,40	0,00	0,00%
2022	General Cargo	CENTRO SERVIZI GENERALI E IMBALLAGGI INDUSTRIALI S	1	1	1,30	1,21	1,21	0,36	€ 0,00	€ 4,91	€ 6,72	-€ 6,72	-	€ 0,00	€ 0,00	€ 4,91	€ 0,11	€ 1,70	0,00	0,00%
2022	General Cargo	CENTRO SERVIZI GENERALI E IMBALLAGGI INDUSTRIALI S	1	1	3,40	1,46	1,46	1,33	€ 0,00	€ 12,84	€ 15,19	-€ 15,19	-	€ 0,00	€ 0,00	€ 12,84	€ 0,30	€ 2,05	0,00	0,00%
2022	General Cargo	D & SRI TRASPORTI SRLS	1	1	2,20	1,41	1,41	0,86	€ 0,00	€ 22,37	€ 25,95	-€ 25,95	-	€ 0,00	€ 0,00	€ 22,37	€ 1,61	€ 1,97	0,00	0,00%
2022	General Cargo	D & SRI TRASPORTI SRLS	1	1	2,20	1,11	1,11	0,86	€ 0,00	€ 22,37	€ 25,53	-€ 25,53	-	€ 0,00	€ 0,00	€ 22,37	€ 1,61	€ 1,55	0,00	0,00%
2022	General Cargo	AUTOTRASPORTI FRANCHI S.R.L.	1	6	20,80	11,98	11,98	8,29	€ 0,00	€ 128,54	€ 161,27	-€ 161,27	-	€ 0,00	€ 0,00	€ 128,54	€ 15,95	€ 16,78	0,00	0,00%
2022	General Cargo	AUTOTRASPORTI FRANCHI S.R.L.	1	4	11,20	7,76	7,76	4,46	€ 0,00	€ 69,21	€ 88,67	-€ 88,67	-	€ 0,00	€ 0,00	€ 69,21	€ 8,59	€ 10,87	0,00	0,00%
2022	General Cargo	T.D.S. S.R.L.	1	2	18,70	17,02	17,02	7,46	€ 0,00	€ 47,54	€ 48,54	-€ 48,54	-	€ 0,00	€ 0,00	€ 47,54	€ 1,00	€ 0,00	0,00	0,00%
2022	General Cargo	G.V. SERVIZI S.R.L.	1	1	4,40	4,34	4,34	0,96	€ 0,00	€ 8,87	€ 15,64	-€ 15,64	-	€ 0,00	€ 0,00	€ 8,87	€ 0,69	€ 6,08	0,00	0,00%
2022	General Cargo	G.V. SERVIZI S.R.L.	1	6	22,30	13,49	13,49	8,90	€ 0,00	€ 44,97	€ 67,36	-€ 67,36	-	€ 0,00	€ 0,00	€ 44,97	€ 3,51	€ 18,88	0,00	0,00%
2022	General Cargo	FERLETTI TIZIANA	1	3	10,50	7,33	7,33	4,18	€ 0,00	€ 35,28	€ 81,69	-€ 81,69	-	€ 0,00	€ 0,00	€ 35,28	€ 46,41	€ 0,00	0,00	0,00%
2022	Ricambi	2F SRL	1	9	2,00	1,05	1,05	0,77	€ 0,00	€ 20,26	€ 21,73	-€ 21,73	-	€ 0,00	€ 0,00	€ 20,26	€ 0,00	€ 1,47	0,00	0,00%
2022	Ricambi	2F SRL	1	10	5,60	0,31	0,31	2,24	€ 0,00	€ 56,72	€ 57,15	-€ 57,15	-	€ 0,00	€ 0,00	€ 56,72	€ 0,00	€ 0,43	0,00	0,00%
2022	Ricambi	2F SRL	1	6	4,20	0,14	0,14	1,66	€ 0,00	€ 42,54	€ 42,74	-€ 42,74	-	€ 0,00	€ 0,00	€ 42,54	€ 0,00	€ 0,20	0,00	0,00%
2022	Ricambi	2F SRL	1	3	0,30	0,07	0,07	0,09	€ 0,00	€ 3,04	€ 3,14	-€ 3,14	-	€ 0,00	€ 0,00	€ 3,04	€ 0,00	€ 0,10	0,00	0,00%
2022	Ricambi	2F SRL	1	2	0,10	0,01	0,01	0,01	€ 0,00	€ 1,01	€ 1,02	-€ 1,02	-	€ 0,00	€ 0,00	€ 1,01	€ 0,00	€ 0,01	0,00	0,00%
2022	Ricambi	2F SRL	1	4	0,70	0,24	0,24	0,25	€ 0,00	€ 7,09	€ 7,42	-€ 7,42	-	€ 0,00	€ 0,00	€ 7,09	€ 0,00	€ 0,33	0,00	0,00%
2022	General Cargo	2F SRL	1	11	4,20	3,03	3,03	1,66	€ 0,00	€ 42,54	€ 46,78	-€ 46,78	-	€ 0,00	€ 0,00	€ 42,54	€ 0,00	€ 4,24	0,00	0,00%
2022	General Cargo	CENTRO SERVIZI GENERALI E IMBALLAGGI INDUSTRIALI S	1	2	9,50	9,41	9,41	1,25	€ 0,00	€ 38,80	€ 52,88	-€ 52,88	-	€ 0,00	€ 0,00	€ 38,80	€ 0,91	€ 13,17	0,00	0,00%
2022	General Cargo	AUTOTRASPORTI FRANCHI S.R.L.	1	4	16,40	8,00	8,00	6,53	€ 0,00	€ 48,81	€ 66,07	-€ 66,07	-	€ 0,00	€ 0,00	€ 48,81	€ 6,06	€ 11,20	0,00	0,00%
2022	General Cargo	AUTOTRASPORTI FRANCHI S.R.L.	1	3	8,20	4,98	4,98	3,26	€ 0,00	€ 24,40	€ 34,40	-€ 34,40	-	€ 0,00	€ 0,00	€ 24,40	€ 3,03	€ 6,97	0,00	0,00%
2022	General Cargo	AUTOTRASPORTI FRANCHI S.R.L.	1	4	12,20	6,43	6,43	4,86	€ 0,00	€ 36,31	€ 49,82	-€ 49,82	-	€ 0,00	€ 0,00	€ 36,31	€ 4,51	€ 9,00	0,00	0,00%
2022	Ricambi	AUTOTRASPORTI FRANCHI S.R.L.	1	12	1,20	1,18	1,18	0,31	€ 0,00	€ 3,57	€ 5,66	-€ 5,66	-	€ 0,00	€ 0,00	€ 3,57	€ 0,44	€ 1,65	0,00	0,00%
2022	Ricambi	AUTOTRASPORTI FRANCHI S.R.L.	1	1	0,10	0,02	0,02	0,01	€ 0,00	€ 0,30	€ 0,36	-€ 0,36	-	€ 0,00	€ 0,00	€ 0,30	€ 0,04	€ 0,02	0,00	0,00%
2022	Ricambi	AUTOTRASPORTI FRANCHI S.R.L.	1	1	0,60	0,55	0,55	0,24	€ 0,00	€ 1,79	€ 2,78	-€ 2,78	-	€ 0,00	€ 0,00	€ 1,79	€ 0,22	€ 0,77	0,00	0,00%
2022	Ricambi	AUTOTRASPORTI FRANCHI S.R.L.	1	3	2,60	0,17	0,17	1,01	€ 0,00	€ 7,74	€ 8,94	-€ 8,94	-	€ 0,00	€ 0,00	€ 7,74	€ 0,96	€ 0,24	0,00	0,00%
2022	Ricambi	AUTOTRASPORTI FRANCHI S.R.L.	1	1	0,30	0,11	0,11	0,10	€ 0,00	€ 0,89	€ 1,15	-€ 1,15	-	€ 0,00	€ 0,00	€ 0,89	€ 0,11	€ 0,15	0,00	0,00%
2022	Ricambi	AUTOTRASPORTI FRANCHI S.R.L.	1	3	0,20	0,05	0,05	0,06	€ 0,00	€ 0,60	€ 0,74	-€ 0,74	-	€ 0,00	€ 0,00	€ 0,60	€ 0,07	€ 0,07	0,00	0,00%

Once the data cleaning process has been completed, process which necessitates a substantial investment of time, attention, and meticulousness, it becomes imperative to compile information pertaining to the designated depot, encompassing its diverse opening and closing hours as well as relevant location details.

