



**Politecnico
di Torino**

Politecnico di Torino

Master's Degree in Engineering & Management

A.y. 2023/2024

Graduate Session April 2024

Business Intelligence: concepts and application

Implementation of an Intelligent Planning through software
Board

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To my family

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Introduction

Rapid changes in the financial landscape and significant improvements in information technology have brought difficulties for several businesses in recent times. Finding the truly crucial part of information is becoming more and more challenging for a company's management due to the expanding capacity to collect and store massive amounts of internal and external data. This situation of information overload is tackled by a variety of analytic concepts and tools which can be summarised under the term of "Business Intelligence" or BI.

The aim of this thesis is to explain the concepts of Business Intelligence and Corporate Performance Management and show how they actually work.

For this purpose, the definition and a brief history of BI is provided in the first chapter, along with an analysis of each element constituting the architecture of a Business Intelligence Software. Moreover, an overview of the BI market is given, making a comparison among the most common BI tools, as well as the social impact of this innovative technology.

The second chapter concerns Corporate Performance Management. Starting from defining the difference between CPM and BI, the fundamental concepts of Key Performance Indicator and Data visualization is provided.

Putting together all the elements discussed in the first two chapters, the third one regards a software which is both a Business Intelligence and a Corporate Performance Management platform: Board.

The choice of studying this specific application is ascribable to the Professional Training I personally conducted at Bios Management Ltd., a consulting company which employs Board to carry out the Intelligent Plannings for its customers.

Therefore, the market positioning of Board and the major components of the software are deeply analysed.

In the fourth chapter a practical application of what explained in theory in the previous section is given, presenting a Business Case I developed by myself during the internship.

Finally, conclusions about this particular kind of technology are presented, leaving room for the various future developments of Business Intelligence world.

1. Business Intelligence

Business intelligence (BI) is a technology-driven process that aids managers, employees, and executives in making well-informed business choices by analyzing data and providing actionable insights. In order to make the analytics results available to business users for operational decision-making and strategic planning, organizations gather data from internal IT systems and external sources, prepare it for analysis, run queries against the data, and create data visualizations, BI dashboards, and reports as part of the BI process.

Better business choices that help companies boost revenue, enhance operational effectiveness, and outperform competitors are the ultimate objective of business intelligence projects. In order to accomplish this, BI combines a number of approaches for organizing and analyzing data using analytics, data management, and reporting technologies.

Many types of information and analysis may be obtained using business intelligence procedures, and they can be used to a variety of situations. Several applications for business intelligence include the following:

- Utilizing data and statistics to highlight market or company patterns; for example, comparing product sales data from the first, second, third, and fourth quarters to determine if sales of a certain product are rising or falling.
- Finding areas where operational efficiency is maximized or may be enhanced through the analysis of key performance indicators (KPIs).
- Comparing present performance (like sales) to past performance or corporate objectives; for example, examining year-over-year sales data in various regions where a corporation operates.
- Making data analysis more comprehensible and helpful for decision-makers by putting it into visual forms like graphs and charts; for example, making a chart or histogram that demonstrates stock sector trends.
- Offering "what if" analyses of various business decisions that may be made, such as forecasting how changing one thing vs another could affect future growth in sales revenue.

While each businesses may use BI differently and for different reasons, the method is generally the same across all sectors and goes somewhat like this:[1]

- Data Sources: it consists in the collection of data that can be both internal company data and external market data.
- The data collected are integrated and stored in data warehouse, often manipulated by ETL processes (Extract-Transform-Load).
- The next step is data mining, which is defined as the process of analysing data from different sources and summarizing it into relevant information.
- BI dashboards, reports, and visualizations in the form of graphs, charts, histograms, and other visual representations are created using data mining results.
- In addition to using their BI dashboard to go deeper into the data for additional information, decision-makers use data visualizations and reports to assist them in making choices.

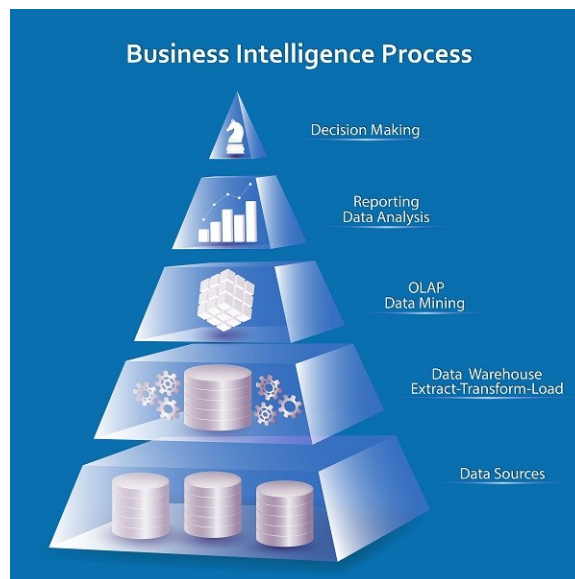


Figure 1.1: Pyramid of BI processes[2]

1.1 History of Business Intelligence

BI has developed throughout time and has been rapidly evolving since the Digital Revolution. Its importance has grown so much that LinkedIn includes Business Intelligence as one of the top 25 skills most wanted by employers in 2018,

In this paragraph, a short history of Business Intelligence from the pre-digital times until today is given.

In the *Figure 1.2* the most important dates for the development of BI are represented^{[3][4]}:

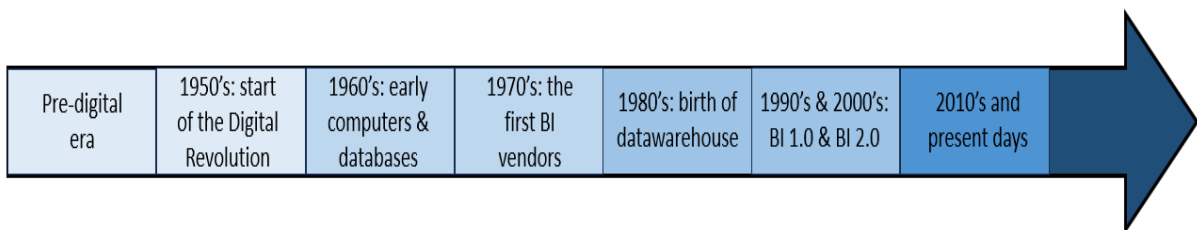


Figure 1.2: BI's Timeline

- Pre digital era

The first written record that we have of the term 'business intelligence' comes from Richard Miller Devens' 1865 work Cyclopaedia of Commercial and Business Anecdotes.

The American author used these words to describe how Sir Henry Furnese, a banker, outperformed his rivals by gathering, evaluating, and using information to support his rational and solid business judgments.

Similar cases to the one above may be found in Devens' magazine, where merchants utilize data acquired from various sources to support their company goals and choices.

The significance of Devens' usage of the term "business intelligence" comes from the fact that he used it to characterize how business strategy is informed by facts and empirical evidence rather than intuition or superstition.

This opened the door for a scientific perspective on business that only considers empirical data.

- 1950's: start of the Digital Revolution

It wasn't until the 1950's, at the start of the Digital Revolution, that business intelligence emerged as a stand-alone scientific method that businesses used to enhance their marketing plans.

The hard disk was created by IBM in 1956. It weighed over a ton and had a memory capacity of 5MB at the time. This milestone is especially important to BI since it made room for digital filing methods to replace physical ones.

However, a new milestone for BI in the United States did not occur until July 1958.

Hans Peter Luhn, an IBM computer science researcher, published a groundbreaking work titled "A Business Intelligence System" in the IBM Systems Journal that year.^[4.1]

Luhn outlined a system for the "selective dissemination" of documents to "action points" based on the "interest profiles" of the individual action points, using the definition of intelligence found in Webster's dictionary as "the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal."

A system like that might be used to distribute information effectively, figure out who needed to know what, and determine what knowledge was already known.

Luhn planted the seeds of the idea for business intelligence as we know it today with the release of his article.

- 1960's: early computers and databases

The introduction and application of computers increased dramatically in the 1960s.

Massive devices that took up entire floors and required specialized personnel to operate began to produce enormous volumes of data.

The first electronic calculator, developed in the early 1960s, could do the work of 50,000 persons doing it by hand.

Despite our ability to collect enormous amounts of data, we lacked the technology and tools needed to do anything meaningful with it.

Due to the new machines' high cost, complicated administration needs, and excessively lengthy data extraction times, there were additional issues with storage and management. However, the primary issue remained the absence of a centralized approach capable of combining all accessible data, as, obviously, data by itself does not provide insights.

It was around this point that hierarchical Database Management Systems (DBMS), like IBM's IMS, first appeared.

Based on binary trees, this kind of database management system stored data in a hierarchical tree structure with two parent records and two child records.

Data security, integrity, and independence were among the outcomes, which made the searches more effective.

More testing of these systems opened the door to more innovation in data organization.

In the same year the Apollo 11 landed on the moon, British-American computer scientist Ted Codd also took a giant leap for BI here on Earth.

He created the relational model for database administration when he was employed at IBM. This model serves as the theoretical foundation for relational databases and relational database management systems.

Codd changed the idea behind databases from being just a mechanism to organize things to a way to query data and uncover relationships that were buried away.

This was good news for business intelligence, and data management saw a significant uptake of his approach.

- 1970's: the first BI vendors

With the appearance of the first BI vendors (SAP, Siebel and JD Edwards, the last two now part of the Oracle Corporation), tools became available to help accessing and organising data in more effective ways.

BI systems were initially created by IBM and Siebel.

We had been gathering enormous volumes of data over the preceding decades, and BI software started to give it form.

The absence of infrastructure for data interchange and discordant systems persisted as a major obstacle, despite the fact that access to data had advanced tremendously since the

1950s. Because the data was obtained from many BI sources and apps, it could only be retrieved separately.

- 1980's: birth of Datawarehouse

The 1980's saw the advent of data warehouses, which are systems used for data analysis and reporting.

Central stores of combined data from one or more sources are utilized as data warehouses. They serve as a single repository for both historical and current data, which is utilized to generate analytical reports for many departments within an organization. These days, they are regarded as an essential part of BI.

Insightful business strategies were in high demand for managers, and brands like MicroStrategy and Crystal Reports were indispensable during the 1980s BI application boom.

At this point, Ralph Kimball and Bill Inmon emerged with their disparate approaches to business data warehouses.

Inmon suggested a top-down layout. According to his methodology, data warehouses are only a small component of the BI system as a whole.

Data marts might pull information from an organization's single data warehouse. Information is kept in third normal form in this approach.

