POLITECNICO DI TORINO

Department of Management and Production EngineeringClass LM-31 Degree: Management Engineering

Master's Degree Thesis

Benefits and Challenges of implementing BI Systems: The case study of Northwind.

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INTRODUCTION:

This thesis originated from my curricular internship at Bios Management S.r.l., a rapidly growing company operating in various fields of industrial process management, from human resource management to Enterprise Performance Management (EPM). Bios' clientele includes national and international banks, consulting firms among the famous "Big Four," and large corporations. The company's flexibility enables it to serve both small entities like SMEs and large industrial groups. The primary goal of this thesis is to examine the evolution of Business Intelligence (BI) in the corporate context. In an era where organizations must quickly analyze large volumes of data to remain competitive, BI tools become essential, even though their application can be challenging, particularly for small businesses. Innovation plays a crucial role in this context. To write this thesis the references used are interviews, and, above all, my field experience at Bios.

The thesis is structured in the following chapters:

- In the *first chapter*, an attempt is made to provide a clear and comprehensive explanation of the concept of Business Intelligence, with a historical overview of this field and a description of its roots.
- The *second chapter* introduces the software used during the internship (Board) and provides a general overview of its capabilities.
- The *third chapter* focuses on a business case study, particularly the Northwind project, to provide a practical illustration of the concepts discussed in the previous chapters.

- The *final chapter* focuses on the role of the BI consultant, how they can bring value to companies, and how the market for such software has evolved in recent years.

The aim is to provide a comprehensive view of the world of BI, starting with a general explanation and gradually deepening the topic to a concrete business case. The final chapter offers an overview of career opportunities in this field. At its core, Business Intelligence goes beyond being just a technology tool; it serves as a crucial strategic requirement for companies aiming to succeed in this data-driven age. It not only allows organizations to make the most of the wealth of information found in data but also provides them with the tools to navigate the vast amount of data effectively. Business Intelligence equips companies with the necessary resources to spot opportunities, manage risks, and, most importantly, achieve long-term success in the ever-evolving business landscape. With its advanced data analysis capabilities and deep insights, organizations can make smart decisions that drive their growth and competitiveness in the global market.

CHAPTER 1

BUSINESS INTELLIGENCE

In recent years, the constant growth of available information, data and technologies has meant that companies had to find a way to manage this renewal in a productive way, seeing these innovations as a possibility for growth and not a problem.

From the analysis of data, in this case called Big Data, it is possible to identify tendencies and trends that can improve the efficiency of a company both from a productive and economic point of view.

The large amount of data allows you to make informed choices by approaching business growth from a numerical and objective point of view, the correlation between data can be a filter and provide real indications on the choices to be made.

The use of big data can also significantly reduce company costs, since it facilitates targeted marketing campaigns to reach customers effectively, quickly identifies the possibility of fraud and digitalize the supply chain in order to prevent costly disruptions.

In order to achieve these objectives and use data correctly, BI (Business Intelligence) was born. BI allows you to integrate data from different sources ensuring data security and accuracy of the result.

A real economic sector has been developed around the BI and numerous programs are used, among those is present Board which is explored in this thesis (Partida, 2022).

1.1 History of Business Intelligence.

The phrase Business Intelligence appears for the first time in **1865** in the "Cyclopædia of Commercial and Business Anecdotes" written by Richard Miller Devens who used it to describe the data storage used by the banker Sir Henry Furnese (Foote, 2023).

BI has its roots in the second half of the **1950s**, more precisely in 1956, when IBM presented the first memory storage system that could contain about 5MB and weighed more than 1 ton. This invention, despite the dimensions that would be insignificant today, represented a real revolution of its kind as it was the first system that allowed to switch from a physical filling to a digital one (Lago, 2018).

That year, Hans Peter Luhn wrote a paper for the IBM system Journal entitled "A Business intelligence system" and defined it as "the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal"; During those years, however, it was only used in some sectors and was a "niche tool" only for highly specialized people in that field.

Luhn exhibiting some of his products showed some of his products. One, in particular, seemed particularly innovative because it was able to catalogue and create indexes using words and not algorithms as we are used to. This technology was called **KWIC** (Key Word in Context). It was capable of cataloguing and indexing a word range of 500 to 5,000 words.

During the 60s there was an exponential growth in the use of calculators and computers. At the time they were gigantic and occupied entire rooms, but they were still far more efficient than manual work. However, these machines had their own problems such as the lack of a technology that could contain large amounts of data and manage them. And it is at this time that IBM presents the first DBMS (Database

Management System), which uses trees in binary language and with a hierarchical data structure. Alongside these inventions, other elements emerged and became the foundations of BI, in particular the OLAP (Online analytical processing) and the ETL (Extract, Transform and Load) (Foote, 2023).

Edgar Codd recognized that the possibility of merging data from two different databases was fundamental and therefore went on to develop what would later be known as the relational database model. The relational model means that the logical data structures—the data tables, views, and indexes—are separate from the physical storage structures, and so you can work on different databases at the same time. In the 70s, the first companies that marketed BI systems were born, such as SAP or JD Edwards. In the late 1980s Bill Inmon and Ralph Kimball created Data Warehouses that made it possible to integrate different data sources into one. Data Warehouses took data from different sources, both current and historical data and merge them to create analytical reports (Foote, 2023).

Between the 90s and the early 2000s what is called Business Intelligence 1.0 takes hold. In the 90s, in fact, the so-called ERPs, i.e. Enterprise Resource Planning, took hold, which are software that allow you to manage and automate some aspects of production and management of a company. The development of the Internet and the ever-growing use of PCs at every level of production will then lead to Business Intelligence 2.0 in the early 2000s (Lago, 2018).

During these years, the methods of using data switched to algorithms and machine learning which allowed not only to consider current data, but also to estimate forecasts for the future. The birth of the cloud also made it possible to no longer have to worry about the amount of data and its accessibility. With the advent of social networks such as Facebook, Twitter or Instagram, the commercialization of BI systems increased and also had a drastic acceleration in the amount of updates.

Companies began using BI systems independently, going from 35% of companies with BI programs in 2010 to about 67% (Foote, 2023).

Today BI is considered a standard element for most companies, it's not see as a competitive advantage but a tool that the firms has to have to be competitive in the market, and there is a tendency to look for solutions that are more and more similar to what the end users could be, so that developing on such programs becomes easier and that there is no need to long periods of training (Heltzel, 2022).

The latest BI updates, called Business Intelligence 3.0 no longer focus on the What but on the Why, thus trying to understand not what is happening inside a process, but the why in order to be able to predict it and in some cases avoid it . Furthermore, we begin to develop what is **Natural Language Processing**, i.e. the possibility of programming using a natural language like the one used on every search engine.

Also using the voice and talk to the BI system is an innovation in this field, voice-activated BI is poised to change how we interact with data. Users can request insights and analyze using conversational language, making BI more accessible and user-friendly. Furthermore, the use via mobile is growing, even if mainly in visualization and not in programming. An important trend of the last years is the new collaboration between the **Artificial Intelligence and Machine Learning**. Using artificial intelligence people can break down a massive quantity of data elaborated by machine learning in a very precise way and with a capacity of predictions that we have not experienced yet (Heltzel, 2022).

1.2 Advantages and limitations of data-driven

Information is the most important characteristic and the basic requirement for the growth and development of a company. The transmission of information within a company plays a fundamental role, as it allows all levels to be ready for changes or to react correctly to market or management requests. In a rapidly changing environment, it is necessary to have cohesion and flexibility in order to respond quickly and avoid inertia or being stuck in a situation of obsolescence. Any interpretation not based on data is to be defined as subjective. In business and corporate management, decisions must be taken, and the consequences must be predicted as precisely as possible.

In business, making formatted and weighted decisions is fundamental, therefore data management, their storage, the way they are used, manipulated and then reported become decisive. Data and everything related to them can be the basis for having a significant competitive advantage over other companies. A clear example of all this is Tesla in the field of electric cars, its advantage is not concentrated only on mechanics, but on the data, it has managed to collect in that field mainly (Fluency, 2020).

This importance of data has led companies to adopt a data driven approach. Data driven means that decisions are made based on data instead of intuition. As subsequently demonstrated, this type of business approach works very well and the companies that use it and therefore make data-based decisions have a percentage that varies between 150% and 200% of the possibility of achieving the desired financial results (Fluency, 2020). That said, data isn't the only thing you need to grow a business. It is important that decisions are not based solely on data. The data must be interpreted and as such there is a need for reasoning and intuition is fundamental in this. There are blind spots in data analysis and in these cases you need experience

and knowledge to know how to move. The data give the input for the analysis which, however, must then be done in a subjective way (Fluency, 2020).

As in any area, excessive use of this practice can expose one to possible risks and consequently to technical and strategic errors like:

- **Poor interpretation of customer needs**: small structural or service changes can lead customers to turn to competitors, especially on everyday items. The use of data may cause a slowdown in the detection of these troubles.
- **Literal interpretation of data**: when used by inexperienced people, they tend to be interpreted literally without paying attention to the elaboration of data combined with strategic skills in order to obtain balanced management between data and "intuition."
- **Dependence on data**: using information as a cornerstone and as the sole approach on which the decision-making process is based can be dangerous, as in the event that these were missing there would be a paralysis of the entire company system.
- ***Tendency to immediately use data for micro-optimizations***: having a lot of data available always could induce the company to make micro corrections and optimizations, in order to follow the data instructions. However, such an attitude risks undermining the understanding of future developments and the interventions applied. On the other hand, any change must be scheduled and must be part of a strategy, so all the optimizations has to be controlled and its impact must be evaluated.

(Fluency, 2020)

A new trend found in recent years in parallel with the data driven approach is the data informed one. A data-informed approach is where decisions are made after

considering data as well as user research, experience, and personal insights. Rather than allowing data to control everything, there's still a human element to decision-making.

A data informed approach allows you to consider a more complete picture of the situation by giving priority to the quality of the data and not the quantity. Through the numbers you can get an idea of the market trend and how it is evolving and in which direction. Only through data are we almost limited by the obvious. Data is used as input; solutions are more original and with a more human touch (Team, 2020).

1.3 Architecture of a BI System

In figure 1.1 is shown the generic architecture of a BI system.

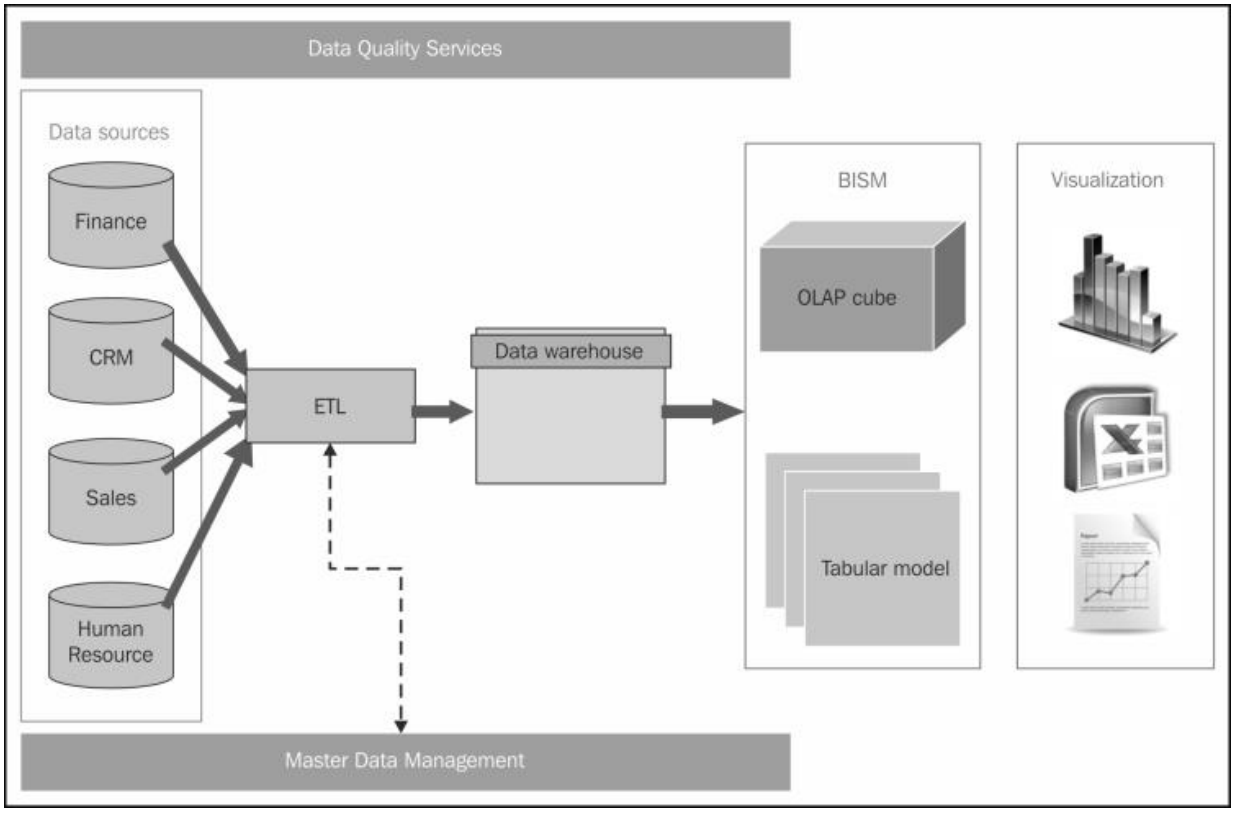


Figure 1.1: Conventional architecture of a BI system.

A BI System can be made in different ways, but conventionally four parts are always present:

- Data Sources

- ETL
- Data Warehouse
- BISM (Business Intelligence Semantic Model)
- Visualization

(Korobeyko, 2022)

1.3.1 Data Sources

The first important macro area of a BI system in the data source. A data source can be the initial location where information is stored and first digitalized. Data stored arrived by two sources: internal and external. The CRM (Customer Relationship Management), the ERP (Enterprise Resource Planning) and the SCM (Supply Chain Management) can be used as the reference for internal data and they provide information about all the business operations. Generally, operational systems are process oriented as they focus mainly on specific business operations such as sales, accounting, and purchasing (Hoffer, Prescott, & McFadden, 2007). External data are those that are generated outside the organization. External sources can be social media, government, market research or statistics or business partners and competitors. Those type of data are often used to make an analysis of the market and of competitors. It's very important for the organization to clearly identify where data comes from. Knowing the sources permits to easily answer to specific business questions and requirements and this means significant time savings and greater speed and information delivery (Hoffer, Prescott, & McFadden, 2007).

1.3.2 ETL

This part allows to standardize different sources in order to have homogeneity and consistency of what will be the data warehouse. Extract, Transform, and Load (ETL) involves the mining of batches of information from the data sources, conversion into

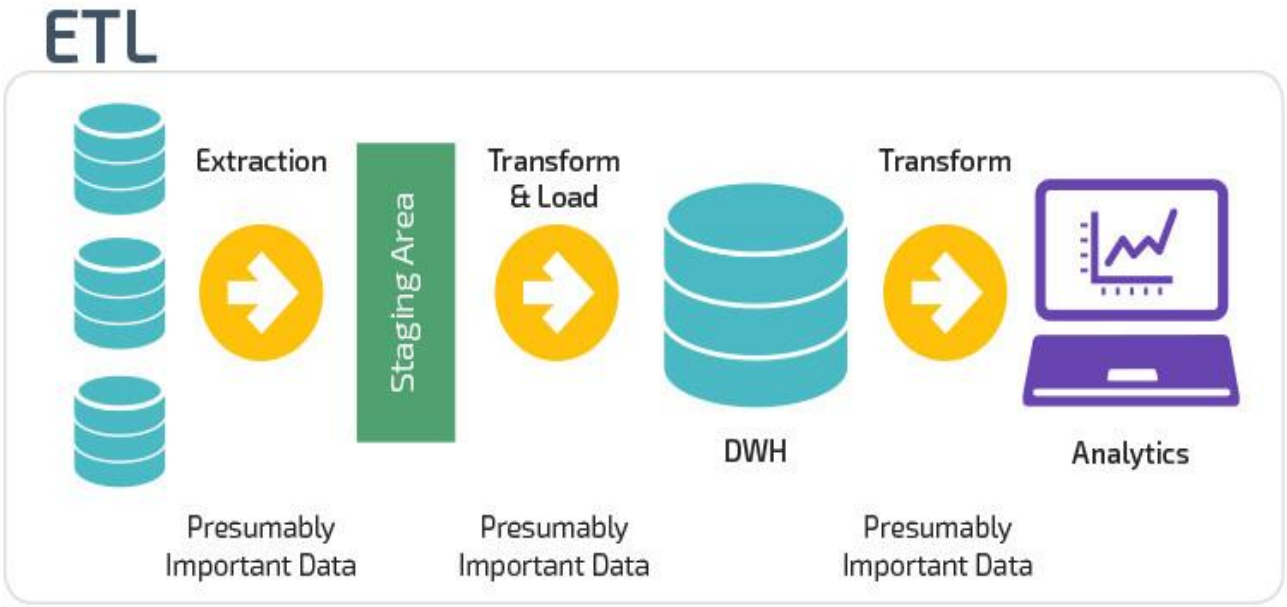


Figure 1.2 Etl Architechture

another format/structure (compatible with the system that are working for), and placement into ultimate storage. An additional element, that is part of ETL Process, is the "*Staging Area*" or "*Operational Data Store*" (ODS) and they are used in order to avoid the necessity to extract data again and have some troubles (Talend, 2018).

Figure 1.2*: Example of an ETL process.*

Here there's a description of the 3 most important passages

- **Extract**: Often the data from internal and external sources are incomplete or duplicated and errors are frequent, so the Extract phase is important to select which data are useful for the organization. In most cases this phase occurs at nighttime or at low activity hours in order to not have a bad effect on production operations. There's two types of extractions; Static, a simple snapshot of data (often this is the first that you made in a DW construction) or

incremental that can be seen as an upgrade of the previous data. Data are then cleaned (Talend, 2018).

- **Transform**: the transformation phase is the most critical. In this phase, the data is processed based on the company requests and the analyzes that you want to do. Cleanliness becomes fundamental, because otherwise it would be impossible to apply company rules. The data in this phase is grouped and sorted, summary reports are made and what was previously a large amount of data becomes a product ready for the final ETL phase (Talend, 2018).
- **Load**: The third and final phase involves loading the data into the DW system. There are two possible ways to do this: Full or incremental loading.
  Full loading means completely reloading the DW and deleting the previous one, Incremental loading instead means updating the previous data and maintaining those that have not been modified. There are some aspects to keep under control, such as exceptions. Often extractions may not be successful or despite previous activities some data may be of poor quality. at this point, monitoring and error management becomes a fundamental practice (Talend, 2018).

1.3.3 Data Warehouse

After the Transformation phase the data are stored in a properly database called the Data Warehouse. The Data Warehouse is divided in three parts:

- **Operational Data Store**: It's used to integrate the data that comes from the ETL Layer and store them in the Data Warehouse. ODS is a database that stores subject-oriented, detailed, and current data from multiple sources to support tactical decision making (Imhoff et al., 2003). Data in the ODS are volatile, it means that they can be overwritten. Generally the ODS does not store the data in any historical data, ODS is used to support operational processing and reporting needs from a specific application providing a business view.

- **Data Warehouse**: Inmon (2005) defines data warehouse as "a subject-oriented, integrated, time-variant, and non-volatile collection of data in support of management's decision-making process".