Subsequently, these data are entered into the Order Import file, wherein they undergo a series of mathematical operations to undergo the necessary encoding transformation as stipulated by PTV. It is crucial that each individual line, representing a delivery or pickup, is associated with a distinct ID, as failure to do so would result in the system not recognizing the orders as distinct entities.

Moreover, during this phase, it is imperative to designate sites with the code 0, while depots are assigned the code 1.

Figure 34. Depot detail

PickupLocationID	PickupIsDepot	PickupLocationName	PickupCountry	PickupOpeningHour1Start	PickupOpeningHour1End	PickupOpeningHour1Days
Arcese Udine	1	Arcese Udine	IT	05:00	23:00	1,2,3,4,5

DATI | OrderImport | FormatDefinition | List_CountryCode | **depot**

Figure 35. Order Import Data

ImportType	ImportVersion	ExtId1	ExtId2	CustomerOrderExtId		OrderActior
OrderImport		1		1-1-SAN DORLIGO DELLA VALLE		delivery
OrderImport		2		2-2-PRATA DI PORDENONE		delivery
OrderImport		3		3-3-BRUGNERA		delivery
OrderImport		4		4-4-PORDENONE		delivery
OrderImport		5		5-5-PORDENONE		delivery
OrderImport		6		6-6-UDINE		delivery
OrderImport		7		7-7-MARTIGNACCO		delivery
OrderImport		8		8-8-UDINE		delivery
OrderImport		9		9-9-FONTANAFREDDA		delivery
OrderImport		10		10-10-FIUME VENETO		delivery
OrderImport		11		11-11-TRIESTE		delivery
OrderImport		12		12-12-TRIESTE		delivery
OrderImport		13		13-13-TRIESTE		delivery
OrderImport		14		14-14-TRIESTE		delivery
OrderImport		15		15-15-TRIESTE		delivery
OrderImport		16		16-16-TRIESTE		delivery
OrderImport		17		17-17-TRIESTE		delivery
OrderImport		18		18-18-GRADISCA D'ISONZO		delivery
OrderImport		19		19-19-SESTO AL REGHENA		delivery
OrderImport		20		20-20-UDINE		delivery
OrderImport		21		21-21-UDINE		delivery
OrderImport		22		22-22-MARTIGNACCO		delivery
OrderImport		23		23-23-PRADAMANO		delivery
OrderImport		24		24-24-PRADAMANO		delivery
OrderImport		25		25-25-PRADAMANO-UDINE		delivery

DATI | **OrderImport** | FormatDefinition | List_CountryCode | depot

Figure 36. Order Import data

AT	AU	AV	AW	AX	AY	BA	BB	
		Time Window						
EarliestDateTime	LatestDateTime	EarliestPickupTi	LatestPickupTime	EarliestDeliveryTime	LatestDeliveryTime	PickupLocationID	PickupIsDepot	PickupLocationName
01/01/2000 00:00:00	31/12/2099 23:59:00	03/10/22 05:00:00	03/10/22 22:00:00	03/10/22 05:00:00	03/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	03/10/22 05:00:00	03/10/22 22:00:00	03/10/22 05:00:00	03/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	03/10/22 05:00:00	03/10/22 22:00:00	03/10/22 05:00:00	03/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	03/10/22 05:00:00	03/10/22 22:00:00	03/10/22 05:00:00	03/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	03/10/22 05:00:00	03/10/22 22:00:00	03/10/22 05:00:00	03/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	03/10/22 05:00:00	03/10/22 22:00:00	03/10/22 05:00:00	03/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	03/10/22 05:00:00	03/10/22 22:00:00	03/10/22 05:00:00	03/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	03/10/22 05:00:00	03/10/22 22:00:00	03/10/22 05:00:00	03/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	03/10/22 05:00:00	03/10/22 22:00:00	03/10/22 05:00:00	03/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	03/10/22 05:00:00	03/10/22 22:00:00	03/10/22 05:00:00	03/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	03/10/22 05:00:00	03/10/22 22:00:00	03/10/22 05:00:00	03/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine
01/01/2000 00:00:00	31/12/2099 23:59:00	04/10/22 05:00:00	04/10/22 22:00:00	04/10/22 05:00:00	04/10/22 22:00:00	Arcese Udine	1	Arcese Udine

DATI | OrderImport | FormatDefinition | List_CountryCode | depot

In this file, it is provided the Format definition of the data to be entered too, which serves as a legend containing the various attributes to be filled in the Order Import file, indicating the attribute, whether they are mandatory or not, their data type, if they are imported and the maximum length allowed.

