POLITECNICO DI TORINO

Department of Management and Production Engineering

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Master's Degree Thesis

Business Intelligence and productivity, a study based on the analysis of a Business Case

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Introduction:

This thesis was created following my work experience, carried out through a curricular internship at Bios Management s.r.l. During this period, the activities carried out led me to get to grips with the concept of Business Intelligence, and specifically the development and implementation of BI applications.

The goal of this study is to examine the impact of the emergence and subsequent evolution of Business Intelligence in the corporate environment. In a scenario in which organisations must be able to evaluate vast volumes of data quickly in order to remain competitive, tools like BI become necessary, even if they are not always easily applied, particularly in smaller businesses. In this context, innovation is a mandatory requirement.

In order to achieve the objectives described above, a careful analysis of the research and publications of the last 20 years in the BI field was carried out, as well as the use of manuals, guides and interviews by experts in the field over the years.

As a result, this document will include:

- A first chapter that seeks to clarify, as simply and comprehensively as possible, what is meant by business intelligence, as well as what the software dedicated to it is and what it is formed.
- A second chapter is designed to be an introduction to the software used throughout the traineeship activities (Board). This definition refers to both the offered service and its positioning in the reference market, as well as the architecture that supports it.
- The third chapter will present a business case, with the goal of providing a realistic illustration of what has been explained in the previous chapters. It

will specifically address the Terre da Vino s.p.a. project, in which i have participated in the execution.

- A fourth and last chapter with the aim of analysing and researching the results and performance produced by businesses that have decided to deploy BI solutions. To accomplish this, it was determined to examine numerous studies and research conducted with this goal in mind.

As will be demonstrated in the following chapters, business intelligence software is an essential instrument for companies to manage, organise, and evaluate large amounts of data. Managers can then be directed towards decision-making process based on facts. Another notable finding is that, despite their poor utilisation, SMEs may benefit significantly from the implementation of a BI tool, both in terms of productivity and cost reduction. Furthermore, according to the research, this kind of software offers a positive impact on Corporate Performance Management and Business Performance. However, such tools have some limitations, such as the necessity for a significant IT infrastructure, high implementation costs, and the need for trained employees for managing the platforms.
Before proceeding with the previous paragraph's elaboration, I'd like to provide a little summary of the company that housed me during my curricular internship.

Bios Management S.r.l. is a BPM and business intelligence solution development consulting firm that has been working in Italy and Europe for nearly 20 years. The projects it works on are mostly medium-sized, which allows the company to deliver a highly tailored service based on the demands of the customers, a trait that has allowed it to carve out a niche in the market in comparison to the Big Leaders of Worldwide Consulting. Today it can count on international customers such as, Loro Piana, Kering Group, Bottega Veneta, as well as several banks in the country.

CHAPTER 1: Business Intelligence:

Definition and Context:

Business Intelligence, often referred to as BI, is a popularized, “umbrella term” introduced by Howard Dresner of the Gartner Group in 1989 to describe a set of concepts and methods to improve business decision making by using fact-based computerized support systems (Nylund, 1999). Sometimes, it also referred to executive information systems, but in a broader perspective, BI can be seen as a set of techniques, tools and abilities that helps managers to understand businesses situations. The aim is to obtain highest level of control over the enterprise data in order to: “Improve performance by create a suitable context to make decision in organization" (Rouhani, Asgari , & Mirhossei, 2012).

Fast access to data and analysis, regarding to users need is critical for modern organizations and Business intelligence is the tool used to collect, analyze, share, and effectively manage the ever-increasing amounts of information available today. Many techniques, technologies, and tools have emerged, over the years, that enable the extraction of valuable and objective support for decision-making processes, both in terms of operational processes and strategic choices.

Business intelligence (BI) has emerged as an indispensable solution for scanning, storing, and analysing raw content, from which preparatory knowledge can be extracted and ultimately converted into accessible, high-level informative language (Khatibi, Keramati, & Shirazi, 2020) It aims to provide clear understanding of various aspects, environments, and study objectives to be analysed and interpreted. This approach does not allow for implicit interpretation based on pragmatic or purely empirical sources, but instead focuses on optimizing and improving the systems of interest and reducing their uncertainties (Chen & Lin, 2020)

The analysis of resources, both internal and external, has become a useful and even indispensable activity in all the businesses sectors. Indeed, it is crucial for monitoring functions and operations, and it serves a multitude of purposes and objectives in every context and subject[1].

Identifying possible correlations among data may provide an advantage within their respective fields, enabling efficient responses and establishing a reliable basis for making more or less informed decisions. By applying appropriate analytical techniques to filter the data, a more comprehensive analysis and valuable insights can be obtained. The importance of summarizing and integrating resource contents into critical and comprehensive visualizations emphasizes the significance of managing information effectively. This underscores the importance of utilize information properly to exploit their full value. On the other hand, the ongoing emergence of ever-more advanced computer technology has aided in the digitalization of data, resulting in the adoption of better instruments for its storage and management (Rouhani, Asgari , & Mirhossei, 2012).

Considering what has been said in the previous paragraphs, from a practical perspective, Business Intelligence translates into software applications that aim to help companies collect data from both internal and external sources, and then filter them based on requirements ((Wieder & Ossimitz, 2015)). Once the data is obtained through the system used, the goal is to reprocess it to obtain useful information for the decision-making process (Rouhani, Asgari , & Mirhossei, 2012). However, this process can be costly for the company, both in terms of economics and resources. This is because while it is true that outsourcing the creation of the software application and data collection to third parties may be

[1] https://extrared.it/it/-/che-cosa-%C3%A8-la-business-intelligence-

sufficient, a successful management of Business Intelligence requires continuous alignment between IT, management, and end-users. Moreover, activities such as identifying new strategies and opportunities based on the obtained analysis are mostly performed internally (Hevner & March, 2007)

History of BI:

The word "Business Intelligence" was first used in a historical document in 1865 (Lago, 2018). The name was first used to describe the formula for banker Sir Henry Furnese's success in Richard Millar Devens' book "Cyclopaedia of Commercial and Business Anecdotes". Furnese had accumulated substantial riches by the gathering, analysis, and use of political and market intelligence, which allowed him to outperform his rivals.

The phrase "Business Intelligence" first appeared in modern literature in 1958, with the publication of Hans Peter Luhn's article "A Business Intelligence System." Luhn displayed a number of his electromechanical gadgets at an international conference dedicated to scientific information in November of that year. They appeared to be conventional at first glance, similar to other computer equipment in use at the time, meant to gather and sort vast stacks of punched cards into slots and containers.

However, unlike other computers, Luhn's devices were not designed to work with numbers and calculations but rather with words and phrases, using an algorithm called "KWIC" (Key Word in Context). By considering a large number of texts, typically articles ranging from 500 to 5,000 words, the KWIC system was able to quickly and automatically build a sort of index. (Lago, 2018)

Considering that at the time, indexing, classifying, and organizing written information was a particularly time-consuming and meticulous process, even for the most experienced specialists, and that the volume of information in many fields was growing at an incessant rate, a fast and more efficient tool that could extract and summarize vast amounts of information was highly desired and now absolutely indispensable. During a gathering of librarians and information scientists held in Washington, D.C., the demonstration of KWIC was met with great interest and enthusiasm, with newspapers across the United States giving significant media coverage to Luhn's astonishing invention at the time (Lago, 2018).

In the development process of Business Intelligence, the contribution of IBM, the company for which Luhn worked, was fundamental. IBM designed and initiated the production of the first hard disks (1956), floppy disks, and other data storage tools (Lago, 2018).

Indeed, these tools quickly gained prominence in companies that were already using computers, enabling the transition from paper-based storage to digital storage. This also spurred the adoption of computerized systems by an increasing number of companies. The shift to digital storage facilitated more efficient data management and retrieval, leading to improved productivity and the widespread use of computer systems across various industries (Lago, 2018).

Following the creation of the first Database Management System, known as the Decision Support System (DSS), the early 1970s witnessed increasing competition among designers from various operating system manufacturers. This competition facilitated the development of increasingly sophisticated software and the creation of the first data warehouses. These advancements significantly improved the flow of data from operational systems to decision support systems.

Data warehousing compressed the time required to access the requested information by consolidating data from different databases into a single location.

Alongside these developments, other elements that form the foundation of BI emerged, such as ETL (Extract, Transform, and Load) tools and OLAP (Online Analytical Processing) software (Lago, 2018).

Business Intelligence began to acquire significant adoption among businesses during the two decades from the 1980s to the early 2000s. Howard Dresner's 1989 definition contributed to its expansion (Combita Niño & Morales Ortega,2020) However, full utilisation was hampered by long data processing times and usage complexity, which was mostly limited to trained technical specialists capable of utilising advanced analysis software. "Business Intelligence 1.0" refers to this period.

The arrival of the twenty-first century marks a watershed moment in technical growth, ushering in the era of "Business Intelligence 2.0." These advancements resulted in considerable advances in data processing speed and complexity. BI 2.0 brought new technologies such as real-time procedures that integrated data from events as they occurred in the Data Warehouse.

This enabled businesses to make decisions based on the most recent information available. Another new technology was self-service access for non-technical users. This meant that staff could now finish projects without having to rely on or communicate with the IT department. It became clear that Business Intelligence was no longer just a nice-to-have or a simple advantage, but was becoming a requirement for firms to stay competitive. Those that did not adopt it had to quickly decide whether to adapt or risk being outperformed and marginalized by more innovative competitors.

Today, the majority of business intelligence tools and software are vertical market software, designed expressly for organisations operating in specific industries or marketplaces (Lago, 2018). These solutions are tailored to the specific demands and requirements of various industries, delivering specialised analytics and insights for certain business fields.

Data Driven Organizations: Advantages and possible limitations.

The transmission of information within a company plays a crucial role in shaping the organization's complexity. The level of coordination and efficiency in sharing information, along with its frequency and content, directly mirrors the company's organizational structure. This structure can be categorized into various types, either based on functionality or divisional aspects. In a rapidly changing external environment, the demand for both flexibility and cohesion in information communication among different components of an organization increases. This is because such dynamics directly influence the organization's ability to respond promptly and adapt to external changes effectively. The timeliness of responses and the ability to avoid inertia in the face of external shifts are significantly impacted by the way information is exchanged and disseminated within the company (Neirotti, 2022)

Any interpretation that lacks a foundation in data can be considered subjective. In the realm of business and corporate management, making informed decisions and accurately predicting their consequences is essential. Therefore, the availability of data, its proper storage, manipulation, analysis, and synthesis, have become increasingly critical aspects, particularly with the advancement of digitalization and these elements are crucial for obtaining and sustaining a competitive

advantage in today's business landscape. (Munhoz de Medeiros, Maçada, & Freitas Junior, 2020)

As information becomes increasingly reliant on data, organizations are embracing a data-driven approach to ensure objectivity and empiricism in decision-making. This approach involves constant data-related planning to support various considerations required to achieve objectives and desired outcomes throughout the organization's layers and projects. Numerous studies have confirmed the effectiveness of the data-driven approach, with companies making data-informed decisions having a 162% higher likelihood of achieving better financial performance in their respective industries (Papudesu, 2021).

However, it's important to emphasize that subjectivity is not inherently flawed or harmful. It remains an essential element in strategy and decision-making processes. Data, therefore, should not be viewed as the sole decision-making tool within a company. Blind spots may exist in data aggregation and analysis, necessitating a more comprehensive approach that integrates subjective insights with the objective data. A balanced combination of data-driven methodologies and subjective expertise leads to more robust and successful decision-making in an organization.

Exactly, like any tool, over-reliance on data, in the absence of contextual analysis and sufficient training, can result in significant inaccuracies. (Dykes, 2022)It's essential to recognize the limitations of data and avoid some common pitfalls:

- **Bad data:** The underlying data must be both credible and relevant for a data-driven approach to have a beneficial impact on your organisation. If no one believes the figures or the data is not aligned with your company plan, there is a core issue that will undermine the rest of the DDDM process. DDDM will be plagued by continuing challenges and will struggle to have

any impact unless sufficient oversight of the quality and relevancy of your data is provided.

- **Weak analysis:** Once the relevant data have been obtained, the organization should have the ability to effectively analyse it. Without proper training and support from analytics teams, the analysis may lack the depth, thoroughness, and accuracy required to be useful and avoid problems.
- **Flawed recommendation:** When an analysis reveals an insight, it must be accompanied by a relevant recommendation for how the company should respond. The DDDM process can still go wrong if the analysis is sound but the proposed solution is absent, inadequate, or faulty. This problem typically occurs when there is a lack of coordination between the data and business teams. While the data team can manage the analysis, they may lack the subject knowledge to make significant recommendations in the absence of business team support.
- **Poor communication:** If you have a strong analysis and a reasonable recommendation, the information should be conveyed to decision-makers in a clear and persuasive manner. Otherwise, it may be disregarded or misread if the audience does not completely get the significance or level of urgency of the discovery. One of the most effective ways to deliver insights that drive to action is through data storytelling, which blends a narrative format with explanatory images. However, it is frequently an underdeveloped data skill in most organisations, necessitating more targeted training, practise, and coaching.
- **Bad interpretation:** Even when an insight and potential solution have been adequately communicated, decision-makers can misinterpret what is being shared with them. Individuals can still misinterpret what the figures

represent and what actions should be taken if they lack basic data literacy and, more especially, data interpretation abilities. To avoid unintended errors, many managers should benefit from basic data interpretation training.

- **Wrong decision:** Even when the data plainly favours a specific course of action, decision-makers can reject it and choose a different path. Cognitive biases such as confirmation bias and the Dunning-Kruger Effect can cause issues in particular settings. Individuals may prioritise personal agendas or gains over what is best for the team or organisation if there is a lack of accountability for decisions. An organisation may experience issues in this area if it does not have a well-established data culture.
- **Faulty execution:** Whether or not a choice is based on evidence, if it is not implemented appropriately, it will most likely fail to produce the expected results. Regardless of how valuable the insights, ideas, and judgements are, they may be rendered ineffective until properly and appropriately implemented. It can be frustrating for everyone if useful insights are lost during the execution phase. The DDDM should not just make a decision. Data should also be used to track and optimise execution attempts.
- **No learning:** Even if an organization successfully pass all of the previous risks in the DDDM process, a company's influence can be limited if it does not systematically review and learn from each data-driven decision. Data-driven decisions will prevail over instinct-based ones in general. However, not all data-driven decisions will yield the desired outcomes. If your company does not measure and learn from its results, it will be unable to adjust and improve future decisions.

Figure 1: Possible Pitfalls in the Data-Driven Decision Making Process

Knowing about these frequent pitfalls will help improve the organizatios Decision making process. It's easy to become concentrated on individual components of the process and lose sight of what has to come together to produce successful data-driven decisions. Having a holistic perspective and understanding of the DDDM process will help you maximise the rewards on your organization's data efforts. Data should inform decision-making, but it should not be the sole determinant. Rather, it should be used in conjunction with critical thinking, domain knowledge, and an understanding of the broader context to make more accurate and well-rounded strategic choices (Dykes, 2022).

The architecture behind a Business intelligence System:

As organisations begin to deploy BI, one critical duty is to ensure that they comply to a proper BI architecture design during the implementation process in order to ensure the success of their BI investment. BI architecture is a framework that details several BI components (such as data, people, processes, technology, and management) and how these components must work together to support the seamless operation of a BI system (Rob & Coronel, 2007).

A BI architecture contains information such as the types of data that must be collected, the methods to be used to analyse data, and the manner in which specific information must be presented. A good BI architecture is essential. Inconsistencies

that occur among the multiple components if the underlying architecture is not adequately planned may lead to difficulties such as difficulties to share information among the components, inability to meet business requirements, and poor business performance. In the worst-case scenario, a poor BI design may result in the delivery of incorrect information to the wrong person at the wrong time. Even if BI systems can be functional despite poor architecture, organisations will be unable to realise the full value of their BI investments (Ramussen, Chen, & Bansal, 2009)

An examination of the literature reveals that there are various functioning BI architectures. These architectures differ in their structures, such as layers, components, processes, and interactions that are used to drive BI implementation efforts (Shariat & Hightower Jr,, 2007). However, these BI models share several fundamental elements, as can be seen in figure 2, like :

A. Data Source Layer
B. ETL (Extract-Transform-Load) Layer
C. Data Warehouse Layer
D. Metadata Layer
E. End User Layer

(Ong, Siew, & Wong, 2011)