The bottom-up design was a dimensional design philosophy developed by Ralph Kimball. According to Kimball, a data warehouse is an organization's collection of all its data marts. In this case, data is consistently kept in a dimensional model.

Despite the differences between the aforementioned methodologies, they all suggested that data might be organized and originate from many sources for a comprehensive integration. Thus, the first generation of BI emerged.

By the late 80's, BI tools were able to analyse and report on the data.

Howard Dresner of the Gartner Group popularised in 1989 the term BI as the umbrella term to describe "concepts and methods to improve business decision making by using fact-based support systems."

- 1990's and 2000's: BI 1.0 and BI 2.0

After the first generation of BI, it comes what is considered Business Intelligence 1.0.

The primary advancement in business intelligence throughout the 1990s was the spread of BI tools. The most widely used was Enterprise Resource Planning (ERP), an application-integrated management tool for managing and automating corporate processes.

Additionally, BI makes its way into the mainstream of business, and its methods are made marketable via batch-processing reporting.

Simultaneously, the growth of the internet and mobile data emerged as the dominant forces in the technology industry.

Between the decades, BI services started to provide decision makers more straightforward tools that helped them become more self-reliant.

Compared to earlier versions, the tools were more user-friendly, efficient, and offered the necessary capability. Now that data could be worked with directly, business personnel could obtain insights and acquire data.

Business Intelligence 2.0, or the 2000s, witnessed a concentration of BI in the hands of IBM, Microsoft, SAP, and Oracle, as well as an acceleration of BI development.

A new technique for utilizing data, algorithms, and machine learning to project future changes in business was made possible by predictive analysis.

As data is perceived differently due to real-time feeds and enhanced visualization, cloud technologies and internet-based software become more prominent.

With the birth of ecommerce and social media channels such as Twitter or Facebook, BI was presented with a brand-new world of opportunities.

By 2010, 35% of enterprises use pervasive BI and 67% of "best in class" companies have some self-service BI.

- 2010's and present days

Today we are in the 3.0 stage of BI.

Every medium-sized or big firm, from banking and finance to IT and communications, now uses business intelligence (BI) as a common tool.

The visual analytics feature of current BI software allows users to apply analytical reasoning to data through interactive visual interfaces that are compatible with many devices.

The goal is to make BI tools and apps as user-friendly as possible while still providing the training required to effectively use them.

- The future: what's next for BI

There are several ways that companies may use BI to their advantage.

As data analytics becomes ingrained in applications and businesses combine hardware and software into whole solutions, BI tools may eventually become obsolete.

Systems development will lead to a growth in the volume of complicated data as well as reports that are simpler and easier to obtain.

Today, one of the main issues facing BI is data quality. But as the sector develops, BI tools are becoming more widely available and cooperative, which will undoubtedly lead to greater commercial chances. ^[4,2]

1.2 The architecture of a BI System

In *Figure 1.3* it is shown the generic architecture of a Business Intelligence system.

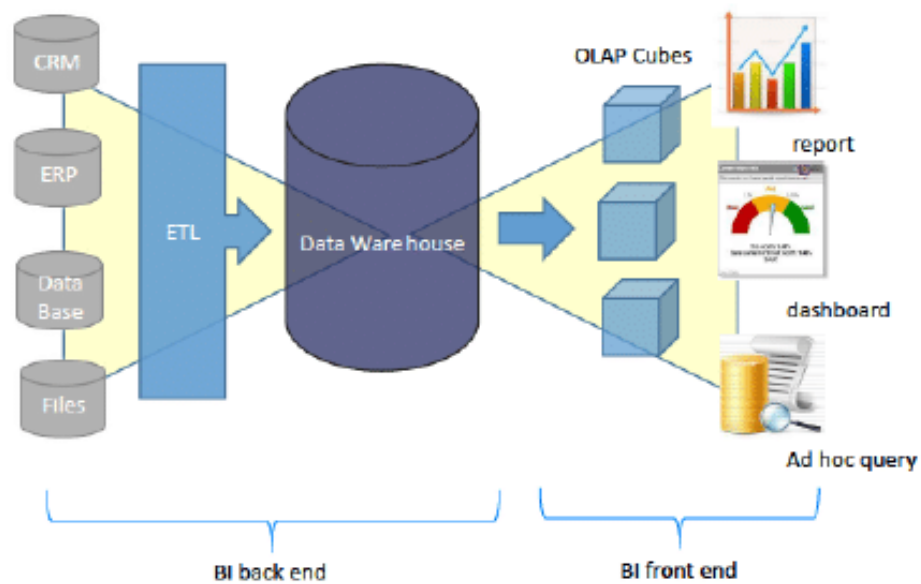


Figure 1.3: Architecture of a BI System^[5]

Depending on the environment and on the software used, the architecture may vary, however there are some components which are usually present in all BI systems. Those elements are the following: ^{[6][7]}

- Operational Sources (CRM, ERP, Database, Files);
- ETL process (Extract-Transform-Load);
- Data Warehouse (Multidimensional Model);
- Data model (OLAP Cubes);
- Data Analysis and Visualization (Report, Dashboard, querying).

The first three elements are called back-end because they allow the functioning of the BI system, but they cannot be accessed by the final user. The last two ones are called front-end because the final user can see them physically and can interact with.

1.2.1 Operational Sources

The first component of a BI System is the data source which can be of different types.

Data can come from a CRM (Customer Relationship Management) System, or an ERP (Enterprise Resource Planning) System, from a database or from generic files (text or spreadsheets).

All these operational sources are called DBMS (Data Base Management System) and they can be distinguished between two categories: OLAP and OLTP.^[7.1]

- OLTP (On-Line Transaction Processing) Systems: the use of these systems is mainly aimed at transactions and processing of queries only, therefore at standard operations, represented by the reading of data or at most modest edits. Data appear to be of current type, detailed and up to date, without reference to historical data as the focus is on daily, operational activities.

OLTP systems are suitable for executing business processes, but not for the evaluation of them, for this reason it is necessary to move to analytical systems.

- OLAP (On-Line Analytical Processing) Systems: contribute to the analysis of data effectively enabling a more structured choice. Decision making processes use aggregated data synthesized and summarized, covering a time span large enough to highlight the variations. Not surprisingly, OLAP systems differ from OLTP systems because of their end use, since there is no need to handle ordinary operations but rather to take directives when it is actually necessary.

The process that enables the transition from OLTP systems to analytical systems is called ETL (Extract, Transform Load) and will be analysed in the following section.

1.2.2 ETL Process

ETL Process is a fundamental step to construct the Datawarehouse (DW).

As mentioned before, there are different kind of data sources, which provide different type of data, so it is necessary to Extract the data, Transform them in a suitable form for the DW and finally Load the data in the DW.

ETL allows to standardize data of the different sources, so that there is homogeneity, correctness, consistency and robustness of what will be the content of the DW.

There are several products that allows ETL, the most famous ones are Microsoft SQL Server Management and MySQL.

Since this process is executed through the SQL language, generally ETL is carried out by companies' IT area.

Let's make an example to better clarify how ETL works.

Suppose that there are three different operational sources which provides the date to the system in different ways:

Operational Source	Input
Source 1	31/12/2023
Source 2	12/31/2023
Source 3	Dec 31 2023

The general rule of the databases is that the same type of data must be written always in the same form.

So, before passing the data to the DW, the ETL process convert them in a standard form (for example day/month/year). The final output will be the following:

Operational Source	Input		Output
Source 1	31/12/2023	ETL	31/12/2023
Source 2	12/31/2023	ETL	31/12/2023
Source 3	Dec 31 2023	ETL	31/12/2023



Extract



Transform



Load



DW

1.2.3 Datawarehouse

Data from the different sources, once processed through ETL processes, are stored in a specific database: the Data Warehouse. It is a fundamental element of a BI system since it enables data analysis and data reporting, supporting decision and strategy making. In order to fulfil its purpose by avoiding any kind of inconvenient and by reducing response time, the data warehouse must have precise properties in its design. The model used to build a DW is called multidimensional model. In the following section the main components of such a model will be described in detail.

1.2.4 Multidimensional model

The multidimensional model represents data in the form of data cubes.

Data cubes allow to model and view the data from many dimensions and perspectives.^[7,2]

There are 3 main elements at the base of this model:

- 1) Fact: it is an item of interest for the company and models a set of events that occur within the business environment. It is represented with a small cube.
- 2) Measurement: it is a numerical property of a fact which describes a quantitative aspect of interest in the analysis. A fact may also contain no measure, in that case only the occurrence of the event is recorded.
- 3) Dimension: a property that describes the projection of the fact through aspects of interest; each fact generally contains multiple dimensions that define its granularity, i.e., the event of maximum detail analysable.

Let's make an example:

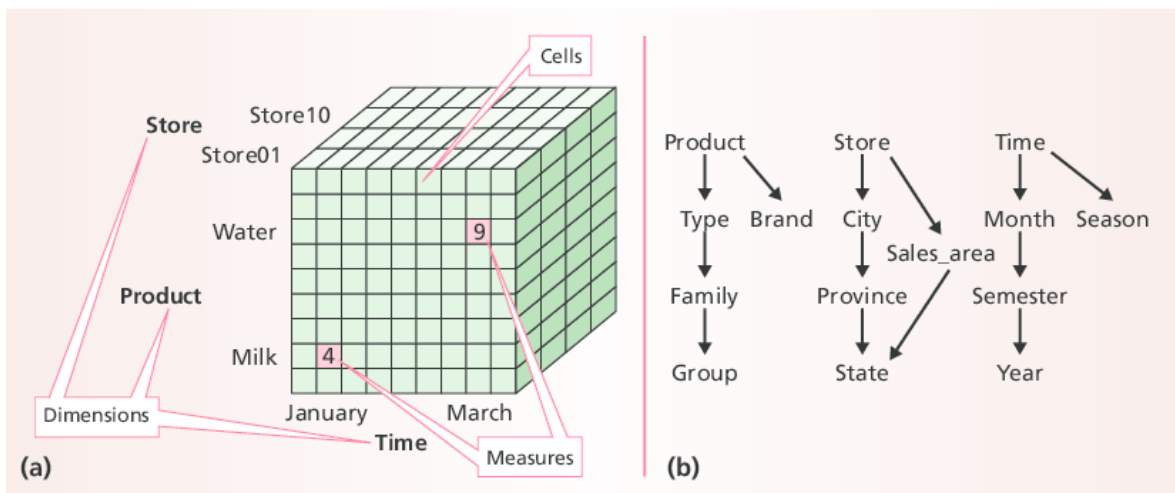


Figure 1.4(a): representation of an info cube^[8]

Figure 1.4(b): granularity of a dimension^[8]

Referring to *Figure 1.4(a)*, the dimensions are Store, Product and Time. Each dimension is composed of several Fact and Measures. The measurements might be for example the quantity sold, the price of the product, the cost of the product. Furthermore, looking at *Figure 1.4(b)*, each dimension has a granularity and each granularity corresponds to a level of detail. For example, the dimension Time has four levels of granularity (Month<Semester<Year). In this way, it is possible to aggregate data and analysed them grouped by the desired level of detail.