  Data Warehouse has these features:

  - **Subject Oriented**: Data from various sources are organized in macro groups that become from the same subject areas like sales, products etc..
  - **Time Variant**: each data stored in the DWH has to keep track of of the time dimensions. Doing this is possible to store historical Changes.
  - **Integrated**: Data Warehouse gathers data from different sources, and all of these must have the same format, in order to be consistent.

  Non-volatile: All the data are stored in read only wat. This means users are not allowed to update, over-write or delete the stored data.

  In summary the data warehouse collect data in order to make analysis and stores data, in addition it stores the historical data that allows to male long-term analysis.

  (Ong, Siew, & Wong, 2011)

- **Data Mart:** d A data mart, like a data warehouse, has the capacity to store data. Unlike a DWH, however, a Data Mart allows you to work on the requests of a specific department of the company and not its entirety. There are three types of data marts:

  - **Dependent**, created from an existing DWH, a bottom-up approach is followed where everything is archived in a single destination and then extracted when needed.
  - **Independent**, an autonomous system that does not depend on a DWH and which is focused on a particular business branch.

- **Hybrid**, they combine data from an existing data warehouse as well as other source systems. They offer the speed and user orientation of a top-down approach, plus the benefits of enterprise-wide integration of the bottom-up method

(Talend , 2021)

1.3.5 BISM

A data warehouse is designed to be the source to make reports and analysis, so it works faster than a normal operating system for producing reports. However, a DW is not enough faster to cover all the requirements because it's still a relational database (a relational database is a type of database that stores and provides access to data points that are related to one another, and that has a unique key) and it has a lot of constraints that reduce the response time. In order to solve this problem a new layer has been created and its name is the data model. The data model contains memory or file based of the data to provide a quick response. The solutions elaborated by Microsoft for the data model is split in two technologies: the OLAP cube and the Tabular Model.

The **OLAP** process extracts data from multiple unrelated sources, organizes the data, and stores it in cubes. Cubes, as opposed to the tables used by the more classic models. In each cube the measures, i.e. numerical data, are organized by dimensions, i.e. categories which can be, for example, geographical or temporal. These dimensions are structured through tree models in which the data has a parent-child relationship depending on the level of aggregation and detail. In a cube, therefore, the measurements are organized in a hierarchical manner, and each data or group of data can belong to multiple dimensions, thus losing the correspondence between value and label. Using this logic requires more effort in the programming phase, but a lower

database update frequency and in particular a shorter system response time (Condemi, 2022).

The **Tabular Model** means loading the records directly into memory and executing the query directly on it. This presupposes a high response speed of the system, but also a large demand for available storage space.

1.3.6 Multi-Dimensional Model

The Entity Relationship Model traditionally used in DBMS design, cannot bu adopted in DW implementation because of its complexity and suitability that makes the process too much slow. In addition, a DW model needs a concept of multidimensionality and aggregation of levels (Rudra, 2019).

The model used in the DW is the DFM, Dimensional Fact Modelling, created by Maio e Rizzi in 1998. This logic, which fits perfectly with the OLAP Cube, represents the DW as a set of tree-structured fact schemas describing the data-cubes (Rudra, 2019).

- **Fact**: is a focus managerial interest, usually an event occurs dynamically. for example, facts in the commercial domain can be sales, shipments or complaints.
- **Measurement**: the numerical property of a fact, for example the quantity sold.
- **Dimensions** are the details of a fact that describes it, in the case of the sells they could be products, stores or categories.

As a prerequisite you need to find the facts of interest in the DW, and to do this you follow 5 steps:

  - Building the Attribute Tree
  - Pruning and grafting the tree
  - Defining the dimensions
  - Defining the fact attributes

- Defining Hierarchies

(Ong, Siew, & Wong, 2011)

In the image below we can see a cube dimensioned by Route, source and time all with their hierarchies and dimensions. The measurement can be for example the quantity transported on a specific date. The Hierarchies is fundamental because it provides the possibility to make subsequent data analysis.

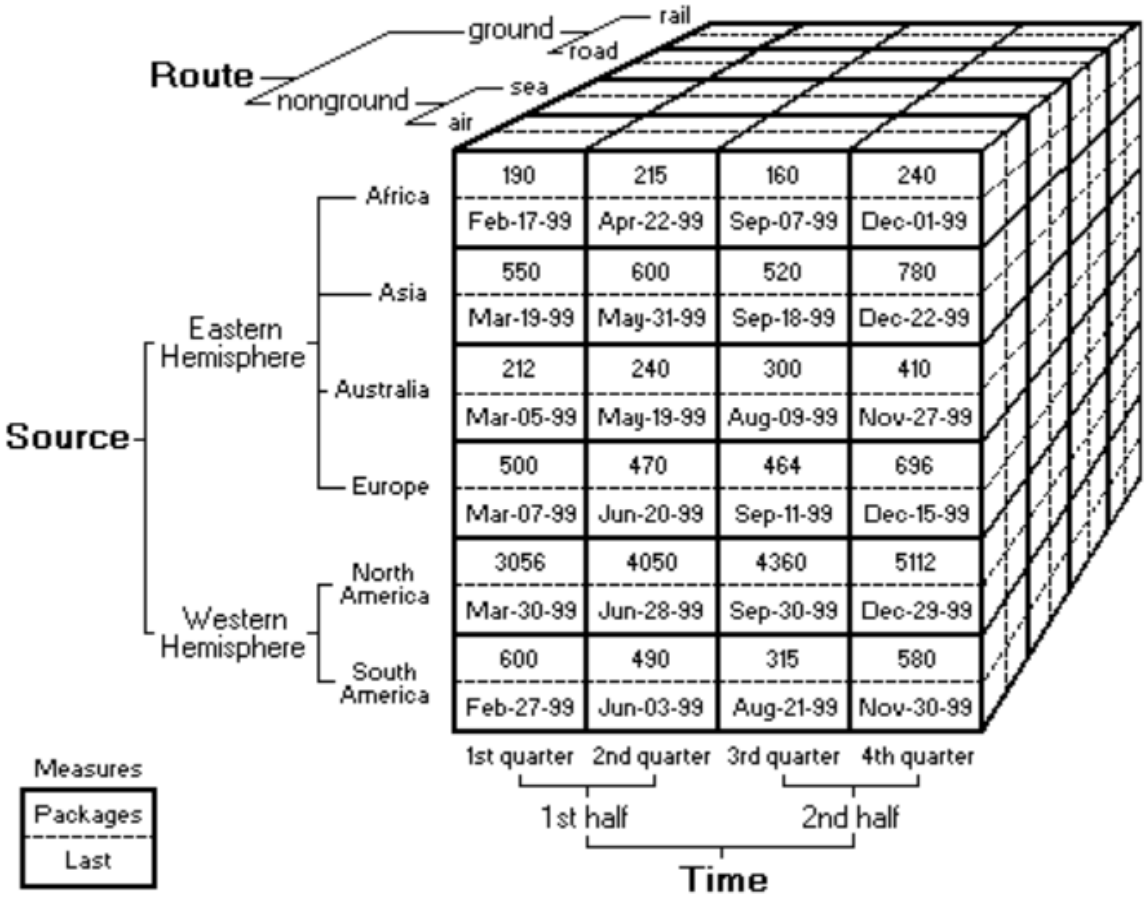


Figure 1.3 Example of a multidimensional model data cube

In this photo the hierarchies are, for example:

- Source: Hemisphere – Continent
- Time: Half – Quarter
- Route: No/Ground – Way

There are a lot of operations that an OLAP can make in order to analyze, report and model the DW, and these combined with the DFM logics allows users to perform in a more efficient way, the most important four are:

- **Drill-Down**: Going down to a lower level in the hierarchy, reducing the level of aggregations of data.
- **Roll Up**: The inverse of drill down, and so increase the level of aggregation (for example from quarter to half in time example).
- **Pivot**: Rotate the axis of cube in order to have a different perspective of data.
- **Slice and Dice**: Increase or decrease (Slice and Dice) the number of components of the cube in order to see the total or to split it in more dimensions.

(Ong, Siew, & Wong, 2011)

1.3.7 Data Visualization

The last part of a BI system is the Data Visualization, after collecting, transforming and loading the data it's fundamental to show them in a properly way to help decision making. In poor words the visualizers' tools are what the final User can see (Ong, Siew, & Wong, 2011). Ther a are a lot of visualizing and reporting tools in the market. Excel for example presents the opportunity to be connected to an OLAP system and can be used to show KPIs, but Microsoft provides also Performance Point, an extension of SharePoint, that performs at its best when connected to an OLAP and it's specialized in dashboard. Another important tool in analysing data is reporting, starting from raw data the report is the end and shows the results. An instrument used in this field of BI is Microsoft SQL Server Reporting Services, that allows final user to build reports that belong from different data sources.

CHAPTER 2

BOARD

During my curricular internship I experienced a period working for Bios Management LTD, an IT consulting firm with Headquarter in Santa Vittoria D'Alba (CN) but with offices all around Italy and Europe. In the first five weeks I did a training period, during which I learned the basic skills and functions. After this initial phase I start working on real cases following the customer needs, implement it with the help of other consultants immersing myself in an immersing myself in a new corporate reality and in a constantly changing work environment.

The Company is relatively young (2004) and works to accelerate automation using digital solutions for finance and decision-making processes related to Corporate Performance Management such as Financial Planning & Consolidation, Cost Allocation, Fast Closing Budget, Forecasting, Profitability & Performance Modelling. They work through software such as already mentioned Board for Enterprise Performance Management Processes and then Arxivar, Qlick, Power BI and Zucchetti for all the others company's branches.

Figure 2.1 Bios Management Logo

It operates collaborating with clients, sharing strategies and helping them in the implementation through platforms of their needs.

In particular, it implements improvement projects from the operational and technical point of view by analysing and enhancing internal processes, while maintaining the goal of company growth in terms of people, turnover and KPI achievement.

2.1 Board

Board is one of the leading decision making platforms on the market and helps thousands of companies worldwide developing business intelligence, corporate performance management, analytics and more all in a single solution. The software is intuitive and does not follow programming languages. Board offers solutions for a variety of business functions, in particular for:

- Finance
  - Budgeting, Planning and Forecasting
  - Profitability analysis
- Supply Chain
  - Sales and operations planning
  - Demand planning
- HR
  - Workforce Planning
  - Performance Management
- Marketing
  - Sales Analytics
  - Salary and incentive management

In particular for all these activities permits to implement procedure of Business Intelligence (Score carding, Dashboard, Analysis, Reporting), Performance

Management (Profitability Analysis) and Predictive Analysis related to machine learning more in deep.

Figure 2.2 Board's Logo

Board Can be accessed in two different ways, in Cloud or Locally:

- Board Cloud: it offers all the features of the platform with also the possibility of the benefits that a powerful cloud infrastructure can guarantee in terms of reliability, security and performance because it's supported by Microsoft Azure. Using Board Cloud all the updates and issue are handled by the Board Cloud team, that works independently.
- Locally: you need to install some services (like a VPN or the Client) and then it's possible to work directly on your pc using the link with the customer

2.2 Board Licenses

There exists different types of licenses in board that allows to do different things, in particular presents differences in which part od the system they have access to and the functionalities they have.

The most important are:

- **Lite**: User has the ability to view the environment but not to modify it
- **Lite Plus**: User has the ability to flag the data views and tables, and to insert number if it's necessary.
- **Power User**: for this type of license is possible to modify the design of the screens and all the functionalities of licenses above.
- **Developer**: This user has all the functionalities and also the possibility to change the database

In the System Administration' Sector "Licenses" you can observe the License Status that allows you to monitor the expiration date, the amount of users associated to each one of those types of licenses and their maximum capacity available.

2.3 Board Structure

After the Login the user is redirect to the main page page of capsules, in which you can navigate the screens and that's the part specific for reports. More in general the Main Menu of board is on the left top corner of the page, and here are present all the sections that you can use in order to program the system. All the functionalities, all the troubles and all you need in order to solve your problem on boar application is on the board manual, it's very used also by consultant and gives a complete view of this BI system.

Board is a BI platform designed to provide accurate and complete views of the company's financial and operational information from corporate data at a glance,

allowing corporate decision-makers to have full control over performance across the entire organisation and its internal sub-functions. (Board Manual)

The Main Menu on board Is divided in five sections, that manage different parts of the system:

- Capsules
- Presentation
- Cognitive Space
- Data Model
- System Administration

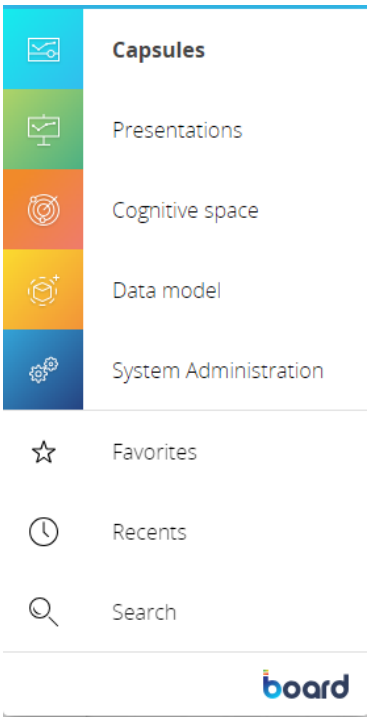


Figure 2.3 Board's Main Menu

There are then three more sections: Favorites in order to save the screen that you use more in order to reach them easily, Recents that allows to reach the last capsule that has been modified, Search that is a tool used to find a capsule or a screen

2.3.1 Capsules

Capsules are usually made up of screens that can be of different types, in which information is arranged to facilitate business decision making and analysis.

It's the part destinated to the end user. Moving between the screens and updating them the end user can manipulate data, updating data model and analyze the data obtaining useful information.

Capsules can be seen as a combination of screens and procedures showing all the reports and allowing to use in an interesting way all the functionalities of the BI system. Capsules do not store any data, but are recognizable as the containers of the data presentation objects such as tables and graphs. A capsule contains within it several screens that are just like the slides of a presentation, which, in addition to data and graphics, may contain buttons that initiate procedures or facilitate navigation.

Capsules can be identified in several categories:

- Analysis capsules with graphs and tables, designated only for displaying the data without modifying it (if not updating it)
- CPM and BI capsules that allow reports to be created and that integrate the data visualization phase and data entry options, thus adding instant data to the analysis.
- Capsule for setting up the system and the relationships between the various entities.

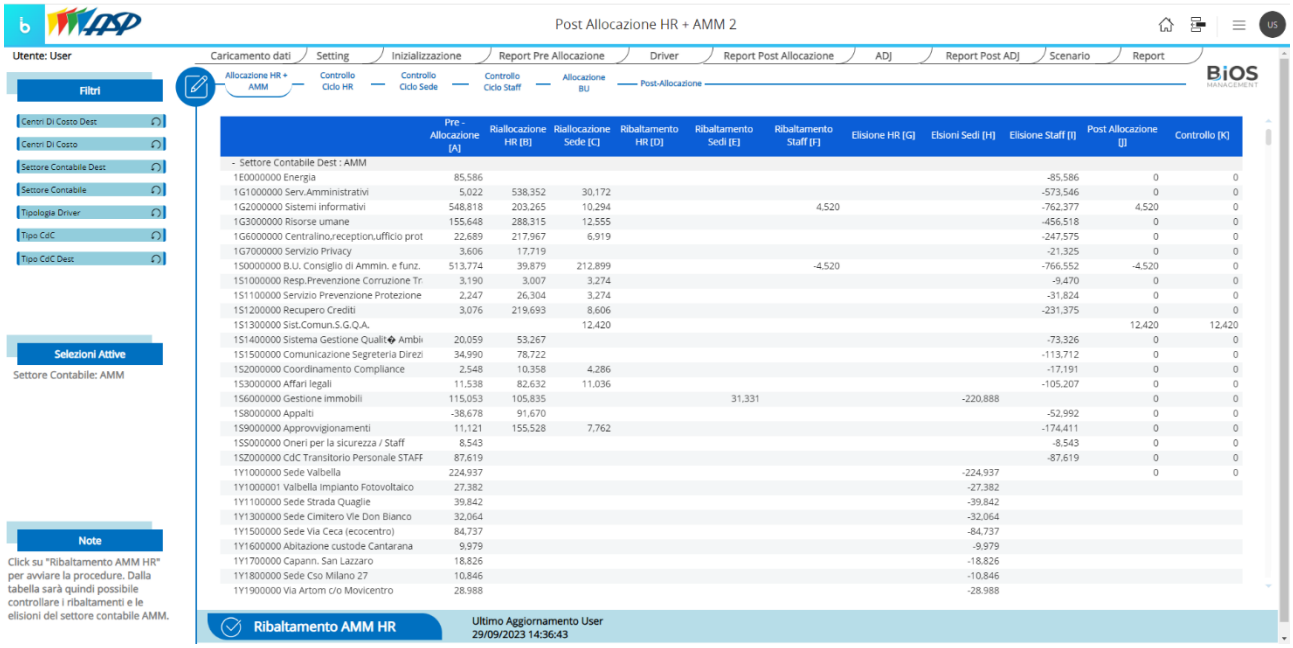


Figure 2.4 example of a screen

2.3.2 Presentation

This section serves to display the data in a simplified manner, arranging the screens in the order you want and being able to take them from different capsules.

From Presentation it is also possible to send automatic e-mails so that snapshots can be shown continuously to those who want them, such as sales agents or sector managers who do not have the skills to use the system (Board, 2023).

Like a SharePoint, presentations can be modified simultaneously by many users without using other software, all that using board.

In the figure 2.5 below you can see the main page of presentation sector, with all the screen ready to be sent.

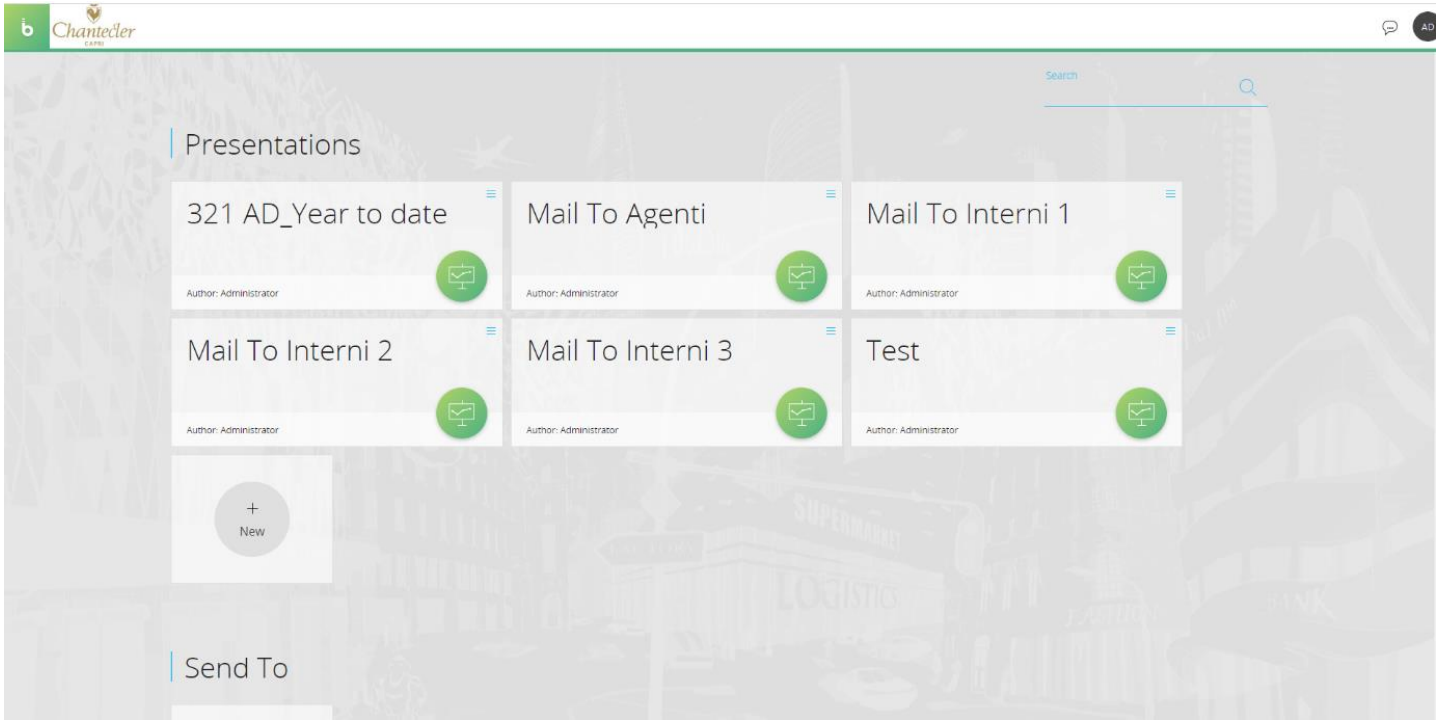


Figure 2.5 Presentation Menu

2.3.3 Cognitive Space

The cognitive space section is a kind of search engine within the board environment, allowing data to be consulted using natural language and obtaining an immediate response from the system (Board, 2023).