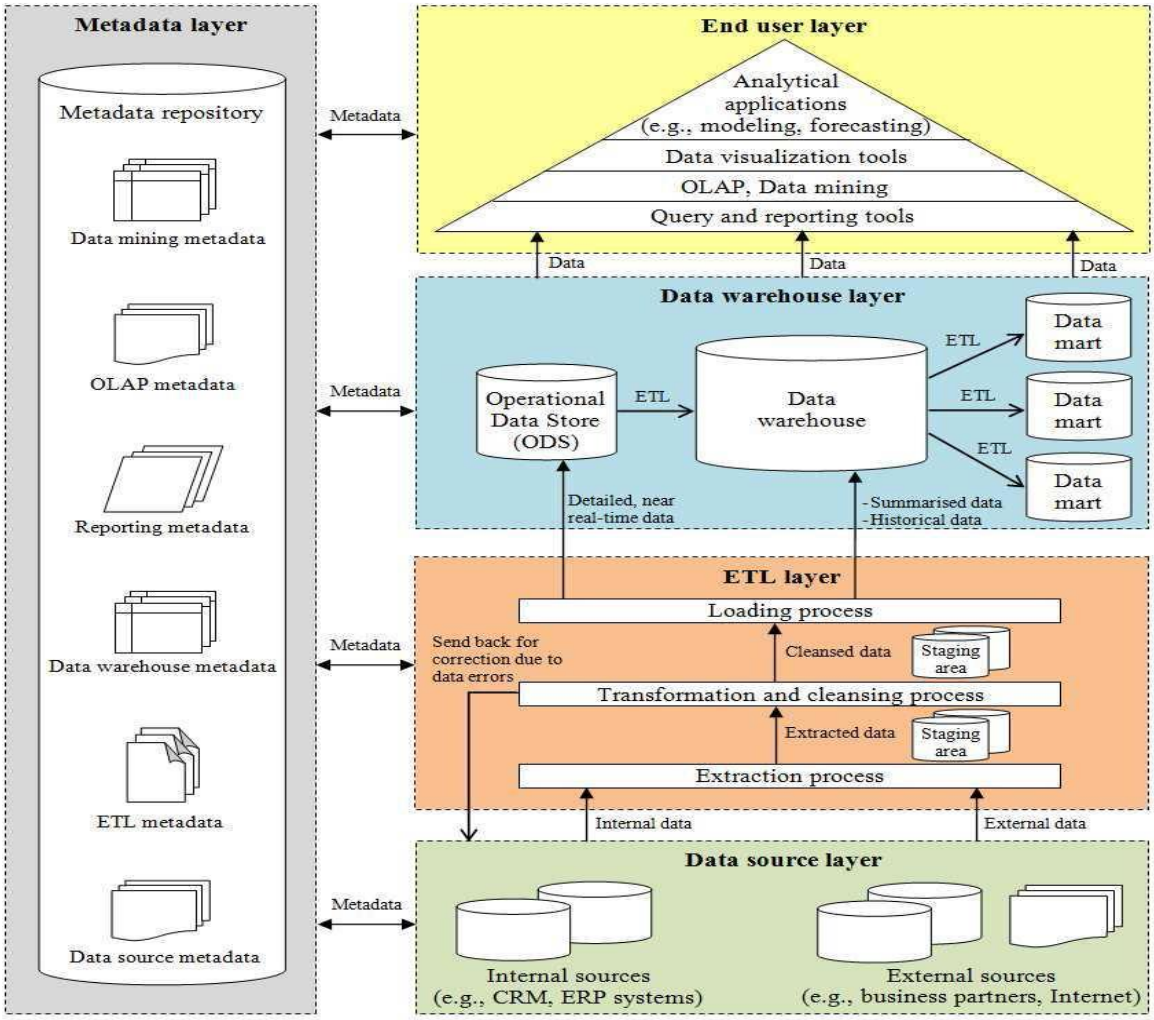

Figure 2:Example of a BI Architecture

Data Source Layer:

Data can be obtained from two sources: internal and external. Data gathered and managed by operational systems within an organisation, such as Customer Relationship Management and Enterprise Resource Planning systems, is referred to as an internal data source. Internal data sources provide information about business operations (for example, customer, product, and sales data). Because they process massive amounts of transactions in real time and update data as needed, these operational systems are also known as online transaction processing

systems. Operational systems contain only current data that is utilised to support an organization's everyday business operations. In general, operational systems are process-oriented since they are primarily concerned with certain company operations such as sales, accounting, and purchasing (Hoffer,, Prescott, & McFadden, 2007). External data sources are those that come from outside of an organisation. External sources of this type of data include business partners, syndicate data suppliers, the Internet, governments, and market research organisations (Ranjan, 2009). These data are frequently associated with competitors, the market, the environment (e.g., customer demographic and economic information), and technology.

It is critical for businesses to precisely identify their data sources. Knowing where to access the necessary data is useful in resolving specific business concerns and requirements, resulting in considerable time savings and faster information delivery. (Ong, Siew, & Wong, 2011)

ETL (Extract-Transform-Load) Layer:

This layer involves with three primary processes: extraction, transformation, and loading.

Extraction is the process of discovering and gathering relevant data from various sources; typically, data obtained from internal and external sources is not integrated, fragmentary, and may be duplicated. As a result, the extraction procedure is required to pick data that will be useful in assisting organisational decision making (Ong, Siew, & Wong, 2011).

Transformation is the process of turning data into standard formats for reporting and analysis by applying a set of business rules (such as aggregation functions). In order to achieve consistency across an organisation, the data transformation process also includes creating business logic for data mapping and standardising data definitions (Davenport & Harris, 2007)

Data cleansing is the act of finding and correcting data mistakes using predefined procedures if an error is discovered in the extracted data, it is returned to the data source for rectification (Dayal, Castellanos, Simitsis, & Wilkinson, 2009). Data is then stored in the "staging area" once it has been converted and cleaned. in this way, if the loading procedures fail or finish, there is no need to modify the data again (Kimball & Caserta, 2004). The final stage of the ETL process is loading. The data from the staging area is put into the target repository.

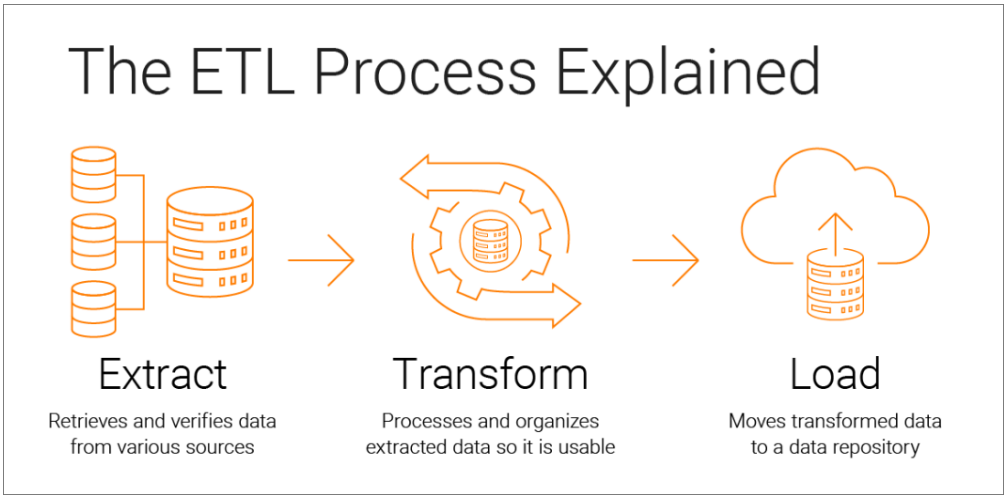

Figure 3: The ETL Process

Data Warehouse Layer:

The data warehouse layer consists of three components: operational data stores, data warehouses, and data marts. Data goes from the operational data storage to the data warehouse, and then to the data mart. (Ong, Siew, & Wong, 2011):

Operational Data Store

All data from the ETL layer is loaded into data warehouses using an operational data store (ODS). Imhoff (2003) defines ODS as a database that stores subject-oriented, detailed, and current data from many sources to facilitate tactical decision making. It offers a unified view of near-real-time data such as transactions and prices. Furthermore, ODS data is volatile, which means it can be overwritten or changed with new data that flows into ODS.

As a result, ODS does not save historical data and is primarily intended to serve operational processing and reporting requirements.

Data Warehouse:

One of the most significant components of BI architectures is data warehouse, that possesses the following features:

- **Subject Oriented:** Data from many sources are grouped according to the subject.
- **Integrated:** All data from various sources must be consistent in format and other features.
- **Time variant**: All data contained in the database has a time dimension. (so you can keep track of trends and changes in the specified data).
- **Non-volatile:** New data can be uploaded on a regular basis without losing the existing ones. (Ong, Siew, & Wong, 2011)

Data Mart:

While data in a data warehouse is primarily utilised to help meet various needs within the organisation, it is not designed to assist what is required from an individual departments. As a result, data marts are required to support them. A data mart is a subset of a data warehouse used to fulfil the analytical needs of a certain business function or department.

It is important to point that the amount of data stored in a data mart is far less than that of a data warehouse. Within a company, there may be several data marts. Data warehouses and data marts are constructed using a multidimensional data model. (Ong, Siew, & Wong, 2011)

A. Metadata Layer:

Metadata refers to a new set of data (created within the BI System) that describe how and when the other data are used, changed and the relations among them. It has to be said that Metadata management and utilisation can reduce development time, simplify ongoing maintenance, and provide users with data source information. (Bryan, 2023)

There are numerous forms of metadata that can be used to support a BI architecture, including data source, ETL, OLAP and data mining information. Data source metadata includes information regarding access mode, data set structure (such as relational tables, views, and stored procedures), and referential integrity requirements. To assure data quality, an extraction log is kept while data is integrated into the data warehouse layer using ETL tools. In general, ETL metadata provides information about sources, targets, transformation rules, and mapping. OLAP information describes the structure of cubes, dimensions, hierarchies, levels, and the type of drill. Data mining metadata includes details of algorithms and queries (Ong, Siew, & Wong, 2011).

B. End-User Layer

The end user layer is made up of tools that show information in various formats to different users. These tools can be imagined in a pyramid shape. The degree of comprehensiveness with which data are processed and displayed grows as one proceeds from the bottom to the top of the pyramid. This is done to respond to the increased decision-making complexity as one climbs up the organisational hierarchy. For example, the highest level of the pyramid consists of analytical applications that are typically used by top management, whereas the lowest level comprises of query and reporting tools that are typically used by operational management. In the following rows there will be a brief descriptions of the main features included into the end-user layer:

- Query and Reporting Tools: Query and reporting tools are extremely helpful tools that enable end users to promptly access and query data, as well as generate reports for decision making and management needs. Standard reports, ad-hoc reports, budgeting and planning reports, and metadata reports are all examples of what as been said above.
- OLAP (Online Analytical Processing)

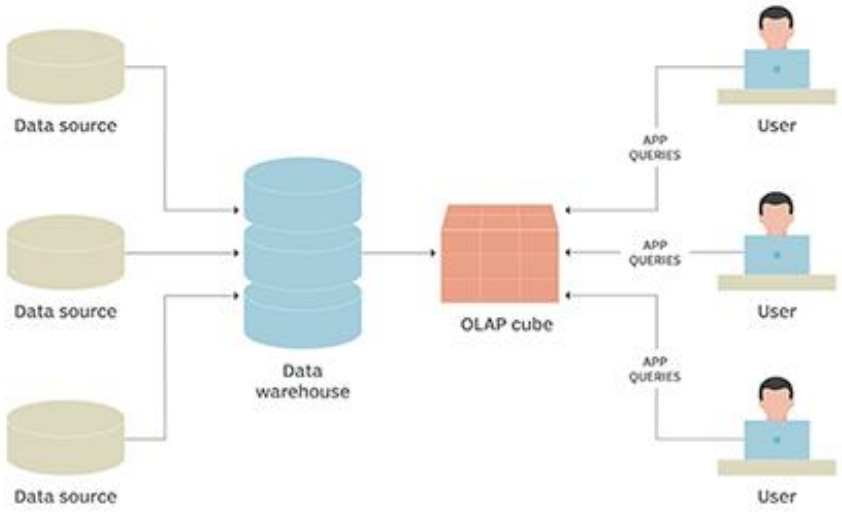

Figure 4: The OLAP Process

One or more OLAP, as can be seen in figure 4, servers can handle data in the data warehouse layer for reporting, analysis, modelling, and business planning (Ranjan, Business Intelligence: Concepts, Components, Techniques and Benefits , 2009)The term "OLAP server" refers to a "data manipulation engine designed to support multidimensional data structures" (Reinschmidt & Francoise, 2000). A multidimensional and summarised view of aggregated data can be provided by an OLAP server. Four basic OLAP operations used in analyzing multidimensional data are:

- **Roll-up:** It raises the level of data aggregation by going to a higher level (less detailed data) along a dimensional hierarchy or by removing one or more dimensions from a particular data cube.
- **Drill-down:** is the inverse of roll-up. It reduces the level of aggregation by going down a dimensional hierarchy to a lower level (more detailed data) or by adding one or more dimensions to a data cube.
- **Slice and dice:** The slice operation produces a sub-cube by selecting a certain value on a single dimension. The dice procedure projects a data cube by picking a range of values over two or more dimensions.
- **Pivot:** It enables users to rotate the axes of the data cube, meaning swapping the dimensions to get different views of data.

(Ong, Siew, & Wong, 2011)

CHAPTER 2: The BOARD Platform:

Basic Characteristics:

Board is an all-in-one BI platform that combines Business Intelligence tools with Corporate Performance Management solutions, such as simulation and predictive analytics, to support decision-making processes.
For example, it enables the development of many sorts of activities for each capability, such as:

1. **Business Intelligence:**
   - Score carding
   - Dashboard
   - Reporting
   - Analysis

2. **Performance Management:**
   - Budgeting, Planning & Forecasting
   - Profitability Analysis
   - Strategy Management
   - Financial Consolidation

3. **Predictive Analysis (Analytics):**
   - Machine Learning Forecasting
   - Simulation
   - Clustering
   - Statistical function

Figure 5:Board's Log

Users may quickly construct their own self-service analytics and planning apps to match their organization's decision-making needs, thanks to the coding-free method, which is independent of the use of a programming language and use a drag-and-drop interface. Board enables the development of dashboards, reports, and analyses that are fully integrated with enterprise-level processes for business planning, modelling, and management. It also provides a comprehensive perspective of the linkages between results, performance, and financial outcomes by bringing together the organization's financial and operational data.

In terms of data, the software allows a unified logical picture of company data by combining any data source into a single and coherent representation. Board operates as a single metadata 'gateway' through its multidimensional physical and logical database, allowing any data to be used as if it were native to the platform. Board's data models normalise and arrange data, allowing end users to view, publish, and update it regardless of its source. It also supports and permits data from a variety of sources, ranging from relational databases to Cloud applications, Big Data to Cloud Data Stores. Board provides a complete range of pre-configured data connections that save the time and effort required to access and utilise data from various sources. The application can be configured in two ways: on the cloud (SaaS) and on premise. Board Cloud is supported by Microsoft Azure and provides all of the platform's features, as well as all of the benefits that a strong cloud infrastructure can provide in terms of security, dependability, scalability, and global performance. The on-premises software, by contrast is directly installed and managed by the company IT structures.

Position within the reference market: The Gartner Magic Quadrant:

According to Gartner's market share estimate, revenue in the contemporary BI platform market increased by 19% in 2019, compared to 22% in 2018. Pricing pressure and fierce competition were mostly to blame for this minor slowdown. Although spending on BI is growing more slowly than in the 2010s, the number of users using BI platforms is rapidly approaching the millions, as reported last year. This massive growth in user numbers is due to the fact that the cost per user is a fraction of what it was a decade ago.

The software platform has been listed in the Gartner Magic Quadrant for 2021 and has received high marks in numerous additional research and evaluations by industry experts[2], consistently outperforming customer reviews of BI and performance management solutions (Richardson,, Schlegel, Sallam, Kronz, & Sun, 2021)

Criteria for Exclusion and Inclusion:

In order to be included in in this analysis, the following four criteria must be met:

1. The company supplying the software must generate at least $15M in annual revenue.
2. In the case of companies that also provide transactional applications, they must demonstrate that their BI platform is also routinely used by organisations that do not use their transactional application.
3. It must provide at least nine of the 13 functionalities identified by Gartner as indispensable for BI software.

[2] Not included and covered in this work.

4. It must be able to obtain a minimum of 20 survey responses from customers who use the vendor platform as their enterprise BI platform.

Criteria for Evaluation:

The following are the criteria used in this Magic Quadrant:

- **Service or product**: this criterion examines how competitive and successful a vendor's BI platform solution is in the important capability areas.
- **General viability:** This criterion is concerned with the organization's financial situation and model in relation to BI. It also considers present and prospective consumers' perspectives on the vendor's projected future importance.
- **Sales Execution/Pricing:** This criterion addresses the vendor's sales capability. involves the overall review, contract negotiation/flexibility with a provider, and the Market Responsiveness/Record: Using a balanced collection of indicators, this criterion analyses the extent to which a vendor has momentum and success in the global market.
- **Customer Experience:** This criterion addresses customers' post-purchase interactions with vendors. The availability of quality third-party resources (such as integrators and service providers), the quality and availability of end-user training, and the quality of the peer user community are all factors to consider.
- **Operations:** This criterion is concerned with how well a company serves its clients and how trouble-free its software is. value received by the client.

The Completeness of Vision criteria used in this Magic Quadrant are as follows:

- **Market Understanding:** This factor considers how well a vendor is connected with the changing demands of analytic purchasers, as well as how extensively its customers adopt new and evolving capabilities.
- **Marketing Strategy:** This criterion analyses if a vendor has a consistent set of messages that communicates its value and differentiation in the ABI platform market, as well as whether that vendor is raising awareness of its differentiation.
- **Sales Strategy:** This criterion considers how well a vendor's sales technique takes advantage of a variety of options and drivers that attract clients to investigate its ABI platform.
- **Sales Strategy:** This criterion considers how well a vendor's sales technique takes advantage of a variety of options and drivers that attract clients to investigate its ABI platform.
- **Offering (Product) Strategy:** Gartner examines a vendor's ability to support important trends that will provide commercial value in the future. Based on its roadmap, each vendor's score for this criterion takes into account existing and planned goods and functions that contribute to these trends.
- **Vertical/Industry Strategy:** This criterion evaluates a vendor's ability to fulfil the needs of diverse industries using templates or packaged data and analytics material.
- **Innovation:** This factor assesses how much a provider invests in and delivers novel capabilities. It analyses whether a vendor is setting innovation norms that others follow.
- **Geographic Strategy:** This factor analyses how well a provider is represented around the world.

Classification of companies:

- **LEADERS:** These are quite strong providers of the breadth and depth of functionality provided by their BI platform and can provide enterprise-wide installations that support large BI plans. Leaders develop a business proposition that is thought to be compatible with the product offered by buyers, and they provide global support for the product from feasibility to operational capability.
- **CHALLENGES:** These suppliers provide a wide range of BI platform capability and are well positioned to succeed in the market. They may, however, be restricted to specific use cases, technological settings, or application domains. Their vision may be hampered by a lack of integrated approach across their BI platform portfolio, or they may lack the sales channel, geographic presence, and industry-specific information provided by vendors in the Leaders quadrant.
- **VISIONARIES:** These vendors are distinguished by a clear vision of the type of BI platform they wish to supply. They are distinguished by the openness and flexibility of their application architectures, and they provide depth of capability in the areas they target, but they may fall short of broader functionality requirements. They are innovators, but have not yet acquired significant scale, or there are worries about their capacity to grow and execute consistently.
- **NICHE PLAYERS:** Vendors who excel in a narrow section of the BI platform industry or who have limited ability to innovate or outperform other vendors in the market. They may specialise on one topic or element but lack functionality in others. Alternatively, companies may have a pretty comprehensive BI platform in terms of functionality but limited installation

and support capabilities, or rather tiny customer groups, such as certain geographies or industries.