1.2.5 Data Model

Data Model contains a template based on files or data memory and aims to provide fast answers when executing queries.

There are two techniques for the Data Model:

- 1) OLAP Cube: structure that stores data on files by uploading them from the DW in a dimensional model. This model provides several operations which allow the navigation of data from different points of view like the roll-up (aggregation of data by reducing their details like the elimination of one of the dimensions), or the drill-down (increase in detail by introducing a new size or an attribute).^[9]
- 2) In-memory tabular model: it consists of loading the records into memory and executing the query directly on the latter. Such a structure turns out to be very fast from the side of response time, but it is also required high storage capacity that is not always available.

1.2.6 Data Analysis and Visualization

It is the front-end part of the BI system, the main part on which the final users faces.

After having collected, transformed and stored data into a data warehouse, modelled them into a Data Model, the final step is to make them visible and to make them useful to the analysis.

There are different ways to visualize the data, but the most common are reports, dashboards and ad hoc query.

1.3 The market of Business Intelligence

Since there are always more and more types of data sources, a growing number of BI software have been developed, all with their own features, strengths and weaknesses.^[9.1]

In the following paragraphs, some of the most common BI software are described, highlighting their pros and cons.

As shown in *Figure 1.5*, the market of BI is expected to grow very rapidly, due to the new technologies and the needs of the companies to be competitive.

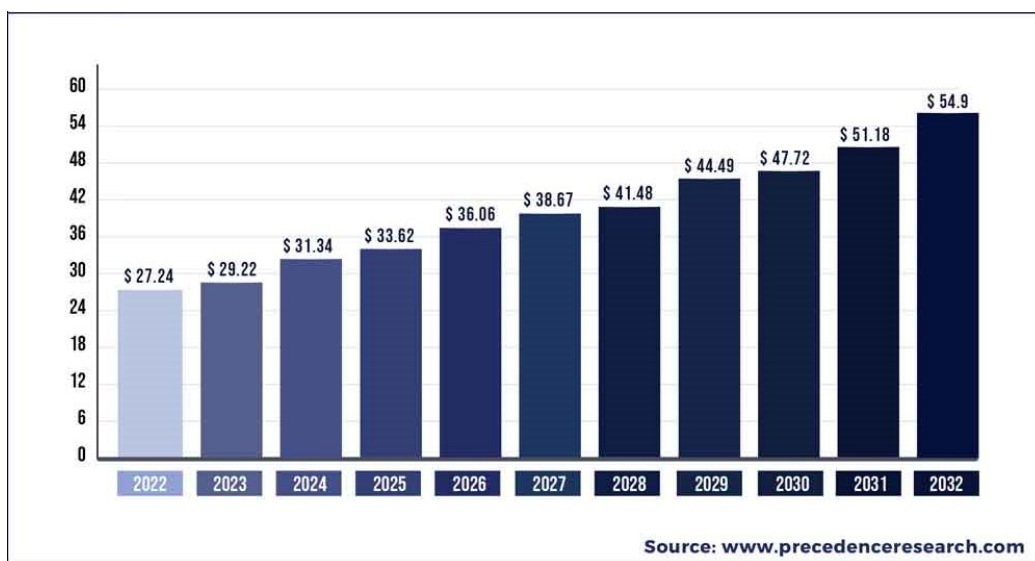


Figure 1.5: BI market size 2022 to 2032 (USD billion)

A useful tool to analyse the various competitors in the Business Intelligence market is the Magic Quadrant (MQ) of Gartner.^{[10][11][11.1]}

It consists in a diagram divided into four parts (quadrants) and in each one is represented a specific group of firms accordingly to the behaviour of the firms. A firm can behave as a Leader, a Challenger, a Niche Player, or a Visionaire.

On the x-axis lies the “completeness of vision”, which reflects the vendor's innovation, and whether the vendor drives or follows the market.

On the y-axis lies the “ability to execute”, which Summarizes factors such as the vendor's financial viability, market responsiveness, product development, sales channels and customer base.

- Leaders: vendors with the highest composite ratings for completeness of vision and execution are found in the "Leaders" quadrant. The market share, reputation, and marketing and sales ability of a vendor in the Leaders quadrant enable them to propel the adoption of new technology. Customers and prospects may utilize these vendors' well-articulated plans to create their infrastructures and strategies since they are innovators, thought leaders, and show a strong awareness of market demands. They also have widespread platform support, a presence in the five main geographic regions, and steady financial success.
- Challengers: a vendor situated in the "Challengers" quadrant engages in the market and performs proficiently enough to pose a significant risk to sellers situated in the Leaders quadrant. They have solid products, a respectable enough market position, and enough resources to support their further expansion. The Challengers quadrant's vendors do not have financial difficulties, but they are not as large or powerful as the Leaders quadrant's suppliers.
- Niche Players: vendors in the "Niche Players" quadrant sometimes have a restricted emphasis on specific markets or segments. This quadrant might also contain bigger suppliers struggling to create and carry out their vision, or vendors that are modifying their current products to enter the market under evaluation..
- Visionaries: a vendor in the "Visionaries" quadrant offers cutting-edge solutions that solve significant end-user problems on a large scale from an operational or financial standpoint, but they haven't yet proven they can gain market share or achieve long-term profitability. Visionary vendors are frequently privately held companies and acquisitions targets for larger, established companies. The likelihood of acquisition often reduces the risks associated with installing their systems.

In *Figure 1.6* it is shown the application of the MQ of Gartner to the market of Business Intelligence. The report is referred to February 2021.



Figure 1.6: MQ of Gartner (Feb 2021) for BI market^[12]

The next paragraphs are going to describe the most common BI software, such as Microsoft Power BI, Tableau and Qlik (the leaders in the MQ), but for the purpose of this thesis, the solution offered by Board is mentioned as well and then deeply analysed in Chapter 3.



Microsoft Power BI: it is the Business Intelligence product developed by Microsoft and its strength lies on the fact that it is able to interact with all the Microsoft environment (especially Excell): the native integration with Microsoft technologies enables powerful data preparation and data querying analysis. It is a robust enterprise-grade tool enabling extensive modelling and real-time analysis. For the last 13 consecutive years, it has been the major leader in the market. ^[13]



QlikView: it is an American platform of business intelligence, known worldwide for its capability to work with a huge volume of data very rapidly. On the other hand, it is an older application, so dashboards are limited in interactivity and customization. [14]



Tableau: it is an American BI software born in 2003. Its strength lies on being extremely user-friendly: Tableau’s intuitive interface allows non-technical users to quickly and easily create dashboards that provide insight into a broad spectrum of enterprise information. [15]

In *Table 1* the main features comparison among those three leader companies have been reported. The scores have been assigned by Cambay Consulting (a Microsoft Partner) in 2022.

Features	Power BI	Tableau	QlikView
Basic Version	Free ★	Free (limited features)	Free (limited features)
Advance Version per user Per Month	Pro-\$10 ★	Tableau Creator \$70	Business \$30
Free Trial	Pro Trial (60days) ★	Tableau Desktop trial(14days)	Business(30days)
Microsoft Information	Yes ★	No	No
Cloud Access Security Broker (CASB)	Yes ★	No	No
Ease of learning	Excel knowledge is enough ★	More than Excel	More than Excel
UI	Easy-to-use UI ★	Seamless UI	Decent UI
Data Connectivity and Big Data Integration	Yes ★	Yes	Yes
Advanced Analytics R or Python-based projects	Yes ★	Yes	Yes
Data Querying	Yes	Yes ★	Yes
Data Security	Yes ★	Yes	Yes
Reporting	Yes ★	Yes	Yes
Dashboard & Data Visualisation	Yes	Yes ★	Yes
Analytics & Interpretation	Good	Very Good ★	Okay
Augmented Analytics	Yes ★	Yes	Yes
Embedded Analytics	Yes ★	Yes	Yes
IOT Analytics	Yes ★	Yes	Yes
Geospatial Analytics	Yes	Yes ★	Yes
Natural Language processing	Yes ★	Yes	No
Native Mobile App	Yes (Android, Mac) ★	Yes (Android, Mac)	Yes (Mac)

Table 1: Comparison between Leaders [16]



Board: it has been developed by Board International, a multinational software company in 1994. It is not only a BI tool, but also a Corporate Performance Management (CPM) software. The BI capabilities include multi-dimensional analysis, *ad hoc* querying, dash-boarding and reporting, while the CPM capabilities include budgeting, planning and forecasting as well as "other finance-related activities." [17]

1.4 Advantages and Limitations of data-driven

More and more companies are implementing business intelligence tools to drive better business decisions and, doing so, they are implicitly shifting toward a corporate culture known as “data-driven”. [17.1]

When a company employs a data-driven approach, it means it makes strategic decisions based on data analysis and interpretation. A data-driven approach enables companies to examine and organise their data with the goal of better serving their customers and consumers.

In other words, companies take full advantage of business intelligence to improve their customer and market knowledge. In the end, this brings more value and improves the competitive advantage of organizations. [18]

With the rising interest and emphasis on data, many companies are looking into the merits of making analytics a priority for not just their data analysts, but all employees. They are looking to foster a data-driven corporate culture. A potential problem with this, however, is that decision makers aren't taking the time to think about the advantages and disadvantages. [19]

Sure, data can be a great resource for making better informed decisions, but data can also cause problems if used incorrectly. In this paragraph it has been analysed the impact of the Business Intelligence tools from a social point of view, looking at the pros and cons of those new technologies. [20][20.1]

Advantages:

- Prevents error and biases: making decisions based off intuition alone can lead to unnecessary errors. That's why it is not recommendable to rely on the instincts when other information is available. If it is possible to have access to the right data, then that data should be used to carve a path towards better and smarter decisions.
- Increases productivity: when the entire company has access to and utility of the key metrics that matter, data becomes a motivational tool for both teams and individuals. When employees can see how their actions affect the larger goals of the

organization, they are more likely to feel connected to the overall efforts. This, in turn, encourages accountability throughout the organization.