Figure 37. Format Definition

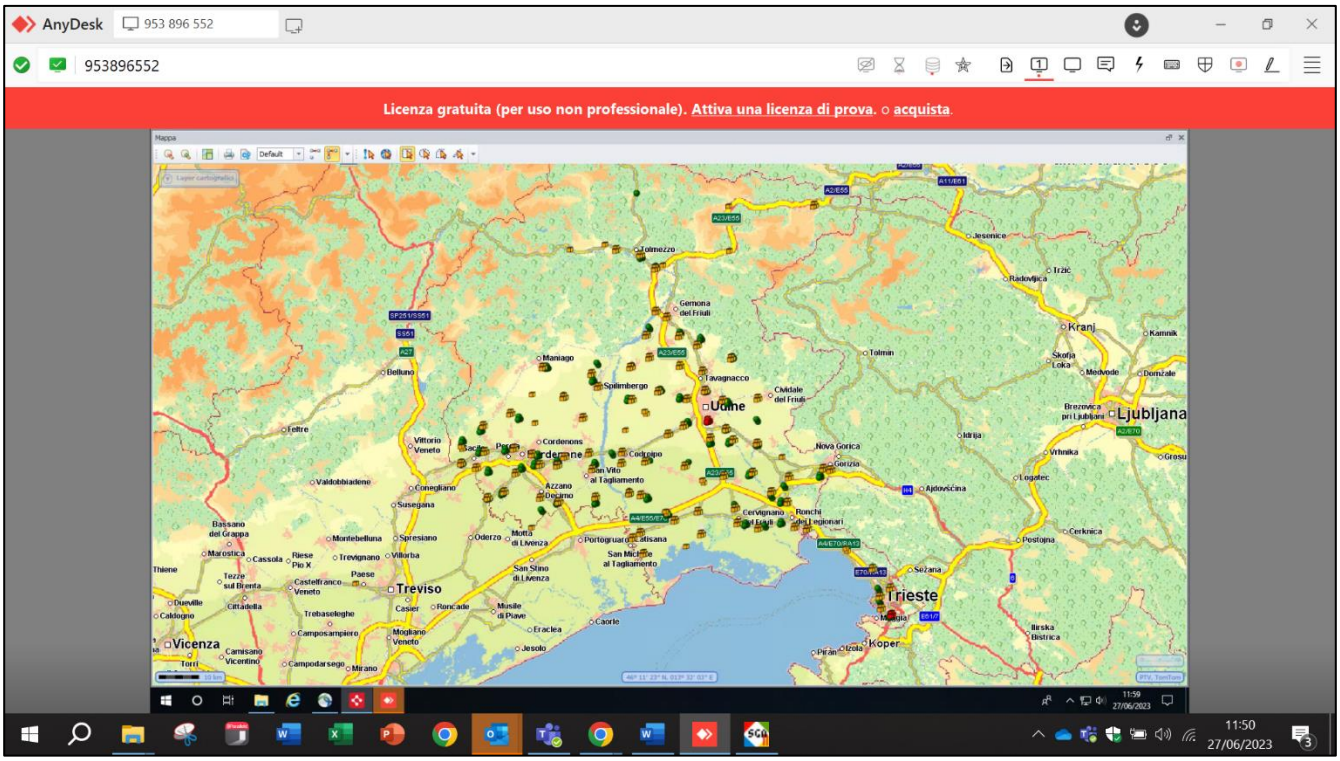
Block	Attribute	Required	Spirit pendant	Imported	Data Type	Valuation	Description
Import Head	CreationDate	YES		**NO**	Formatted String (TT.MM.JJJJ hh:mm:ss)		Timestamp of data row creation
	CreatedBy	NO		**NO**			User / System identification for created data row
	ImportAction	YES		**NO**	String (predefined list)	List_ImportAction!A1	Identifies the import action: create, update or delete
	ImportType	YES		**OrderImport**	String (predefined list)	List_ImportType!A1	Only OrderImport" is currently supported
	ImportVersion	NO		**NO**	Formatted String (##.##.##)	1.00.00	Reference to which import format version this data row belongs
Order Head	ExtId1	YES	Order.ExtId1	YES	String	min. 1 character max. 50 character	External unique reference ID; used to look up existing elements
	ExtId2	NO	Order.ExtId2	YES	String	max. 50 character	Additional external reference ID
	CustomerOrderExtId	NO	Order.CustomOrderExtId	YES	String	max. 50 character	Order ID of the ERP system (can be the same as ExtId1)
	OrderAction	YES	Order.OrderType	YES	String (predefined list)	List_OrderAction!A1	Action to be performed; this also decides whether an order is related to a depot or not
	Note	NO	Order.Note	YES	String	max. 250 character	Additional information about the order, such as hints to the driver
	Assortment	NO	Order.Assortment	YES	String	max. 50 character	Assortment type (imported "as is")
	Customer	NO	-	YES	String	max. 50 character	Unique identifier of a customer dataset
	Contract	NO	-	YES	String	max. 50 character	Unique identifier of a contract dataset
	Taskfield1ExtId	NO	Taskfield.ExtId1	YES	String	max. 50 character	External ID of a taskfield the order is to be assigned to
	Taskfield2ExtId	NO	Taskfield.ExtId1	YES	String	max. 50 character	External ID of an additional taskfield the order is to be assigned to
	Taskfield3ExtId	NO	Taskfield.ExtId1	YES	String	max. 50 character	External ID of an additional taskfield the order is to be assigned to
	PrecombinedTourId	NO	Order.PrecombinedTour	YES	String	max. 50 character	Tour ID from ERP system used for a precombination
	PrecombinedTourFix	NO	Order.PrecombinedTourFix	YES	int	0 = no; 1 = yes	If activated the tour planning process will never change the precombined tour
	VehicleRequirements	NO	LocationVersion.VehicleRestrictions.Vehi	YES	String	max. 254 character	Order requirements of vehicle (0=don't care, 1=must, 2=must not) e.g. '102' means: first requirement must, second don't care, third must not
	LogisticId	NO	Order.LogisticsId	YES	String	max. 36 character	
	TourPos	NO	ActionPoint.TourPos	YES	int	max. 4	0 = None, 1 = First, 2 = First-Section, 3 = Last-Section, 4 = Last
	Solo	NO	LocationVersion.PlanningRequirement.Sc	YES	int	0 = no; 1 = yes	
	Priority	NO	Order.Priority	YES	int	value range 0-9	Importance of order (higher value means higher importance)
	AlternativeDepots	NO		YES	String	max. 255 character	comma separated list of depots
	PreassignedTruck	NO		YES	String	max. 50 character	ExtId1 of a truck with which the order has to be executed
	Weight	NO	Order...	YES	Double		The weight of the freight in kilograms [kg]
	Volume	NO	Order...	YES	Double		The volume of the freight in cubic meters [m³]
	LoadingMeter	NO	Order...	YES	Double		The loading meters of the freight in ldm

DATI | OrderImport | FormatDefinition | List_CountryCode | depot

After all the import file-related files have been completed, it is possible to import the file through the import section of PTV Route Optimizer, as shown in the previous chapter.

Once the data is imported, it is immediately possible to view the map of pickups and deliveries in order to have a fairly clear overview of the general model of deliveries and pickups planning that will be implemented.

Figure 38. Deliveries and Pickup of Friuli



Now, the software requires the definition of the fleet management section, where all the data related to the vehicles to be used in route and trip planning is specified. During this phase, the costs of the various vehicles that the system can utilize are also defined, aiming to maximize the volumes to be transported and minimize the costs of the trips to be made. Of course, once the planning is done, it is still possible to manually modify the output based on specific requirements or future implementations.

Figure 39. Fleet Management Data

	Weight (kg)	Volume (m^3)	Loading Meters (m)	Cost of 1 trip(€)	Cost of 2 trips(€)
40-ton truck tractor	5000	25	7	250	300
80-ton truck tractor	9000	40	10	300	350
18-ton van	1000	10	4	200	250

Once all the data regarding the fleet has been determined, the final output consisting of various routes and volumes can be obtained. Subsequently, the exploration of investing in a new warehouse becomes necessary.

For pickups, a default time of 40 minutes per stop was assumed, while for deliveries, it was set at 20 minutes. This difference is generally due to the nature of pickups from various sites, often involving mass retrievals. Consider the extensive pickups made by Arcese S.p.A., particularly in the automotive commodity sector, where pickups are directly made from manufacturing companies engaged in large-scale production. These mass retrievals involve significant weights and volumes. Once these retrievals are completed and transported to various branches, they are unpacked and distributed through a process

called break bulk. Starting from larger pallets, the goods are divided into smaller pallets with reduced quantities and volumes. Of course, the opposite can also occur, known as make-bulk. The consolidation of goods in inventory storage locations ensures that multi-product orders for customers can be delivered together. However, analyzing retrievals and shipments at Arcese, it is evident that the first scenario is more common, leading to a longer pickup time compared to delivery time.