Thanks to the introduction of NLR (natural language recognition) and NLH (natural language generation), the software translates what the user has written in natural language into queries and provides the required reports. In addition to this, it also provides on-the-fly descriptions from which the user can easily obtain insights into what he has requested (Board, 2023).

The following picture shows the result of a search and presents a graph that the system considers as the best response and a list of screens related to the capsules.

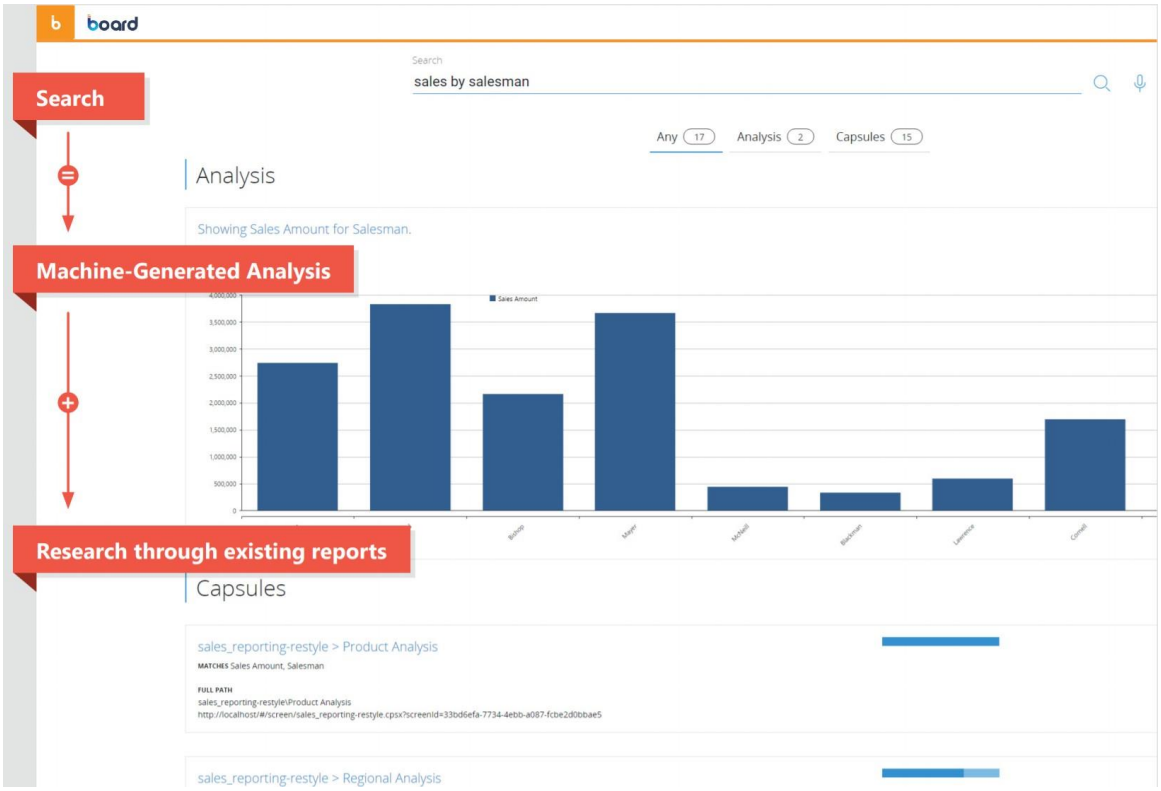


Figure 2.6 Example of Cognitive Space in Board

2.3.4 Data Model

Board makes it possible to handle a huge volume of data by processing it through multidimensional models. This is because there are many variables to be considered within a process and it is necessary to consider more than one of them simultaneously. A multidimensional model works by creating data cubes. As explained in the previous chapter (add reference), each data intersection (cell) of a cube forms a piece of data.

The dimensions of the cubes are the entities that are in turn managed hierarchically according to their granularity. A sales cube can for example be formed by 'Facts', that

in board are the entities, such as Date, Manufacturer, Customer, Delivery Number, Category.

A multidimensionally modelled cube allows Sales to be evaluated as a function of all variables together or just based on part of them, changing the settings according to what you want to observe.

Board allows you to work on the cube concept by using entities, that is, these multidimensional concepts where the numerical data are normalized according to the

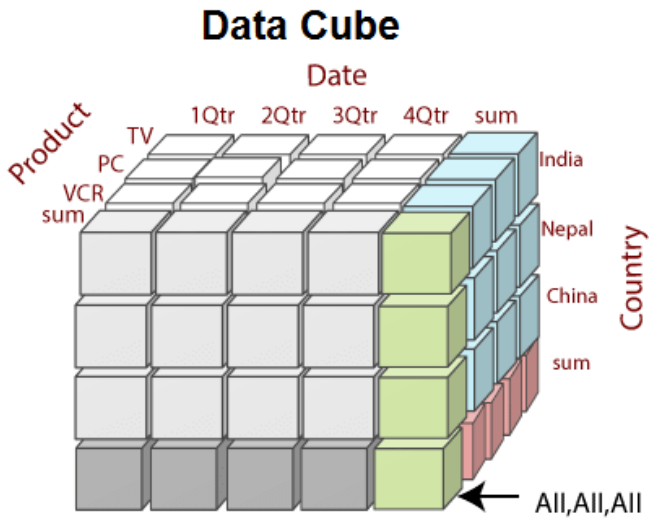


Figure 2.7 Example of the structure of a data Cube

intersections that you have between them, an example can be the intersection that you have in the sales cube when an entry is recorded, this will be marked by date, shipment, category, manufacturer and customer thus going to fill a cell of the cube.

Before implementing and going to create entities and cubes, however, it is necessary to follow steps in creating and setting up the data model. The main ones are:

- *Creation of the data model*: this is done from the main section by going to click on "+ Data Model" and assign the title to which you will refer.

- Once this is done you need to assign the time variables, what are called *Time Range* on the board. The Time Range is the interval of time of existing data time and expand it for a few years in the future for planning purposes.

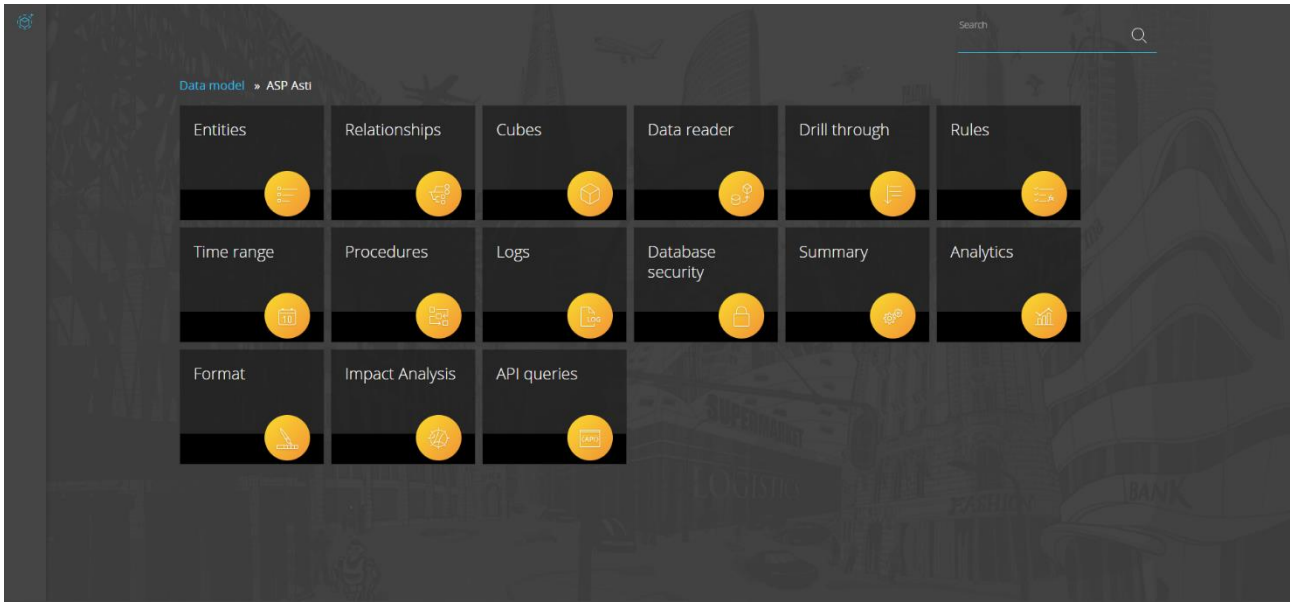


Figure 2.8 Main Menu of Data Model

2.3.4.1 Entities

It is therefore now possible to go on to create the actual cube bricks, the *entities*. They are usually string type fields containing text or alphanumeric codes describing elements such as Customers, Products, Cities, etc. A single occurrence within an entity is called a 'Member' (Board, 2023).

Easy and intuitive steps are taken to create them:

- **Name**: a unique name must be assigned to each entity so that it is clear what it will be populated with
- **Group**: Category to which the entity belongs, to make it easier to find it
- **Code and Description**: Maximum number of characters that make up the members at both code and description level.
- **Max Item Number**: Maximum number of members that make up the entity.

- **Sort By**: Defines the sorting and can be by code, description or customized.
- **Display**: in this section you decide whether at report level you want to show code description or both, it is a choice that can be modified later.

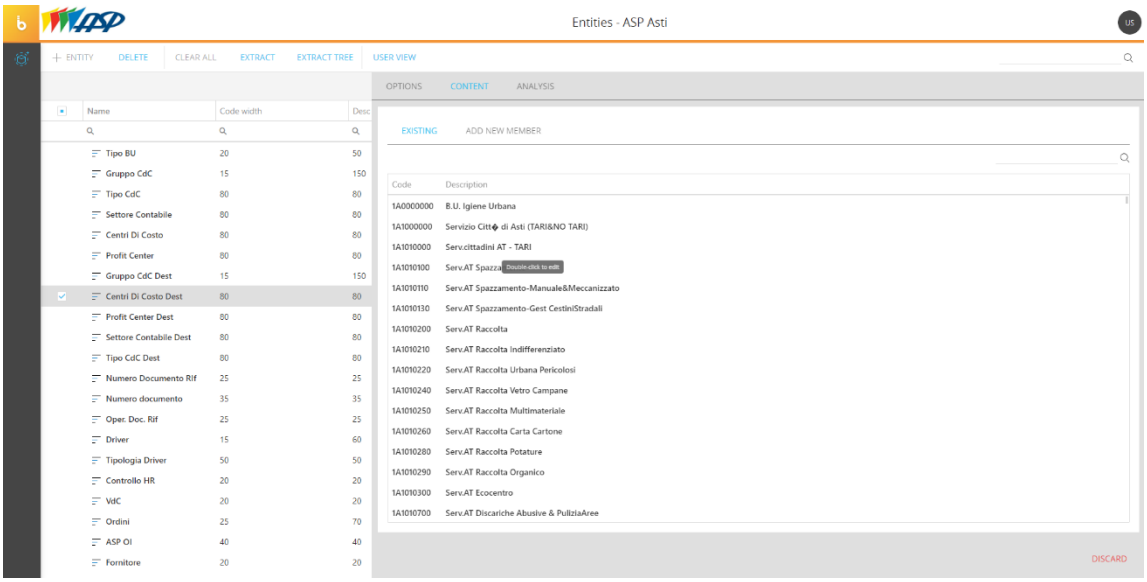


Figure 2.9 Example of a List of entities with Focus On "Centro di Costo Dest"

2.3.4.2 Relationship

After creating the entities, it is necessary to manage the hierarchical levels, and in this respect, Board has a section called *Relationship*, of the Data Model, which allows the entities to be related to each other and to visualize as a tree diagram what are the links between the various relationships. It also allows relationships to be normalized and to assign a default member to those without a level or 'parent' entity.

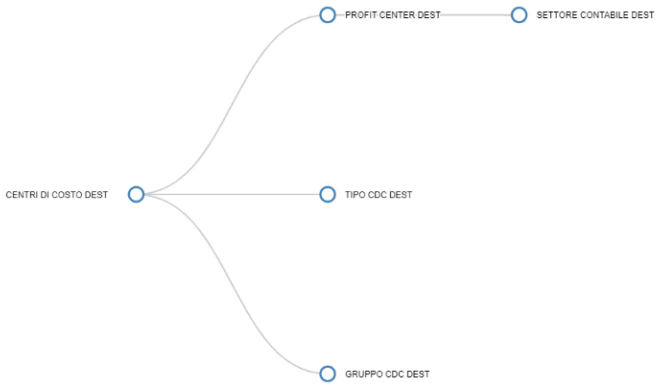


Figure 2.10 Example of a Relationship Tree.

The absence of hierarchical structures may lead to inconsistency and redundancy of data (Board, 2023).

2.3.4.3 Cubes

The creation of the *cubes* is the last part before the load of the data, like the entities the passage are simple and intuitive. You must give a name to the cube, a group. Each cube than can have from 1 to 32 dimensions but it's better to not exceed 8 in order to not make the system too cumbersome for the end user.

The data within the cubes, as well as the members of the entities are imported onto the board via a specific section of the data model, i.e. the *data readers.*

Within this section, the mapping of data onto entities is also managed, relations and cubes. During the import of data, these can be modified via a specific section of the data reader which is the ETL.

Board utilizes different data providers for importing the data:

- Open Database Connectivity (ODBC) standard and OLE DB for connecting with relational databases.

- Csv and Txt files.

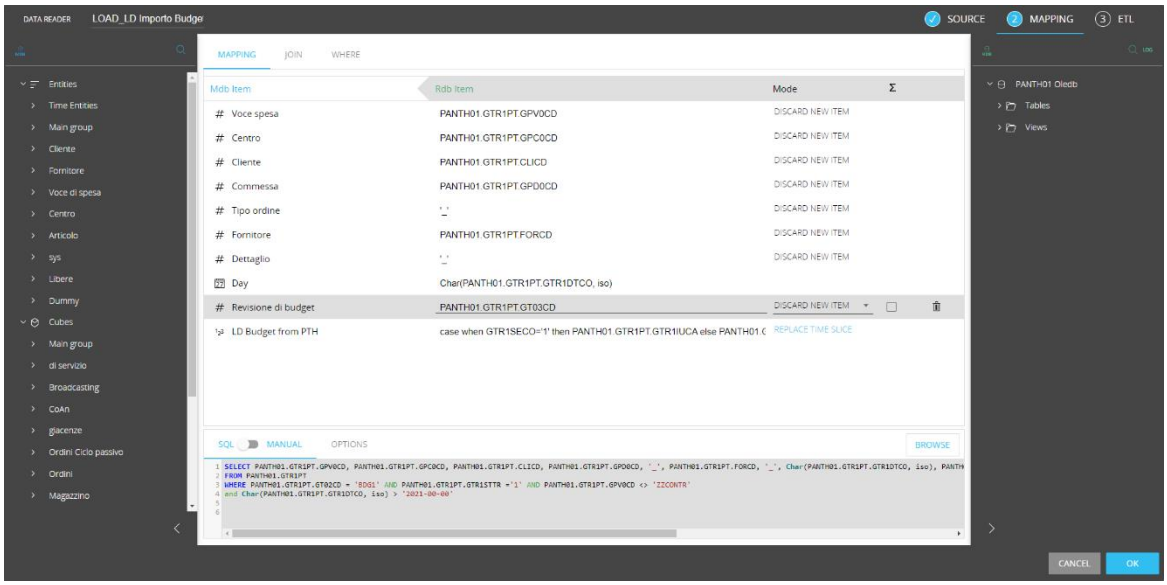


Figure 2.10 Example of a Data Reader with SQL

In order to be able to handle large amounts of data, Board also implements solutions to avoid overloading the system, such as the possibility of discarding already loaded elements via the discard option. Furthermore, by means of a 'Sparse' cube logic, it can recognize empty cells in a system, thus avoiding loading them into the cube (Board, 2023).

2.3.4.4 Procedure

A procedure is a list of actions, which can be programmed and customized, in order to achieve a certain goal. A procedure is capable of performing a wide range of tasks: for example, it can be used to perform calculations, to extract data, to move through screens or simply to invoke other actions of the data model. They can also be used for hidden data processing tasks, from simple calculations of values in cubes to complex allocation procedures required in business models such as budgeting, planning, forecasting, profitability models and general business simulations.

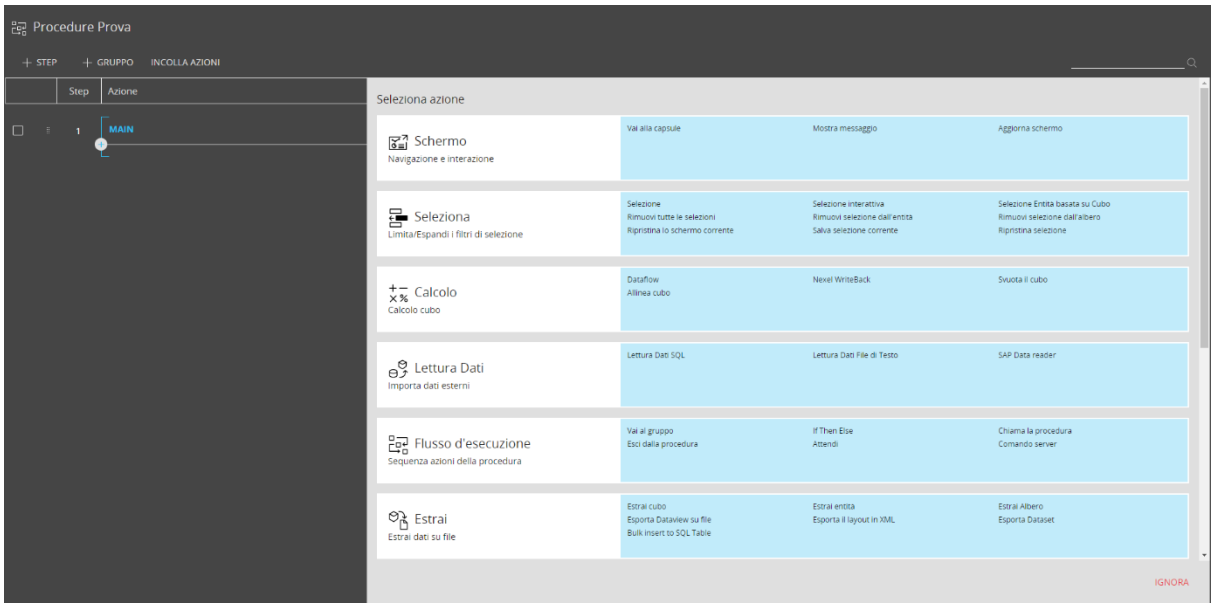


Figure 2.11 Implementation Menu of a procedure

Each step in the procedure is called an action and these can be divided into groups according to how they function. An action can execute a data reading protocol, perform a calculation step (called a dataflow) on a cube, extract data from a card and much more.