- Promotes transparency and understanding: when data is accessible for everyone, individual employees also have the opportunity to increase their understanding of that data. This can open the door to new insights from all levels of the organization, as people come to understand how metrics are composed and how efforts drive results. Team members can even leverage data to identify problem areas and devise a game plan for how to make the necessary improvements.

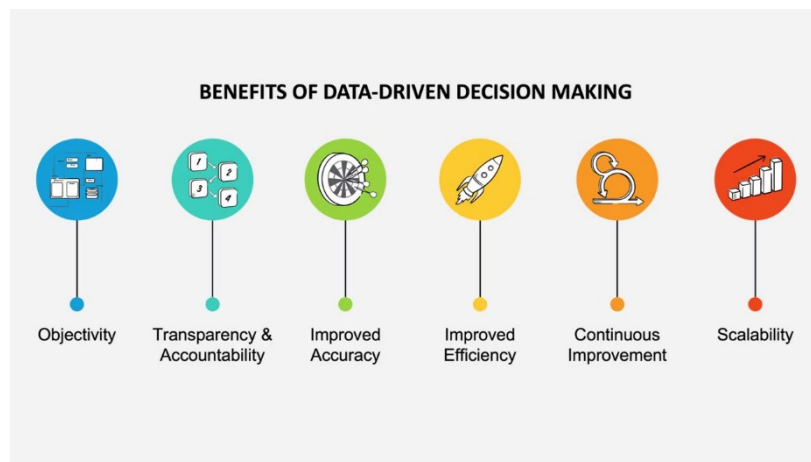


Figure 1.7: Advantages of data-driven^[21]

Disadvantages:

- Elicits blind trust: a data-driven corporate culture can lead employees to overly doubt their own judgement and experience. Believing that something must be true just because the data says so, without any further investigation or thought, can be very harmful. During data analysis, it's important to keep some healthy scepticism around numbers that seem too good to be true, or conversely wrong.
- Leads to possible misinterpretations: data doesn't lie, but it can mislead when it doesn't show the complete story. If a person does not have the full context, he/she could make inaccurate decisions based off assumptions.
- May be low quality data: the insights are only as reliable as the data they are based upon. There are several factors that can lead to poor quality data, from human data entry errors to gaps from third-party tools. In fact, recent research

from Gartner found that organizations believe poor data quality is responsible for an average of \$15 million per year in losses.

Today, alongside the definition of data-driven, the concept of data-informed is also achieving great success. A data-informed attitude starts from data to go further and integrate this evidence with other considerations of a more strategic nature.

Data-informed is a broader approach, designed to link metrics to the subjective behaviour of the user to take into account the context. It implies the adoption of a critical attitude towards the evidence offered by data; it is important, in fact, to always question the chosen metric and the results obtained. Adopting lateral thinking strategies and questioning oneself starting from the search for error can be a winning strategy.

The bottom line is Business Intelligence is a really powerful and useful tool, but it cannot substitute the human thought. Data are an important support to our decisions, but they should be seen as a check of our intuition.

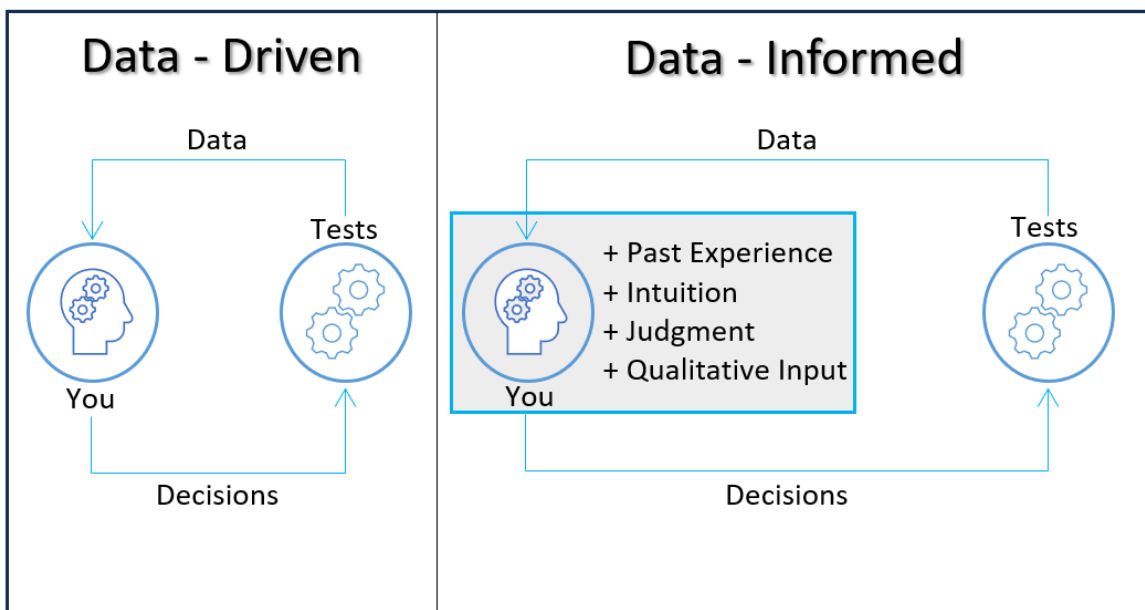


Figure 1.8: data-driven vs data-informed

2. Corporate Performance Management

Corporate Performance Management (CPM) is best described by leading analyst firm Gartner Research^[22]:

“CPM is an umbrella term that describes the methodologies, metrics, processes and systems used to monitor and manage the business performance of an enterprise. Applications that enable CPM translate strategically focused information to operational plans and send aggregated results. These applications are also integrated into many elements of the planning and control cycle, or they address Business Activity Monitoring (BAM) or customer relationship optimization needs. CPM must be supported by a suite of analytical applications that provide the functionality to support these processes, methodologies, and metrics.”

Corporate performance management (CPM) is a term used to describe the various processes and methodologies involved in aligning an organization's strategies and goals to its plans and executions in order to control the success of the company. CPM is a subset of business intelligence (BI) that involves monitoring and managing an organization's performance, according to key performance indicators (KPIs) such as revenue, return on investment (ROI), overhead and operational costs.^{[23][23.1]}

It is fundamental clarifying that corporate performance management is not a strategy by itself, but rather it is a compilation of intelligent business tools to measure the performance of a company. Therefore, companies should set up workable frameworks to ensure there is actual performance management; those frameworks could be^[24]:

- Balance Scorecards: a collection of several organizations' viewpoints;
- EFQM (European Foundation for Quality Management) Excellence Model: a framework for developing strategies based on the ideal operations of competitive organizations;
- MPO (Metropolitan Planning Organizations): sketch out trends or plans for how a company should change to keep up with the ever-evolving world of global commerce;
- Six Sigma: A data-driven framework that uses a straightforward DMAIC (define, measure, analyze, improve, and control) strategy to eliminate defects in order to assure successful business operations.

- Key Performance Indicators (KPIs): measure performance of the above frameworks.

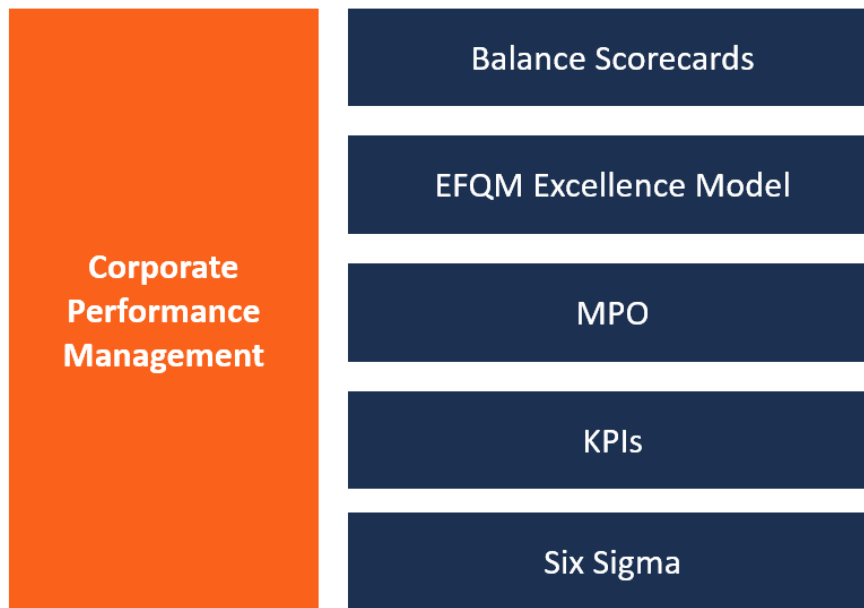


Figure 2.1: CPM's frameworks^[24]

The goal of CPM is to provide companies with significant business insights through processes like budgeting, scenario analysis, financial planning, forecasting and data reporting. Supply chain management (SCM) and risk management are two practices that should also be aligned with corporate performance management.

SCM is responsible for planning, controlling and executing a product's journey from materials to production to distribution in the most efficient and economical way possible. Risk management enables organizations to track the related risks of each plan or process alongside the performance results.

More broadly, Corporate Performance Management can be classified into^[25]:

- Strategic Corporate Performance Management (SCPM): describes how a CPM system may help the Office of Finance manage strategy and organizational performance.
- Financial Corporate Performance Management (FCPM): refers to the capacity of a CPM system to assist the Office of Finance in completing the financial closure and managing the accounting cycle

The most common CPM software are: Board, IBM Planning Analytics, Oracle Planning and Budgeting Cloud and SAP Business Planning and Consolidation.

2.1 Difference between BI and CPM

The ability to engage meaningfully with their data is essential for organizations trying to manage performance. While Corporate Performance Management systems are more robust and offer greater planning and reporting capabilities, Business Intelligence solutions focus on information delivery. Since both CPM and BI systems frequently include interactive dashboards, they might appear rather similar, but they are significantly distinct from one another.^[26]

The primary function of BI systems is to collect and organize data, after which the data is presented as a dashboard or visualization. These visualizations are highly successful in communicating previously gathered historical data, and they are often customizable. BI makes it possible to analyze past events, such as those that have occurred during an initiative's duration or the organization's existence.

Planning for the future, however, requires tools that BI platforms are not designed for. Platforms for Corporate Performance Management are designed with forecasting, planning, and decision-making in mind. Using the historical data, for instance, the CPM solution enables to project figures and then compare the objectives and projections with actuals as they occur. Enhanced CPM platforms frequently have integrated business intelligence features or interfaces, such dashboard components, but their planning functions end where BI does.^[27]



Figure 2.2: BI vs CPM^[28]

The ideal situation is a software of Business Intelligence which is endowed with Corporate Performance Management tools. Luckily, there is plenty of example of software with this feature and one of them is Board (see chapter 3).