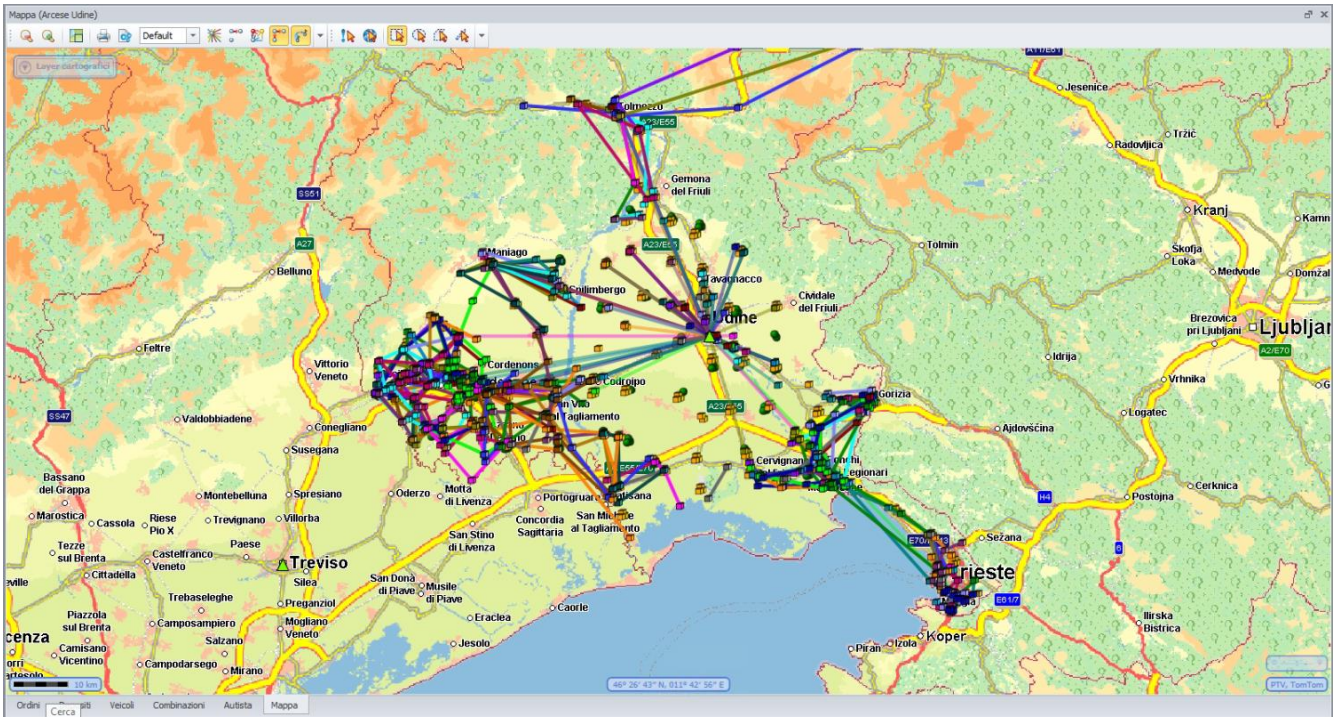
Additionally, a maximum vehicle utilization of 90% has been set to account for certain factors inherent to the vehicles themselves that prevent reaching a utilization level of 100%.

Regarding the availability schedule for the vehicles, the following time ranges have been established (of course these times do not represent the effective hourse that drivers works)

- Van: 06:00-23:00
- 40-Ton Truck Tractor: 06:00-23:00
- 80-Ton Truck Tractor: 06:00-23:00

Once all these data are introduced, the route planning process can commence. The system automatically identifies various routes on the map and assigns vehicles to pickups and deliveries, taking into account the specified constraints previously decided.

Figure 40. PTV Routes



Then, it is possible to extract the output from PTV.

Figure 41. Output of PTV

ID	Stops	N°shipments	ID Veihicle	Use	Vehicle	Gross Weight	%Weight	Loading Met	Volume	Departure Tim	Arrival Tir	Lenght
10985	4	2	Van (7)	1	Furgone Udine	176,98	0,19	2,2	1,462	28.10. 07:00	28.10. 10:02	82,20 km
N	Departure	Arrival	ID 2	Destination	ZIP Code	N°orders	Load Weight	Loading Meters	Unload weight	Unloading Meters	New Weight	New loading Meters
0	07:00	08:00	Arcese Udine	Udine	33100	2	176,98	2,20	0,00	0,00	176,98	0,00
1	08:40	09:00	100001916	Gorizia	34170	1	0,00	0,00	56,98	1,40	120,00	0,80
2	09:01	09:21	100001930	Gorizia	34170	1	0,00	0,00	120,00	0,80	0,00	0,00
3	10:02	10:02	Arcese Udine	Udine	33100	0	0,00	0,00	0,00	0,00	0,00	0,00
10939	12	11	80-ton truck tractor 2 (263)	1	80-ton truck tractor 2 (263)	1461,6	0,29	8,2	7,305	04.10. 08:00	04.10. 15:17	127,77 km
N	Departure	Arrival	ID 2	Destination	ZIP Code	N°orders	Load Weight	Loading Meters	Unload weight	Unloading Meters	New Weight	New loading Meters
0	08:00	09:00	Arcese Udine	Udine	33100	10	1.461,60	8,20	0,00	0,00	1.461,60	0,00
1	09:34	09:54	100000073	Mossa	34070	1	0,00	0,00	326,00	1,30	1.135,60	7,50
2	10:01	10:21	100000068	Gorizia	34170	1	0,00	0,00	81,00	0,80	1.054,60	6,70
3	10:21	10:41	100000076	Gorizia	34170	1	0,00	0,00	10,83	0,20	1.043,77	6,50
4	10:43	11:03	100000075	Gorizia	34170	2	0,00	0,00	577,14	4,00	466,63	2,50
5	11:17	11:37	100000017	Gradisca d'Isonzo	34072	1	0,00	0,00	303,14	1,40	163,49	1,10
6	11:42	12:22	100002888	Fogliano Redipuglia	34070	1	270,00	3,10	0,00	0,00	433,49	4.4
7	12:33	12:53	100000060	Monfalcone	34074	1	0,00	0,00	81,40	0,60	352,09	3,80
8	12:59	13:19	100000070	Ronchi dei Legionari	34077	1	0,00	0,00	11,17	0,12	340,92	3,68
9	13:20	13:40	100000061	Ronchi dei Legionari	34077	1	0,00	0,00	44,34	0,80	296,58	2,88

4.2.1 COMPARISON BETWEEN THE TWO CONFIGURATION

After the software generates the output, it is important to determine how shipment management varies with the establishment of the new warehouse in Udine. It is expected that the number of pickup and delivery trips from Udine will decrease compared to the trips previously handled by Treviso. The new order management will consolidate these trips by maximizing the number of shipments per vehicle, optimizing the space utilization, and minimizing costs.

In the month of October, the management of pickups and deliveries for the Friuli region by the Treviso depot exhibited these specific characteristics.