Some actions can be automated while others can ask the consultant or user to apply selections or confirm the intention to proceed for example.

Procedures can be executed and launched in three different ways:

- Automatically activated when a screen is opened so that the data updates (procedure trigger)
- Via banners inside the screens that act as keys to start the algorithm.
- Run as a batch process, launched via command line or from a scheduler.

2.3.4.5 Rules

Rules are small calculations that can be made on entity members. Rules can be created in the Rules section of a data model. Using a rule it is possible, for example, to create a P&L; which after receiving data from data readers can be implemented so that the various members (which will be part of an entity) are added to and subtracted from each other in order to have what is desired, irrespective of any active Selection on that Entity (Board, 2023).

A rule is always associated with a single Entity and may be used with (or applied to) all cubes that have that Entity as a dimension in their structure.

2.4 System Administration

System administration is used to manage, from a technical point of view, a single environment. Those who have access to this environment, through the necessary authorization, have the possibility of managing users, security profiles, licences, the graphic theme of the platform and much more.

This area can be divided into different sections, depending on which part of the environment one wishes to manage:

- In *Users and Security* - or Security in case the platform is not associated with a Subscription Hub - you can define access authorisations to capsules and folders, their modification, and in particular the modification of the data model (only through the 'Developer' licence can you access this section). It is also possible to manage Users and, if a Subscription Hub is associated with the platform, to access it immediately.
- Under *Monitoring* it is possible to review user activities, see which tasks that are currently running and configure system logs. Platforms not associated with

a Subscription Hub will also show details about the main Board license, users licenses and which additional features are enabled.

- Under *Administration* it is possible to manage the Broadcasting function, that allows to send via e-mail a Board Presentation to a list of recipients on a scheduled basis, configure Data sources for Data models, translate text strings according to selected languages, define visual elements of the user interface, upload taxonomies for iXBRL reports and configure the internal search engine of Board.
- Under *Transporter* it is possible to take Data model snapshots in order to compare them and apply metadata changes from a source Data model to a target Data model. Entities, Cubes and Relationships can be transferred, but not the actual data. It is also possible to execute this process via Windows PowerShell, command line or Unix shell.

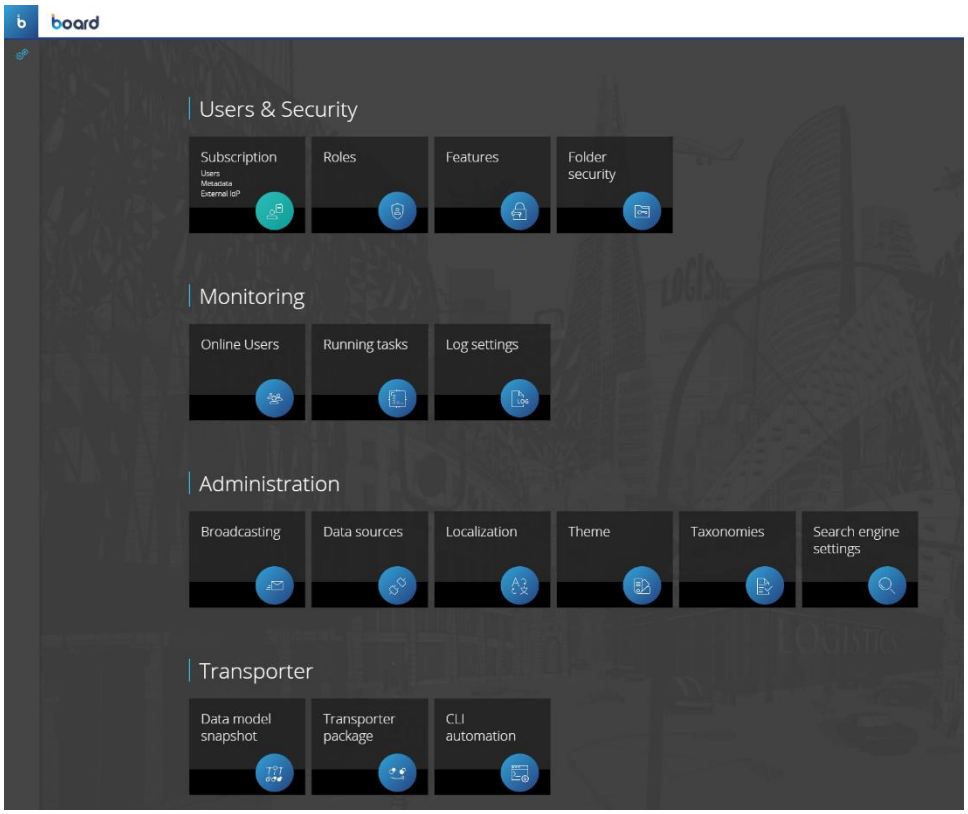


Figure 2.12 System Administration

2.5 The Gartner Magic Quadrant

A Gartner Magic Quadrant is the culmination of research within a specific market that provides a great view of where competitors are positioned within the market.

Through the application of graphical treatment and a uniform set of evaluation criteria, a Magic Quadrant helps to quickly verify the degree to which technology vendors' stated visions are realized and how well they perform against Gartner's view of the market (Gartner, 2022).

The Magic Quadrant provides a division of vendors of a specific technology into four types, the differentiation between them is clear:

- *Leaders* implement the current market vision well and are strategically positioned for the future, ready to embrace change and innovation.
- *Visionaries* understand market trends and can see changes but are not yet able to implement them.
- *Niche players* either focus successfully on a small segment or are not focused and do not innovate or outperform others.
- *Challengers* are very important in the current market, but they are not able to understand the direction of the market.

Board was recognised as a *Leader* in the Gartner Magic Quadrant 2022 for *Financial Planning solutions*. Strengths of Board's Intelligent Planning platform that were highlighted include: "structured support for application deployment at the customer's site"; "powerful collaboration capabilities"; and "advanced innovation".

According to Gartner®, 'Board's product provides the data, scalability and flexibility to address complex business planning challenges in a single integrated application' (Gartner, 2022).

Figure 2.13 Gartner Classification

CHAPTER 3

NORTHWIND BUSINESS CASE

3.1 History and overview of the Company

In the early 1840s, life in Ireland took a harsh turn. To exacerbate the situation, the infamous Great Potato Famine struck in 1842, compelling a significant number of people to abandon their farms and seek settlement just across the Irish Sea in the English cities of Liverpool and Manchester.

Among those who undertook this journey was James Northwind, a market trader from the small town of Ballynahinch in County Down, Northern Ireland. Married to Mary, he was the father of two sons, Joseph and James Junior. Shortly after his relocation, James ventured into the trade of cooked meats, specializing in bacon and hams. In 1843, they formalized their business, marking an official move from Duncan Street to Salford, Manchester.

The success of their enterprise was noteworthy, leading to the establishment of additional processing and distribution centers in Liverpool, Birmingham, and the Isle of Man. In March 1941, J. Northwind & Sons Ltd achieved the esteemed status of a Danish bacon agency. For eight successive generations, and continuing to the present day, the Northwind family name has symbolized high-quality, exceptionally flavorful bacon: Northwind Bacon.

While a substantial portion of their bacon was imported from Denmark, another significant part came from English factories. Bacon held a pivotal place in the diet of that era. It wasn't until the 1950s and 1960s, with the introduction of major breakfast cereals from the United States, that breakfast habits began to evolve. Some of these innovative ideas might have been introduced during the time when Americans were stationed here during World War II.

Operational activities involved the smoking of bacon and the cooking of hams, as evidenced in the attached image 3.1. Bacon was transported in bales, and the antiquated delivery method, using flat-roofed vehicles, can be observed. Intriguingly, such vehicles remained in use until the 1970s, a practice that might not align with contemporary standards. Throughout the 20th century, the primary focus remained on supplying meat to butchers and retailers across the North West of England.

Figure 3 Transportation of Bacon

In the following years, the company underwent significant expansion, beginning to export a wide range of food and beverages and evolving into an international enterprise. Bacon became a niche sector, almost a specialty, leading to the hiring of sales representatives and the company's transformation into a multinational corporation. At present, the original family holds only a small stake in the company.

This company has been a Board customer for almost ten years and has consistently sought the development of a BPM application capable of assisting them in their everyday tasks.

3.2 Brief overview of the project

The project I participated in is an integral part of a comprehensive system that encompasses not just programming but also financial closures and a Database Management System (DBMS). My responsibilities predominantly revolved around:

- **Budget Management**: This facet of the application empowers the creation of future-year budgets, encompassing the analysis of costs, margins, and ongoing marketing initiatives.
- **Production Analysis**: Within this segment, one can scrutinize exports, categories, days overdue, and all aspects related to the operational side of the business.
- **Administration Module**: This module facilitates the management of the administrative aspects of the system, called CEO area.
- **Utilities Department**: Supervisors within the company leverage this section to review and modify data relevant to the aforementioned segments.
- **Sales Department**: This department allows sales personnel to analyze customers, update sales records, and, most importantly, keep the company informed about incoming and outgoing flows for comprehensive situational monitoring.

With the aim of establishing a completely new environment, there were basically three tasks to complete:

- *Client Communication*: To completely grasp the needs of the client and make sure that every single one could be satisfied by the BOARD platform, it was imperative to have a conversation with them. This required a thorough comprehension of the specifications and the conversion of those requirements into workable solutions.

- *Environment Implementation*: After assessing and understanding the demands of the client, the ideal environment has to be put into place. This involved importing data from pre-existing databases, which were mainly maintained via SQL. In order to handle client data correctly and provide the necessary functionality, the BOARD environment has to be designed and developed.
- *Building an Appealing Front-End*: The third request was to design a front-end interface that was easy to use and had seamless page transitions. It was also essential to guarantee precise and timely calculation execution. This required creating an eye-catching user interface and streamlining computations to deliver accurate results and prompt responses.

To put it briefly, the objective was to satisfy the client by means of clear and precise communication, precise execution, and the development of an interesting and highly functional user interface.

Following the customer's needs, our colleagues and I opted to partition the environment into five distinct sections:

- *BI Analysis* was the section that dealt with all matters pertaining to profitability and sales KPIs. It was centred on a thorough examination of corporate data to facilitate well-informed decision-making.
- *CEO Area*: Using tables and charts showing all of the important metrics, this area was created to give the CEO a concise and understandable summary. It was made mobile-friendly so that users may conveniently access it while on the go.
- *Marketing*: Tools to maximise marketing and promotion tactics were provided by discussing price and product management in this section.
- *Forecasting*: The budgeting component of this section allowed for precise resource and future activity planning.

- *Planning*: This part included sales and agent management and provided resources for performance evaluation and sales activity planning.

The separation of the environment into sections was done with the intention of efficiently organizing it so that each department could immediately access the functionality and pertinent information for their work.

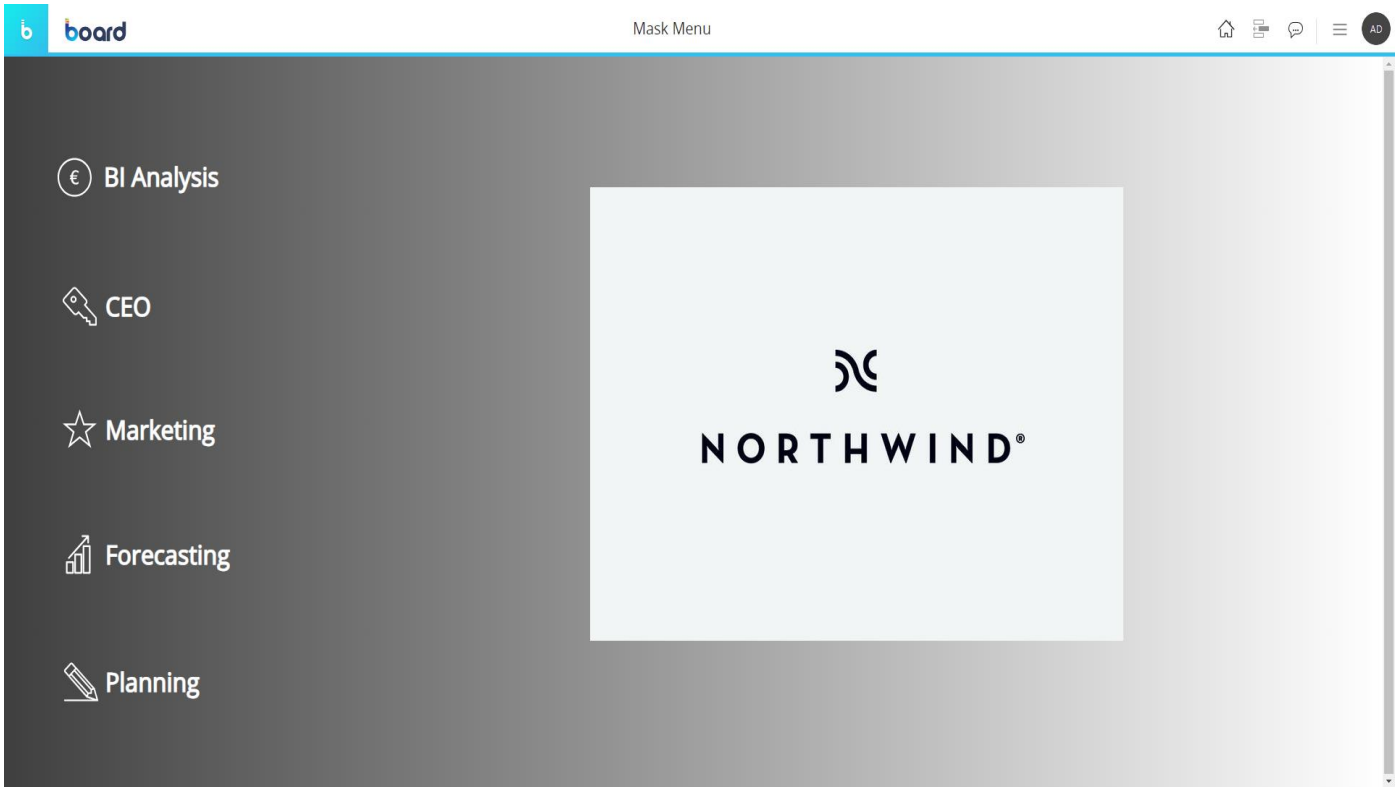


Figure 3.2 Transportation of Bacon

3.3 Data Model Creation

Making the structure is the first stage in putting the programme into action. Entities, relationships, and cubes are just a few of the components that must be filled in for the data model to take shape. To do this, we developed a unique data model for the project and programmed the whole thing by interpreting their demands.

3.3.1 Entities

The time range is always the first entity to set up, and it's the most important one because it specifies the temporal range that can be used to gather data. The system will be allowed to collect data within that timeframe, reading all records made up to those dates, for instance, if you set a time range of 2010 to 2023. Setting the data granularity is also essential. You must indicate the least aggregated scale; for example, selecting days allows data to be sorted by month and year. For this project, we decided to use days as the granularity and gather data from 2018 to 2025.

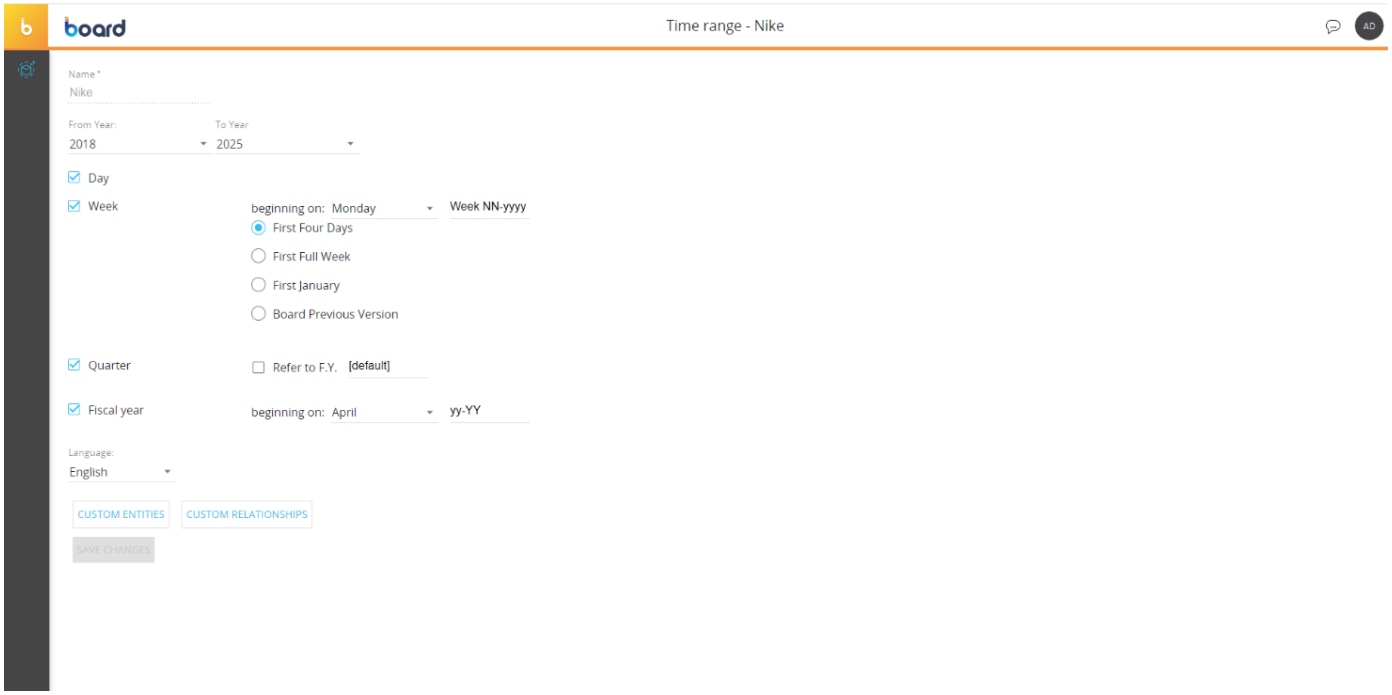


Figure 3.3 TimeRange screen

The remaining entities and groups for the project, which are the parts that will enable data visualisation, can then be highlighted and created. The following are the primary groups in this project along with their underlying entities:

- *Customer*: This group, which includes the designated representatives and area managers, describes the qualities of Northwind's clients.
- *Dataflow* and *Test* are two entities that are used as supporting elements in calculations. They can be used, for instance, to indicate a decision or the beginning of a process.