While using a BI platform alone to run the business has several significant advantages, it leaves too much on the table:

- Absence of planning and budgeting: displays the data that the companies now possess but is unable to offer predictions about the future.
- Lack of the ability to perceive the wider picture: no integration of facts from several sources into a single source of truth.
- Lack of adaptability: the plans are rigid in the face of changes or crises and do not allow for the visualization of many future possibilities.
- Lack of context: It is easy for misinterpretations to arise when complicated circumstances are shown just in their final form.
- Difficulty in producing precise reporting outlines: insufficient dimensions to produce assertions that are legitimate reporting documents.

Integrating BI with CPM will answer to those issues:

- Insight: projections grounded in the company's past.
- Holism: compiles information on various goods, divisions, or entities.
- Agility: allows for swift adjustments in response to new information.
- Context: offers a drill-down to view details hidden from view.
- Reporting: makes use of all relevant aspects to provide reports that are useful.

To conclude, BI is powerful on its own, but adding a CPM solution enables the company to take full advantage of the data, even better if this happens in a unique software: doing the analysis, planning, and reporting in the same place cuts out inefficiency and room for error. ^[29]^[30]

2.2 Value creation of CPM process

Automation of business operations is critical for organizations in the current age of business management intelligence. The following are some advantages of using a CPM solution:^[30.1]

- Real time feedback: smart dashboards in CPM software include all the quantifiable metrics a management team might require to make decisions. The benefit, though, is not in the diversity, but it lies in the capacity to interpret and use data when real-time changes occur throughout the whole company.
- Data consolidation for easy management: the technologies are intelligent enough to collect, organize, and merge data from many departments, spreadsheets, and even companies.
- Provide ease of risk management: the incorporation of tools like what-if models is one of CPM's main benefits. For example, by simulating both the best and worst-case situations, the model enables managers to reduce risks and make wise decisions.
- Provide simple data feedback and access: CPM solutions facilitate managers' access to information while maintaining accuracy and quality standards.
- Ease of collaboration: to enable users to remain in sync across all departments, CPM tools are connected to the cloud in addition to being locally integrated.

However, if used improperly, CPM could turn out to be a pitfall. Corporate performance management faces significant challenges that need remedies in the initial stages as outlined below.

- Strategic alignment of major elements: this refers to making sure that all organizational procedures and essential components—like budgeting, project and program management, risk management, etc.—are in line with the main goal.
- Smart automation: a badly carried out CPM will result in total failure. To guarantee that information is simply integrated, processed, and reported in accordance with suggested standards, a company should set up an intricate, suitable, and conveniently available ICT infrastructure.
- Goals synchronisation: businesses shouldn't only employ pre-existing tactics without also concentrating on their own. Rather, they must concentrate on clearly

stating their main objectives throughout the organizations to ensure that CPM and all other stakeholders are following the established plans.

- Collection of Key Performance Questions (KPQs): though derived from KPIs, KPQ is about collecting meaningful, relevant, and usable data by asking the right questions of the proper departments and sources.
- Fostering a positive learning environment: utilizing the information in meaningful ways is the next step after data has been gathered, examined, and evaluated. That is, making certain that relevant divisions inside businesses are authorized to use, rectify, and enhance areas recommended by CPM measurements.

To resume, the CPM process can be seen as a cycle or a continuous process which starts with planning and continues improving itself. In *Figure 2.3* it is shown the various stages in which CPM's value added is gained.

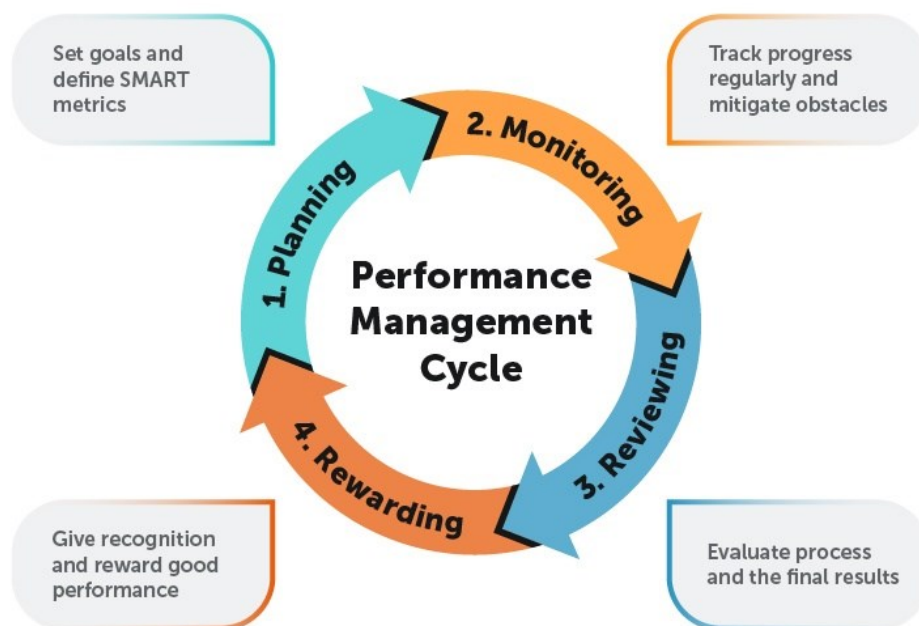


Figure 2.3: CPM process cycle^[31]

1. Planning: the first phase of the process is the planning. At this point the KPIs are defined and the goals of the company are set as well as the strategies to achieve them. This measure will be better analysed in the next paragraph.

2. **Monitoring:** in this step managers are supposed to look at the process and evaluate if the strategies previously defined are efficient and, eventually, take corrective actions.
3. **Reviewing:** this is the analysis phase. At this point the CPM along with the BI systems give the management the results obtained in the two previous stages. The KPIs previously defined are now meticulously analysed through the reports and dashboards provided by the two software. An important tool that the IT department should implement in the BI/CPM tool is the “alert”: thanks to it, all the people involved in the process are immediately aware if the KPIs are below or beyond the forecast.
4. **Rewarding:** give recognition and reward good performance.

2.3 Key Performance Indicators

The business metrics, or Key Performance Indicators (KPIs), used in CPM provide measurable values that reveal how a company has progressed in relation to its strategic goals. The information used to create these metrics often comes from books of accounts - including income statements, balance sheets and cash flow statements - or from budgeting and forecasting data - such as revenue, expenses and inventory reports.^{[32][32.1]}

They can be high level KPIs, then they focus on the overall company’s performance, or low level KPIs, then they focus on processes between company’s departments, such as Sales, Marketing or Human Resources.

KPIs are defined before the business process begins, in order to compare the actual value obtained at the end of the fixed time period and the forecast one. The management, then, will take corrective actions to reduce the gap between the two values and they can investigate the causes.^{[33][33.1]}

The KPIs used in CPM can be organized into five categories:^{[34][35][36][36.1]}

1. **Financial:** this includes all financial performance numbers, such as sales, costs and profits.
2. **Internal:** the employee experience can have a significant impact on the long-term success, or failure, of a company. Internal metrics offer an evaluation of the quality of company management.

3. Customer: customers are essential to every business; they are the source of the company's income. Customer satisfaction and loyalty can be key indicators of business health and performance.

4. Compliance: the company must demonstrate legal compliance with employment regulations, financial reporting and environmental rules.

5. Strategic: these metrics will reveal how well the company executed the strategies that management implemented to reach immediate targets and move towards long-term organizational goals.

In the *Table 2* some of the most common KPIs in CPM are reported:

KPI	Category	Meaning
Customer Retention rate	Customer	Number of customers who make repeat purchases through the company or continue using the company's product over an extended period of time
Sales Revenue	Financial	Month-over-month sales results; crucial indicator to understand if the company is doing well and if it still holds a competitive position in the market
Net profit margin	Financial	How efficiently a company generates profit compared to its revenue
Gross margin	Financial	It measures a company's productivity (the higher the gross margin, the more a company earns from every sales dollar)
Employee happiness	Internal	It measures employee satisfaction rates using surveys or HR tools
Sales growth	Financial	It shows a business the pace at which its sales revenue is increasing or decreasing.
Stock	Strategic	It shows the level of the storehouse. It can be measure in monetary terms, quantity or period of coverage

Table 2: some examples of KPI

2.4 Reporting

The reporting is the front-end part of a BI and CPM software.

It allows final user to visualize the data in a useful way in order to take the decisions for the business.

Since reporting is the element the user interacts with, there are some rules to make it as useful as possible, such as: ^[37]

- Representing in the report only data that are useful to the report the user is currently looking to. That's because the aim of a report is to show data in the easiest way possible, avoiding confusing the user.
- Allow the user to interact with the report, by means of drill-down/roll-up functions, or by means of filters to select what data to see.
- Organizing the screens with a logic, avoiding changing spot of the objects along the reports (e.g. filters are always on the top-left of the screen, charts are always on the right of the scree, etc.). By doing so, the user is facilitated in the reading of the various reports.

A report is composed by different objects, each having its own function. The most common tools are:^[38]

- Dataviews: they are tables in which data are organized by rows and columns; usually the user is allowed to make drill-down/roll-up in order to analyse data with more level of detail/less level of detail respectively.
- Charts: diagrams in which data are visualized in a graphic way; usually they are preceded by dataviews. Some examples of charts can be histogram, pie chart, Gantt chart, etc.
- Filters: they allow user to see desired data by making some selections on the report; usually filters are applied on dates (to see only data relative to a specific time period) or on entities (to see only data relative to specific element of the dataviews).
- Alerts: to highlight if a value is above or below a fixed threshold.
- KPIs: to measure the performance of the company and visualize them in an easy and eye-catching way.

The most common type of reporting is the “dashboard”. A dashboard is an information management tool that receives data from a linked database to provide data visualizations. It typically offers high-level information in one view that end users can use to answer a single question. In many cases, they can be configured to provide specific information to the end user and how this information is visualized (e.g., Numbers, charts, or graphs).^{[39][39.1]}

In *Figure 2.4* an example of dashboard made in Board is shown.