Table 1. Summary Pivot Table

		Valori						
Province	Flag_Delivery_Pickup	N°shipments	Gross Weight	Volume	Costs	N°Trips	Average weight/trip	Average volume/trip
GO	Collection	27	54,38	24,18	801,64	8	6,80	3,02
	Delivery	168	252,30	111,83	2.316,31	35	7,21	3,20
GO Totale		**195**	**306,67**	**136,01**	**3.117,95**	**33**	**9,29**	**4,12**
PN	Collection	294	2.230,34	891,21	11.018,54	70	31,86	12,73
	Delivery	703	1.781,22	980,59	19.282,98	90	19,79	10,90
PN Totale		**997**	**4.011,56**	**1.871,79**	**30.301,52**	**139**	**28,86**	**13,47**
TS	Collection	23	53,68	21,26	332,85	9	5,96	2,36
	Delivery	423	691,57	317,57	12.090,00	33	20,96	9,62
TS Totale		**446**	**745,24**	**338,83**	**12.422,85**	**33**	**22,58**	**10,27**
UD	Collection	223	786,67	817,19	8.471,03	66	11,92	12,38
	Delivery	975	1.930,86	1.025,60	29.994,61	130	14,85	7,89
UD Totale		**1198**	**2.717,53**	**1.842,79**	**38.465,64**	**186**	**14,61**	**9,91**
tale complessivo		**2836**	**7.781,00**	**4.189,42**	**84.307,96**	**391**	**19,90**	**10,71**

Thus, the initial step necessitates the determination of the volume of inbound and outbound material to be transported at the prospective subsidiary. Nowadays, the facility will oversee the movement of approximately 2836 shipments per month, which means 135 on a daily basis, if we suppose 21 working days, comprising 80% for deliveries and the remaining 20% for pickups. To ensure efficient operations,

each courier will be allocated a designated zone, with an average distance traveled of 240,4 kilometers. Consequently, each courier is expected to achieve an average daily performance of 7.25 shipments within their assigned area. A tabular representation of these particulars is provided below:

Table 2. Actual Configuration

SHIPMENTS	**2836**
N°TRIPS	**391**
AVERAGE SHIPMENTS/TRIP	**7.25**
N°STOPS	**1678**
AVERAGE STOPS/TRIP	**4,29**
AVERAGE KM/TRIP	**240,4**
AVERAGE TRIP/DAY	**19**

With the establishment of the new warehouse in Udine, it is possible to observe how PTV has been able to optimize pickup and delivery trips by maximizing volumes and weights, thus optimizing the management of pickups and deliveries.

The results show that the delta in kilometres is over 100 km, and this is evident because the vehicles no longer have to depart from Treviso and potentially travel to distant locations from there, covering a significant distance, only to return back. This allows to maximize the consolidation from Treviso to Udine, loading the vehicles as much as possible. Once they reach the new warehouse, the goods will be unloaded, sorted, and delivered to various destinations, completing the last-mile delivery. The same reasoning applies, of course, to pickups.

Table 3. Figure configuration

Etichette di riga	N°shipments	Trips	Average Trip Lenght	Average Stops	Gross weight	Volume	Costs	Average weight/trip	Average volume/trip
40-ton truck tractor	1645	153	104,20	9,52	366.273,37	1.745,50	37.904,89	2.393,94	11,41
80-ton truck tractor	911	79	122,96	9,51	374.566,96	1.753,33	18.144,12	4.741,35	22,19
Van	280	87	109,07	4,43	37.259,66	690,60	9.353,01	428,27	7,94
Totale complessivo	**2836**	**319**	**110,17**	**8,13**	**778.100,00**	**4.189,42**	**65.402,01**	**2.439,18**	**13,13**

Table 4. Future Configuration

SHIPMENTS	**2836**
N°TRIPS	**319**
AVERAGE SHIPMENTS/TRIP	**8,89**
N°STOPS	**2593**
AVERAGE STOPS/TRIP	**8,12**
AVERAGE KM/TRIP	**110,17**
AVERAGE TRIP/DAY	**15**

Results show how the new warehouse should help the firm in saving around k€18.91/month which means k€226.87/year.

4.3. INVESTMENT ANALYSIS

The second part of the project was dedicated to the investment analysis in this new warehouse. Warehouses hold a significant position within modern supply chains and exert a profound influence on the fortunes of businesses. They serve as pivotal hubs that facilitate the smooth flow of goods and play a crucial role in enhancing operational efficiency and cost-effectiveness. However, it is noteworthy that warehouses can account for approximately 25% of the total logistics costs, necessitating careful analysis and consideration before embarking on the establishment of a new warehouse facility.

In order to foster growth and development within a company, it is imperative to employ a robust organizational system that enables a comprehensive evaluation and selection of the optimal course of action from a range of alternatives. Throughout a company's lifecycle, from its inception to subsequent stages of development, critical decision points may arise, warranting meticulous deliberation. The decision-making process is rooted in the strategic choice to forego the pursuit of new business ventures in favor of extracting dual forms of returns from an already implemented and stabilized project:

1. Protracted capital recovery over a predefined timeframe, allowing for the gradual recuperation of invested funds.
2. Attainment of an appropriate profit margin that serves as a compensatory measure for the selected investment decision.

By carefully evaluating the costs and benefits associated with warehouse establishment, companies can make informed decisions that optimize resource allocation and drive sustainable growth.

First, it is necessary to evaluate the management costs.

- **Personnel costs**: calculated based on full-time equivalents, which is the number of people present in the company on a full-time basis.
- **Space costs** (cleaning expenses, security expenses, warehouse maintenance...) all the expenses required for the normal operation of the new warehouse.
- **Operational costs** such as maintenance expenses, transportation costs, vehicle maintenance costs, insurance expenses, and equipment costs
- **Overhead costs** which refers to costs that are difficult to isolate and often relate to multiple tasks or activities that are not always connected.

When considering options for acquiring a warehouse, two primary choices emerge: renting an existing facility or constructing a new one. These alternatives vary significantly in terms of costs and financial implications which basically consists in:

1. **INITIAL COSTS:**

   - Renting a Warehouse: renting entails monthly or yearly payments, often accompanied by security deposits or upfront payments. However, the initial investment is generally lower compared to building a warehouse from scratch.
   - Building from Scratch: construction requires substantial initial investments for land acquisition, obtaining necessary permits and licenses, as well as hiring architects, engineers, and other professionals. Costs can vary significantly based on the warehouse's size, location, and specifications.

2. **PROJECT TIMELINES:**

   - Renting a Warehouse: once a suitable warehouse is identified, the rental process can be completed swiftly, minimizing waiting times.
   - Building from Scratch: construction entails a longer time period, ranging from months to years, depending on project complexity, required permits, and approvals.

3. **CUSTOMIZATION:**

   - Renting a Warehouse: Renting an existing warehouse may limit significant customizations. However, in some cases, limited flexibility might be allowed to adapt the space to specific needs.
   - Building from Scratch: Constructing a warehouse from scratch offers the opportunity to design and customize it according to specific business requirements. Optimal layout, storage capacity, and incorporation of advanced technologies and systems are possible.

4. **LONG-TERM OPERATING COSTS:**

   - Renting a Warehouse: monthly or annual rents constitute the primary long-term operating costs. Rent increases may occur periodically.
   - Building from Scratch: operating costs include repayment of financing used for construction, maintenance expenses, utilities, insurance, and property taxes. However, after the initial investments are amortized, operating costs can significantly decrease.

5. **RISKS AND RESPONSABILITIES:**

   - Renting a Warehouse: the tenant is subject to the contractual conditions established by the landlord and may face rent increases or renegotiation of the contract in the future.

- Building from Scratch: the owner assumes the financial and operational risks associated with constructing the warehouse. Thus, it is responsible for managing costs, ensuring compliance with regulations, and addressing any unforeseen challenges.

In conclusion, renting a warehouse offers lower initial costs, quicker implementation, and fewer responsibilities, but limits customization options. On the other hand, building a warehouse from scratch entails higher initial investments, longer timelines, and greater customization possibilities, along with increased financial and operational risks. The decision ultimately depends on the specific needs, financial capacity, and long-term objectives of the business.