In this research, Board is rated as a Niche Player, as can be seen in figure 6. It distinguishes itself by providing a decision-making platform that more thoroughly supports business operations than other ABI product suppliers. The company was formed in Switzerland, and the vast majority of its customers are still in Europe, but it also has significant clientele in the United States. Board provides a subscription pricing model for on-premises and hosted cloud deployments. The analysts observed the following strengths and weaknesses:

- **Low-code, closed-loop application development**: Board's platform characteristics allow customers to go beyond traditional BI use cases. They can utilise self-service to construct and deploy process-oriented analytic applications with drag-and-drop functionalities such as data entry and business rules.
- **Unified analytics, business intelligence (BI), and financial planning and analysis (FP&A):** Board is one of only two suppliers in this Magic Quadrant that provides a modern ABI platform with integrated FP&A features. As a result, Board stands out for purchasers trying to bridge the gap between BI and activities like planning, budgeting, and financial consolidation.
- **Lack of market momentum:** According to Gartner, Board appears infrequently on vendor evaluation shortlists, and its new client growth is restricted. Furthermore, Board has one of the smallest user communities among the vendors in this Magic Quadrant, with very little user-created content available on public video-sharing services. Given the near functional parity of most ABI platforms for fundamental use cases,

ecosystem characteristics are becoming increasingly important in product selection processes.

- **Minimal brand recognition beyond financial departments:** In most situations, the Board joins a company through the finance department, where its brand is well-known. It can be tough to persuade end users in other functions to adopt its platform as an alternative to more well-known BI solutions. Users of Gartner's client enquiry service rarely name Board as the sole or primary BI standard.

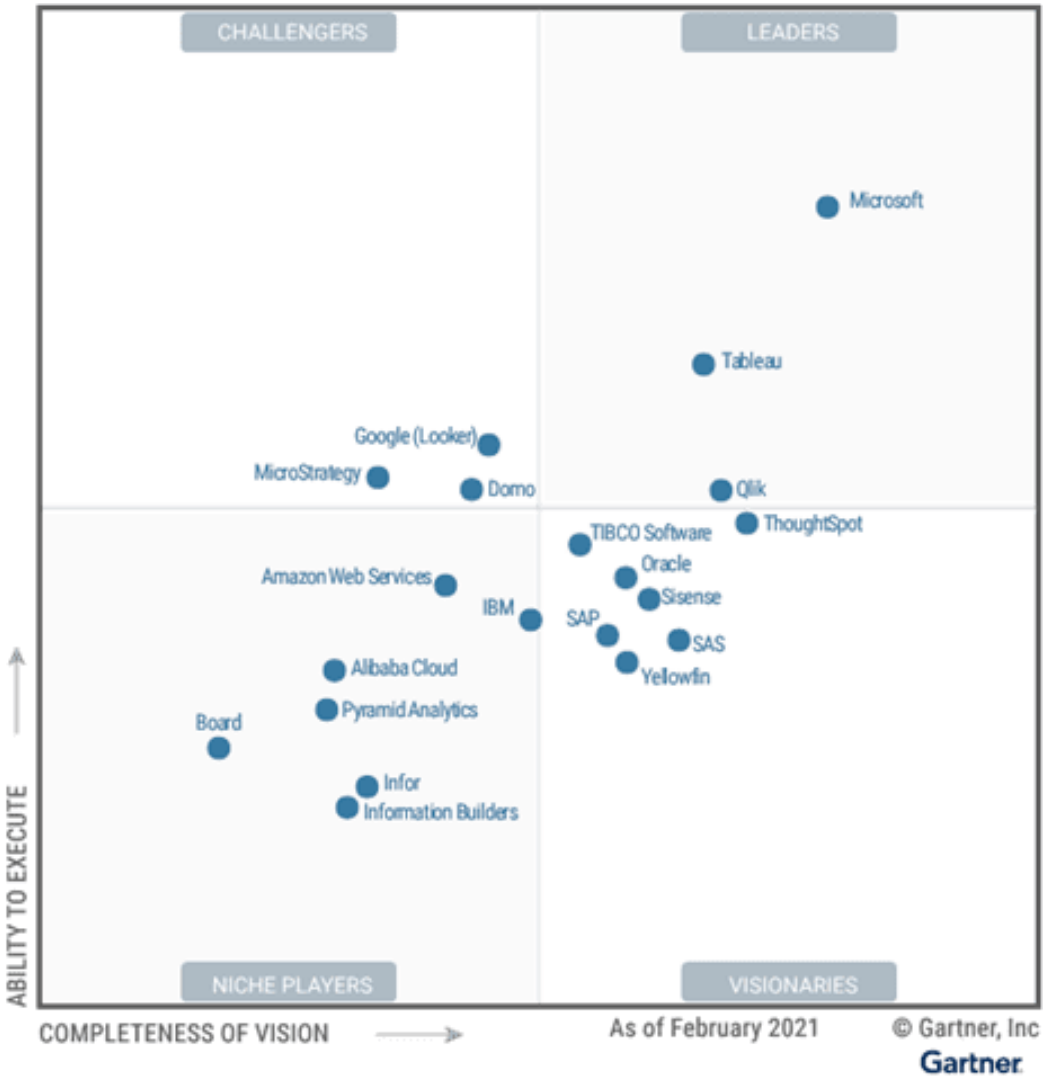

Figure 6:Gartner's Magic quadrant 2021

(Board Manual, s.d.)

Platform Architecture and Function:

The sections that follow are designed to describe the architecture that supports the Board application. All the material was extracted directly from the online handbook[3], which is also used by consultants, as a guide, during application development work.

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 menu on Board is divided into five sections:

1) **Capsules:** represents a collection of Screenshots and Procedures containing the reports you want to view, thus allowing you to see useful information commissioned by business decision makers.
2) **Presentation:** is a simplified way of displaying the organisation's corporate data. This section allows you to create customised versions of business reports by adding screenshots, even from different Capsules, and arranging them in new slides in a customisable order.
3) **Cognitive Space:** this section offers a natural interaction between the user and the data, providing a search experience really similar to what a
4) **Data Model:** this can be categorised as the heart of the software solution, as it is the section used for loading data and defining all the analysis variables according to the Entity-Relationship model.
5) **System Administration:** The System Administration part of the Board is dedicated to the administrators of each unique platform. A user with the proper capabilities can manage and see users, security profiles, licences,

[3] Boardmanual.com

the instance's graphic theme, and much more from the administration section.

The ordinary licencing does not allow access to all areas; however, to gain full access to all features, a developer's licence is required.

A reference sample will be supplied to make the description of the software architecture easier to understand. In particular, consider the case of a corporation having a chain of stores spread across multiple geographic regions.

Data Model: Entities, Relationships, Cubes

The data models that Board allows you to manipulate are of the multidimensional type, these data patterns arise from the understanding that the variables that influence a process can be many and vary; this technology allows you to analyse metrics of interest as a function of one or more variables at the same time. Consider the example of a retail chain. Individual shop sales can be examined using a variety of criteria, including date, point of sale, geographic area, seller, quantity sold, and others. A multidimensional cube makes it possible to evaluate Sales metrics as a function of all variables simultaneously or as a function of a subset of them, in this case aggregating on the variables that are not considered, figure 7.

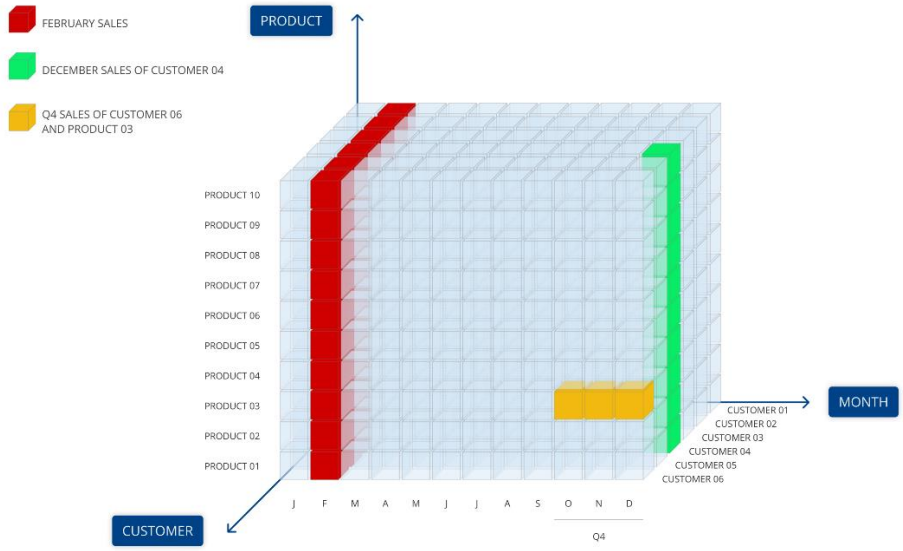

Figure 7: Example of a Multidimensional Cubes

The Board application, in particular, allows data to be modelled using an object named Cube. Each cube, in particular, has its own structure, the dimensions of which are referred to as Entities. Cubes can be text, numeric (integer, single, double), or picture. Although the numeric type is undoubtedly the most widely used, the same qualities can be applied to all others, as will be shown.

The definition of Entity Relations is used to handle the hierarchical tiers of data. The shop, for example, will be linked to the city to which it belongs, which will be part of a geographical area, and so on. Here, "father and son" relationships are formed, with the key rule being that each son (for example, the store) can only have one father (the city/geographical area to which it belongs), whereas each father can have a limitless number of children.

Board enables you to define and visualise the accuracy of the relationships defined through a graphical view called relationship tree, as can be see in figure 8.

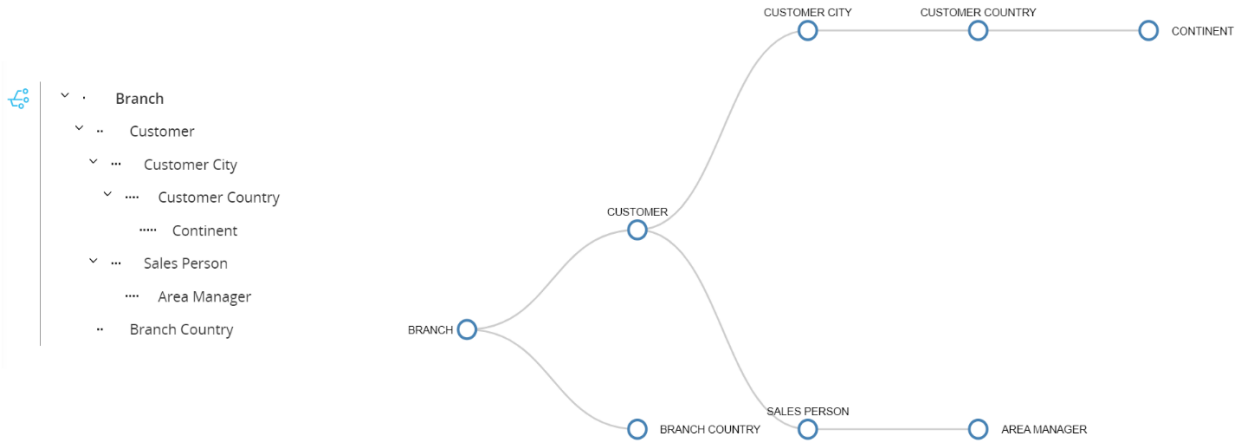

Figure 8: Example of a relationship tree

In the end, all Board Data model has the following three components:

- **Entities**: are information collections, most commonly text and codes. Within a single Entity, for example, there could be a list of Customers, Products, or Cities. Cube dimensions are entities (and hierarchies).
- **Relationships (hierarchies):** A Relationship (or hierarchy) can be defined when two or more Entities have a many-to-one relationship. Because there is a many-to-one link between Customer and City and City and State, the entities Customer, City, and State can be organised into the link "Customer City State."
- **Cubes:** Cubes contain data (typically numerical, but also text, files, dates, and other types) that may be analysed and examined using their many dimensions and hierarchy levels.

Business data very often derive from several sources, but in order to be able to analyse them as a whole, it is necessary to unite them under a single database. For this reason Board allows users to link, integrate, and federate data from using:

- Data warehouses and relational databases

- Enterprise apps (for example, SAP ERP)
- Sources with several dimensions (including SAP BW)
- API calls to web services
- TXT, CSV, and Excel files
- Sources based on the cloud

Data Reader is the name of the tool used to import data into the Board platform. Data Readers are also in charge of mapping data to Entities, Relationships, and Cubes. Imported data may also undergo transformation processes via the ETL section during this stage. An example of the process can be seen in the figure 9.

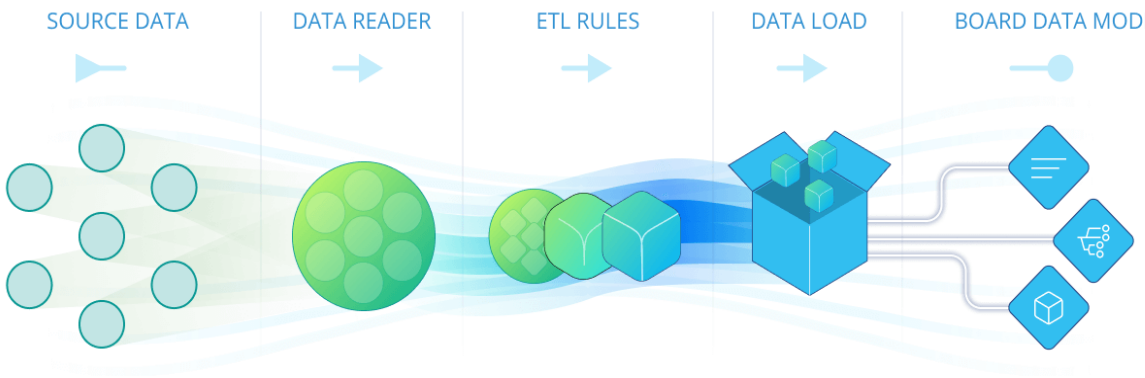

Figure 9: Data reader basic functioning

The technology that underpins Board's Data Model ensures maximum efficiency in managing large volumes of data while always providing high calculation performance. The software implements several database management techniques that allow it to avoid overloading the space occupied by the database in a short period of time, which is a common problem in multidimensional solutions. In particular, because the cubes are real matrices, they can be “sparse” i.e., have a null value on certain entity crossings. Board employs a calculation engine that automatically distinguishes scattered attributes and avoids them throughout the calculation phase because, as empty cells, the results of operations on these

intersections are meaningless in any case. Going back to the example above, a cube analysing sales by customer, shop, and geographic area may have null values at some of the crossings because it is not certain, for example, that every customer buys at every shop, so there will be null crossings at the individual customer at the shops where he did not buy, see figure 10.

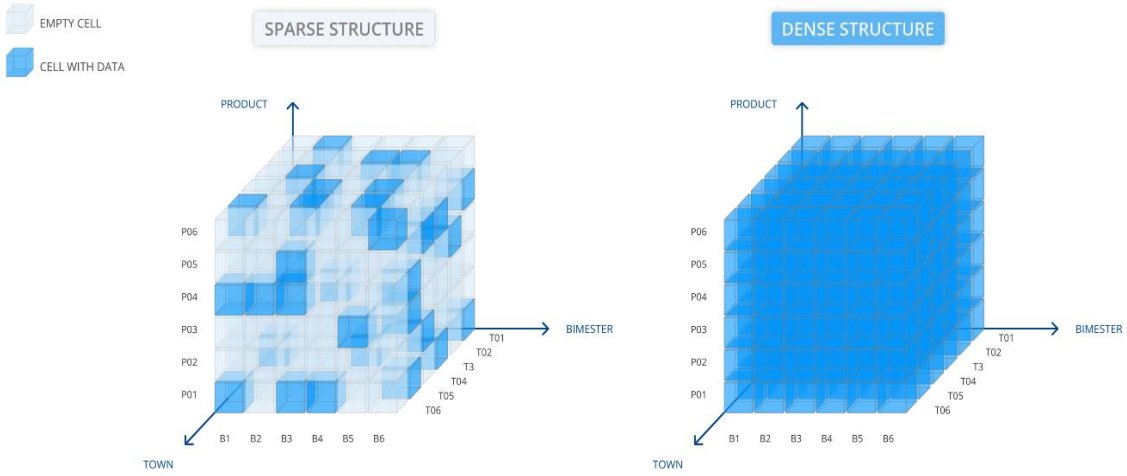

Figure 10: Sparse and Dense Cube

Drill Throughs:

Drilling into data stored in an external relational database or an ODBC or OLE-DB compliant data source from Board report is possible using the Drill through feature. This function comes in handy when you need to analyse data in greater depth than what is placed into the Board Data model.

The detail level of Cubes in a standard Board Data architecture allows you to drill down from summary reports to the particular Cube cell described by the Cube structure. For example, suppose that in a report in which sales are analysed by shop, the user needs to increase the level of detail, i.e. to evaluate sales by sales rep. Simply drill down (double-click on the sales rep of interest) and a new report will automatically appear with the data broken down by sales rep. Of course, this

can only be done if a relationship has been created between sales rep and shop, an example in the figure 11.

Board Entities are mapped to matching fields of the SQL data source's table or query via a Drill-Through protocol. Additional table (or query) fields can be added as desired.

Drill down by **Historical_SalesRep**

Month **Apr.23**Year **2023**

	Yearly Net Sales	PY Net Sales	Growth%	YCV
Davolio	29.437$	1.272$	2.214,23%	55.788$
Fuller	34.464$	816$	4.122,03%	71.347$
Leverling	7.673$	2.015$	280,76%	69.471$
Peacock	6.430$	7.008$	-8,24%	46.625$
Suyama	3.861$	7.718$	-49,97%	17.182$
King	25.484$	8.619$	195,68%	45.242$
Callahan	15.603$	2.347$	564,95%	42.634$
Dodsworth	1.986$	1.654$	20,06%	33.499$
TOTAL	124.940$	31.449$	297,27% MAX	71.347$

Figure 11: Exaple of drill down report

Rules

Rules are collections of formulas that can only be applied to members of the same entity. Rules can be created in the Data Model menu's Rules section.