- *IBP* is an entity that handles currency conversion, which is especially helpful for exporting businesses.
- *Product* This object describes the properties of the goods that are shipped.
- *Document* This entity holds all the shipping documents' contents as well as all the bureaucratic data related to shipments.

Apart from these, a plethora of other entities are employed as needed or in particular situations to provide support.

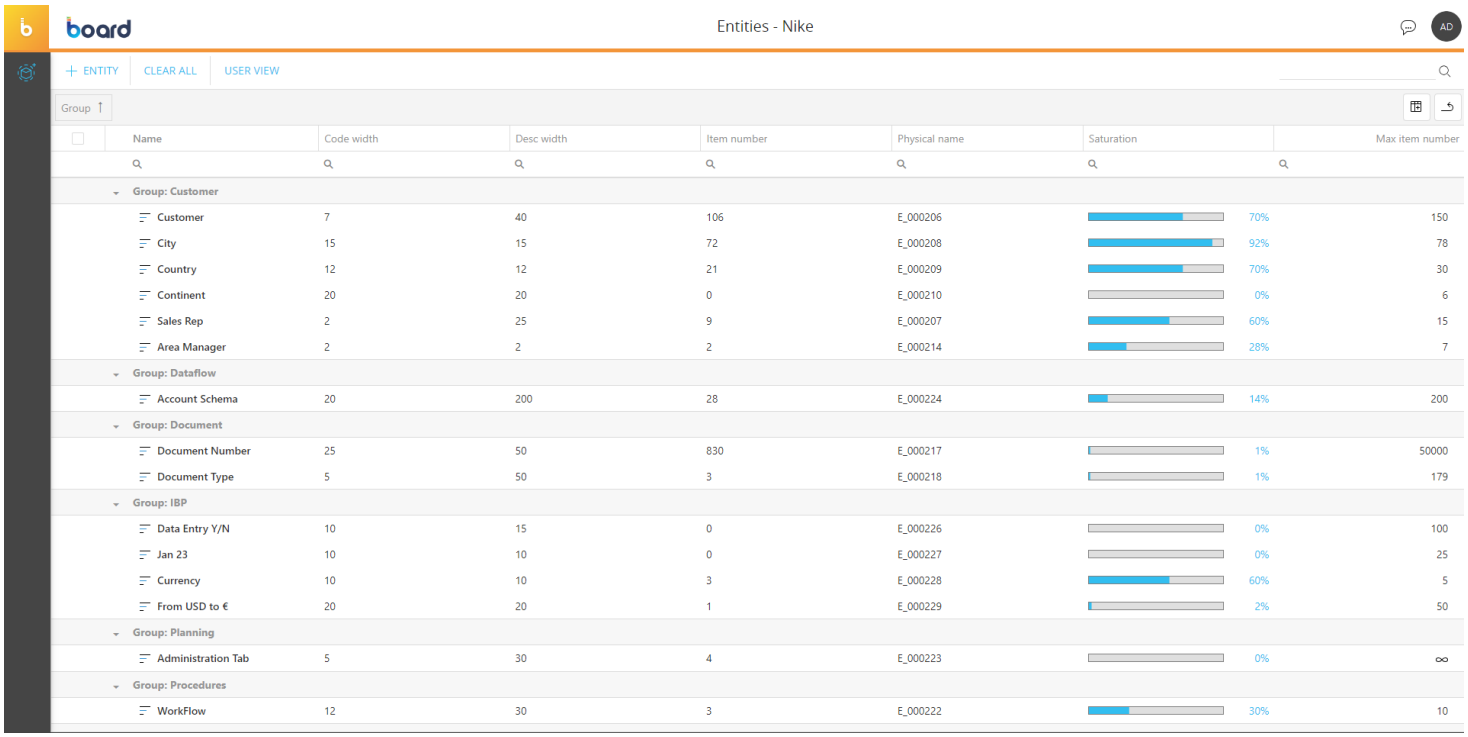


Figure 3.4 Enitities' Group of the Project

3.3.2 Relationships

Relationships between the entities must be established after they have been mapped. As previously discussed in the chapters, relationships let users define the connections between entities so that they can visualise data anyway they see fit. Building connections also makes two key processes easier:

- *Roll-Up*: To reduce dimensions or generalise values inside the hierarchy, this operation aggregates measures. It might, for instance, use information from

"quantity sold by brand" to determine the overall "quantity sold by category." (Board, 2023)

- *Drill Down*: The feature "Slice & Dice" is comparable to "Drill Down." This feature enables you to view data at a more detailed level. To obtain a more detailed perspective, you can switch, for instance, from "quantity sold by brand" to "quantity sold by model". (Board, 2023)

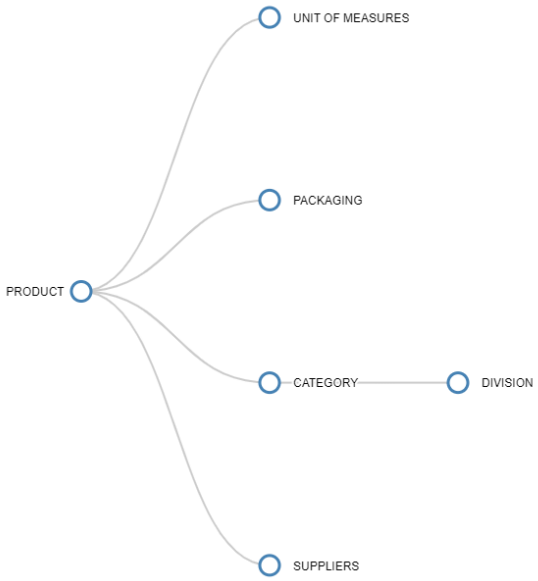


Figure 3.5 Example of Relationships

3.3.3 Cubes and Data Reader

The first step in creating an Infocube is defining its properties, which include the cube's name, group, and data structure. Board supports the following four types of data: text, double, integer, and currency data. If the data to be submitted is numerical, the selection typically falls into one of the first three categories, especially if the data being examined has more decimal digits than seven units.

Define these items as a necessary initial step for the study that follows, as the platform offers several configuration possibilities. This section will also demonstrate how the various cubes utilised in the project are arranged. Since the platform offers

multiple configuration options, defining these items is essential to moving forward with the research. The configuration of several of the cubes utilised in the project will also be shown in this section.

After establishing the characteristics, the programmer must next input the cube's structure, which involves setting its axes, up to a maximum of 32 (reaching beyond 8 could place undue strain on the system). Indicating the cube's group membership at this stage is also essential, as it enables the grouping of data loaders from the same industry or business region.

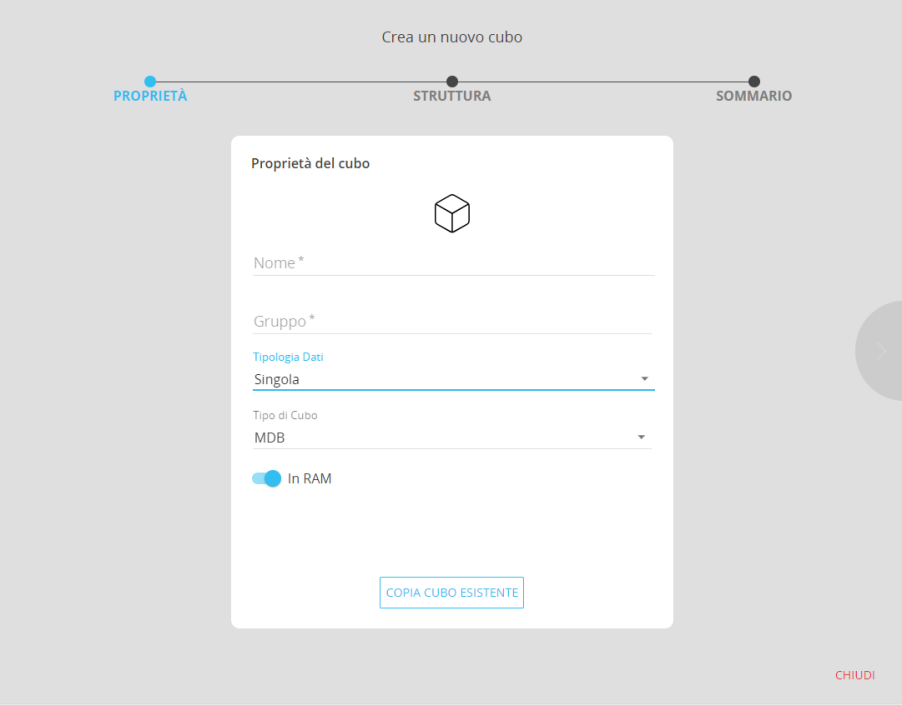


Figure 3.6 Creation of Cube

When you're in the process of creating a multidimensional cube, it becomes essential to determine whether a particular dimension should be considered as "dense" or "sparse." In this context, "sparsity" pertains to how data is distributed within the cube concerning that specific dimension.

A "dense" dimension suggests that many value combinations within it are populated with actual data, while a "sparse" dimension indicates that only a small portion of combinations contains relevant data. The choice between density and sparsity hinges

on the objectives of your analysis and the structure of the data. Sparsity proves advantageous when numerous combinations lack significance, leading to reduced storage requirements, while density is the preferred option when a significant portion of combinations holds meaning in the data. The determination of sparsity for each dimension plays a pivotal role in the design of multidimensional cubes, significantly impacting how data analysis is carried out.

Similar to how we categorized entities, cubes have also been grouped based on their specific purposes, ranging from planning to sales. Furthermore, each cube is typically prefixed with a code to facilitate organization and ensure their unique identification.

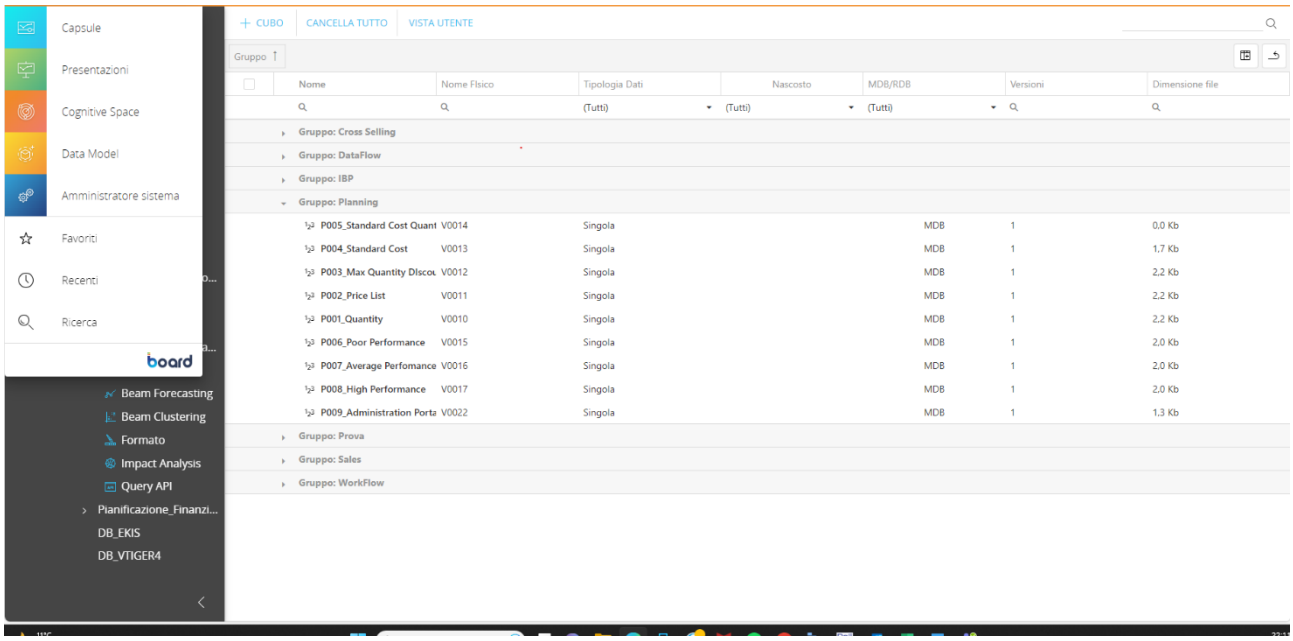


Figure 3.7 List Of Cubes

The next stage after cube creation is to populate them, and data readers are used in BOARD to accomplish this. There are two ways to use these data readers:

- *Static Usage*: The data model is where they are launched straight from.
- *Dynamic Usage*: They are carried out inside of procedures, and each time they run, the cube is updated.

Readers of data can retrieve information from a variety of sources, such as TXT, CSV, SQL (using a fixed Oracle connection in BOARD), and SAP, which has a connector that

converts information into a BOARD-readable format. The mapping process is required to specify which columns—which represent dimensions—need to be filled in after the connection has been made. The ETL (Extract, Transform, Load) functionality can be employed to select data, impose WHERE conditions, or set loading conditions to ensure data compliance with allocation rules.

Mapping data when loading from CSV or TXT is straightforward and intuitive, involving the straightforward identification of columns. In contrast, when using SQL, it often requires writing machine code to guarantee a correct loading process. Furthermore, data readers can be used to map the relationships between entities, which will help populate the so-called "anagrafica." In order to enable the system to create accurate associations, this entails using a single data reader to read every entity in the hierarchy. This means that there are two types of data readers involved in this project: the first group fills in the cubes, and the second group fills in the entities and creates links between each instance.

3.4 Capsule Development

Following the creation of the Data Model and its properties, capsules and reporting screens may be constructed, from which the customer's user will do the activities.

3.4.1 The Sales Analysis

The following important requests were raised in meetings with different executives:

- General Manager: GM stressed the importance of daily reviews and a focus on short-term indicators like Sales Performance and Profitability Analysis. He asked for a straightforward dashboard to provide a quick overview.
- The director of sales, asked for a reporting package that would help area managers evaluate the productivity, profitability analysis, and sales performance of their sales representatives.
- Corporate Controlling: required mandatory reports that were primarily concerned with profitability and KPIs, with particular attention paid to format and computations.
- The head of logistics expressed concern about stock shortages and asked for forecasts and estimates of the amount expected to be sold in the upcoming month.

In conclusion, while the executives had different needs, they were all focused on timely analysis and efficient data visualisation that was specific to their areas of responsibility. In the data that was presented, accessibility and simplicity were prioritised.

It was imperative that we address a variety of business aspects pertaining to operations and sales in our project. In order to accomplish this, we used a methodical approach and created a special project section named "Sales," which is split into four main sections:

- Sales Performance: The "Sales Performance" section is specifically designed to evaluate and communicate the performance of our sales operations. This section is enriched with intuitive charts that provide an instant overview and visual insights. It focuses on a variety of performance metrics, including:
    - Year-over-Year (YoY) Sales Growth: We analyze sales growth by comparing the current year's performance to previous years, helping us understand the progress and trends.
    - Performance Thresholds: To draw attention to exceptional circumstances, we've set thresholds at 10% to highlight situations where sales performance experiences significant growth or decline.
    - Agent-Specific Insights: To enhance the user experience, we've incorporated selectors that enable users to focus on a specific sales agent's performance. This functionality prevents users from having to sift through unwanted data, ensuring a more targeted and efficient analysis.

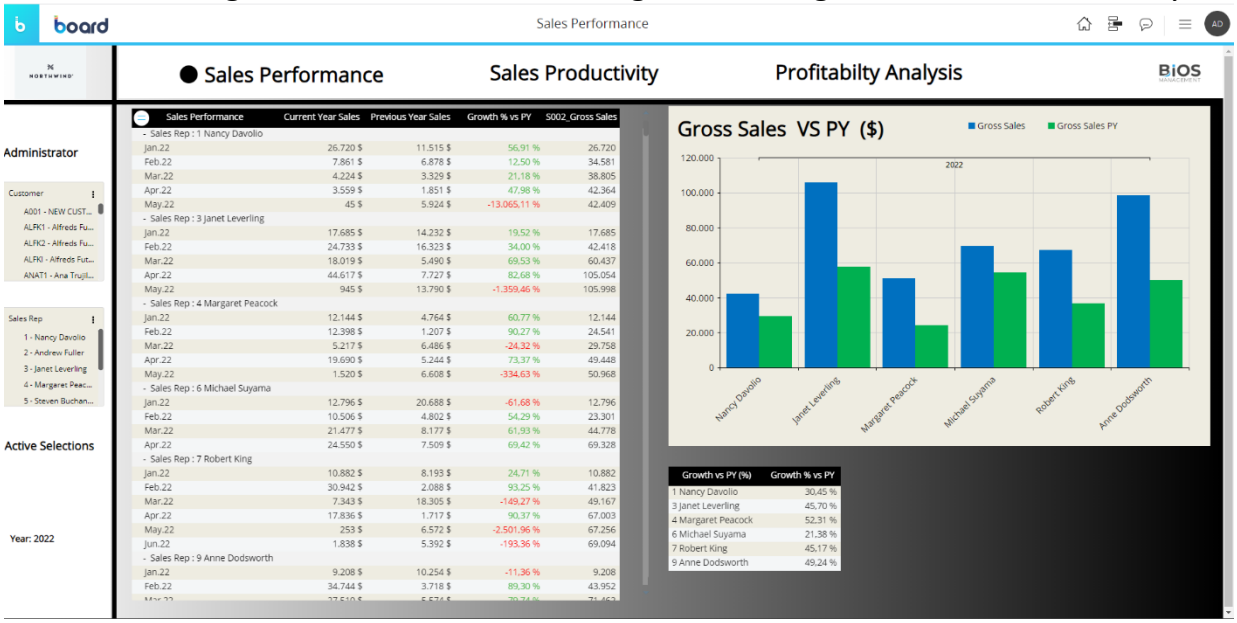


Figure 3.8 Sales Performance

- Sales Productivity: The project's main focus in this section is sales productivity. Important metrics are analysed, including the mean order value, the mean order time, and the mean order value per hour. Clearly defining the best and worst performances with respect to these three crucial parameters is the aim.