All these factors required careful analysis by top-level management within the company Arcese, and as a result of these deliberations, the decision was made to proceed with the rental of an existing warehouse in Udine that could meet all the necessary requirements. This decision was primarily based on the recent significant investments in the construction of a new warehouse in the Tortona (AL) area, a massive complex spanning 54,000 square meters, which is expected to commence operations by the end of 2023. In addition, there are several new projects and investments underway, such as the development of TYP, a new firm that is part of Arcese, which will provide a different service compared to the current operations, focusing more on national express courier services catering not only to B2B but also to B2C customers.

Thus, a more cautious approach was taken, aimed at continuing to grow the company's business but in a more conservative manner. The intention was to assess how the establishment of a new warehouse could benefit the company and potentially consider the possibility of constructing a new facility from scratch in the coming years, if the volume of the area significantly increases and the current warehouse alone becomes insufficient.

This strategic decision reflects the company's focus on optimizing resources and evaluating the potential impact of expanding operations. By carefully considering the future growth prospects and market conditions, the company aims to strike a balance between prudent business expansion and maximizing operational efficiency.

It is crucial to comprehend that in both scenarios, in fact, whether constructing a new warehouse from scratch or opting for rental, Arcese S.p.A Trasporti was driven by the aspiration to expand its business in the Friuli region. In line with this objective, the company has made the strategic decision to hire two dedicated sales representative specifically for this warehouse. The primary purpose of this strategic move is twofold: to enhance the service level provided to existing customers in the area and to facilitate market development in the region.

The role of the sales representative holds immense significance in achieving these objectives. With their expertise in sales and customer relationship management, the sales representative plays a pivotal role in penetrating untapped markets, acquiring new customers, and broadening the company's customer base. Their responsibilities encompass managing customer contacts, leading negotiations, providing comprehensive assistance, and ensuring efficient post-sales support. An effective sales representative goes beyond transactional interactions and strives to establish a foundation of trust and reliability with customers. By nurturing strong relationships, they enhance customer satisfaction and foster long-term loyalty. Their ability to understand customer needs, anticipate requirements, and offer tailored solutions contributes to customer retention and repeat business.

Moreover, the sales representative serves as a valuable source of market intelligence and competitor analysis. Their direct engagement with customers and continuous monitoring of market dynamics enable them to gather crucial insights. By staying attuned to evolving customer preferences, emerging trends, and competitive activities, they provide invaluable feedback to the company's marketing and product development teams. This information empowers the organization to refine its strategies, develop targeted marketing campaigns, and launch competitive products or services.

Therefore, Arcese S.p.A Trasporti seeks to capitalize on new business opportunities, expand its market reach, and ultimately bolster its revenue streams. The sales representative becomes an integral part of the company's growth strategy, actively driving market expansion and reinforcing Arcese's position as a leading player in the Friuli region.

4.3.1 INITIAL INVESTMENT ON THE TDS WAREHOUSE

Arcese S.p.A decided to invest in leasing warehouse space from TDS Trasporti Distribuzione Servizi SRL, located at Piazzale dell'Agricoltura 4, 33100 Udine, because it presents a strategic investment opportunity. TDS specializes primarily in merchandise transportation within the Triveneto area, handling an annual volume of approximately 360,000 tonnes of goods in Friuli Venezia Giulia, Veneto, Northern Italy, and abroad in Austria, Slovenia, and Croatia. With over 72,000 deliveries completed, TDS has established itself as a reputable player in the industry.

This collaboration would enable Arcese to secure a portion of the warehouse for flexible durations, tailoring the agreement to meet specific operational requirements. The arrangement offers the advantage of scalability, allowing the company to adjust the leased space as needed to accommodate seasonal surges or increased workloads. The warehouse itself encompasses an impressive area of approximately 3,000 square meters and is equipped with nine loading docks, providing efficient access for loading and unloading operations.

By leveraging this partnership with TDS, Arcese would gain access to a well-established warehouse facility, strategically positioned in Udine. This advantageous location allows for seamless logistics operations and could enhance Arcese's ability to effectively serve its clients within the Triveneto area and beyond. The presence of TDS as a trusted partner further instils confidence in the reliability and security of the warehouse space, ensuring the smooth flow of goods and minimizing potential disruptions in the supply chain.

Overall, this leasing opportunity provides Arcese with the necessary infrastructure to support its operations while maintaining the flexibility to adapt to evolving market demands.

Therefore, by leveraging the extensive experience and capabilities of TDS, Arcese can optimize its logistics operations, enhance customer satisfaction, and position itself for continued growth in the region.

Figure 46. TDS Warehouse [67]

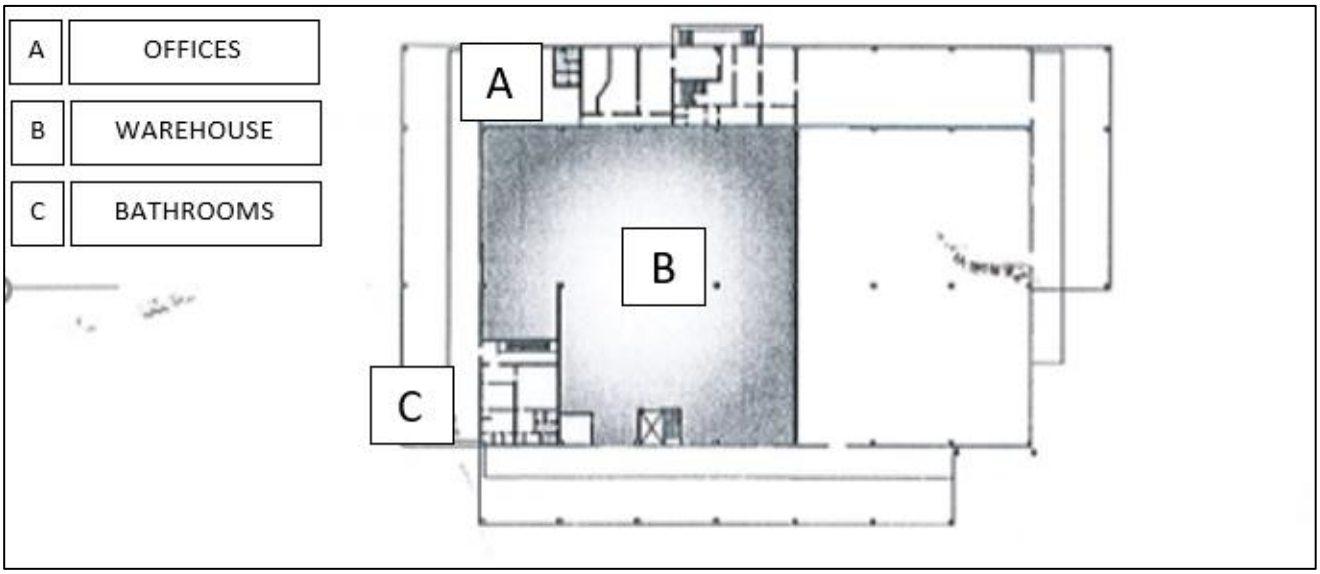


Figure 47. TDS Warehouse [67]

Figure 48. TDS Warehouse [67]

Figure 49. TDS Warehouse [67]

Figure 50. TDS Warehouse [67]

The initial investment of this renting can be summarize in this expenses:

- **Security devices**: in terms of IT devices, the warehouse in Udine already has 8 existing security cameras. However, an additional 11 cameras will be installed to ensure wider coverage, reducing blind spots, and increasing the likelihood of detecting suspicious activity through real-time area monitoring. The installation cost will depend on wiring expenses, including necessary cables, the number of entry points, and cable specifications. Additionally, a digital video recording device (DVR) will be purchased to record camera footage. The purchased cameras will be professional-grade, and a professional set of power supplies, connectors, junction boxes, and other accessories will be acquired for powering and connecting the cameras to the system. Based on an estimated cost of €230 per camera, an initial quote of approximately k€8.2 has been generated.