It is possible to specify a specific member as the outcome of a formula involving other members of the same entity using a Rule, regardless of any selection that is active on that entity. One such application is the production of aggregating Profit and Loss macro-items from the company's individual income statement figures..

A Rule is always connected with a single Entity and can be applied to any Cubes whose structure includes that Entity as a dimension.

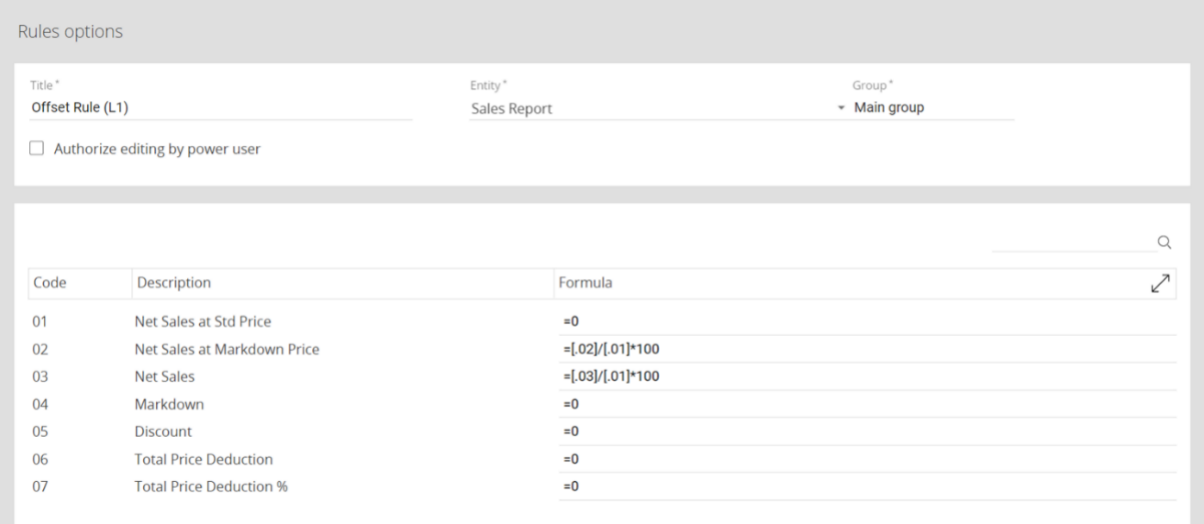

Figure 12: Examples of Rules page creation

The Time Period section:

The Time Range part of a Board Data model and its specific attributes are described in this article.

You can inspect and adjust settings related to Time Entities and their Relationship inside the Data model from the Time Range section of a Data model.

You have to define the time range of your data when you constructed the Data model: this first configuration normally mirrors your existing data lifespan and extends for a few years in the future for planning considerations.

Returning to the example of the retail chain, it is critical to precisely identify the time range, which will allow the company's data to be imported into the application beginning with a specific year. Outside of specified time frame, the application will automatically reject values.

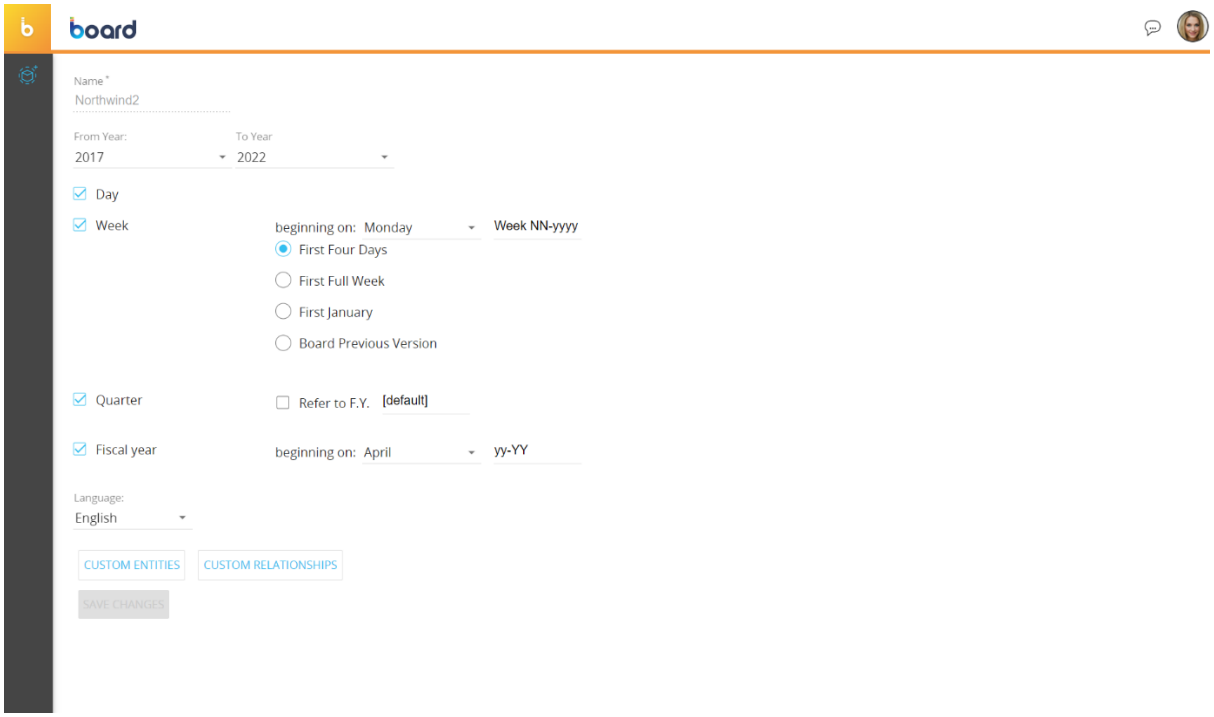

Figure 13: Time Period section

Procedures:

Procedures are the tools that allow you to manipulate data within the software. As a result, Procedures are classified as algorithms that the user can create in a coding-free mode; this is one of the main benefits of Board because it is easily used even by users who lack specific computer programming skills. In particular, within a procedure, various activities that manipulate data can be included: from simple copying or calculating on cubes to more complex allocation activities typical of business models such as Pianification and Simulation Activities. Furthermore, if necessary, it is possible to enable the execution of written code within Python or R modules, which are therefore external to Board.

Figure 14: Exaple of procedure

A procedure can be executed in three different ways:

- Launched manually, thanks to a specific button contained in a screen.
- Activated automatically when a specific screen is opened or closed by the user (this option is called trigger procedure).
- Executed as a batch process, launched by command line or a scheduler.

Capsules:

The term "Capsule" refers to a collection of Screens and Procedures that allow for a dynamic environment. Each capsule is fundamentally made up of reportage screens where information is shown and organised in such a way that it allows for quick identification of critical information for business decision making. Screens may contain tables, graphics, test-taking buttons, and other items with the purpose of displaying data.

The capsules do not store any data, yet they can be classified as data presentation objects such as tables and graphs. To configure a Capsule, the report layout and presentation objects must be defined. When a Capsules is opened, the system does

an automatic update of all the objects present with their Data Model of input, ensuring that the user always has the most recent data available in chronological order.

The "Screen" of a Capsule may feature tables, graphics, and other data visualisation tools, as well as elements that allow navigation inside the Screen of a Capsule, such as buttons and menus.

The capsules respond to a variety of fundamental user requirements:

Tables and graphics with the sole purpose of visualising data might be created for analysis. Reports for CPM and BI analysis that integrate the Data Visualisation phase with the ability to perform data entry in real time by the user are frequently used to perform simulations. It is also possible to create capsules with the goal of making the reporting environment's configuration phase more intuitive for customers.

In the preceding example, the capsules are the interface via which the user will interact with the application. For example, the corporation may elect to have a capsule for each store that, when combined with the proper security measures based on the user profile, allows access to the data of the individual store. It may then decide to develop a capsule for studying logistical data and another for top management with the economic trend provided by management control, and so on.

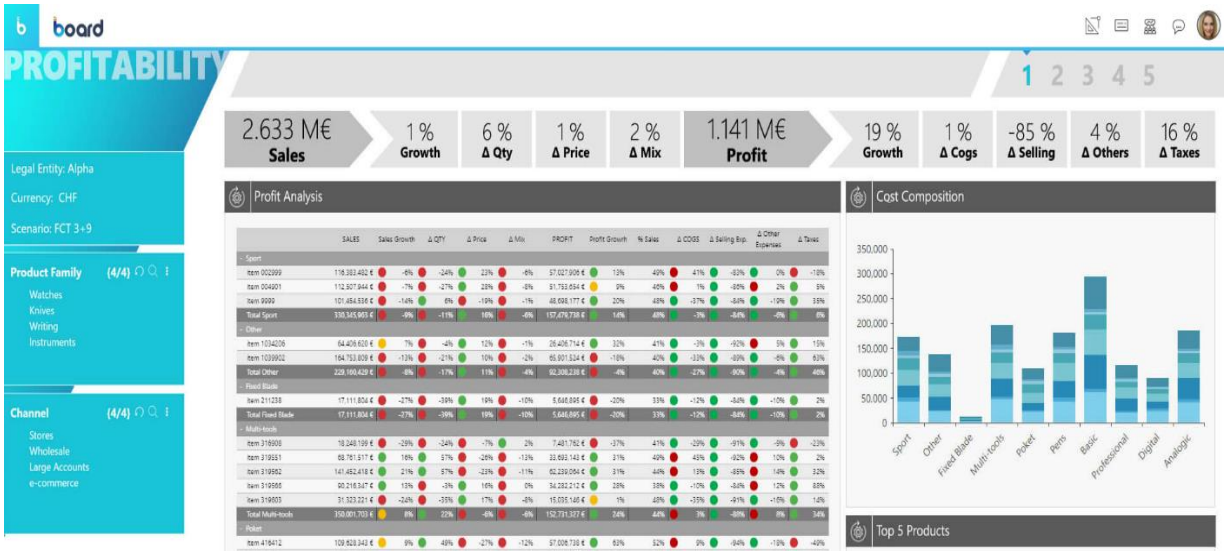

Figure 15: Examples of capsules

Cognitive Space:

Board's implementation of Natural Language Recognition (NLR) and Natural Language Generation (NLG) technologies enables exceptionally inventive and effective interaction between users and data across the whole Board Platform.

To get the most relevant information, a user can talk directly to the system or interact with it using search strings, similar to how a typical web search engine works. The user may simply acquire all relevant information from the analyses, neatly highlighted for him/her, thanks to cutting-edge technology that automatically converts speech into questions and delivers "machine-generated" results along with clever on-the-fly descriptions.

The Cognitive Space area of Board allows users to interact naturally with data while also providing a completely web-like search experience and saving time.

System Administration:

The Board's System Administration section is for administrators of a single Platform.

A user with a good knowledge of the platform can manage and examine users activity, security profiles, licences, the Platform's graphical pattern, and much more from the administration section.

This area of the platform can be divided into four sections, figure 16:

1. **Users & Security :** User authorizations for folder access, Capsules access and editing, and Data model access and editing can be defined under Users & Security - or Security if a platform is not coupled with a Subscription Hub.
2. **Monitoring**: allows you to evaluate user activity, check which processes are currently performing (such as Dataflows, Data Readers, Layout executions, and others), and configure system logs.
3. **Administration**: Under Administration, you may handle the Broadcasting function, which allows you to distribute a Board Presentation to a list of recipients on a regular basis via e-mail.
4. **Transporter**: It is possible to collect Data model snapshots in Transporter in order to compare them and apply metadata changes from a source Data model to a target Data model, this can be very helpful, when in the same project there is a server of development and a server of production, in this way you can make all the changes into the development server and, only once they are all tested, you can transfer the new features to the final server.

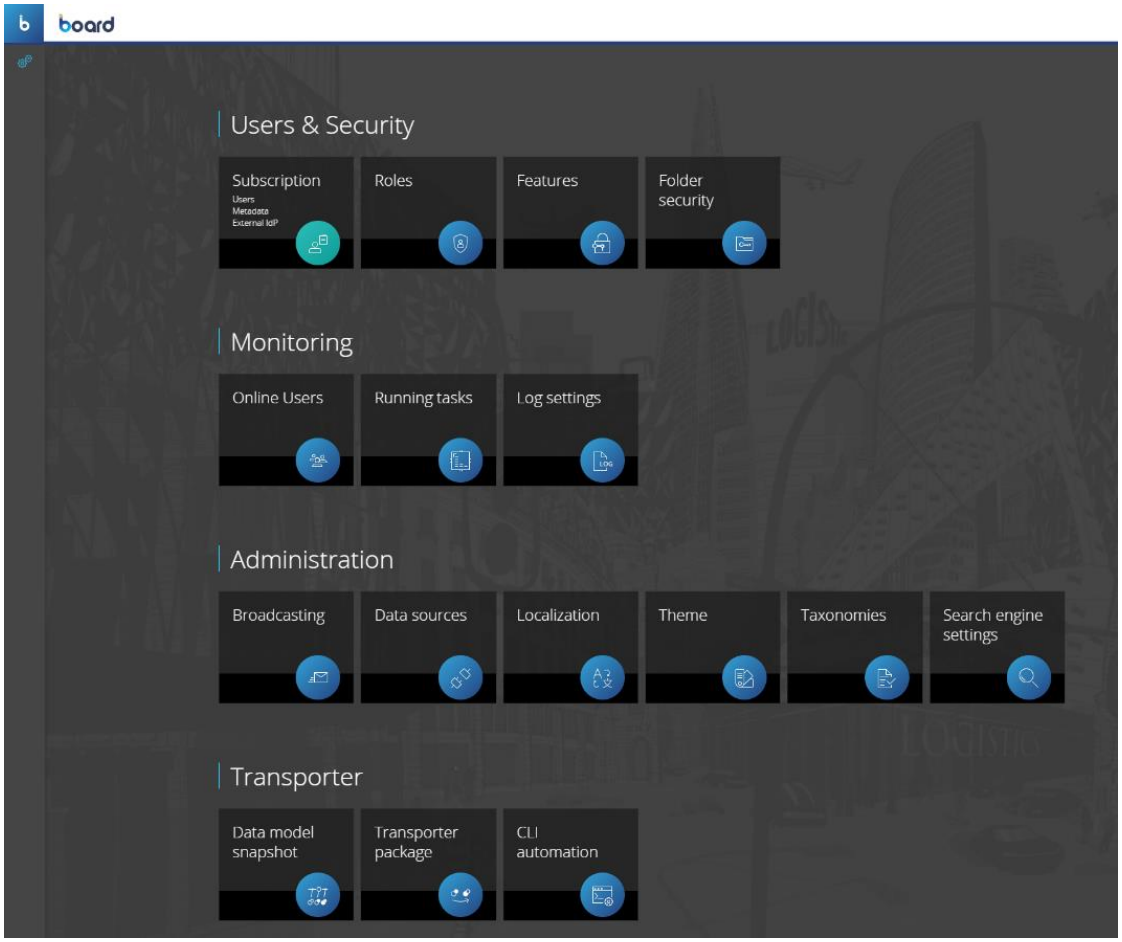

Figure 16: System administration menu

More features will be described in the chapter concerning the Business Case.

CHAPTHER 3: Effect of BI on enterprises

In previous chapters, we defined the impacts of installing a BI system within a corporation from a strictly theoretical standpoint. The goal of this chapter is to look at the effects of BI from a point of view that is practical. Although research in this area is still scarce, there are enough papers to make assessments. We will look specifically at the impact of BI on small and medium-sized businesses, the consequences on CPM, and lastly the possibles links between a BI system and greater Business Performance.

Business Intelligence and Small-Medium enterprises

Small and medium-sized enterprises (SMEs) have been slow to implement intelligent business solutions (Gauzelina & Bentz, 2017). They view these solutions to be effective only for major corporations that invest heavily in technology. The resources required to build, maintain, and hire highly skilled personnel to work on the BI systems are available in large organisations. This is similar to SMEs who operate with limited resources. Because these technologies are so pricey, they are out of reach for small firms (Lueg & Lu 2013). SMEs, on the other hand, can use BI systems that are not complex and do not require a high level of expertise to manage. BI systems are critical instruments in the client management of SMEs. Søilen (2012) discovered that SMEs utilise BI systems to manage clients and integrate information in a simple and quick manner when conducting research on small business companies in Sweden. As a result, BI systems are key tools for SMEs because they assist them in managing their consumers. Small businesses might use BI systems to improve budgeting efficiency. The budget is vital in a small firm because it shows how to balance multiple aims while maximising the limited resources available (Gauzelina & Bentz,2017). Budgeting issues among SMEs are caused by a lack of

understanding of the budgeting process, as well as a lack of simplicity and user-friendly IT systems. The absence of systems for validating the data used in budgeting leads to inaccuracies in the final budget. As a result, company resources are wasted. Business intelligence, according to Lueg & Lu (2013), can be used to improve budgeting efficiency. This is due to the fact that business intelligence improves transparency, user friendliness, and simplicity, all of which are critical in improving data validation and, hence driving budgetary efficiency. Furthermore, business information can assist small businesses to compete. Businesses today operate in a dynamic environment where competition appears to drive all strategic plans. As a result, a SME should learn to deal with and cope with these competition issues. Small business firms can successfully deal with competitiveness by implementing BI (Ponis & Christou, 2013). This is because competitive intelligence includes organisations' willingness to enhance their performance. As a result, business intelligence can assist SMEs in gaining a competitive advantage, and small businesses that have adopted business intelligence have a competitive edge in the market since they operate more effectively (Guarda, Santos, Pinto, 2013). Furthermore, the knowledge obtained through business intelligence can be used for future strategic planning, which can aid in avoiding any coming competition (Guarda, Santos, Pinto, 2013).