- The "Profitability Analysis" section is dedicated to a detailed examination of profitability within our operations. It specifically encompasses the following aspects:
    - *Discount Analysis*: This component delves into the extent of discounts offered and aims to understand the discounts' influence on our Gross Sales Value by Customer. We pay special attention to identifying patterns of customer indulgence in seeking discounts.
    - *Product-Specific Insights*: The analysis is further segmented based on products. We explore various dimensions of product profitability, including quantity sold, list price, average monthly price, and the percentage differences between list prices and average monthly prices. By breaking down profitability data at both the customer and product levels, this section provides a comprehensive view of how discounts

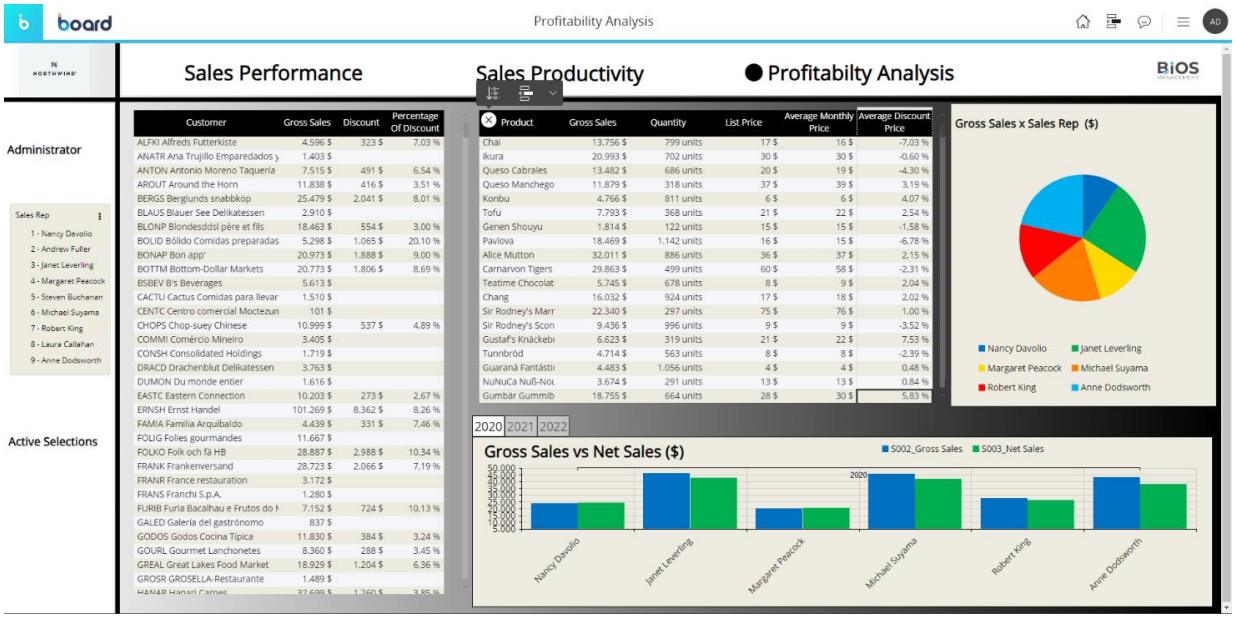


Figure 3.9 Profitability Analysis

- Logistics: The final section of the project is dedicated to logistics. Here, our focus is on procurement and inventory management. Our goal is to forecast the expected monthly demand based on the previous month's sales. We calculate

the annual moving average, the 18-month moving average, and the 3-month moving average to determine which of these predictions is the most accurate compared to the previous month's sales.

Each of these sections has been designed with the objective of providing clarity and ease of understanding for the different responsible areas of the business involved. This allows us to thoroughly address challenges and opportunities related to sales and business management, ensuring that relevant data and information are easily accessible with a single click.

3.4.2 The Planning Part

After completing this phase, we had another meeting with the client to discuss the next steps of the project. The meeting was a bit confusing, but they provided further details on what they wanted to see implemented in the system and how they wanted to proceed with the collaboration. This meeting helped to further clarify their expectations and define the project's future direction.

The key points discussed were:

- Sales Plan and Usability Improvements:
    - Creation of a data input module that allows salespeople to efficiently plan sales.
    - Ability to define prices for customers and products, with the option to enter quantities in grams or liters for greater accuracy.
    - Calculation of commissions based on sales targets and actual data to assess salesperson performance.
    - Improved usability with an option that allows salespeople to plan based on value or percentage discount.

    - Inclusion of a predefined list of discount values with 5% increments from 0% to 25%, with validation to prevent discounts higher than 25%.
- Commission Calculation:
    - Development of a module dedicated to commission calculations.
    - Use of specified percentages to calculate commissions based on achieved sales targets.
    - Consideration of various target ranges for commission calculation.
- Cost of Goods Calculation:
    - Creation of a feature that allows the input of standard costs associated with products.
    - Use of standard costs to calculate the cost of goods based on projected quantities.
    - This function will contribute to more accurate cost and profit margin management.
- P&L Planning (Profit and Loss Planning)
    - Development of a planning module that allows the selection of accounts to include in financial planning.
    - Input of financial data to calculate projected financial results.
    - Locking of accounts once they are completed to ensure data consistency.
    - Addition of a function to modify descriptions of existing accounts for greater customization.
- New Account Addition:
    - Implementation of an option that allows the simulation of adding new accounts to the chart of accounts.
    - Ability to assign new classifications to accounts with short descriptions, contributing to better accounting organization.

- Modification of descriptions of existing accounts to more accurately reflect business operations.

These implementations require the development of highly customizable data input modules and automatic financial result calculations. It will be essential to ensure that the system provides an intuitive and user-friendly experience, especially for the salespeople involved in the sales planning process.

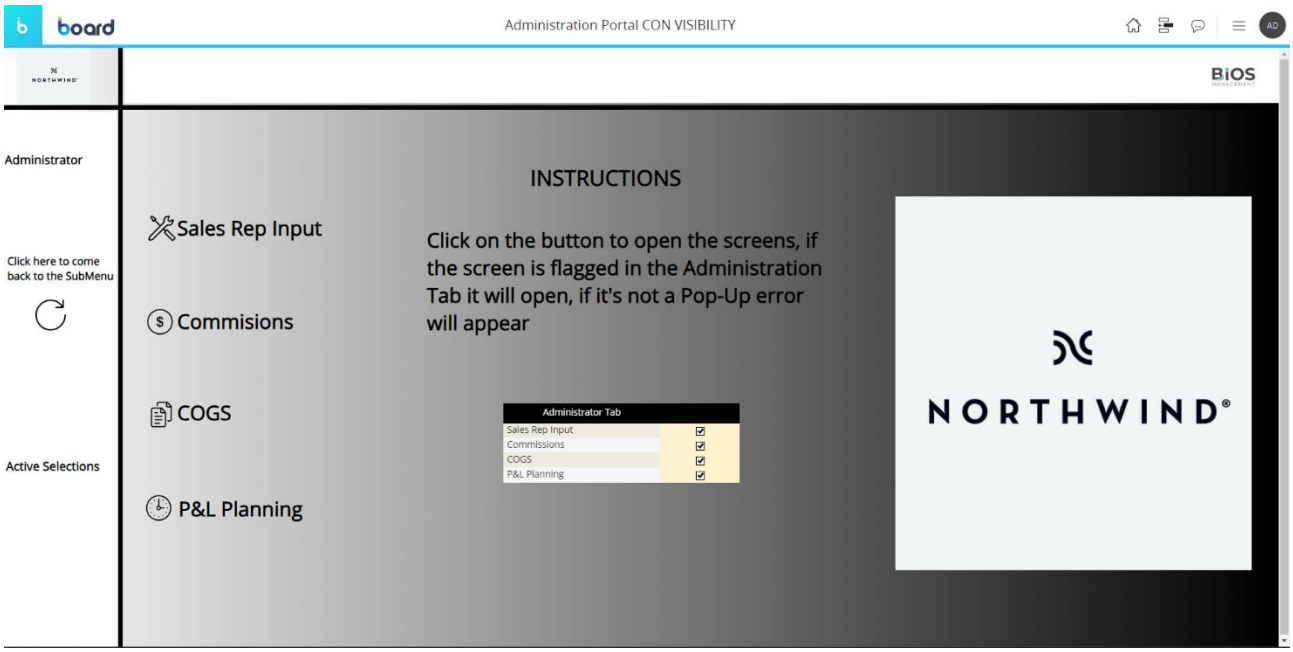
To meet the client's requests, we created a planning area, which was further divided into five distinct zones. This organization was designed to facilitate the implementation of the requested functionalities and to ensure that each of them had a well-defined space within the system. Each of these zones was carefully designed to ensure a smooth workflow and an intuitive user interface so that salespeople and other users could use the system with ease and efficiency. The division into these five zones allowed us to manage the implementation of different features in a targeted manner and to ensure that the system fully met the client's needs. This well-defined structure also helped us keep track of the project's progress and facilitate communication between our team and the client.

The first zone was designated for the administration of this part of the system and was appropriately named the *"administration portal".* Access to this area is password-protected and allows administrators to restrict certain users' access to specific screens using flags. Within this area, there is an internal trigger procedure that activates whenever a flag is set. A trigger procedure is a set of automatic instructions within a system that responds to specific events or conditions. In the described context, it manages access to the system's screens, allowing or denying entry to users through flags. This mechanism is crucial for ensuring security and

permission management within the system. The trigger procedure is activated based on flag changes.

Figure 3.10 Administration Portal

Designed with sales representatives' needs in mind, the "*Sales Rep Input Screen*" is a



crucial component of the system. It acts as a platform that enables them to carefully and quickly enter data pertaining to sales. Sales representatives can precisely define prices for customers and products, identify specific quantities for sale, and apply related discounts with this flexible tool. The entire coordination of sales management and the optimization of sales tactics are greatly aided by this thorough and in-depth planning feature.

Interestingly, this module greatly improves usability in addition to functionality. It gives sales representatives the option to plan using preset percentage-based discounts or the actual value of sales. To further guarantee adherence to predetermined discount limits and prevent errors, strict data validation procedures are in place

This screen has significant systemic ramifications. It is essential to the optimization of sales operations, which significantly increases the sales team's overall productivity and effectiveness. Three important selectors related to month, representative, and customer are located on the carefully designed screen. These selectors act as entry points that are easy for users to use, facilitating the entry of desired data while upholding predetermined policies and procedures.

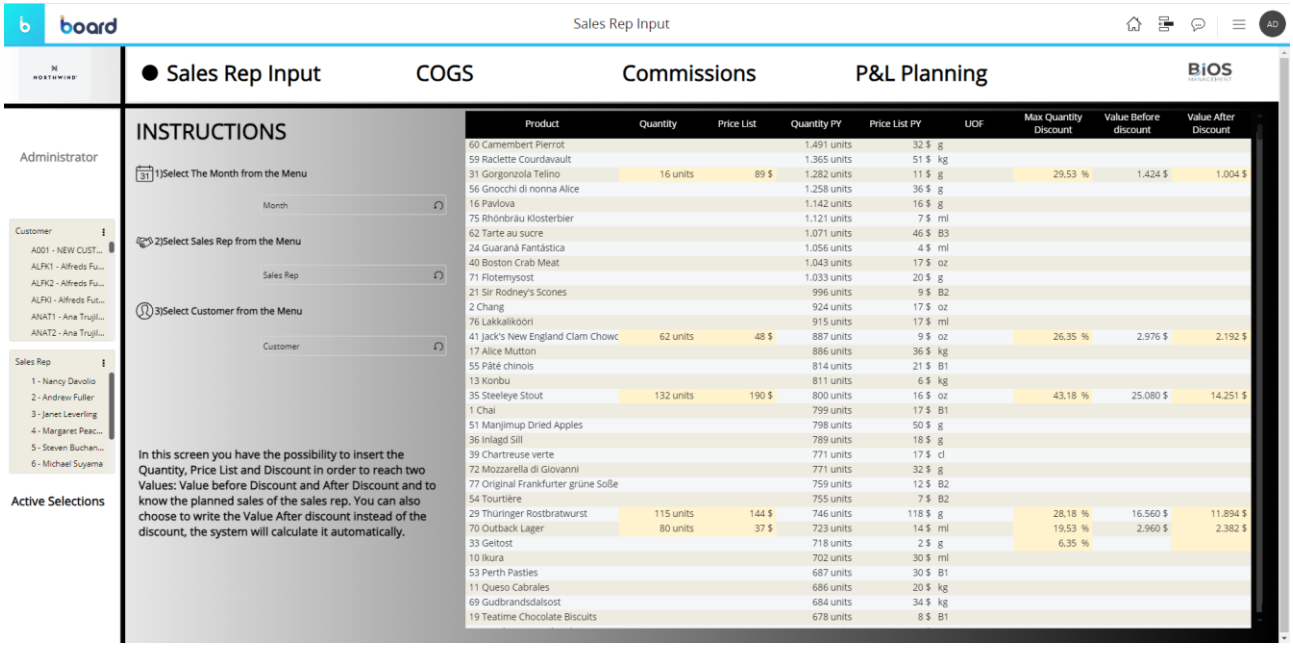


Figure 3.11 Sales Rep Input

The "*Cost Of Goods Sold*" (COGS) screen follows a similar logic to that of the "Sales Rep Input Screen." Through two key selectors, one for product category and the other for the reference month, users can access sales data for that month and enter the quantities sold and the respective prices for each product. This modular and user-friendly approach significantly simplifies the data entry process for cost of goods sold, enabling precise monitoring and efficient management of this vital information for financial planning. Therefore, the system can automatically calculate the "Cost Of Goods Sold" based on the user-entered data in the screen. This automated functionality greatly simplifies the calculation process and provides accurate financial

data for analysis and planning. It represents an additional advantage in optimizing the system and facilitating the work of users.

A further essential part is the screen for handling *commissions* on sales. This feature is especially important for salespeople who work internationally because a large portion of their income comes from commissions. Each year, management determines these commissions, which are expressed as a percentage of sales and are based on several factors including the number of clients served, years of service, target achievements from the previous year, and more. Area managers enter three commission thresholds for every member of the sales team in the sales commissions screen. Whether a salesperson hits 75%, 85%, or 95% of their sales target determines these thresholds. These benchmarks are set by internal computations that evaluate each member of the sales team individually. After entering all required data, transmitting this data to the budget cubes is initiated by clicking the corresponding button. The budgeting process benefits greatly from these data since they make it easier to calculate expected commissions and provide accurate financial planning for these expenses. The management of sales commissions is made much simpler by this automated method, which also guarantees precise financial resource allocation.

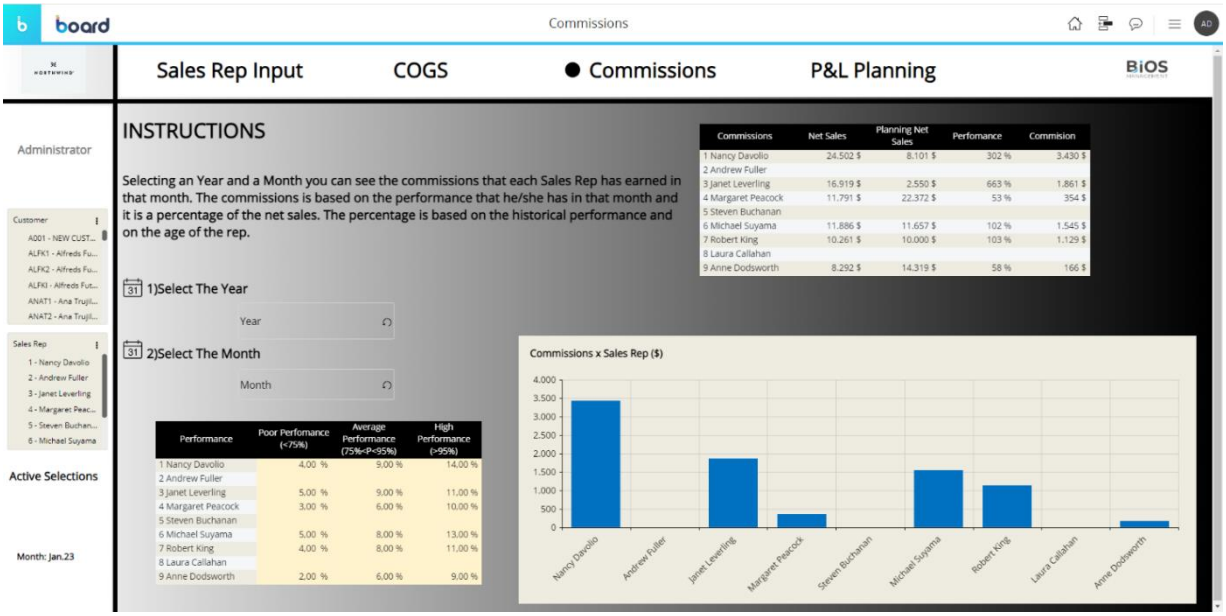


Figure 3.12 Commissions

One of the most important tools for predicting the company's financial performance for the current year is the *P&L (Profit and Loss)* planning screen. Its purpose is to give the business a broad picture of projected sales so that it can make financial plans for the future. Using data from the prior year, a corporate multiplier is applied to account for different factors. After projecting this data onto the current year, useful insights regarding anticipated revenue are obtained.

This screen is noteworthy for its adaptability when it comes to representing currencies. The company can meet the different needs of its different international branches by having the ability to switch between euros and dollars. This adaptability guarantees that the financial data presented can be easily interpreted and used by all stakeholders, regardless of where they are in the world. In the end, the P&L planning screen gives the business the ability to make wise financial choices and match its plans with its projected profit and loss.

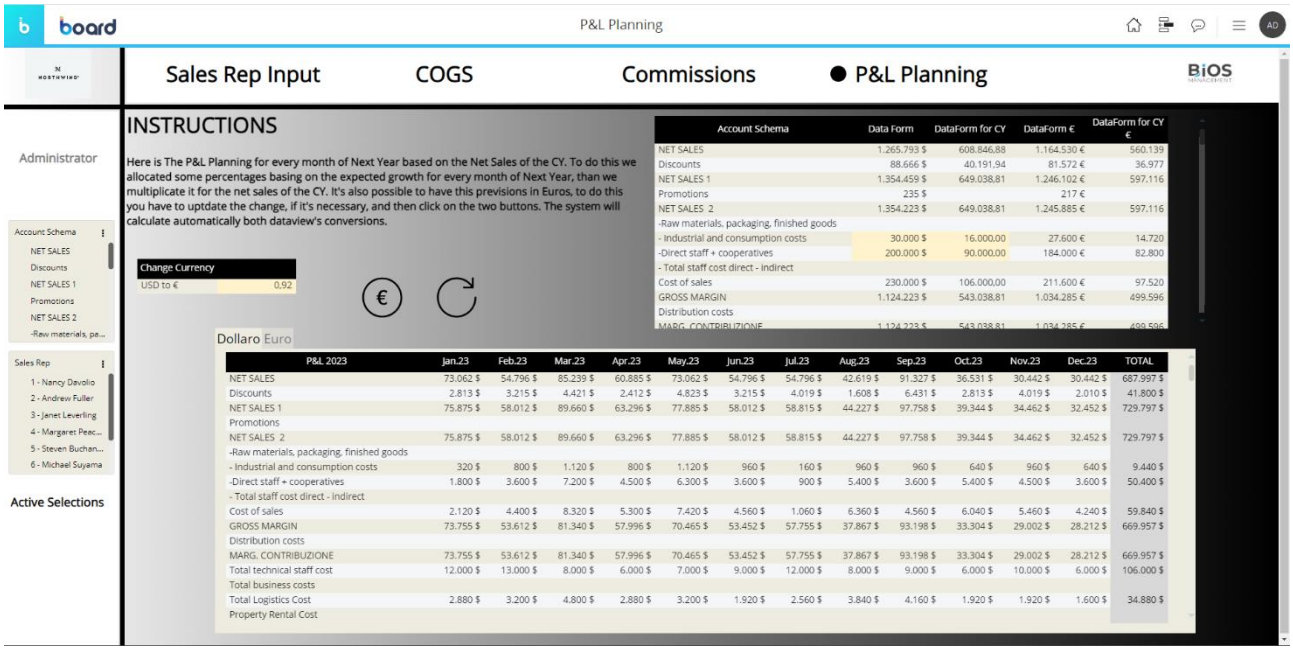


Figure 3.13 P&L Planning

3.4.3 Sales Forecast and Set New Customer

The customer's request included the development of a sales forecasting screen, a critical component for effective business planning. During this phase, our primary objective was to calculate custom growth indicators for individual products. These indicators were thoughtfully designed to provide highly informative insights, utilizing accurate market data to enable precise predictions of growth within specific product categories. By selecting the year flag, the procedure instantly incorporated data for the chosen year, offering a comprehensive and detailed view of the specified timeframe. This particular feature streamlined the sales forecasting process, enhancing efficiency and accuracy, and contributing significantly to the creation of an advanced planning tool that the customer can depend on for well-informed decision-making.