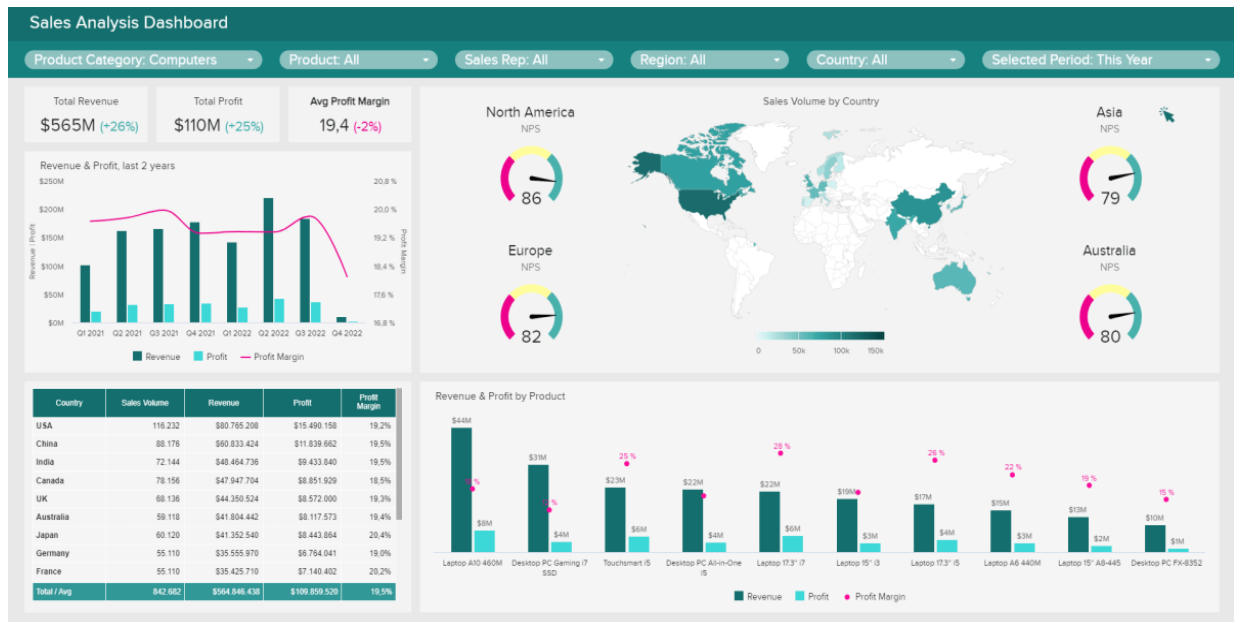


Figure 2.4: Example of Dashboard in Board^[40]

Looking at the image above, it is clear that the report is composed of several elements, each one positioned in a specific spot.

On the top bar, there are the filters to select a specific set of data. Then, immediately below, there are the KPIs, the histogram and the dataview. On the right side, there are two charts showing data by country (with relative KPIs) and by product.

To better understand how to make a report in Board, please see Chapter 3 and Chapter 4.

3. Board

Board is a Business Intelligence and Corporate Performance Management software developed by Board International SA.

The company was founded in Chiasso, Switzerland in 1994 and then in Boston, Massachusetts. ^{[41][42]}



Figure 3.1: Board International logo^[41]

Currently, Board International operates in 19 countries, with around 3000 customers worldwide, from a number of variety of industries, such as:

- Automotive industry: Toyota, Volkswagen, CNH Industrial;
- Food and Beverage industry: Coca-Cola, KFC, Rummo;
- Banking and Financial Services: Sella, Banco BPM, Illimity;
- Fashion and Luxury: Puma, H&M, Burberry, Moncler.

So, the applications of Board are illimited and they can be grouped in five departments:

1. Finance
2. Retail
3. Supply Chain
4. Sales
5. Human Resources

Despite Board fits very well for each of the above fields, the most suitable purpose is the Financial Planning.

Indeed, Board named a Leader in 2023 Gartner Magic Quadrant for Financial Planning Software. ^[43] The chart is reported in *Figure 3.2*.

Referring to *Figure 1.6*, in that case the Gartner MQ is about the best Business Intelligence software on the market (Board is a “Niche Player” because it focuses mainly on small segments such as Financial Planning) , while the Gartner MQ in *Figure 3.2* looks specifically to the best BI software for Financial Planning purposes.



Figure 3.2: Gartner MQ 2023 for Financial Planning Software^[43]

Financial planning software, in particular, is described by Gartner as the essential instrument that enables businesses to automate and optimize their enterprise-wide financial planning procedures. Through the connection of pertinent operational and driver data to profit and loss, balance sheet, and cash-flow financial statements, the program facilitates the planning, budgeting, and forecasting processes. The program also provides improved analytics and decision assistance that can be tailored to specific planning needs. Financial planning software provides this assistance through the provision of data integration, data modeling, reporting, and workflow features, all of which improve the

user's capacity to efficiently oversee the planning process and the financial success of their firm. ^[43]

Following the Gartner's report (available at link [43]), let's analyse the strengths and cautions of Board that made it a Leader in the financial planning software.

This is the Gartner's introduction^[44]:

"Board is a Leader in this Magic Quadrant. Its product, also called Board, integrates planning processes in a single platform, offering strategy, finance and operations with real-time analysis and data sharing. Board is a private company with customers worldwide and the majority in Europe. It serves clients in an array of verticals; its top three include manufacturing, retail and professional services. An innovative feature is its new Azure Machine Learning integration, which uses AI and ML algorithms as part of budgeting and forecasting processes. In 2024, Board plans to build on its extended ModelOps support and provide faster planning applications with features based on GenAI, including LLM technology foundations."

Strengths:

- **Data Integration:** Board supports more than 270 API (Application Programming Interface) connections to source systems, 59 of which are certified. Certified APIs include ERP and non-ERP sources that are popular with Gartner clients, such as SAP, Oracle Cloud, Microsoft Dynamics 365, Salesforce and Workday.
(An API is simply some software that sends information back and forth between a website or app and a user ^[45]).
- **Workflow Automation:** Board has a strong workflow capability with several notable features. In addition to graphical status reports providing a clear view of processes, issues, bottlenecks and delays, it offers integration with Microsoft Teams to orchestrate approval processes, which may be particularly attractive for organizations that use Microsoft products.
- **Market Responsiveness:** Board directly engages customers through community feedback and has effectively delivered on items outlined in its 2022 and 2023 roadmap. Fulfilling these commitments is essential to instil confidence in its roadmap, enhancing customer trust in its planned initiatives.

Cautions:

- Pricing: Board offers ML (Machine Learning) capabilities enabled by Azure, which comes with an additional annual cost. While not unusual for advanced prediction engines, ML features among vendors vary, and customer evaluation teams should assess alignment with their current and expected use cases.
- Product enhancements: Board's recent releases include functionalities that some Leaders already have, such as API development, integration with Azure Machine Learning, upgrades to the user interface and the multidimensional engine for greater capacity. Potential clients should assess the alignment of current and planned features to meet their evolving requirements.
- Vertical strategy: although Board has specific planned market share initiatives for the retail sector, its vertical strategy for other sectors is still evolving and currently only targets customers aligned with its ideal personas. Prospective clients should assess industry alignment to ensure their business needs are effectively met.

The Gartner's report also provides the evaluation criteria at the base of the MQ and their weight. Those criteria are:

- Product/Service: The vendor's essential products and services for the specified market. This covers the quality, feature sets, expertise, and other aspects of the present product and service offerings, whether they are provided directly or through OEM agreements or partnerships as specified in the subcriteria and the market definition.
- Overall Viability: This refers to the likelihood that a particular business unit will continue to invest in, offer, and advance the state of the art for the product within the organization's portfolio of products, as well as the financial health of the organization as a whole and the business unit's practical and financial success.
- Sales Execution/Pricing: The capacity of the vendor to carry out all presales tasks and the infrastructure to back them up. This covers price and negotiating, deal management, presales assistance, and the sales channel's general efficacy.
- Market Responsiveness/Record: Capacity to react, pivot, exhibit adaptability, and secure a competitive edge as prospects arise, rivals take action, client demands alter,

and market conditions shift. This criterion also takes the vendor's track record of responsiveness into account.

- **Marketing Execution:** The program's quality, originality, and effectiveness in delivering the organization's message to impact the market, promote the brand and business, raise consumer awareness of the products, and forge a favourable association between the organization and its offerings. A mix of media attention, marketing campaigns, thought leadership, word-of-mouth marketing, and sales activities can generate this "mind share".
- **Customer Experience:** Connections, goods, and services/programs that help customers succeed in using the things under consideration. In particular, this covers the methods via which clients obtain account or technical help. Ancillary tools, customer support programs, user group accessibility, service-level agreements, and other things might also be included in this.
- **Operations:** The organization's capacity to fulfil its obligations and aspirations. Aspects include the calibre of the organizational structure, as well as the knowledge, expertise, plans, processes, and other tools that the company needs to continuously run successfully and efficiently.
- **Market Understanding:** The vendor's capacity to assimilate and transform customer demands and desires into goods and services. Vendors with the greatest level of vision pay attention to and comprehend the demands and desires of customers, then use their additional vision to shape or improve them.
- **Marketing Strategy:** A distinct, well-articulated set of messages that are regularly disseminated within the company and externalized via advertising, websites, customer programs, and positioning statements.
- **Sales Strategy:** A sales strategy expands the breadth and depth of market reach, as well as the skills, knowledge, technologies, services, and customer base, by using the right network of direct and indirect sales, marketing, service, and communication affiliates.
- **Offering (Product) Strategy:** The vendor's technique of developing and delivering products that prioritizes feature sets, functionality, distinction, and methodology in relation to present and future needs.

- Business Model: The viability and consistency of the vendor's core business proposal.
- Vertical/Industry Strategy: The approach taken by the vendor to allocate assets, competencies, and product offerings to suit the particular requirements of distinct market segments, including vertical markets.
- Innovation: Arrangements of resources, knowledge, or capital that are direct, connected, complementary, and synergistic for objectives of investment, consolidation, defence, or prevention.
- Geographic Strategy: The vendor's plan to allocate assets, competencies, and product offerings to address the unique requirements of regions outside of their "home" or native territory, either directly or through subsidiaries, partners, and channels as those regions and markets demand.

In *Table 3* the evaluation criteria and their relative weights employed in making the Gartner Magic Quadrant are reported.

Evaluation criteria	Weighting
Ability to Execute	
Product or service	High
Overall viability	Medium
Sales execution/pricing	Medium
Market responsiveness/record	High
Marketing execution	Low
Customer experience	High
Operations	Low
Completeness of Vision	
Market understanding	High
Market strategy	Low
Sales strategy	Low
Offering (product) strategy	High
Business Model	Medium
Vertical/industry strategy	Medium
Innovation	High
Geographic strategy	High

Table 3: Gartner's MQ Evaluation criteria

As mentioned in the previous chapters, Board is not just a BI software, but it combines BI, Analytics and CPM in an all-in-one solution.