Given the reasons stated above, small and medium-sized businesses should also use a BI system. A study conducted in France by Sophian Gauzelina and Hugo Bentza in 2017 attempted to identify potential issues and constraints to the adoption of these systems by SMEs. Interviews were performed with a group of employees from French SMEs to accomplish this. In particular, 5 managers and 15 juniors were questioned for each organisation, for a total of 200 interviews.

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

Figure 17:Aspect tested by the junior employees interviews

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 18:Aspect tested by the Managers

The findings of this analysis can be divided into three categories:

1. BI Use and deployment in SMEs:
2. Lack of skilled employees for managing a BI system
3. The Impact of Business Intelligence on SMEs

BI Use and deployment in SMEs:

According to the report, just a small percentage of SMEs use BI systems in their operations. In fact, just 45% of top managers say they utilise such technologies in their activities, and that figure reduces to 19% if the use is extended to all sectors of the organisation. In support of the latter figure, just 15% of junior employees claim their organisation uses BI. These data support the findings of Lueg & Lu (2013), who discovered that small enterprises lag behind large organizations when it comes to BIS implementation. According to Lueg & Lu (2013), intelligence systems are prohibitively expensive for firms, making them economically impractical for SMEs. The high cost of BIS is also one of the constraints that prevents SMEs from adopting these tools (Gauzelina & Bentz,2017). Olszak and Ziemba (2012) discovered another probable explanation for this limited utilisation

of BI: they recognised that SMEs do not have enough technological equipment at their disposal since it is particularly expensive, and they prefer not to invest in this type of capital as part of a cost-cutting plan. As a result of these decisions, small businesses are limited in the opportunities that come with having sophisticated computer systems. Another probable cause is that most BI systems currently are hosted online but SMEs, on the other hand, appear to have a (security) prejudice against such software available via internet. This could be another reason limiting smaller firms' utilisation of these services (Yeboah-Boateng, Essandoh, 2014).

The second key finding of Gauzelina and Bentz (2017)'s study is the existence of an intrinsic resource problem in administering a BI system. Indeed, 61% of the managers polled admit that their firms' BI systems are complicated and require qualified and experienced personnel to handle them. The reality is that just 25% of the managers who made such an observation feel that their business has resources with that level of skills. The results of the interviews with managers are corroborated by junior employees; in reality, just 20% of the participants believe they have the skills to run a BI system adequately. From these results, it is apparent that those SMEs that have embraced BIS use the complex one. Complexity is still one of the most significant impediments to the adoption of any invention or technology. This is because less complex technologies are more likely to be adopted than more complex ones: they do result in a higher rate of adoption (Boonsiritomachai, 2014). The complexity of BI systems derives from the fact that correctly managing this type of technology necessitates a high level of both IT and mathematics skills. According to the interview, the majority of employees do not have both, making BI systems appear to be especially challenging. Furthermore, as previously stated, SMEs possess restricted resources, which, according to Lueg and Lu (2013), prevents these organisations from attracting more experienced employees (because they can offer lower compensation than

large enterprises) and prevents SMEs from having the right personnel to manage BI Systems.

The third and last theme that arose from the research is the influence of a BI system on SMEs. In fact, nearly 90% of the managers polled agree that this type of technology aids in organisational decision-making. This is due to the fact that BI gives data that is dependable, of high quality and delivered on time for the firm. The information generated is of excellent quality since it is thoroughly analysed; the only task left for company executives is to understand the results. As a consequence, BI Systems are significant since they enable a company to monitor the market and foresee occurrences. Aside from data integrity, 95% of the managers polled agreed that BI systems provide additional benefits to the organisation, including: increased corporate efficiency and productivity. What has been said appears to be consistent with the arguments of Poleto, Carvalho & Costa (2015), who claimed that judgements based on data extrapolated from a BI system were specifically capable of improving operational efficiency and corporate productivity. As a result, BIS delivers critical and reliable information utilised to guide the organisation on how to increase its efficiency and production. The study's final notable impact is related to ROI. Indeed, it has been stated that a BI system has the potential to reduce expenses while improving revenues and margins. Actually, BI provides a low-cost data collection tool, allowing resources that were previously allocated to market research to be redirected to other company branches. Furthermore, 70% of those polled felt that the system helps people to be more productive and to perform better at work, which leads to improved corporate performance. This could be due since the reports produced by BIS are helpful in providing to company leaders information on how to encourage staff. As a result despite its currently not very utilized in SMEs, BI may be a significant instrument for boosting corporate performance.

It is crucial to note that what has been stated above refers to a study conducted within French territory with personnel coming from local organisations; thus, the results may not be totally applicable to SMEs of other nations.

Impact of BI on Corporate Performance Management (CPM):

A study done in 2014 by Gregory S. Richards (University of Ottawa) on 337 senior managers was analysed to examine the probable association between the adoption of a BI system and an improvement in the CPM process. CPM, also known as business performance management or enterprise performance management, can be defined as a set of management practises and technologies that enable corporate performance (Richards et Al., 2014). CPM cycle management practises typically include planning, measurement, and analysis. One of the most common issues raised in the literature is that BI systems frequently fail to affect decision-making processes due to a lack of communication between IT and end users (Ko & Abdullaev 2007). This led the researchers to believe that there is a link between proper BI system implementation and effectiveness of the CPM process (as depicted in the picture 19).

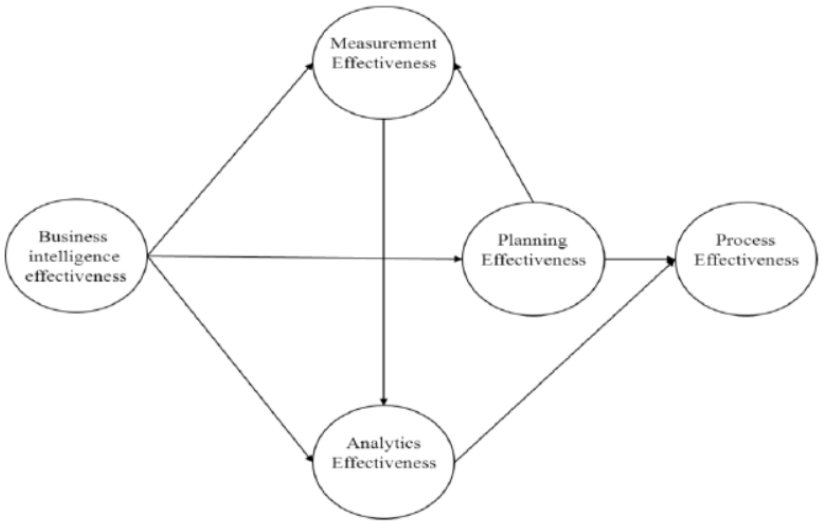

Figure 19:Framework of the research

Thanks to the framework described in the figure, and to what has been said previously, the researchers have identified seven hypotheses, to be verified or disproven during the study:

a) H1a – Business intelligence positively influences planning effectiveness.
b) H1b – Business intelligence positively influences measurement effectiveness.
c) H1c – Business intelligence positively influences analytics effectiveness.
d) H1d – Business intelligence indirectly influences process effectiveness through analytics and planning.
e) H2 – Effective planning positively influences process effectiveness.
f) H3 – Effective planning positively influences measurement effectiveness.
g) H4 – Analytics effectiveness positively influences process effectiveness.

Without going into the technical aspect of the analysis methodology used during the research, which can be found entirely in the reference paper, the goal is to evaluate the results obtained, specifically Richards et al. (2014), who managed to verify four of the seven hypotheses proposed as a result of the study conducted, specifically:

- BI effectiveness positively influences planning effectiveness.
- BI effectiveness positively influences analytics effectiveness.
- BI effectiveness indirectly positively influences operational process effectiveness, through analytics.
- Analytics effectiveness positively influences operational process effectiveness.

Hypothesis	Independent variable	Dependent variable	Supported?
H1a	BI	Planning effectiveness	Yes
H1b	BI	Measurement	No
H1c	BI	Analytics effectiveness	Yes
H1d	BI(through analytics)	Process effectiveness	Partially
H2	Effective planning	Process effectiveness	No
H3	Effective planning	Measurement	No
H4	Analytics	Process effectiveness	Yes

Table 1: Results of the research

The findings indicate that an effective BI system can favourably influence the planning process; in fact, this process looks to be data-intensive, and so BI can assist managers in carrying it out through many of the features they adopt. Furthermore, these systems have a positive impact on analytics, thanks to integrated data manipulation systems. For example, BI tools like dashboards and scorecards allow for rapid variance analysis, while the use of statistical tools (like data mining) allows for sophisticated analysis of patterns of relationships within each dataset. BI has an indirect impact on operational process effectiveness through analytics. As previously stated, simply having data available within the organisation does not improve processes. Data analysis is what determines particular areas for improvement. This logic is supported by the observation that BI has an indirect impact on process effectiveness.

Furthermore, the study's authors recommend a number of conclusions based on the findings:

- The study demonstrates the positive connection between proper BI system implementation and the CPM process. This is particulary significant given the advent of Industry 4.0 technology and the internet of things.

- BI enables improved management practises by providing more likely and correct access to information. Furthermore, the instruments enhanced analytic functionality is likely to yield new insights.
- Even if 70% to 80% of BI initiatives fail due to insufficient communication between IT and business users, the findings imply that BI should be integrated into the management system in order to allow a better knowledge of the precise uses to be made of the various BI tools available.
- Last but not least, the findings reveal that sector and size have no influence on the association discovered between BI systems and CPM. As a result, even SMEs can benefit greatly from the proper usage of a BI system inside the CPM process.

Business Intelligence&Analitics (BI&A) and the effect on Business performance:

As said in the previous chapters, investments in business intelligence are increasing year after year (Garner, 2013). According to several research, the business intelligence sector is one of the top three IT investments for large corporations in the United States (Kappelman et al. 2013). The goal of this paragraph is to identify the potential consequences of a business intelligence system on corporate performance, in order to provide an objective assessment of how advantageous it is for a firm to invest in BI.

Some studies have found a direct correlation between BI and supply chain and operational performance (Trkman et al. 2010), others have discovered that

Business analytics[4] improves performance by identifying actions that create value (Shanks et al. 2010), and still others (Williams et al. 2010) have found that Business intelligence has the ability to increase sales, decrease costs, and thus maximise profits. However, because the literature in this area is still limited, it was chosen to focus the contents of this paragraph on the research of Mohammad Daneshvar Kakhki and Prashant Palvia (2016) of the University of North Carolina, that conducted a study on a sample of 116 US information industry firms. This study aimed to answer two major questions:

1. What effect does BI&A (Business intelligence and analytics) have on business performance?
2. What variables interact with BI&A and business performance?

The model suggested by the study is that BI&A implementation affects business performance, and the type of BI&A moderates this relationship.

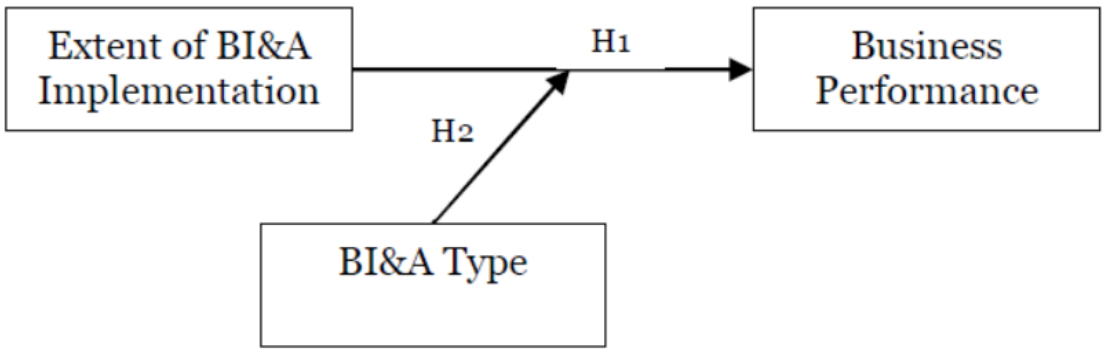

Figure 20: Research Model

[4] Business analytics refers to software that is capable of not only extrapolating and manipulating data (as is typical of BI), but also predicting potential future patterns and trends and recommending actions to be taken (predictive functionality). Business Analytics will not be addressed explicitly in this thesis work, despite the fact that some studies cited, mix it with Business Intelligence. In terms of the Board int software. It is primarily defined as a BI tool with analytic components added in the most recent releases.

The study established the following indicators to analyse business performance: ROI, ROA, ROE, ROS, and market share. In terms of the Extent of BI&A Implementation, firms require sufficient hardware infrastructure, hence the research used the extent of BI&A implementation as a proxy for BI&A investment. The study employed Chen et al. (2012)'s classification for Type of BI&A and views these three types as the major strategy for responding to the individual needs of company.

Construct	Variable	Description
Extent of BI&A implementation	Extent of BI&A implementation	Total number of BI&A related workforce divided by number of employees multiplied by 1000.
BI&A type	Type one	It is defined as 0 and 1 and any organization that has the BI&A workforce is assigned 1 and 0 otherwise.
	Type two	It is defined as 0 and 1 and those organizations that have any evidence for second type of the BI&A are assigned 1.
	Type three	It is defined as 0 and 1 and those organizations that have any evidence for third type of the BI&A are assigned 1.
Business performance	ROI	Return on Investment
	ROA	Return on Assets
	ROE	Return on Equity
	ROS	Return on Sale
	Market Share	Total Sale divided by sum of Total Revenue from sale for companies in the same market.

Table 2:Descriptive statistics for key variables

Two hypotheses were developed based on the proposed research model:

- Hypothesis 1: The extent of BI&A deployment is related to company performance favourably.

- Hypothesis 2: The type of BI&A modifies the link between the extent of BI&A deployment and business performance.

The study methodology employed is not directly given but may be consulted in the paper in question, the point of interest is focused on the results obtained, which is that both hypotheses offered were subsequently confirmed by the analyses carried out, this leads to implications like:

- There is an empirical support for a strong positive association between the level of BI&A deployment and business performance. According to the findings of the investigation, BI&A increases business performance by increasing ROI and ROE. In other words, as mentioned in the literature, BI&A enhances decision making, which leads to improved resource implementation, and there is also evidence that BI&A is able to improves ROS.
- The various types of BI&A and their impact on corporate success are substantial. Type 2 BI&A, which incorporates technology such as web mining and social media analysis, has the most influence on improving business performance. Furthermore, organisations who adopt Type 3 BI&A, which includes analytical tools for sensor data, outperform those that do not.

The fundamental limitations of the study under analysis is that the extrapolated data pertain to enterprises in a specific sector (Information Industry); consequently, the conclusions cannot be considered to be applicable and generalizable to the others sectors. Furthermore, because all of the companies were part of the American market, the conclusions may have differed if the analysis had been undertaken, for example, considering European companies. Despite its limitations, the study was able to confirm a positive link between

the use of BI&A and business performance, which should prompt organisations to consider the benefits of investing in such tools.

CHAPTER 4: The Terre da Vino Business Case

An overview of the company:

The "Terre da vino s.p.a" is a major Piedmontese winery. Its origins may be traced back to the second half of the twentieth century, when hundreds of winemakers in the Langhe region attempted to expand productions and elevate Piedmonts wines to an international level.

One of the major issues found at the time was the presence of a large number of small producers who were unable to compete on a global scale. The company's strength was the ability to bring together 100 different producers under a single brand, for a total of 420 hectares cultivated between the Barolo and Barbarsco areas, pushing production towards unequivocally appropriate volumes for international export. The Terre da Vino brand now includes roughly 2000 small winegrowers in its consortium, with 5000 hectares of vineyards organised in 14 winemaking cellars.

Figure 21:The Terre da Vino 's headquarters

In 2016, they decided to establish a new brand named "Vite colte" that is aimed at high-end products whose wines are sourced from vineyard initiatives. Vite

Colte, whose tagline is "hands, head, heart, the art of cultivating the vine," is built on the expertise of 180 skilled winemakers who produce over 300 hectares of vines in Piedmont. Terre da Vino's key markets are Germany (60%), the United Kingdom, and the United States, as well as the home market. Terre da Vino is involved in or has been involved in a number of research collaborations with Italian universities in the fields of viticulture and enology. In recent years, the sales volume has been around 5,000,000 bottles per year, with a turnover of 25 million EUR. The brand's most well-known products include Barbera d'Asti Superiore "La Luna e i Falò," Piedmont Moscato Passito "La Bella Estate," and Barolo "Essenze." However, the company cultivates, vinifies, and distributes over thirty distinct types of wine in total.

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

An examination of the Project:

The project I worked on during my internship is part of a much bigger project that began roughly ten years ago. As was anticipated, the customers required an application capable of managing data from several company areas. More specifically:

- A **Budget** portion: In this section, the application allows you to create a budget for the coming years, as well as analyse costs, margins, and ongoing marketing efforts.
- A **Production** section: In this section, you can conduct an analysis of the production for the various wine categories, as well as perform quality control checks.
- An **Administration** section: This is where you can get accounting data.

- A **Utility** section: This is where the firm supervisors examine and modify the data that can be used in the previous capsules.
- A **Commercial** section: separated into many categories such as export, HoReCa, GDO, and web. In which the sales quantities of the various commercial regions and teams are displayed and examined.

When it comes to the specifics of the activities I performed, they can be divided into two categories:

In the first one: Pre-existing environments were migrated to a more contemporary and performant software version. The key effort during this activity was twofold: from the back end, it was important to ensure that the various procedures and databases had been migrated and were still working after the transfer. In addition to that, the client requested that the already existing environments (namely, all of the environments described above with the exception of the commercial ones) be rearranged, resulting in a more appealing and graphically modern result.

The second activity was to create new capsules for commercial analysis, reporting and Sales planning. Following specific client requests, four separate environments (figure 22) of the same type were established, each containing:

1. The first contains information on **Exports**: that is, updated data on sales in foreign countries.
2. The second set contains **HoReCa** data: This section analyses and categorises sales to Hotels, Restaurants, and Cafés, bringing the worlds of catering and hotels together.
3. The third set of data concerns the **GDO (Grande Distribuzione Organizzata)**: this is the data of the "Large Organised Distribution," which comprises supermarket chains spread across the country.