  In addition to this expense, there will be costs associated with intrusion detection devices, including two intrusion detectors to be added to the existing system. The costs here will also depend on wiring, system customization, and the type of intrusion detection system. Given the extensive area to be protected, installing security alarms in such a large warehouse necessitates a more complex process and a higher investment in sophisticated systems. The estimated cost for these devices amounts to k€4.3, resulting in a total overall cost of approximately k€12.5.

- **IT devices:** setting up a reliable network infrastructure is crucial for seamless communication and data transfer within the warehouse. This includes the acquisition of routers, switches, cabling, and other necessary network equipment to establish a robust network environment. Furthermore, the procurement of hardware such as servers, workstations, barcode scanners, printers, and mobile devices is essential. Additionally, software licenses for operational systems and productivity tools are required. TDS's warehouse, however, already possesses most of the necessary equipment, with only minor adjustments required for the setup of various printers and scanners, and setting up dedicated workstations in the warehouse.

  One vital aspect to consider is the implementation of a Warehouse Management System (WMS). A WMS is indispensable for efficient inventory management, order processing, and shipment tracking. Within Arcese's actual WMS, the creation of the new Udine warehouse is essential, including all the integration details associated with it. The cost includes purchasing or licensing fees for the WMS software, customization, integration with existing systems, and employee training.

  Two other crucial elements to consider are data security and integration with partners and systems. Ensuring data security is paramount for a transportation company. This involves investments in firewalls, prevention systems, encryption tools, antivirus software, and regular data backups. These cybersecurity measures are vital for safeguarding sensitive customer information and preventing potential data breaches. Particularly after the security breach experienced in 2021, Arcese has significantly increased investments in this field to prevent similar incidents from occurring. Additionally, establishing connection and integration with external partners requires investments in APIs, EDI systems, and other integration tools because this ensures smooth data exchange and streamlines operations throughout the transportation ecosystem.

  Therefore, the total expenditure should amount to approximately k€30.

- **Transfer**: these are additional costs that need to be taken into account due to the transfer and are all incurred during the relocation to the new branch. They are initial costs associated with managing the transfer to the new branch and need to be considered as they are crucial. Most of these tasks are realized internally by the logistic area of Arcese, to reduce the costs, but of course require huge investments of time and money too. The higher costs will be of course the procurement of material and equipment to use in the warehouse, in particular two new forklifts and 4 transpallet for a cost of approximately k€60. They can be divided into:
    - ❖ Fisical: such as layout and flows design, definition of horizontal and vertical signage, moving part of the office material from the warehouse of Treviso to the warehouse of Udine, procurement of equipment and assets for warehouse management, such as forklifts, ramps, chocks, carts, stands, and dock plates.
    - ❖ Logical: such as creation of locations, lines, and routing, management of the goods moved from Treviso to Udine.
    - ❖ Safety and Security: like HACCP, ADR and safety setup or management of branch access and time clocks.
    - ❖ Facility: definition and allocation of personnel in the office and in the warehouse
    - ❖ Legal: contract definition for all the details connected to the rent
    - ❖ Cost and Control: such as identification and segregation of flows for accurate billing attribution and cost calculation

Table 5. Initial Investment

Expenses	Cost (k€)
Security devices	12.5
IT devices	30
Transfer	80
Total	122.5

In subsequent years, the initial setup costs for IT infrastructure, security systems, and other necessary preparations managed in the transfer will have already been accounted for and implemented. Therefore, these costs will not be incurred again. However, it is important to note that ongoing maintenance expenses will arise as part of the regular operations of the warehouse.

The maintenance costs associated with overhead expenses may include routine inspections, repairs, upgrades, and replacements of equipment, machinery, IT systems, security systems, and other relevant infrastructure. These costs are necessary to ensure the smooth functioning, efficiency, and safety of the warehouse operations.

4.3.2 ANNUAL COST OF RENTING

At this point, it is necessary to understand the costs that the company will have to face during the year:

- **Cost of renting:** the annual rent for the building amounts to €6 per square meter. Considering that Arcese has decided to lease only a portion of the warehouse with an area of 1500 square meters, the annual rental cost would be €108,000.

- **Personnel costs:** considering the costs of personnel in a warehouse, several factors come into play. First and foremost is the direct labor cost, which encompasses the wages of the warehouse staff engaged in various activities such as receiving, storing, picking, packing, and shipping goods. Additionally, there are personnel working in office roles to perform complementary tasks. Naturally, in this calculation, the benefits and insurance of the employees must be taken into account, as it is mandatory to provide health insurance, retirement plans, paid time off, and other perks or incentives. Assuming an average of 8 workers, with 5 working within the warehouse and 3 in office roles, and an average gross cost of €15/hour, the total cost of a worker amounts to €120/day. This translates to k€2.52/ month based on 21 working days, resulting in an annual total cost of approximately k€242.

  Moving on, there are two sales representatives, as previously discussed, one operations manager responsible for coordinating and managing all operational activities within the warehouse, and a quality control manager which ensures the accuracy and quality of incoming and outgoing shipments, conducts inspections, implements quality control procedures, and addresses any issues or discrepancies. The operations manager's responsibilities also include planning activities, managing resources, implementing company policies, and overseeing staff performance. The total costs for the sales representatives should amount to around k€7.4/month, while the operations manager's cost is estimated at k€5.5/month and the quality control manager k€4,4/month. This brings the monthly total to k€17.3 equivalent to an annual cost of k€207.6.

  Of course training and development need to be considered too because investing in the training and development of warehouse staff is crucial for maintaining a skilled workforce and improving productivity. Costs associated with training programs, workshops, certifications, and ongoing professional development should be factored in. The costs associated with training and development can vary depending on factors such as the type and duration of training programs, the number of staff members involved, and the specific training providers or resources utilized. On average, companies may allocate around 1-5% of their annual payroll budget for training and development activities. For a warehouse like this, with a payroll budget of approximately k€449.6, the annual training and development costs could be on average k€13.5.

- **Overhead:** these costs include expenses for executive management, administration, accounting, human resource management, marketing, corporate communications, and other core functions necessary for the management and coordination of activities. Proper management of overhead costs is crucial for cost control and ensuring overall operational efficiency of the company. Overhead costs will be divided on a proportional allocation which will be based on the space occupied by the tenant.

This can be calculated by comparing the square footage of the rented space to the total square footage of the entire warehouse, which initially will be divided equally, but may vary based on market needs as explained earlier. Among the various costs to consider are:

- Communication and Transportation: these costs include expenses for corporate communications, such as telephony, internet services, postal services, courier services, business travel, employee transportation, and other expenses related to internal and external communication of the company. A possible estimation of these costs is approximately k€2/year.