Generally speaking, the basic functioning of Board is the following:

1. different types of data enter in Board;
2. data are transformed and elaborated into useful information;
3. the information are visualized by the final users in a smart form.

Board gives businesses the ability to work with data in a simple way to generate a single, accurate, and comprehensive picture of their company information, obtain insights that can be put to use, and take complete control over their performance as a whole.

Figure 3.3 shows the general functioning of the application.

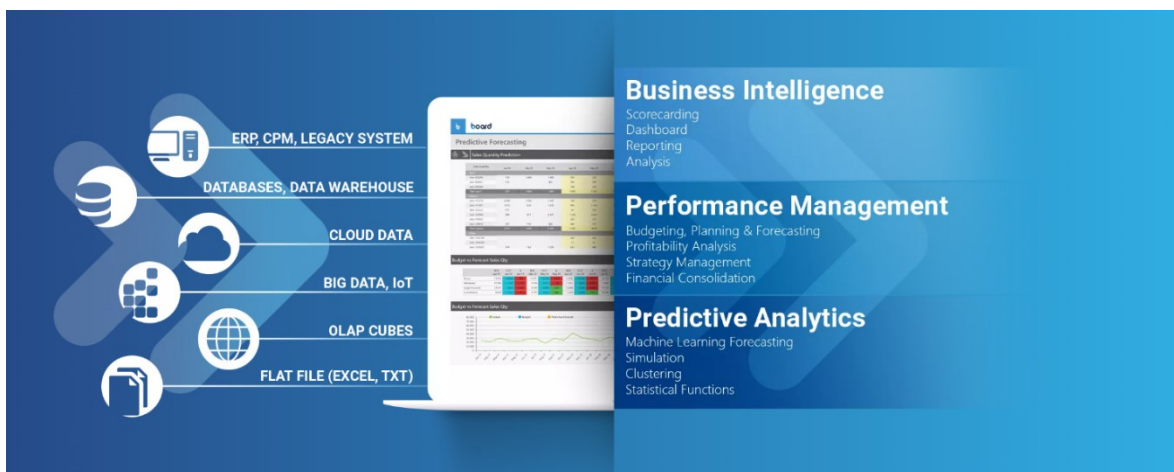


Figure 3.3: Board's general functioning^[41]

There are two methods to access Board: locally or on the cloud:

- Board Cloud: powered by Microsoft Azure, it provides all the platform capabilities together with the exceptional security, dependability, and performance that only a robust cloud infrastructure can provide. The Board in Cloud team will also be directly in charge of updates, installation, and development.
- Locally: it's necessary to install the various services, with which the user will work directly from his/her PC.

In the next paragraphs, the major elements of Board will be deeply analysed, providing a theoretical guide of the software. A practical application is then provided in Chapter 4.

3.1 Board's main elements

All the Board's elements are grouped into five sections, which are available in the main menu of Board.

Most of the information contained in Chapter 3 are available on the official Board Reference Manual: 2023 Summer Release ^[46].

The main menu (reported in *Figure 3.4*) is composed by:

1. Capsules
2. Presentations
3. Cognitive space
4. Data model
5. System Administration

Note: depending on the user license purchased and the role, some menu items could be unavailable. For the purposes of this thesis, all Board's functions are usable due to the most expensive license purchased (Developer, role Administrator).

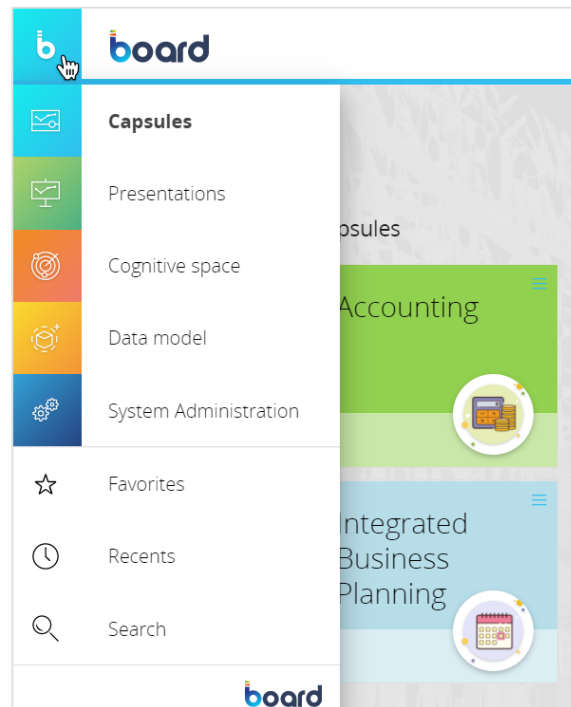


Figure 3.4: Board's main menu^[46]

In the following paragraphs, each of these sections are deeply analysed, always making reference to the official Board Manual.

3.2 Capsules

In basic terms, a capsule is a dashboard that could have many screens on it. Every screen has the ability to hold both single and many items (such buttons, menus, tables, charts, etc.) as well as procedures. The end-user will see, navigate, and interact with the Capsule; contingent on the authorizations granted, the user may also be allowed to modify data and change the associated Data model.^{[46.1][46.2]}

A capsule merely holds the report specifications (the layout) and the definitions of the objects used to exhibit data (charts and tables). It does not store any data. Every time a Capsule is opened, new data is obtained from the Data model. All of the objects within a

Capsule synchronize with the Data model and one another, enabling them to respond to user activities automatically.

A capsule may serve one of the following roles, depending on the items shown in the different screens: Analysis capsules, which feature reports with tables and charts; Business Intelligence and Corporate Performance Management capsules, which integrate reporting with data-entry and simulation screens; and Application Settings Administration capsules, among other types.

Example: The Capsule Sales Analytics (Figure 3.5) contains various Screens analysing how the company is going in different Countries. Inside the Capsule there are different Screens, each of them representing the performance in a specific Country. Among the others, there is a Screen (Figure 3.6) which resumes the sales worldwide.

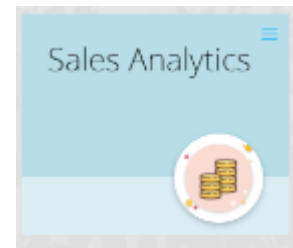


Figure 3.5: a Capsule^[46]



Figure 3.6: a Screen (dashboard)^[46]

Masks make it simple to modify capsules. Graph templates known as masks are able to be applied to all screens simultaneously and can include objects and selectors that aren't specified by a layout. One way to customize a Mask is to include navigational objects. This way, once a Mask is connected to every Screen in a Capsule, all of the Screens will have the same navigation path.

3.3 Presentations

A Presentation is a streamlined way to show your data in your organization. You can create customized versions of your enterprise reports by adding Screens, even from different Capsules, and by arranging the newly created slides in any order you like. Each screen will be added together with all its Objects, which will continue to be interactive even in the Presentation: this means that you will be able to drill down, drill anywhere, select and edit data on the fly, provided your user has the necessary authorizations. All Presentations are automatically stored in your personal workspace within Board.

Once you have finished configuring your presentation, you can easily share it with other users or user groups in a variety of formats and through different mediums. All users that have the necessary authorizations can work on the content simultaneously, all this without leaving the Board environment and workspace and without the need to use other software.

Example: Once the Profit and Loss Statement has been created in various Screens, an easy way to show the report to the CFO is by using Presentations. Instead of export the report into a PowerPoint file, you only have to select the Screens containing the P&L and bring them into the Presentations section. Then, Board will automatically create the slides which can be edited by the user at any time and the report will be automatically upload with the new editing.

The screenshot shows the 'board' software interface for 'IC0 - Incentives Settings'. The top navigation bar includes 'Target Planning', 'Account Planning', 'Incentives & Compensation', 'Sales Analytics', and 'Sales Planning'. Below this, there are four tabs: '1. Incentives Settings', '2. BU Mgr. What-If Analysis', '3. Target Optimization', and '4. Cost of Sales Dashboard'. The main content area is divided into several sections:

- Base Salary by Manager Level:** A table with columns for 'Level' and '2019'. Rows include Level 1, Level 2, BU MANAGER, and SBU DIRECTOR.
- Commission Incentives Plan:** A table with columns for 'Level 1', 'Level 2', 'BU MANAGER', and 'SBU DIRECTOR'. Rows include Tier Comm., Margin Comm., Gate Comm., and SPIFF Comm.
- Manager Level Definition:** A table with columns for 'Level' and 'Manager Name'. Rows list various managers and their levels.
- Tier Commission Rate Setup:** A table with columns for 'Level' and 'Commission'. Rows include LVL 1, LVL 2, LVL 3, and LVL 4.
- Margin Commission Setup:** A table with columns for 'Level' and 'Commission'. Rows include LVL 1, LVL 2, LVL 3, and LVL 4.
- SPIFF Setup:** A table with columns for 'SBU' and 'Bonus'. Rows include SBU 1, SBU 2, SBU 3, and SBU 4.
- Gate Commission Setup:** A table with columns for 'Level' and 'Bonus'. Rows include LVL 1, LVL 2, LVL 3, and LVL 4.

On the right side, a 'PRESENTATIONS' sidebar is open, showing options: 'Design mode', 'Show screen list', 'Refresh', 'Add to presentation', 'Export printable report', 'Export data to slide', 'New subscription', 'View all subscriptions', 'Select Bookmark', 'My view', and 'Screen fit'.

Figure 3.7: how to create a Presentation from a Screen [46]

3.4 Cognitive Space

This Board's section is the most innovative one since it employs the Artificial Intelligence (AI). It is based on two main technologies: the Natural Language Processing (NLP) and the Natural Language Generation (NLG). [46.3]

NLP, or natural language processing, is the area of computer science that focuses on teaching computers to interpret written and spoken language in a manner that is similar to that of humans. More precisely, it is the field of artificial intelligence, or AI. Thanks to this technology, computers can now interpret text or speech data including human language and fully "understand" what is being said or written, including the speaker's or writer's purpose and mood. [47]

Once the machine understood the human language, the NLG provides to give the user an answer. Natural language generation is the use of AI programming to produce written or spoken narratives from a data set. [48]

Board's NLP and NLG technologies enable incredibly creative and efficient user-data interaction throughout the Board Platform.

Similar to a standard web search engine, a user can communicate directly with the system or use search phrases to retrieve the most pertinent information. Modern technology that converts voice into queries automatically and provides "machine-generated" reports together with intelligent, real-time explanations allows the user to quickly and easily retrieve all of the important information from the analysis, neatly highlighted for them. In addition to offering a search experience that is genuinely web-like and saves time, Board's Cognitive Space section facilitates natural interaction between users and data.