4. The fourth type of data is **WEB** data, which includes sales made through the company's e-commerce channel.

Figure 22: Subdivisions of the "Commerciale" environment

The following sections will describe the process of developing the environments from the very start, beginning with the specification of what is required at the database level and finishing with the design of capsules and reporting screens. For reasons of corporate privacy, the figures and data that will be put in the following pages are not those made for the client, but rather came from an environment created with the purpose of explain what is described.

Data Model Development:

The first step in building the project commissioned by the company was to design a specific Data Model. The establishment of the Data Model, in turn, allows for the design of Entities, Cubes, and Relations, which will be the attributes and input objects of the Data Readers and Procedures, allowing data to be imported, processed, and manipulated.

Definition of Entities and Relationships:

The first entity to be defined within a Data Model is always the temporal entity; in fact, it is the most important analysis dimension, so much so that the software

does not allow manual creation of this entity, but the user is asked when the data model is created through the definition of the 'Time Range'. The project was commissioned for a time period spanning from 2018 to 2026, with daily granularity. This means that all computations will be conducted using the latest information that is available, beginning in 2018 and continuing to the present.

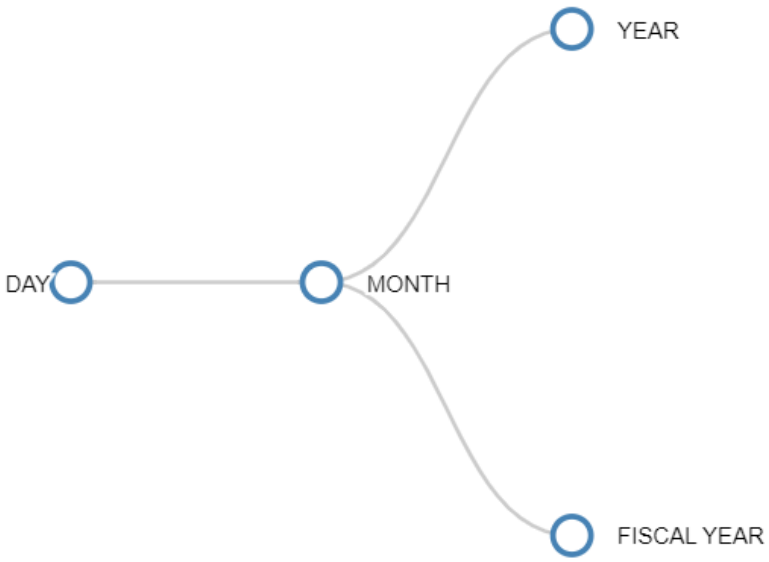

Figure 23:Relationship between time entities

Following the definition of the reference time frame, additional analytical dimensions were included, which will be separated into the following group for the sake of the presentation:

- P&L Group: comprises all of the entities required for the initial preparation of the Income Statement and, later, the Reclassifieds requested by the customer.
- Product Group: contains all the entities required to describe the company's products, such as entities carrying all the labels of the manufactured items, suppliers, and their aggregating entities.
- P&L Version Group: This is the subgroup that contains the entities that identify the Budget and P&L scenarios. This group of entities is required to

generate a scenario analysis and to allow a comparison of the different versions created as well as the real values and those computed on the estimate.

- Customers group: includes all entities that can be used to analyse and describe the company's customers.
- Order Group: Contains the detail of the order made by each customer.

Figure 24:Examples of Classification of entities groups

The Board programme requires the definition of some fundamental features when defining the entity, such as the length of the Description and code string, as well as the number of occurrences inside the entity. These settings must be carefully examined by the consultant in collaboration with the customer, since improper values (for example, a code length that is too short) may result in the exclusion of some items during loading via Data Reader. The most recent versions of the software allow you to define an entity with an unlimited number of occurrences, although this option is generally not advised by consultants because it causes significant computational performance losses.

In addition to grouping, entities are related to one another via 1-n relationships, often known as parent-child relationships. Thus, the data attributed to a specific entity can be grouped based on the aforementioned relationships (figure 25). For example, for a single customer, the geographical area of origin, the designated sales representative, the orders placed, and so on can all be registered, as can be seen in the following figure. Relationship management is critical to the project's success since missing or erroneous associations might impair the software's capacity to employ the Drill-Down and Roll-up features or, worse, lead to discrepancies following data manipulation.

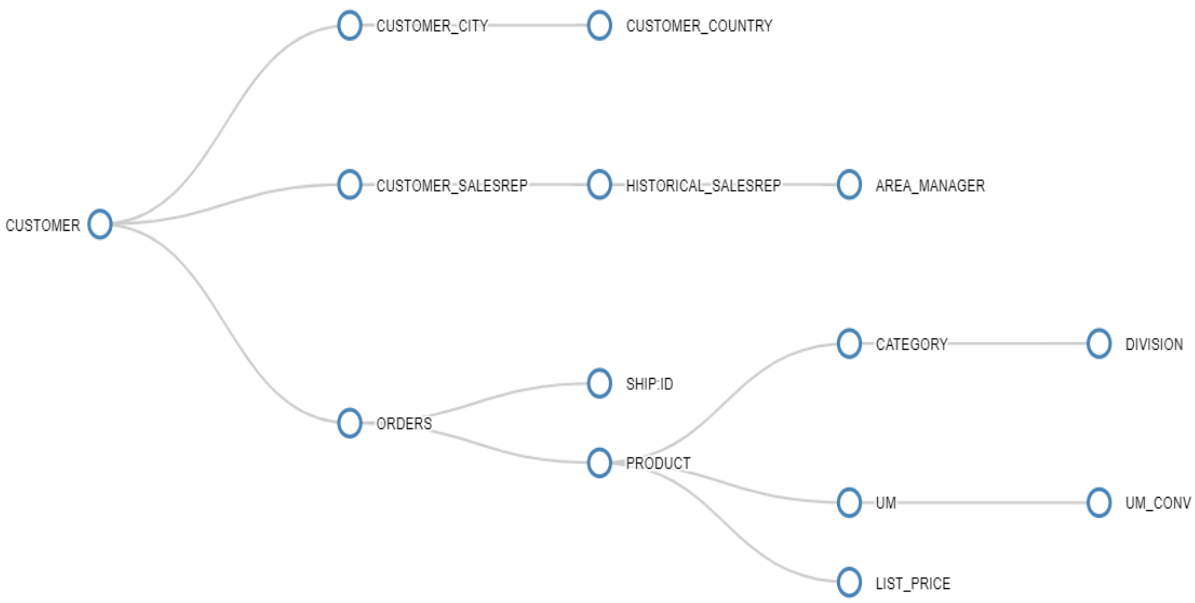

Figure 25:Example of en entity tree relashionship

Cubes definition and creation for the database:

The last phase in the Data Model definition process is the construction of InfoCubes, which are objects that organise data according to a multidimensional model with respect to the entities described in the previous paragraph. Board's Cubes are built in the "Data Model --> Cubes" section. The defining of these

objects is essential for proceeding with the analysis, as there are several options that may be configured within the platform. This section will also show the configuration of a number of cubes utilised in the project.

The process of defining an Infocube begins with the inclusion of its properties, which include the cube's Name, Group to which it belongs, and Data Structure. Within Board, four sorts of data are compatible: int, double, currency, and text data. If the data to be input is of the numeric type, the option falls on the first three types, and especially on the double type if the number of decimal digits of the datum under analysis exceeds 7 units.

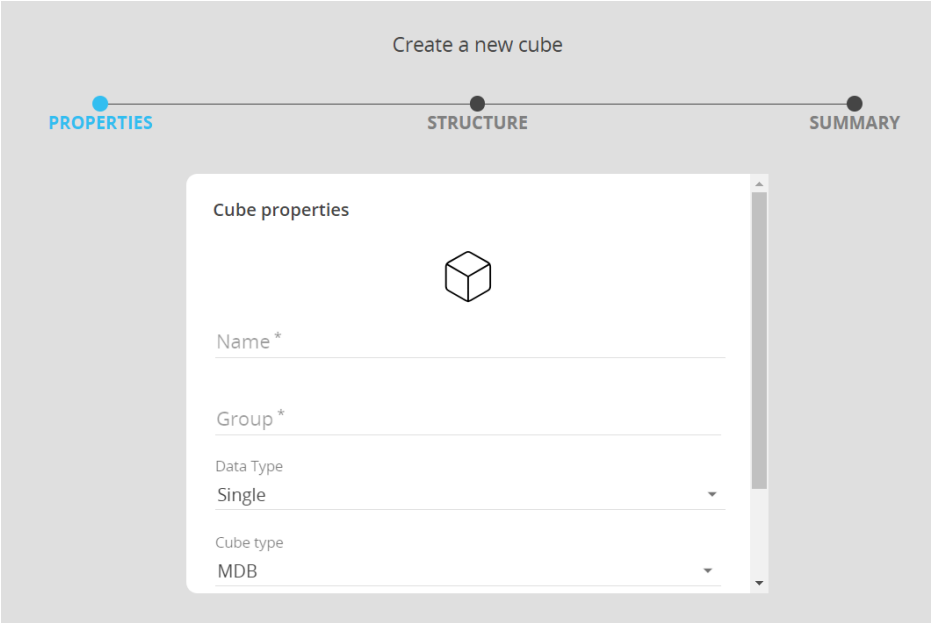

Figure 26: Definition of the cubes properties

Afther the properties the structure must be specified, so the consultant have to choose the "axes" entities of the cube, i.e. those entities that represent an analysis variable of the contained data, must be set. Even though the standards specify that the ideal number of entities contained whithin a cube should not exceed 7-8 units, the Board software supports cubes with dimensions ranging from 1 to 32; in fact,

it has been discovered that a cube with more than 8 dimensions is difficult to manage and understand for the end user.

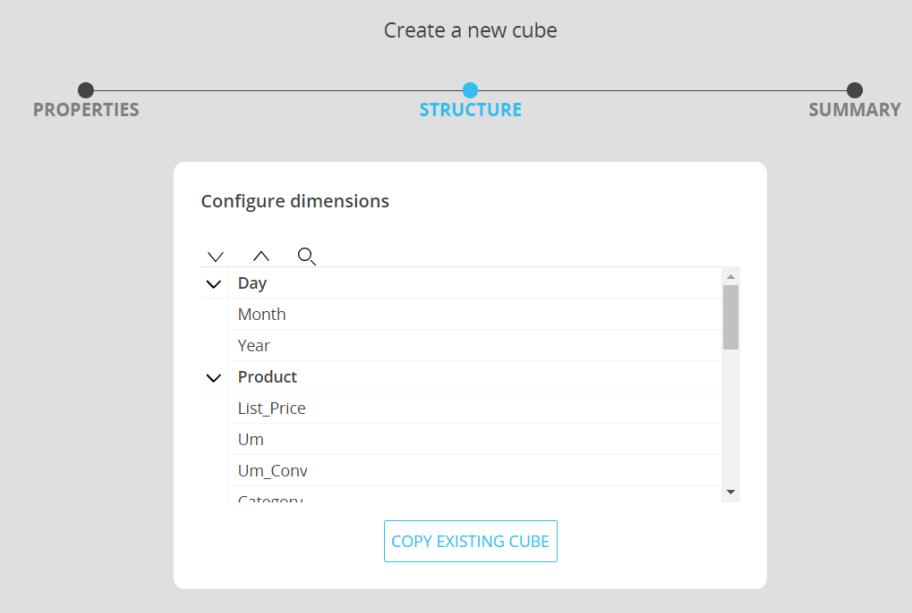

Figure 27: Definition of the cubes structure

Following the definition of the structure, the Density or Sparsity of the entities involved can be specified. It is important to remember that the temporal entity in Board must always be of the dense type, but the value for all other entities is set automatically by the neural engine. Even if at least one object must be of the sparse type, this parameter can be altered manually to make calculations more efficient. Finally, different versions of a cube can be added; a version of a cube is distinguished by a structure with a lower level of detail than its basic structure (for example, instead of having data defined by month, the dimension used in the second versions is year, as shown in the following figure), and this enables certain calculations in which maximum granularity is not required to obtain significant processing time savings.

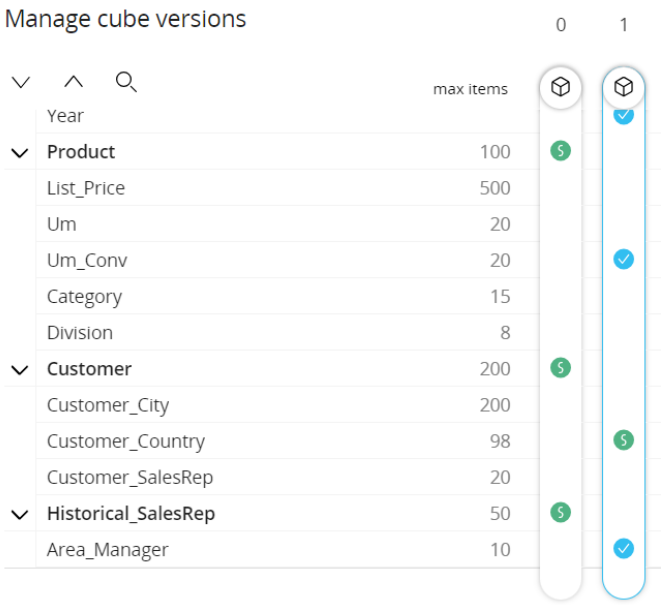

Figure 28: Different versions of the same Cube

There are numerous cubes made for the project that can be classified have been classified (for organizational reasons) into groups like:

- ADMIN Group: Consists of cubes used to enable and disable functions within environments.
- DATAFLOW Group: This group contains cubes that are populated after the start of various calculation procedures, such as commissions or others.
- P&L Group: Contains the income statement's destination cubes.
- SALES group: Contains cubes containing data on both realised and budgeted sales.
- MATRIX group: Which includes cubes of matrices used for the allocation of overhead costs on the product.
- VERSION group: Contains cubes in which the various budget and forecast versions are saved.

Populating a cube: the data reader tool

At the end of the Data Model definition activities, it will be made up of Infocubes with no value; the next phase will be to fill these data-structures utilising protocols known as Data Readers. Data Readers can be used in two ways:

- Static mode: a single data reading procedure is done, which will not be repeated on a regular basis unless manually initiated.
- Procedural mode: the Data Reader is executed automatically by software based on user input; automation is enabled due to the use of special algorithms known as Procedures.

In terms of the project, it was decided to use both methods; in fact, the cubes were initially populated through Data readers launched individually, allowing us to import the data from the sources they provided us; however, procedures have been defined to allow the customer to update the data contained in the cubes with more up-to-date values at a later time. Speaking of the data's origin, it comes from various management programmes employed by the client, which provide data via ORACLE connections in SQL language.

The process for constructing a Data Reader can be divided into three steps:

1. SOURCE: This step is required to identify the data source from which these must be extracted, in our case a SQL source.
2. MAPPING: This phase connects the entities or cubes to the path of the source from which the data must be extracted.
3. ETL: formulae can be entered in this phase to change the format of the data before it is loaded on the entity or cubes."

In addition to the previously listed SQL sources, the software allows you to extract data from text files, csv files, and SAP/ERP sources.

By thoroughly examining the SQL-type Data Reader, it is vital to note that, once the connection with the source has been established, the mapping step, i.e. relating the source data to the destination of the Board Cubes, must be completed. However, it is possible that the data from the sources comes from multiple linkages, which must be integrated and converge on the same destination. To achieve this, the software board allows you to enter more complex SQL queries than those automatically provided, allowing you to tailor the Data Reader tool to any customer requirement. This can be done by setting the SQL source in the Mapping phase to "MANUAL". To verify that everything works correctly, simply click on BROWSE and the required table will appear.

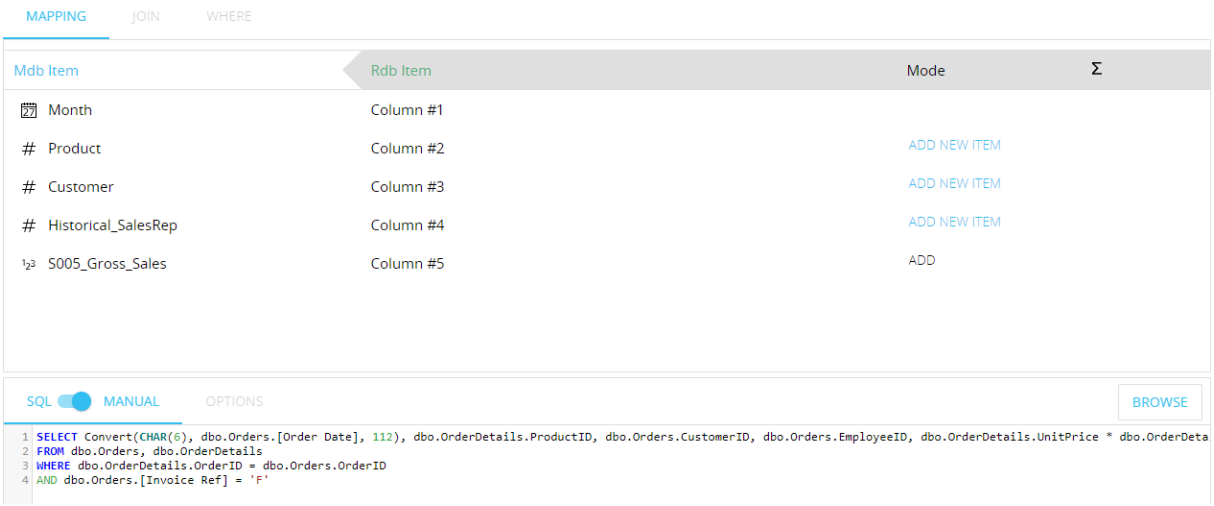

Figure 29: Example of a Data reader with the Manual Query configuration

(Davenport & Harris, 2007). Another common application for data readers is to define the relationships between the occurrences of two distinct items. The relationships that exist are specifically indicated during the entity definition process. However, after loading the occurrences, it is required to indicate the relationship that exists between them (for example, the entity state's occurrence Italy must be tied to the entity continent's occurrence Europe). This can be done manually (by expressing the relationship of each occurrence to the parent entity) or automatically via a Data reader (for example, by linking a product to its

category). As a result, the data readers in this project may be separated into two categories: the first is the one that populates the cubes, and the second is the one that populates the entities and creates the links between all of the occurrences.