- Maintenance Expenses: it is important to consider the maintenance expenses of the warehouse which include repairs, routine and extraordinary maintenance, cleaning, and other services necessary to keep the warehouse in good operating condition. Determining the exact amount of maintenance and repair costs for a warehouse of 3000 square meters can vary significantly based on several factors, including the age and condition of the facilities, equipment, and machinery, as well as the specific maintenance requirements and frequency. We have to consider the maintenance costs for the physical infrastructure, such as roofing, flooring, walls, and structural elements, can range from 1% to 3% of the building's value per year which means an average of k€5. Then, there are the storage equipment expenses related to maintaining storage racks, shelves, pallets, and other storage systems can vary based on the type, complexity, and age of the equipment. A general estimate for maintenance costs could be around 2% to 5% of the equipment's value per year which for an average value of storage equipment of k€160, the annual maintenance costs might be approximately k€4.8. Another one is the vehicles and machinery maintenance costs for the vehicles, forklifts, conveyors, or other machinery. These costs are highly dependent on the usage intensity and specific maintenance requirements of the equipment. As a rough estimate, maintenance expenses for vehicles and machinery could range from 5% to 10% of their purchase or market value per year. Given a value of machinery of k€60, then we have a cost on average of k€4,2/year. Finally, we have the cost of maintenance of the IT devices which of course is fundamental too and requires approximately k€8/year. Overall, we can consider a cost of k€22/ year.

- Public Utilities and Utilities Expenses: such as electricity, water, heating or air conditioning, as well as expenses for utilities such as electricity, gas, telephone. These costs can vary based on actual usage and the rates established by service providers. Of course this cost will be extremely variable year by year because it will depends on usage patterns, energy efficiency measures, and local utility rates but an approximation for a warehouse of these dimensions should be k€50/year, and Arcese should pay for half of them and so k€25/year.

- Insurance: the warehouse insurance policy, which covers risks such as fire, theft, damage to goods, liability, etc. The tenant's insurance coverage is separate from the property owner's insurance and should be a cost of approximately k€11/year.

- Other costs: such as professional services which include costs for external consultants, lawyers, accountants, and other professionals who provide specific services to the company,

or office supplies which encompasses items such as paper, pens, pencils, printer toner, and other consumable goods necessary for the day-to-day operations of the company. Another thing is the depreciation which represents the allocation of costs for durable goods, such as machinery and equipment, over time, taking into account their decrease in value. Assuming as we have seen before machinary and equipment of k€60 and a useful life of ten years, should be around k€6/year. Overall, these costs should be around k€10/year.

Table 6. Annual cost of renting

Expenses	Cost (k€)
Rent	108
Personnel	463,1
Overhead	70
Total	641.1

4.4. LIMITATIONS OF THE PROJECT

The project proves to be highly beneficial in assessing the impact of the new warehouse in terms of flow optimization, facilitation of internal processes, and enhancement of service levels provided to customers. However, PTV is not without its limitations. Currently, Arcese predominantly utilizes PTV from a strategic rather than operational perspective, primarily for analyzing and determining the presence of actual flows within a specific geographic area. PTV does still present optimization-related issues which require additional implementation and attention. For instance, if there are two shipments to be delivered on the same street but 1 km apart, the system recognizes the distance but assigns a travel time of zero, which is not entirely accurate.

Furthermore, other systems used for data extraction are not perfect. The object used in the company's QV for calculating shipment-related costs, which is extensively employed at present, has some issues that result in costs often not perfectly aligning with reality, but differing by a few units, rendering the calculation less accurate. Resolving these issues requires highly complex elaborations, entailing significant reverse engineering efforts by technicians to ensure that all data within the company is traced as accurately as possible, reflecting reality.

Another limitation arises from the Data Warehouse. SGA calculates shipment costs based on the taxable weight present within the journey. Consequently, if a trip includes a massive shipment of, for example, 20,000 kg and another of 1,000 kg, the heavier shipment absorbs all the costs associated with the journey, leaving a minimal portion for the smaller shipment, even if the latter needs to be delivered to a more distant location. This is one of the reasons why Arcese has invested in TYP, enabling them to focus on their core business more coherently, avoiding the handling of less voluminous and heavy shipments, which will instead be handled by the latter company. The project analysis utilizes a significant number of vans, but Arcese's objective is not to rely on vans. Vans are costly despite being the most economical means of transportation, as they have limited capacity and cannot transport the typical goods of Arcese's

business. Arcese aims to develop its network primarily with trailers capable of carrying more goods, increasing volumes and gross weights, maximizing deliveries, and reducing costs. Vans should only be used in situations where delivery with a truck is impossible, such as highly congested urban centers.

Lastly, a significant limitation lies in the constrained cost analysis. Constructing a new warehouse undoubtedly requires a highly accurate cost analysis, which is inherently challenging due to unforeseen issues and contingencies that may arise during the transfer or over the course of the year, leading to changes in timelines and costs.

CONCLUSIONS

In conclusion, the implementation of a dedicated software for optimizing transportation flows represents an essential tool for transportation and logistics companies facing the decision of opening a new warehouse. Through in-depth analysis of data related to goods flows, load characteristics, and transportation conditions, the software allows for precise evaluation of operational efficiency and warehouse management capacity.

The use of optimization software offers significant strategic advantages for the company. Firstly, it enables the identification and reduction of waste and inefficiencies within the transportation system by optimizing routes and reducing delivery times. This results in increased customer satisfaction, reduced operating costs, and a notable improvement in overall competitiveness in the market.

Secondly, the software provides a comprehensive and detailed view of the existing warehouse management capacity. By collecting and analysing data regarding storage capacity, space availability, and goods handling operations, the software enables an assessment of whether opening a new warehouse is genuinely necessary to support the company's growth. This avoids unnecessary or misaligned investments and allows for optimal utilization of available resources, maximizing the efficiency of the logistics system.

Lastly, the transportation flow optimization software allows the company to simulate and evaluate different scenarios and strategies. Using advanced predictive models, accurate simulations can be performed to assess the impact of opening a new warehouse in terms of cost, operational capacity, and delivery times. This predictive capability enables informed decision-making based on concrete data, providing an in-depth understanding of the operational, financial, and human resource implications associated with opening a new warehouse.

As presented in the latest RF LTL Italia Committee on September 17th, the new Arcese branch in Udine will be active. The Udine branch will have distribution competence in Friuli, covering the following provinces: Udine, Pordenone, Gorizia, and Trieste.

The Arcese platforms that will serve as hubs for Udine are:

- Milan
- Treviso

- Bologna

This new opening will change the planned routing for shipments departing from platforms and destined for Udine in this way.

Table 7. New Planned Routing

Branch	**First Hub**	**Second Hub**	**Third Hub**
Arexons	TV	UD	
AN	BO	UD	
BO	BO	UD	
CT	VR	TV	UD
FI	TV	UD	
MI	MI	UD	
MO	TV	UD	
NA	MO	TV	UD
R1	TV	UD	
TR	TV	UD	
TV	TV	UD	
VN	TV	UD	
TN	VR	TV	UD
PR	MO	TV	UD
BA	BO	UD	
PE	BO	UD	
MT	BA	BO	UD
CS	BO	UD	
ME	BO	UD	
PA	BO	UD	
FG	BO	UD	
GE	MI	UD	

Through data analysis and the application of advanced algorithms, we were able to optimize the entire process, achieving significant results in terms of efficiency and cost reduction.

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