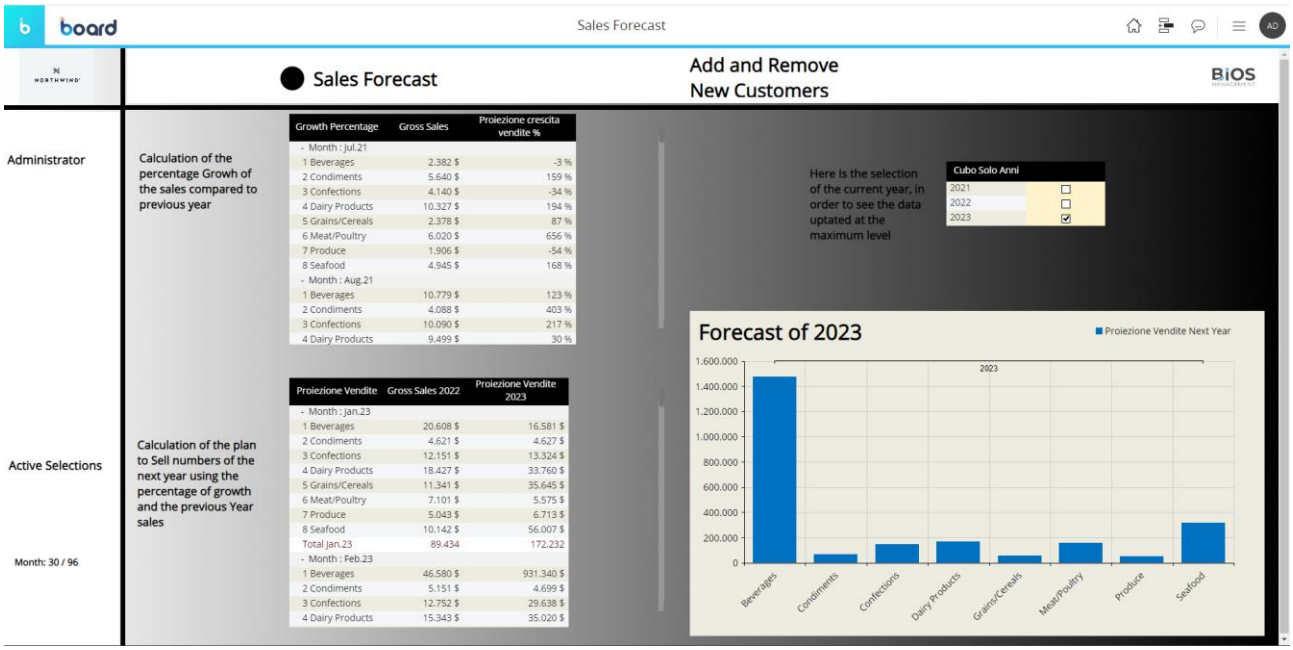


Figure 3.14 Sales Forecast

In order to enhance our data analysis, we have implemented a customer management feature accessible through the "Entity Editor" tool within the dedicated settings area. The Entity Editor Object is designed for managing Advanced Transaction Object (ATO)

environments, allowing users to create new Entity members, modify descriptions of existing members, and manage their relationships with other Entity members.

This tool includes two distinct procedures:

- The first procedure enables the assignment of a reference customer to newly added clients, facilitating their inclusion in the analysis. Since new clients may lack historical data, this procedure utilizes data from a similar customer as a reference point until sufficient data is available for the new clients.
- The second procedure, effective from a specific month, allows for the removal of a customer from the system. This functionality is valuable in cases of payment defaults or when a customer switches to a competitor. Deleting a customer is essential to prevent inaccuracies in sector-specific data, ensuring that outdated records are removed from the system.

These features provide increased flexibility and accuracy in customer data analysis, ensuring the maintenance of reliable and relevant data for well-informed business decision-making.

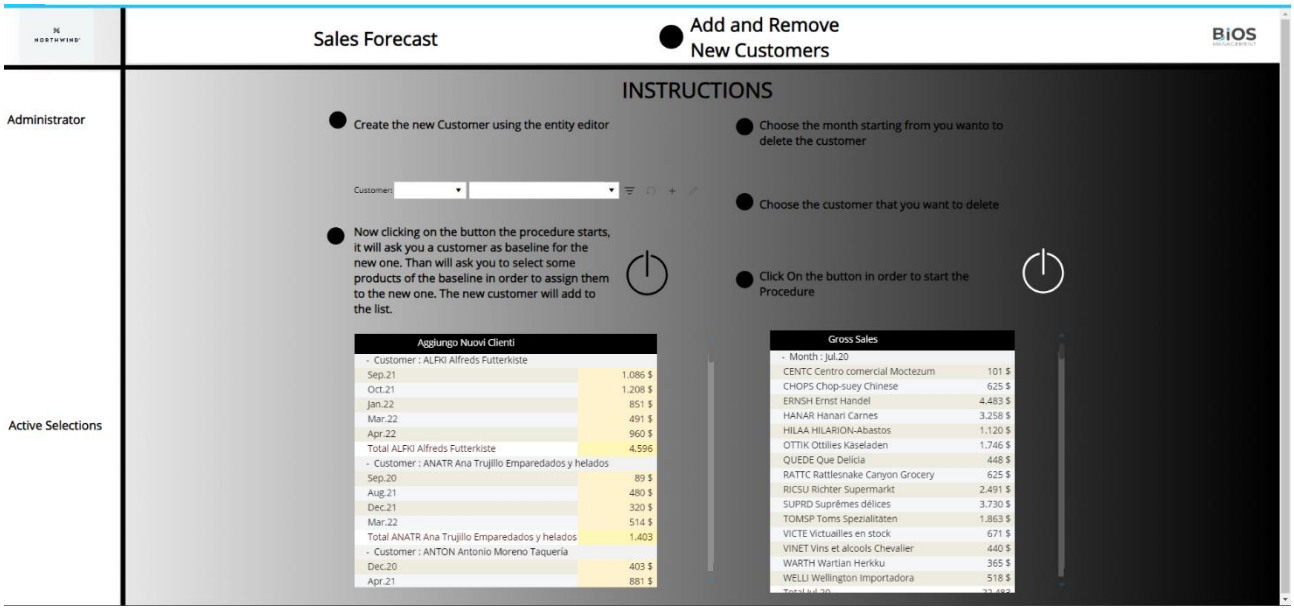


Figure 3.15 Settings For Customers

3.4.4 Cross Selling

One essential element was still absent from the Northwind environment in the last stages of our project: the installation of a cross-selling screen. Based on customers' recent or past purchasing habits, this specialised feature is intended to recommend and promote additional product or service purchases to them. These enlightening suggestions show up when customers are making purchases or perusing the merchandise in our virtual store. For instance, the cross-selling screen suggests adding recently introduced or newly associated beverages to a customer's order when they are purchasing multiple items in the "beverages" category. This calculated move increases overall sales dramatically and is consistent with our mission to satisfy our clients' changing needs.

We've included a powerful tool to empower our developers right into the screen that we've developed. Our developers can now map and identify the complex relationships between customers and products thanks to this tool. It provides users with a simple and intuitive method to visualise these intricate relationships and export them in a PDF format that is widely compatible with devices through a clearly explained procedure.

The result of these complex relationships can be safely printed, digitally stored, and shared via email at a later time. This ground-breaking feature makes connection management easier and more efficient, which makes it possible to analyse cross-selling data more deeply and perceptively.

In our project, we have established the foundation. The company's committed developers will be in charge of actively marketing and promoting these products to our esteemed clientele, making the most of this cutting-edge instrument to guarantee the continuous prosperity of the Northwind environment.

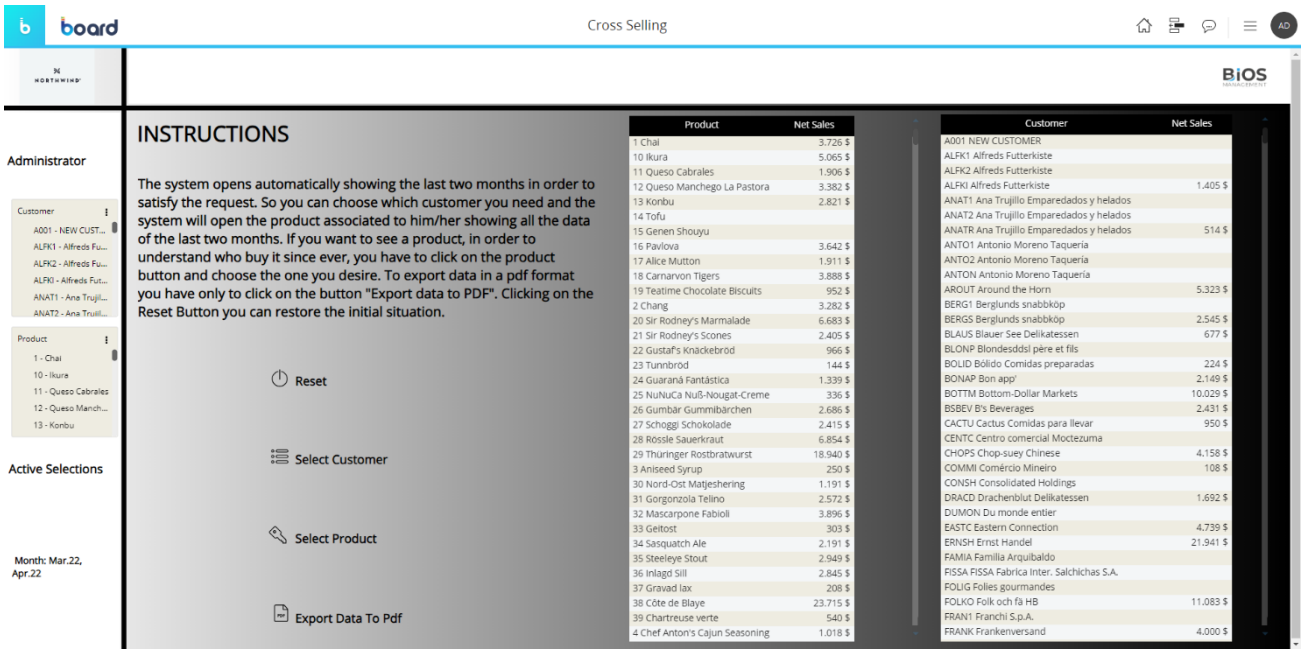


Figure 3.16 Cross Selling

3.4.5 CEO

The implementation of a screen for Northwind's CEO was the final and most general request. All of the key performance indicators (KPIs) for analysis had to be included in this screen. It needed to be visually understandable and, above all, simple to read. The CEO was supposed to see this screen and instantly have an idea of the company's sales.

The total revenue, the sales breakdown by sales representatives, and the sales divisions by product categories were the essential elements that needed to be presented. The CEO would be able to swiftly pinpoint areas that are succeeding and those that need extra care thanks to this visual representation. The screen had to emphasise the flagship products in terms of sales as well as the best-performing customers in terms of purchases. When the CEO is making strategic decisions, this information will be extremely helpful.

Board gave very clear and easy-to-use infographic tools in order to satisfy these requirements. The CEO would have a thorough and immediate overview of the business's performance thanks to these tools, which would enable for the efficient and clear visual representation of the data.

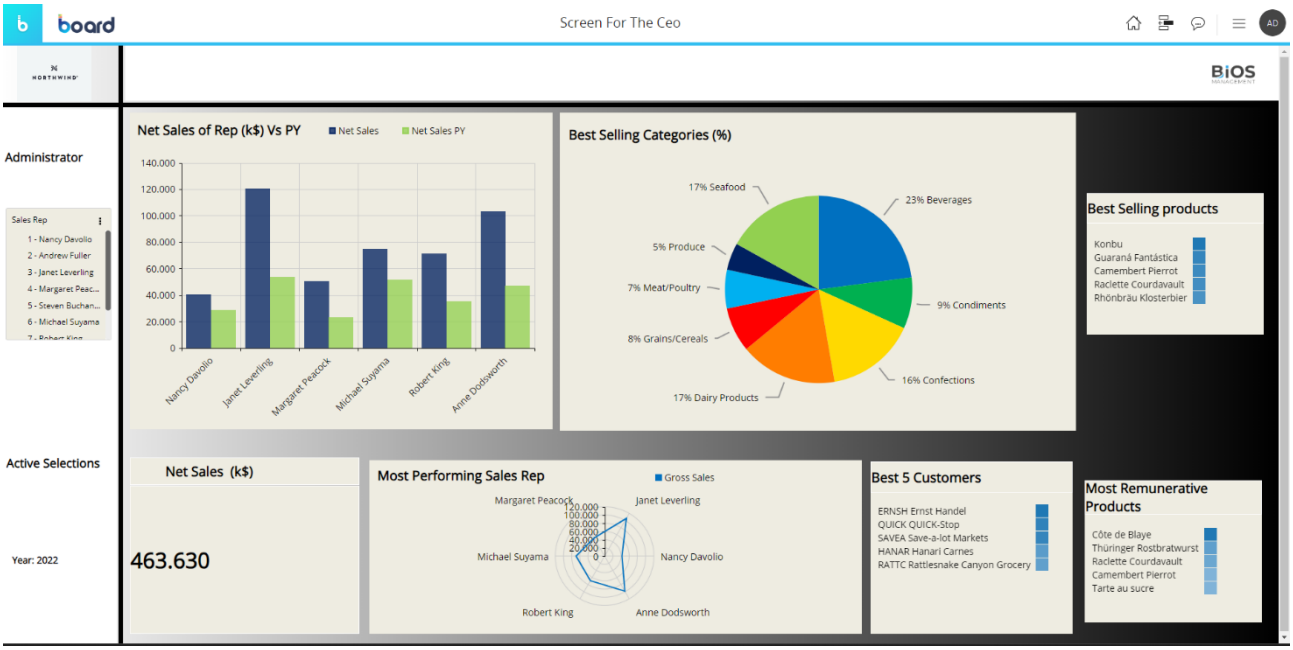


Figure 3.17 Screen for the CEO

CHAPTER 4

BI Consulting: methodologies for the choice of the BI player.

4.1 The job of the BI consultant

Before discussing the choice of a suitable consultant, it is necessary to clarify what the job of the BI Consultant is.

The BI consultant uses the technology at his disposal to collect, extract and optimise data from various sources that could be useful for analysis and decision-making.

Improving business processes are the main goal of a BI Consultant's work, reducing expenses and improving business growth are the consequence.

The implementation of data analysis methodologies and the development of models for reading key business behaviors is fundamental for this professional figure.

At a technical level, the skills required to approach this job are:

- Good knowledge of SQL
- Data Mining skills
- Statistical training
- Basics of economics

(Sabanet, 2022)

The consultant provides clients with the tools to be able to improve their capacity to store and reorganize data.

Specifically, a BI expert must perform these tasks on a daily basis:

- Daily verification of the update and status of company databases
- Organize applications and procedure implementations in order to best meet customer requirements.
- Plan the data setup and cleaning phase.

- Define the structure of the data, then choose the dimensions and metrics to be used and the most appropriate model to employ.
- Ensure the required privacy by then modifying the entry authorisations to different areas of the system by then setting passwords and credentials where necessary.
- Manage a working relationship with clients guaranteeing professionalism and efficiency.

(Sabanet, 2022)

Solving a Business Intelligence problem then becomes a task that follows 3 steps:

- Problem identification
- Solution implementation
- Execution

One or more models are then built according to the customer's needs and tested to ensure that they function correctly.

Access and views are then defined, then the official version of the product is released. After release, there often follows a maintenance phase to incorporate the changes and optimizations required by the customer learning to use the tool (Sabanet, 2022).

4.2 Choosing the right BI vendor.

In recent years, particularly since the Covid 19 pandemic, the market for Business Intelligence platforms has seen exponential growth. Between 2023 and 2029 with the increasing development of Artificial Intelligence, the market is expected to grow even more (Fraccaro, 2023).

The largest vendors and most important Business Intelligence software are SAP, SAS, IBM, Qlick, Microsoft and Oracle all with strengths and weaknesses.

The market for Business Intelligence applications has seen double-digit growth in recent years, a phenomenon that does not seem to be slowing down (Fraccaro, 2023).

This phenomenon is due to several causes including:

- The increase in data in circulation and an ever-increasing need for information to be processed.
- The need for information in a very short time, particularly for specific purposes such as performance reports, customer monitoring and clustering, and financial projections
- The expansion of data sources.

(Fraccaro, 2023)

It therefore becomes a key factor to choose the right BI system to rely on.

The factors that determine this tool can be summarized from 3 points of view:

- *User Prospective*, a platform must be easy enough to use so that it can be used correctly even by people with limited technological capabilities. In a more general sense, the prevalence of one model over the other stems substantially from two methodological choices concerning standardization activities (whether entrusted to the IT area or to specific business divisions) and reporting activities (whether delegated to qualified personnel or instead to individual business functions).
- IT Prospective, the possibility of taking data from different sources, ETL and the ability to work in different configurations (on premise, onCloud, Multicloud) become an integral part of the process of deciding one BI over another.
- Procurement and more generally of direct, indirect costs and the possibility of local support.
- The cost of licences varies significantly between one platform and another and according to customer needs. Platforms such as SAP guarantee high processing capacity and efficiency at the highest level, but have very high licence costs.

- As for support, it is generally provided remotely, and the excessive localisation of some applications can make their adoption outside the geographical region complicated.

(Fraccaro, 2023)

4.3 Market of BI Tools

The estimated value of the global business intelligence (BI) software market in 2023 was $25.73 billion. Experts in the field predict that this sector will grow at a rate of 5.83% per year over the next five years, which could result in a $35 billion market value by 2028. The sector is currently experiencing rapid expansion (Fortune, 2022).

Significant growth was already evident in the BI software market in 2021, when it reached $24.05 billion, a remarkable 8.7% rise from the year before. It is important to note that the market for BI software not only survived the COVID-19 pandemic but flourished, growing at a rate of more than 8% annually and exceeding prior rises (Fortune, 2022).

This significant increase is primarily due to the fact that businesses used BI software more and more to analyze emerging trends and reduce operational risks during a time of crisis and uncertainty. The ability to use the software from any location proved to be crucial, especially when working remotely. This was an important feature in a rapidly changing business environment.

Businesses are gradually realizing the benefits of BI platforms for data-driven decision-making and operational streamlining in an era marked by swift changes. Furthermore, the need for business intelligence software is expected to rise significantly among businesses in the near future due to the quick generation and accessibility of data made possible by smart devices and the Internet of Things (IoT), as well as the development of fields like artificial intelligence and big data analysis (Fortune, 2022).

The demand for enterprise software, in particular business intelligence (BI) software, is being driven by digitization and online data collection, which is creating a greater need for data insights, customer analysis, and various business processes. Software for supply chain management (SCM), customer relationship management (CRM), and enterprise resource planning (ERP) are also included in this category. Overall, enterprise software contributes significantly to the total revenue of the software industry and is essential to companies' digitization efforts. Given the continued importance of a customer-centric strategy in digital business environments to gain a competitive edge, CRM stands out as the industry leader within Enterprise Software (Fortune, 2022).