Capsules 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.

Profile Security system:

As previously stated, the project is comprised of a number of web environments. These do not all belong to the same capsules, but each is housed within its own capsules, which are contained within a distinct folder, as indicated in the figure below. This is because the customer has requested that not all environments be accessible to all corporate users. To accomplish this, a security system based on Board user profiles was implemented, which allows you to grant access to certain folders for a single profile, providing each Profile access to a different region of the Board application. Those working in budgeting, for example, will only be allowed to see that area and so will not be able to see the sales data contained in the area called “Commerciale”.

Figure 30: Macro Area of the Board environment developed.

This ensures that information is compartmentalised and that employees from various areas do not have access to material that does not belong to them or to personal information of other employees.

The Sales analysis and Planning Environment

As previously stated, a substantial portion of the project was devoted to the development of commercial capsules. In particular, while it was necessary to develop four different environments, they all have similar characteristics and differ only in the type of data contained (as mentioned on previous pages), so it is sufficient to describe one of them, for example, the one concerning the EXPORT sector, and what has been said may also be applicable to the others (HoReCa, GDO, and WEB).

To begin, every environment includes two fundamental features:

- The first was to provide the most recent sales data for individual employees in order to evaluate their performance, productivity, and conduct analyses on the best-selling products.
- The second step is to determine sales volumes and associated commissions in order to create a budget for the coming year.

In terms of reporting, it was chosen to divide it into three Dashboard screens: Sales Performance, Sales Productivity, and Sales Analysis:

The sales Performance page, as shown in the picture below, allows you to watch the sales trend for each period and compare it to prior year data. You can also observe which sort of product is most sold by the single seller.

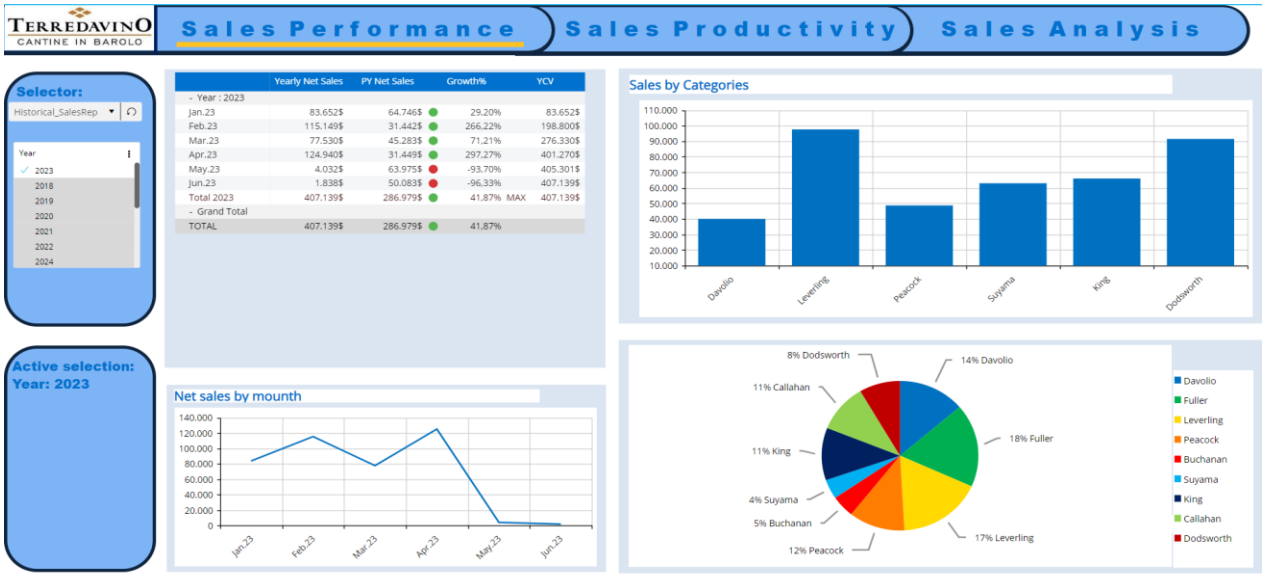

Figure 31:Sales Performance page

Regarding the Sales Productivity screen the customer required information on the capabilities of various salespersons to produce sales so that they could subsequently launch an incentive system based on three main KPI (As shown in figure 32). As a result, the request was to analyse the average order value, defined as total sales/number of orders, the average number of hours required to complete a sale defined as total hours worked/number of sales, and thus the average value of sales made for each hour of labour engaged, defined as € of product sold per hour of work. These three characteristics then have to be drillable by sales employee, reference time period, and type of goods sold.

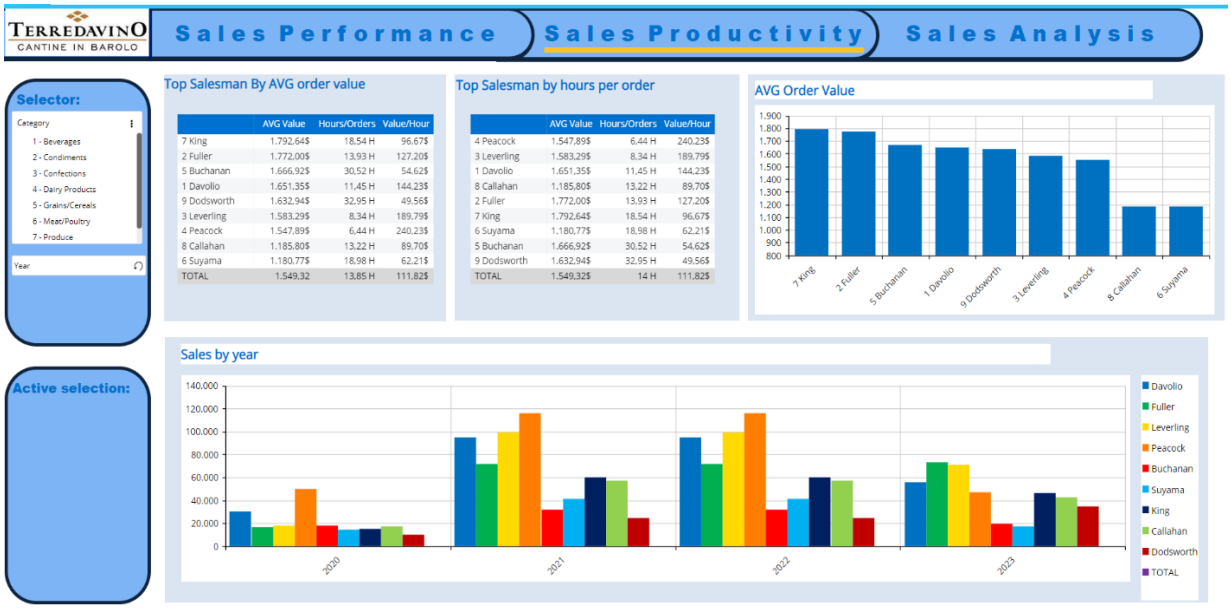

Figure 32:Sales Productivity screen

The last page was added to allow for analysis depending on the discounts given to each customer. The company's sales process appears to be based on the issuing of a yearly price list of the products, to which the sellers will then apply a certain percentage discount to the customer, who must be kept within the pre-set boundaries, unless otherwise approved by area managers. The purpose was to maintain track of the actual discount granted to each particular consumer for a certain product type. In this way, it is easy to ensure that the sales personnel adhere to the pre-established guidelines and that no consumers receive excessive extra discounts. An alert system has been introduced to make the page easier (As depicted in the figure 33) to comprehend, so that if the real discount is more than the maximum permitted, the last block is coloured red, instead of green. Ideally, as we were told by the customer contact person, there should be no red coloured blocks.

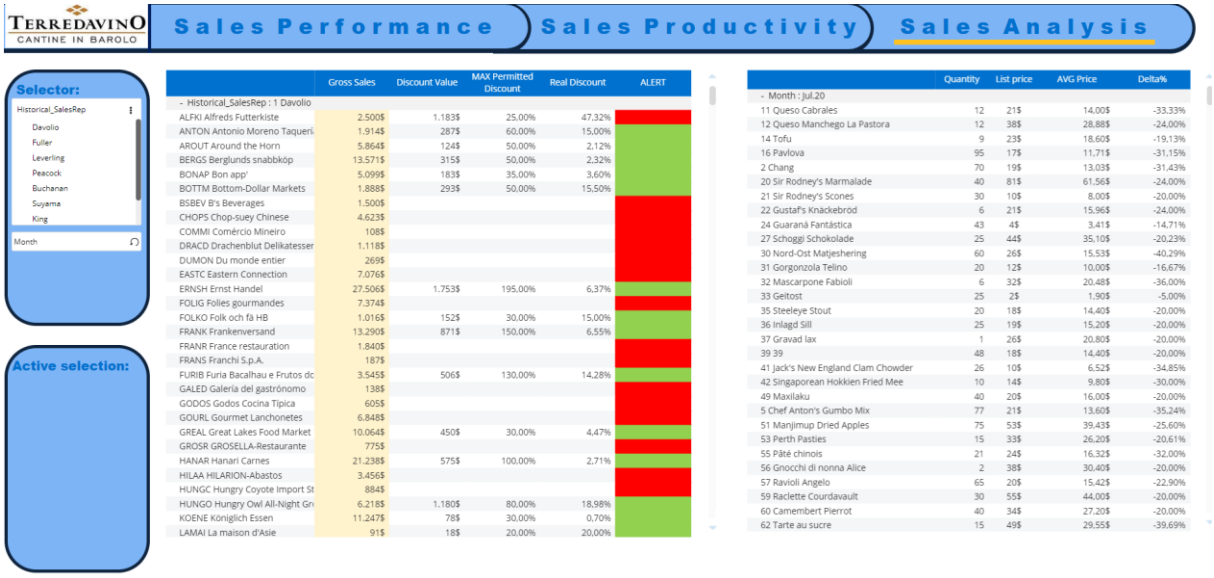

Figure 33:Sales Analysis Page

The client intended to make these three screens available only to managers, so that they could access the data of the various vendors under their supervision, but on the advice of the Bios Management consultants, it was decided to allow access to these three screens to each sales employee (who will only be able to see data relating to themselves), this also to allow them to verify their performance in a timely manner.

In addition to the dashboard panels, sales planning screens for budgeting have been built. As shown in the figure below, every salesman or area manager can generate an estimate of future sales. Specifically, once the desired customer has been selected, an estimate of the quantity, gross sales price and discount applied for each product must be entered. This information will subsequently be incorporated into the administration's budgeting process. To help the selection of data to be input, it was chosen to enter the previous year's history as a starting point for compilation.

	Budget Quantity	Budget Price	Actual Q	CY Gross Sales	CY AVG Price	Um	Budget Discount	BDG Gross Sales	BDG Net Sales
1 Chai	75	20,00$	370	6.660$	18,00$	B1		1.500$	1.500$
10 Ikura	265	235,00$	322	9.982$	31,00$	ml	5,00%	62.275$	59.161$
11 Queso Cabrales	20	20,00$	272	5.712$	21,00$	kg		400$	400$
12 Queso Manchego La Pastora	35	40,00$	70	2.660$	38,00$	g	5,00%	1.400$	1.330$
13 Konbu			609	3.654$	6,00$	kg			
14 Tofu	20	20,00$	15	349$	23,25$	g		400$	400$
16 Pavlova	22	60,00$	404	7.050$	17,45$	g		1.320$	1.320$
17 Alice Mutton	325	20,00$	175	6.825$	39,00$	kg		6.500$	6.500$
18 Carnarvon Tigers			141	8.813$	62,50$	kg			
19 Teatime Chocolate Biscuits	33	15,00$	251	2.309$	9,20$	B1		495$	495$
2 Chang	35	36,00$	323	6.137$	19,00$	oz	20,00%	1.260$	1.008$
20 Sir Rodney's Marmalade			95	7.695$	81,00$	B2			
21 Sir Rodney's Scones			331	3.310$	10,00$	B2			
22 Gustaf's Knäckebröd			108	2.268$	21,00$	g			
23 Tunnbröd	10	12,00$	186	1.674$	9,00$	g		120$	120$
24 Guaraná Fantástica	35	5,00$	509	2.291$	4,50$	ml	5,00%	175$	166$
25 NuNuCa Nuß-Nougat-Creme			95	1.330$	14,00$	g			
26 Gumbär Gummibärchen			169	5.278$	31,23$	g			
27 Schoggi Schokolade			65	2.854$	43,90$	g			
28 Rössle Sauerkraut	15	60,00$	165	7.603$	46,08$	g		900$	900$
29 Thüringer Rostbratwurst			332	41.098$	123,79$	g			
3 Aniseed Syrup			79	790$	10,00$	B0			
30 Nord-Ost Matjeshering			221	5.722$	25,89$	g			
31 Gorgonzola Telino	37	40,00$	282	3.525$	12,50$	g	5,00%	1.480$	1.406$

Figure 34:Sales Plan Screen

Another important component is the screen dedicated to sales commissions: especially for sellers who operate internationally, a commission on sales made is part of their income. These commissions are a percentage of sales, and the percentage is determined annually by the management based on a variety of parameters such as previous year's achievement of specified objectives, years of service, number of clients served, and so on. In this page (depicted in figure 35), area managers must input three commission thresholds for each sales staff, based on whether the salesperson achieves 75%, 85%, or 95% of the target. The target threshold is obtained thanks to an internal calculation. Once the needed information has been loaded, by clicking on the relevant button, all of the information is transmitted to the budget cubes, where it will be used in the budget process. There is also a screen linked to the cost of sales (COGS) seen at the top of the following image. The cost of sales data from the corporate management systems might be slightly updated in this screen by the area managers by inserting costs that were not previously considered, always for budget purposes.

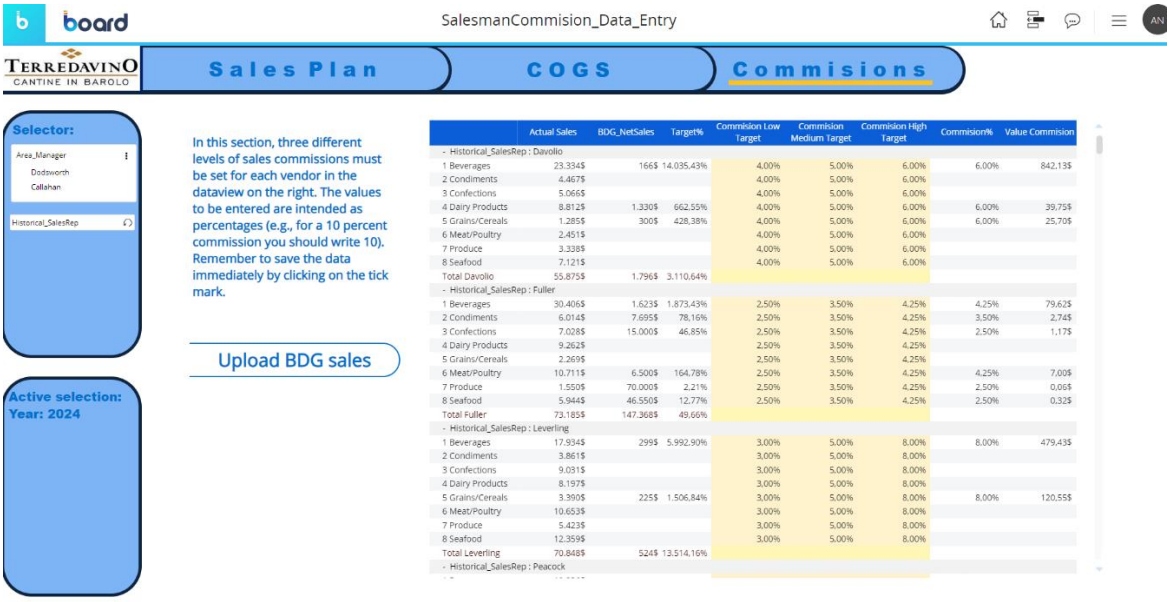

Figure 35:Commission Plan Page

According to what has been said previously, the data inserted into the stated planning pages is subsequently transferred to cubes used for budget planning in subsequent years. This is accomplished by a procedure in which estimated sales, COGS, and Commissions data are sent via data flows, as seen in the picture below.

DF001_Sales

+ STEP + GROUP

	Step	Action	Detail
	1	MAIN	
	2	Show message	Do You want to Upload the sales Previsions?
	3	Clear cube	DF002_Sales
	4	Selection	Month: Jan.24, Feb.24, Mar.24, Apr.24, May.24
	5	Data flow	DF002_Sales = b*((a/100)+1)
	6	~~Exit procedure~~	
	7	Reset to all	Reset whole selection
	8	Data flow	DF005_MonthOpenSpecular = IF(a=1,0,1)
	9	Selection	Month: Jun.24, Jul.24, Aug.24, Sep.24, Oct.24, No...
	10	Data flow	DF002_Sales = b*((a/100)+1)*1,2
	11	Refresh screen	

Figure 36:Exaple of Data Flow Procedure

Integrated Business Plan Environment:

Following the development of the sales planning screens, as previously said, the values input will flow into the budget process, the end result of which is an income statement for the company. The Steps of closing the Budget P&L (which they name IBP) will be illustrated on the following pages.

The first phase in the budget closing process is to review the cost allocation matrix, which is a matrix divided by product in which a certain percentage of cost is connected with sales. Factors such as depreciation, marketing, industrial costs, personnel costs, and so on are considered in this screen. (As illustrated in figure 37). The matrix has been filled with standard parameters provided by the customer, but they can be changed, either on the total or on a single item, by performing a data entry operation directly at the intersection of cost item and product. When the income statement creation procedure is launched, the entered numbers are automatically re-parameterized in a percentage-based proportion.

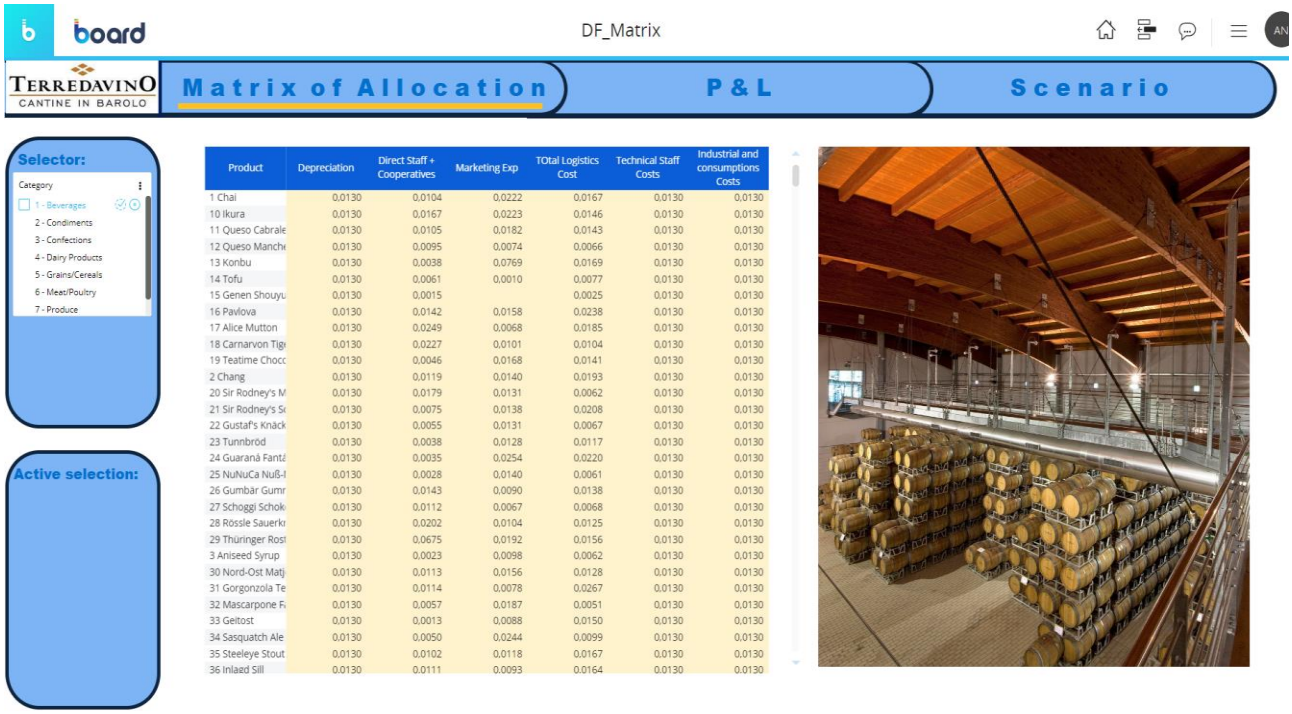

Figure 37:Matrix of allocation Page

After defining the allocation parameters, the user can proceed to the final report setting screen. During this step, the employee has the option of selecting which income statement item to include in the final report. This can be accomplished by directly ticking the item of P&L in the appropriate data view (see figure 38). After selecting the cost items to enter, some will have been populated in previous phases, while others may need to be populated or modified; to do so, activate the Data entry feature solely for the items in question. It was decided not to enable data entry for all of the income statement voices at once in order to reduce the possibility of entering inaccurate values. The last feature requested and included in the screen was the conversion of values between euro and dollar, thus after having entered the exchange rate in the proper block, the user can launch a procedure that will convert all the values in the report. To merge and update data from other processes, it is necessary to press the appropriate button, as can be seen in the figure. In addition, an RULE has been applied to the P&L. This tool, which was previously discussed in the chapter on the software board's architecture, allows the indirect calculation of some elements based on others, like calculating net income=EBT-Taxes.

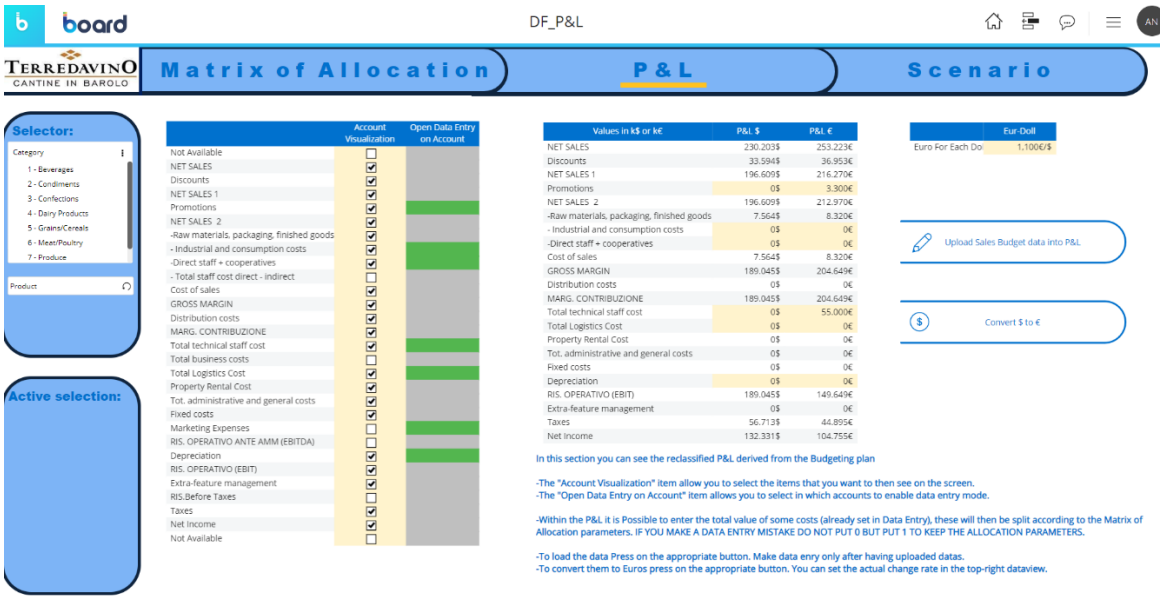

Figure 38:P&L Settings Screen

The budget generation process is completed by saving a specific version within a destination cube. In fact, the corporation operates by developing multiple versions of the budget for the following year, each of which takes into account a distinct set of elements. However, these versions must be kept in such a way that they can be reviewed and analysed in the future. A scenario definition screen was designed to accomplish this: The first step is to establish a new scenario occurrence, which may be done directly on the screen using a tool called "entity editor", which allows the user to add occurrences on a specific entity without having to enter database settings. This tool is quite advantageous since it allows users with non-development licences to perform the necessary operation, and it also prevents giving access to sensitive[5] parts of the programme to individuals who may not be completely trained for this.

The second required step is to mark the new version that we intend to use as a destination for our data as "Work," while leaving the others as "other." This is done via a data view in which you can change this setting directly by clicking in the desired block (see central data view in the figure 39). The previous passage is critical because it enables the data saving mechanism to automatically choose which version to save the data in. It's worth noting that if you load version twice and constantly utilise the same occurrence (so the same destination version), the data will be overwritten.

To finish the process and save the data in the new version, click the relevant button, which will initiate a procedure that will integrate the data. Furthermore, the data will be automatically saved in the two specified currencies (€ and $) and will be immediately available in the data view on the right side of the screen.

[5] Actions such as deleting occurrences of an entity or others could cause malfunctions in the database, as it impacts the metadata structure.

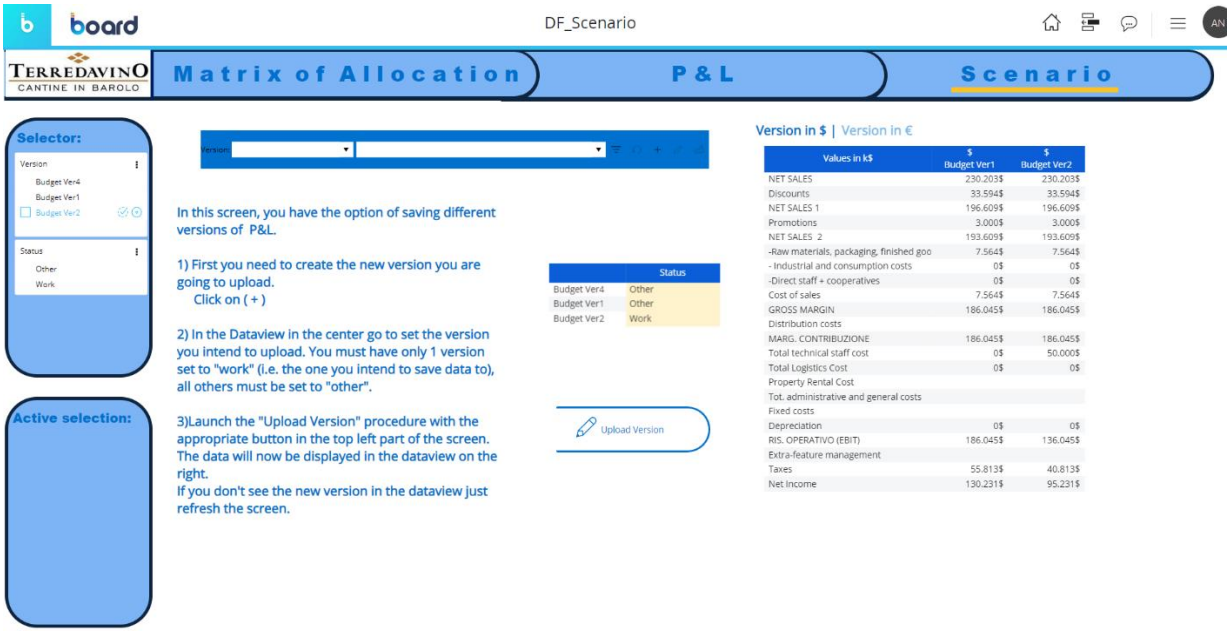

Figure 39:Scenario settings screen

Migration activities:

As previously stated, part of the project included the migration of a portion of the pre-existing programme to a more recent version of the software; this process included:

Procedure examination: When shifting between two versions of the software, some commands might stop working properly due to a change in the platform's calculating logic. As a result, debugging the operations step by step with the appropriate tool (see figure 40) was required to ensure that everything functioned. This apparently mechanical approach actually allowed me to better comprehend the rationale that underlies Board's operation, such as the concept of a dense or sparse cube and the opening of the domain (So allowing the calculation an all the possible intersepion of the cube) for computation execution.

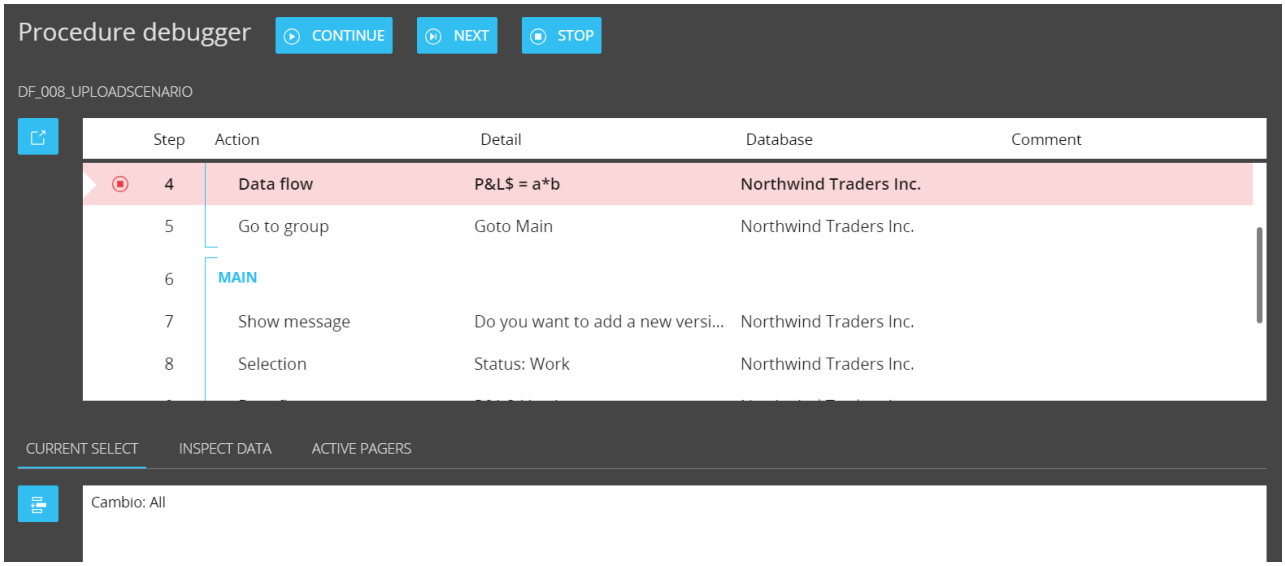

Figure 40: Procedure debugger

Capsule migration: entails ensuring that the pre-existing screens keep the intended layout. However, at this phase, the client expressed a desire to have front-end environments that were more up-to-date in design than the previous ones. This task proved to be more complex and time-consuming than anticipated, and it included the customer's active engagement in a much stronger degree than in others activity of the project. The figure 41 depicts an example of a homepage designed with the aforementioned goal in mind.

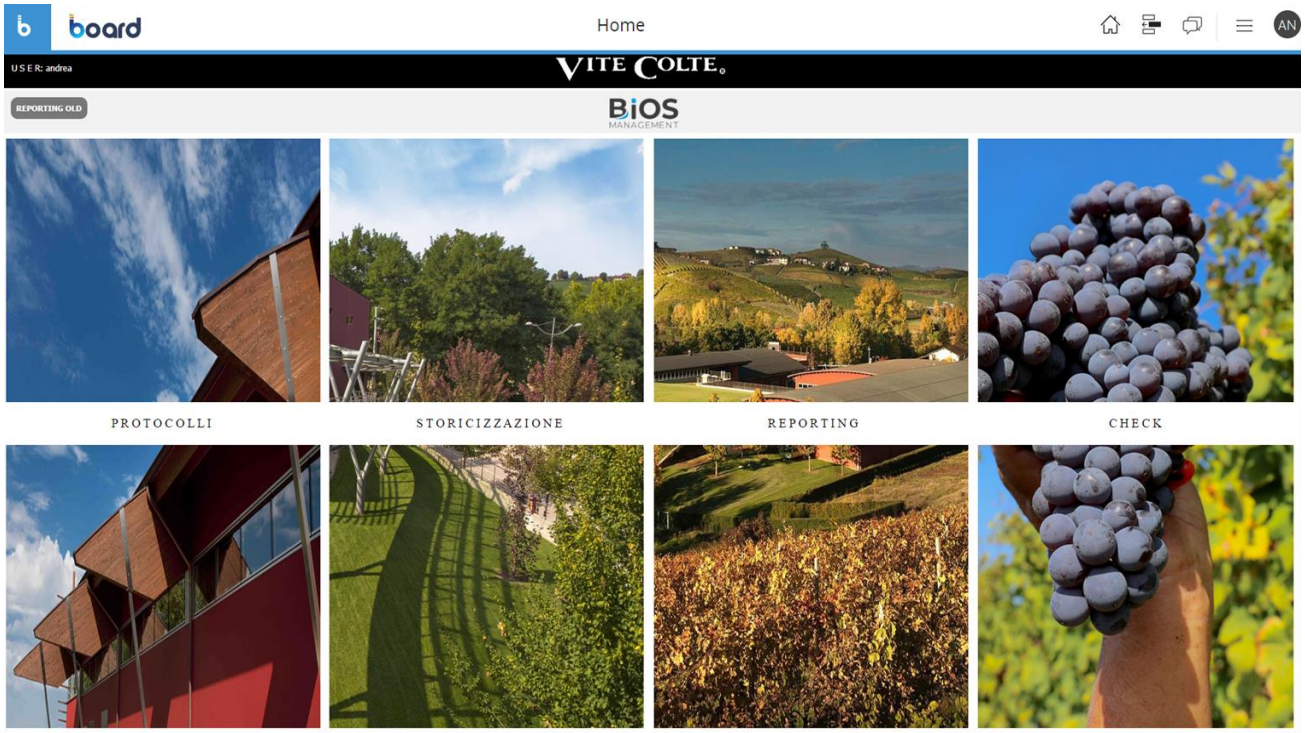

Figure 41:Example of an Homepage

Conclusions:

For at least a decade, the business intelligence market has been flourishing and consistently growing, with estimates predicting practically assured expansion until at least 2029 (Richardson,, Schlegel, Sallam, Kronz, & Sun, 2021). This can be attributed to the fact that these tools enable the corporation to establish procedures that have a beneficial impact on CPM and, as a result, business performance. Business Intelligence has now adopted the role of a tool that is now required within a company, a tool that is required to extrapolate the full worth of the data that company operations generate on a daily basis. The continuous measurement of performance and data in real time enables process optimisation and resource savings. Only a clear and highly detailed image of a company's vital condition, based on in-depth, objective information that is representative of reality, can enable the implementation of an effective plan.

Some of the remaining disadvantages of this technology are the technological infrastructure necessary for its operation and the requirement, at least perceived by management, for highly specialised employees to use this technology effectively. These factors, together with the substantially high implementation cost, imply that SMEs have not completely realised the potential of these tools and, as a result, tend to restrict the usage of BI software to the realm of large enterprises.

The evolution of Business Intelligence in the near future will be heavily impacted by technical progress and the high availability and interconnection of data within and beyond the business structure. If, on the one hand, more data and more sophisticated techniques for extrapolating them from different and multiple sources will be available, on the other hand, it will be possible to create increasingly advanced and detailed information reports that will be more intuitive

and immediate thanks to the use of new artificial intelligence models and techniques.

With reference to the activities carried out during the internship period, it became evident that each individual company represents a world of its own . Internal dynamics differ in each reality, so the data used, the reports required, and the application in general must be very dynamic in order to adapt to the client's specific demands. The consultant's duty also includes assisting the customer through the development of the application, ensuring that the customer's needs are met while also attempting to offer value and advise capable of giving a truly high-level service.

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