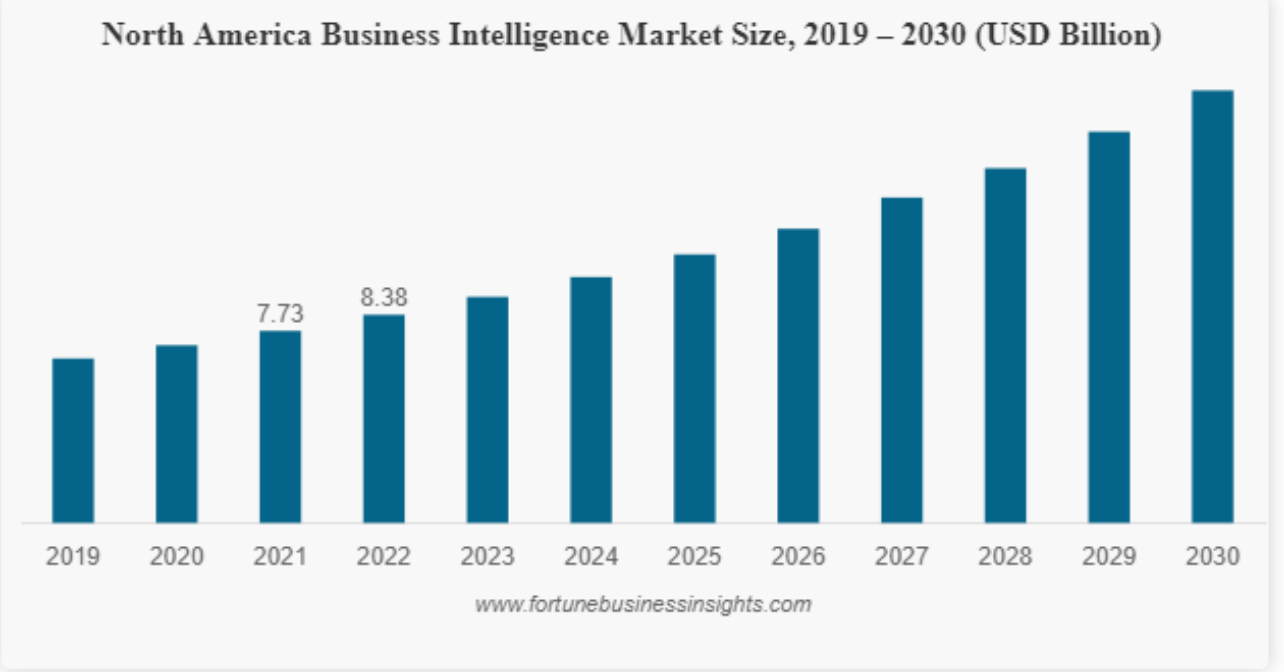


Figure 4.3 Bi Market Graphic

4.4 Market division according to the industry of the end users

A thorough analysis of the market has been conducted, accounting for a range of end-users and placing special emphasis on the banking, insurance, and financial services industries. The most technologically advanced of these industries is the banking, financial services, and insurance (BFSI) sector; as such, it is the perfect industry in

which business intelligence (BI) platforms have had the most success (Grand View Research, 2020).

BI technologies—which make use of blockchain, biometrics, machine learning (ML), and artificial intelligence (AI)—have been seamlessly integrated with the cutting-edge systems that are already in place in these industries.

Financial institutions are using these technologies to improve their ability to make decisions by experimenting with business automation, Internet of Things (IoT), and predictive and adaptive analysis. Given its size and consistent growth, it is clear that the banking, financial, and insurance sectors will continue to present BI software development companies with a plethora of lucrative opportunities (Grand View Research, 2020).

It is noteworthy that IT and telecommunications companies hold a substantial share of the market, accounting for roughly 25% of the total. Geographically speaking, North America and Europe continue to lead because of their highly developed technology infrastructure. However, due to rising demand in developing nations like China and India, the Asia-Pacific area is predicted to grow at the fastest rate. A growing demand for customer insights, outsourcing activities for cloud deployment, and the widespread adoption of BI software and tools are some of the major factors driving market growth in the Asia-Pacific region (Grand View Research, 2020).

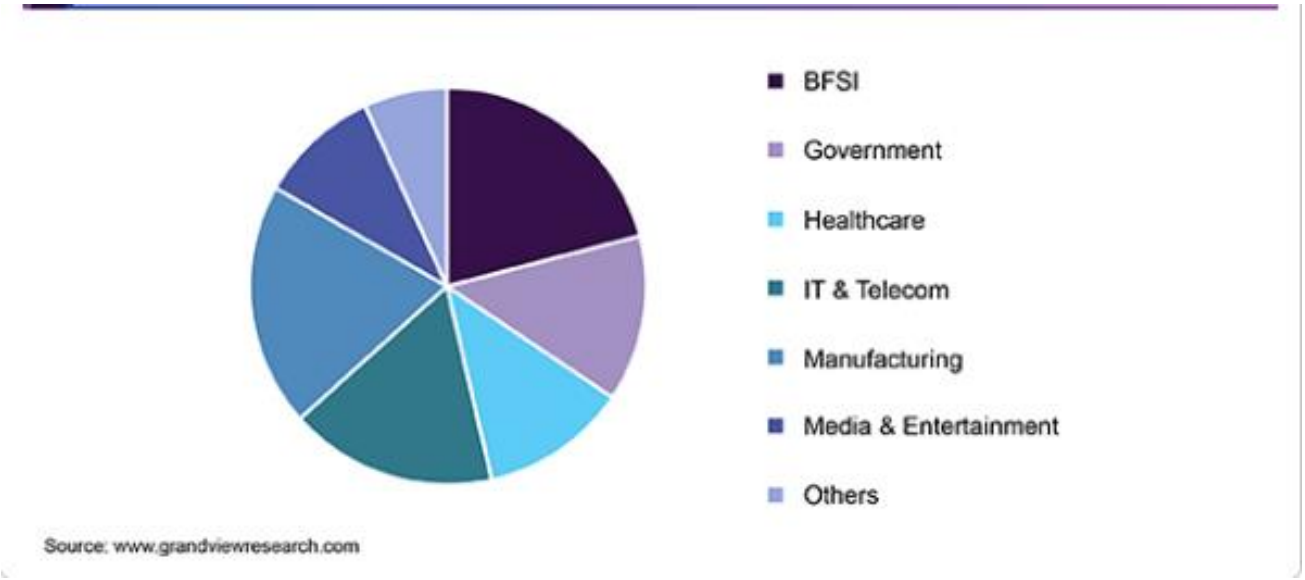


Figure 4.2 Category Segmentation

In conclusion, the market for BI software is steadily growing, led by the BFSI sectors in particular and an openness to new prospects in developing nations, which is creating the groundwork for future advancements in the sector (Grand View Research, 2020).

4.5 Effect of BI Systems on Enterprises

SMEs, or small and medium-sized businesses, have been slow to adopt business intelligence (BI) systems, especially in Italy. They frequently believe that these systems are only useful for big businesses with substantial IT budgets. They frequently feel that hiring and training specialized staff for these systems would be too costly, and they would rather have outside businesses handle their data. Furthermore, small and medium-sized businesses cannot afford licenses due to their high cost (Lueg & Lu, 2013). Rather, they frequently depend on easier and less expensive fixes, like Microsoft Excel spreadsheets. These spreadsheets have features that can help extract valuable insights, such as detailed spreadsheet modelling and cell modelling.

Research on small businesses in Sweden was done by (Soilen K. , 2013), who discovered that SMEs use business intelligence (BI) to manage their customers

effectively. They can automatically catalogue materials, keep track of incoming and outgoing orders, and streamline warehouse operations with the aid of these systems. As a result, BI systems are crucial tools for SMEs since they make customer management much easier (Soilen K. , 2013).

The Studies also brought attention to the fact that SMEs frequently choose their BI systems based only on their impression of how well these systems can fulfil their particular requirements, rather than taking into account all of these systems' potential (Soilen K. , 2013). Furthermore, rather than carefully assessing which solution is actually the most appropriate for their needs, they frequently select software based on what other businesses in their network of contacts frequently use. Business intelligence (BI) also works wonders for small and medium-sized businesses when it comes to budget management, significantly streamlining the procedure. Due to their complex and illogical creation process, budgets are frequently misunderstood and ignored (Soilen K. , 2013).

Additionally, inaccuracies that result in the waste of corporate resources can be caused by a lack of tools for validating the data used in budgeting. The research assert that business intelligence has the power to completely transform how effective budgeting is (Lueg & Lu, 2013). These systems' capacity to make the procedure clear-cut and simple to understand makes this possible. An accurate and validated final product is also made possible by the automation of the necessary processes.

Business intelligence can also be a useful tool for small businesses to use when they are up against competition. All business decisions are influenced by competition, which is a key factor in decision-making. SMEs deal with this issue on a daily basis. Utilising business intelligence is one strategy for addressing this problem (Ponis & Christou, 2013).

This is due to the fact that business intelligence entails a method by which companies obtain data about their rivals and apply it to their planning and decision-making

processes in order to perform better. As a result, BI can provide SMEs a competitive edge. Small businesses that have implemented business intelligence (BI) have an advantage in the market because they compete more successful. This is made possible by the extra data on rivals and clients that was gathered. SMEs frequently acquire the upper hand in business decisions by learning about their rivals and are frequently able to outsmart them (Guarda, Santos, & Pinto, 2013).

It is advised that small and medium-sized businesses (SMEs) incorporate a business intelligence (BI) system in view of the previously mentioned factors. In 2017, Sophian Gauzelina and Hugo Bentza led a research study in France that aimed to identify potential problems and barriers associated with SMEs' adoption of BI systems. Interviews were conducted as part of the research methodology with staff members from different French SMEs. More specifically, five managers and fifteen junior employees from each organisation were interviewed for this study, for a total of two hundred interviews (Gauzelin & Bentz, 2017).

BIS Aspects Tested Through Mangers Interviews	% Yes	% No
Deployment of BIS	45	55
Usage of BIS at all organizational levels	19	81
Complexity of the BIS deployed	39	61
Availability of skilled employees for manage BIS	25	75
BIS assistance in decision making	89	11
Other impacts of BIS other than helping in decision making	95	5
Perception on continuation of the use of BIS	96	4

Business intelligence systems aspects tested through junior employee interviews	% Yes	% No
Usage of BIS in the company	15	85
Knowledge of BIS	20	80
BIS impact on employee productivity and performance	70	30
BIS impact on business performance	69	31
Views on continuation of BIS use	85	15

Figure 4.3 Aspect Tested by junior employees and by managers

The results of this study fall into three primary categories:

- Application and Use of Business Intelligence in SMEs.
- A shortage of qualified workers for BI system.

- Business Intelligence's Effect on SMEs.

4.5.1 Application and Use of Business Intelligence in SMEs

Using business intelligence (BI) systems to manage internal processes in small and medium-sized enterprises (SMEs) is one of the themes that emerged from the results. The bulk of SMEs have not yet implemented BI systems, according to the interview results. Of the fifty managerial-level workers surveyed, forty-five percent attested to the fact that their SMEs had in fact put in place BI systems. However, only 15% of junior employees said that their companies use these systems, suggesting that they are less aware of their adoption. Moreover, just 19% of senior executives attested to the application of business intelligence across all organisational levels. This indicates that SMEs still need to embrace the implementation and usage of BI systems more fully in their internal processes. According to (Lueg & Lu, 2013), the research findings show that intelligence systems are too expensive for businesses, rendering them unfeasible from an economic standpoint for SMEs. Thus, one of the things keeping SMEs from implementing BI systems is their high cost. This is due to the fact that SMEs have a limited budget and purchasing BI systems is seen as a burden on those resources rather than something that will inevitably add value to the business (Gauzelin & Bentz, 2017). PMI, moreover, frequently lack the information technology tools required to accommodate and manage BIS effectively. Certain appliances require significant capital investments, which discourage many PMI from making such investments as a cost-saving measure. As a result, these restrictions significantly reduce the opportunities that information systems could present to small businesses (Gauzelin & Bentz, 2017).

4.5.2 Shortage of qualified workers for BI system

This study's second major theme is related to the intricacy of business intelligence systems (BI) and the availability of skilled workers for their upkeep and application. Of the managers surveyed, 61% acknowledged that their small businesses' BIS

implementations are complex, and only 39% said they employ more basic BI tools. Even so, most of these businesses lack the staff required to administer and maintain these sophisticated BIS systems (Gauzelin & Bentz, 2017). The findings showed that only 25% of managers said they had staff members who are qualified to handle BIS, which causes delays and problems when implementing tasks. Employee interviews revealed that only 20% of them had any real-world experience with BIS, which further supported this trend. One of the main obstacles to these systems' adoption is their complexity. Business intelligence (BI) systems are complicated because they use mathematical functions to forecast and resolve business issues. Furthermore, IT expertise is essential for the efficient administration of business intelligence systems. The interviews indicate that one of the main obstacles to the adoption of these systems is typically a lack of IT and math skills (Lueg & Lu, 2013).

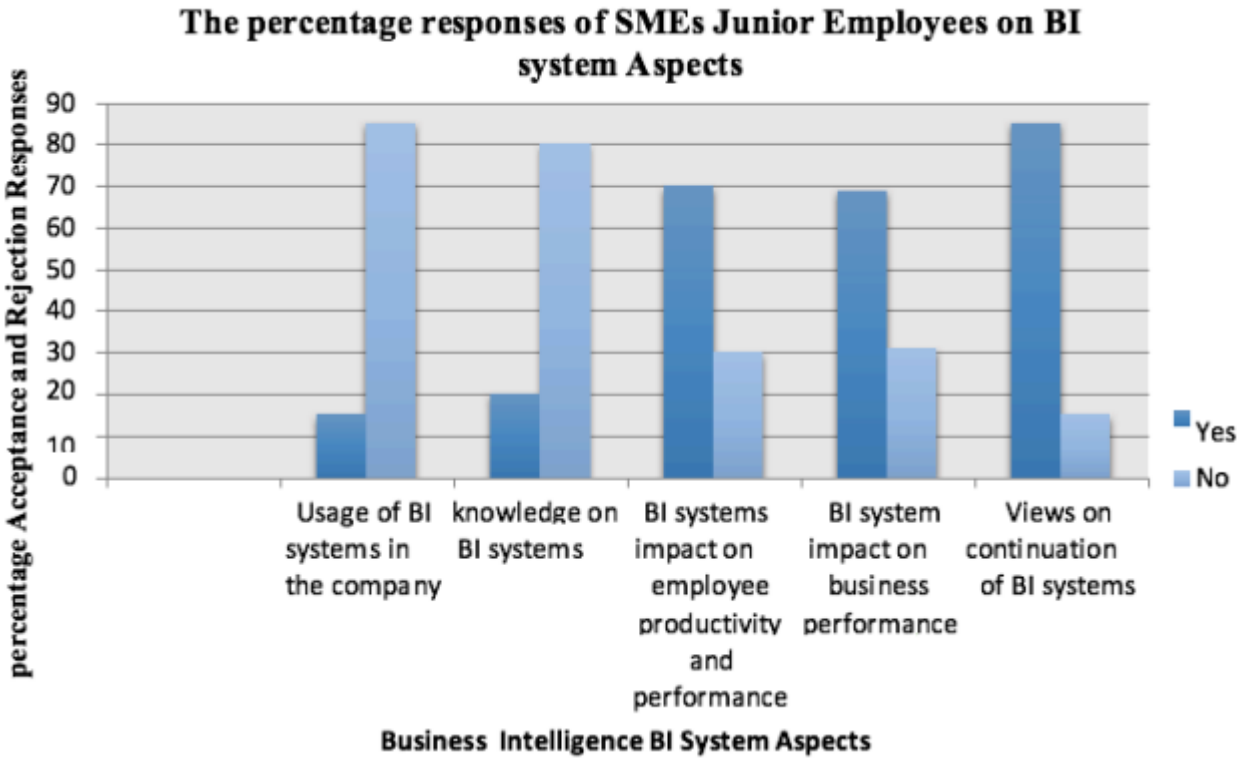


Figure 4.4 Graph showing the responses of SMEs junior employees on the various aspects of business intelligence (BI) systems.

4.5.3 Business Intelligence's Effect on SMEs

The research's third and last theme is concerned with how Business Intelligence (BI) systems affect small and medium-sized enterprises. To be more precise, ninety percent of the managers who responded to the survey concur that this kind of technology helps a lot with decision-making. This is as a result of BI's consistent, excellent, and timely data. Because it is subjected to extensive analysis, the information produced is of exceptional quality, which facilitates the comprehension of the outcomes by business executives. Because of this, BI systems are crucial in helping businesses keep an eye on the market and forecast future developments.

Furthermore, as agreed upon by 95% of the managers, there are advantages beyond data integrity and operational efficiency, such as enhanced corporate productivity and efficiency. The results is that decisions made using information gleaned from business intelligence (BI) systems have the unique potential to increase productivity and operational effectiveness (Poleto, Carvalho, & Costa, 2015). Furthermore, it has been stated that a BI system has the potential to reduce expenses while improving revenues and margins. In fact, BI provides a low-cost data collection tool, allowing resources previously allocated to market research to be redirected to other areas within the company. Moreover, 70% of those surveyed believe that the system helps individuals become more productive and perform better at work, leading to improved corporate performance. This may be due to the fact that the reports generated by BI are useful in providing company leaders with information on how to motivate staff. Therefore, despite its current limited utilization in SMEs, BI could be a significant tool for enhancing corporate performance (Gauzelin & Bentz, 2017).

Conclusions

The fourth industrial revolution is currently underway, representing a powerful engine of change that requires a swift rethinking of the traditional market approach. Recent instability and sudden market shifts leave no room for delay in adopting innovation by businesses. The digitalization of organizations has become an essential requirement to ensure their sustainability in the target market.

These revolutions will bring about a series of changes, some positive and others negative, affecting both society and the world of work. In this context of transformation, it becomes crucial to reconsider the business organization and operational processes, involving people in this cutting-edge industrial approach. Business Intelligence (BI) plays a critical role in this context, serving as an example of a 4.0 decision-making approach. Geopolitical instability constantly generates new variables that require careful monitoring in the short and medium-term management of companies. An analytical approach to situations allows for clarity and confidence when operating in uncertain environments, which is of fundamental importance.

In an era characterized by instability, decisions must be accurate and efficient. Relying solely on managers' instincts is no longer sufficient; instead, it is essential to increasingly base decisions on data, without neglecting the experience of leaders within organizations. In the context of this thesis, a comprehensive analysis of the software used throughout the entire internship period, which is the Board software, has been conducted. This analysis has a dual perspective: on the one hand, it explores the technical aspects, focusing on the system's foundations, while on the other hand, it examines its practical implementation in the business environment.

Another point of interest that has emerged from this research is the concrete illustration of how the implementation of a Business Intelligence (BI) environment and the utilization of data can result in a fast and intuitive system for visualizing Key

Performance Indicators (KPIs) for a large-scale enterprise. Throughout the thesis, through a practical case based on the company Northwind, it is demonstrated how this strategy can translate into significant added value for an organization.

During the internship period, it became evident that each company operates in its unique ecosystem. The internal dynamics within different organizations vary significantly, necessitating a high degree of flexibility in a consultant's approach. Consultants must be prepared to constantly adapt their strategies to cater to the specific demands of each client. In this role, consultants not only provide assistance in application development but also take on the responsibility of ensuring that the client's needs are met. Simultaneously, they strive to offer valuable insights and guidance, ultimately delivering a service of the highest caliber. This dynamic environment calls for continuous adjustments and a proactive stance to deliver effective and tailored solutions.

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