Example: the user wants to know the order count by year. Instead of making a research among all the Capsules, he/she just have to ask Board his/her request in the Cognitive Space section. The simulation of this example on Board is reported in the *Figure 3.8a* and in the *Figure 3.8b* below.

Analyses and capsules will be included in the search results. An analysis is a graphic that Board automatically creates to show the search results by extracting information from Board's Data Model.

3.5 Data Model

Implementing the Board's Data model is the last stage of the back-end part of the project.^{[46.4][46.5]}

Due to their multidimensionality, Board's data models are ideal for online analytical processing (OLAP). In theory, a multidimensional data model is based on the concept of a data cube, in which the dimensions stand in for the many potential views on the data and the cube cells store values. A "sales" cube, for instance, may be seen by a number of dimensions, including product (i.e., the sales figure per product), geography (i.e., the sales figure per city or area), time, and so on.^{[48.1][48.2]}

Normalized data is kept in multidimensional objects called Cubes that are organized by Entities (e.g., Month, Customer, and Product) and include information on turnover, assets and liabilities, costs and revenues, among other things.

Certain entities, classified as Unbalanced, can support indirect hierarchical structures, but other entities, connected by connections, can create hierarchical structures (e.g., Customer → Country → State). Regardless of the data sources they use, users may read, write, and update Cubes.

A Board Data model is made of:^[46.6]

1. Entities: they are collections of data, usually in the form of text and codes. For instance, a list of Customers, Products, or Cities might all be included inside a single Entity. The dimensions of the Cube are entities (and hierarchies).
2. Relationships: A relationship, also known as a hierarchy, can be described when there is a many-to-one relationship between two or more entities. Given that there is a many-to-one link between Customer and City and between City and State, for instance, the entities Customer, City, and State can be arranged as the link "Customer → City → State".
3. Cubes: Cubes are collections of data, usually numerical but not always, that may be examined and interpreted according to their many dimensions and hierarchical levels.

Cubes, Relationships, and Entities make up the company's multidimensional data model, or the modelled system more broadly. An entity or a relationship as a whole that may serve as an axis for a cube is referred to as a "dimension". For instance, Cubes with dimensions like "Orders value" and "Invoiced value" may have the entity Currency as a component. Because of their hierarchical relationship, the three elements Customer, City, and State create a distinct dimension known as the Customer dimension: The dimension is called after the Relationship's base level Entity, which stands for its most intricate level.

The Data Model also includes: [46.7]

4. Data Readers: their function is to import data from external sources into Board and they also handle the mapping of data to Entities, Relationships and Cubes.
5. Procedures: the manipulation of data happens by means of Procedures.

More detailed explanations about Entities, Relationships, Cubes, Data Reader and Procedures are provided in the next paragraphs.

As shown in *Figure 3.9*, the Data Model has many other sections, such as the Time Range, where the analysis' time period is set and the granularity of the Time Entities (year, month, day, fiscal year, quarters, etc.) is chosen according to the analysis' requirements.

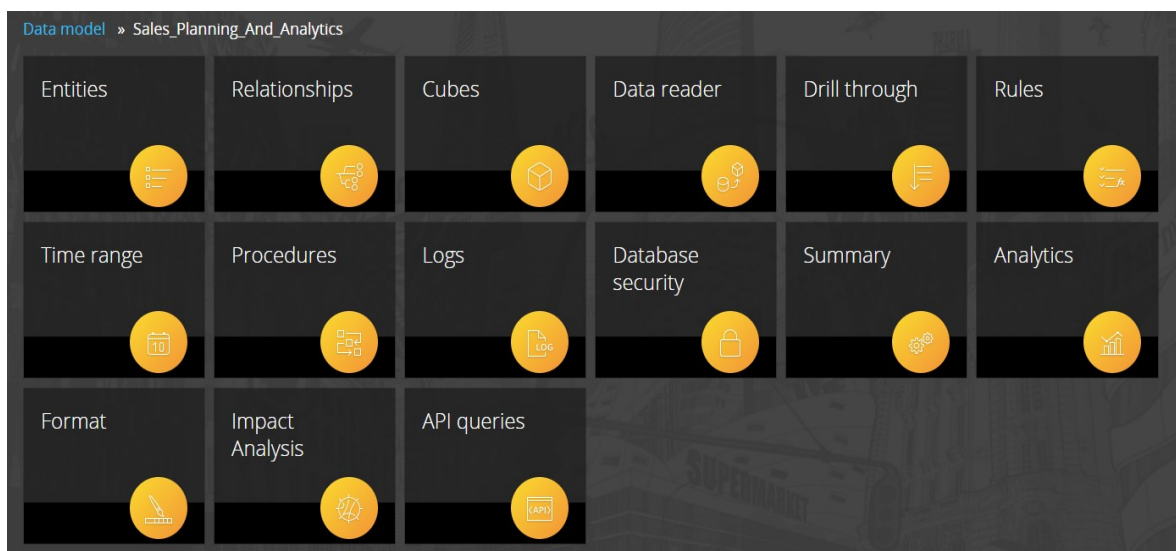


Figure 3.9: Board's Data model components

3.5.1 Entities

Defining Entities is really important, since it allows to identify:

- The general structure of the application;
- The most significant analysis' dimensions;
- The application's output (BI, CPM, Finance, etc.)

An Entity generally is a set of homogeneous items by which data can be viewed and summarized. A single occurrence of an Entity is called an "Entity member", "Item" or simply "Member". Entities in Board are typically used as dimensions of Cubes, but they can also be added as Data Blocks or in the Axes of a Layout.

Example: The Entity "Product" contains a list of products which are the Members, as well as the Entity "Customer":

Entity	Members
Product	01 Table
	02 Chair
	03 Glasses
Customer	01 Mario Rossi
	02 Chiara Verdi
	03 Andrea Bianchi

Table 4: Example of Entities and Members

When you create an Entity, Board asks you to digit the Name, the Group, the Code Width, the Description Width, the Max Item Number (the maximum Members an Entity can contain). These Metadata are essential to identify every Entity, so it is necessary to study very well how to assign their values.

Obviously, the user is not expected to digit every single Member in each Entity; the Entity can rapidly be populated with a large number of Members by means of the Data Readers.

Once you created the Entity, Board will assign it a Physical Name which cannot be changed.

As the user inserts Member, Board will show the percentage of saturation of the Entity. If the Entity is full, then Board will not record the new Members anymore, so it is important to decide the Max Item Number properly.

These metadata are visible in the Entity recap page (*Figure 3.10*).

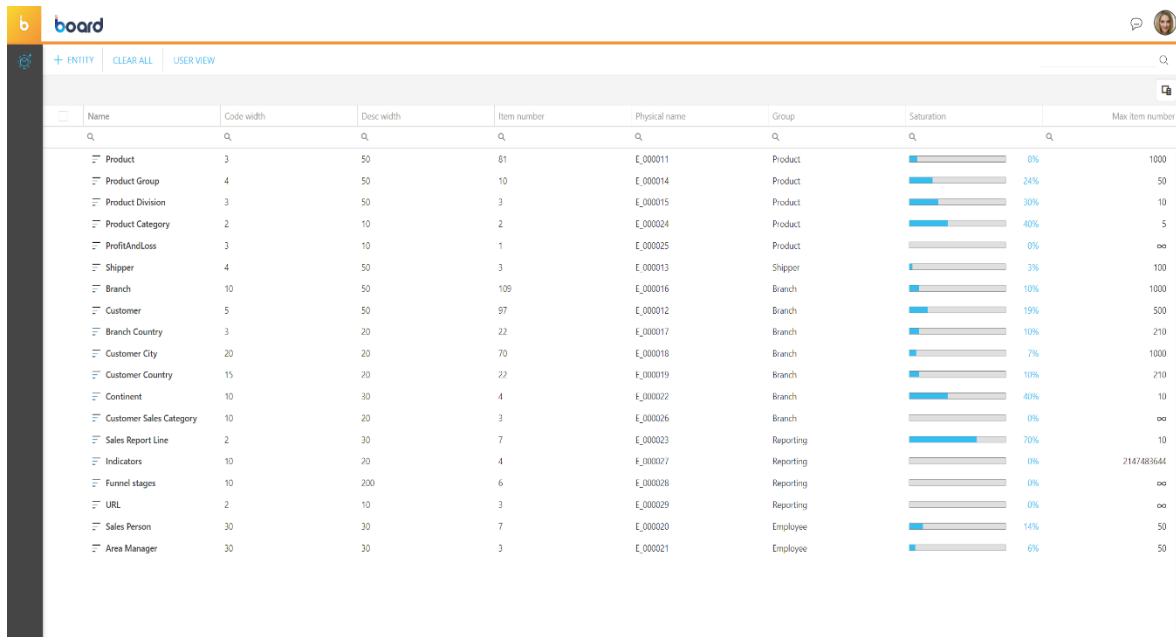


Figure 3.10: The Entities recap page [46]

3.5.2 Relationships

The term “relationship” refers to the correlation between two or more Entities.

In Board the only admissible relationships are [1:1] and [n:1]. It is not possible to have a [1:n] or [n:n] relationship’s cardinality.

Example:	[1:1]	Student ID → Student	One student ID is associated to one student
	[n:1]	City → Region	More cities belong to one region

Relationships in a Board Data model are always many-to-one links between two Entities; they are always hierarchical. As a result, the entities are known as the parent entity and the child entity.

For this reason, in a typical Board situation, Relationships can also be referred to as hierarchies or trees. For instance, since a city may only be in one state and a state often consists of several cities, it is evident that the Entities "State" and "City" are related to one another like parents and children.

Since entities and hierarchies are employed as dimensions in the Cube structures, they offer perspectives on Cubes at different aggregate levels. For instance, you could wish to view sales data in a sales cube by city or state. To achieve this, you can use the drill-down

functionality to dynamically change the cube's aggregation level or you can replace the entities in the Layout editor's Axis section.

Another common term used to describe two entities in a parent-child relationship is less aggregate (child) or more aggregate (parent) entities.

In the Relationship section of Board, the first Entity at the top of the tree (*Figure 3.11a*) is the least aggregate (child), while those nested and indented down along the tree are more aggregate (parents).

Board also allows a graphical view of Relationships (*Figure 3.11b*); in this case, the child Entity stays at the left of the parent Entity.

Example:



Figure 3.11a: Relationships tree^[46]

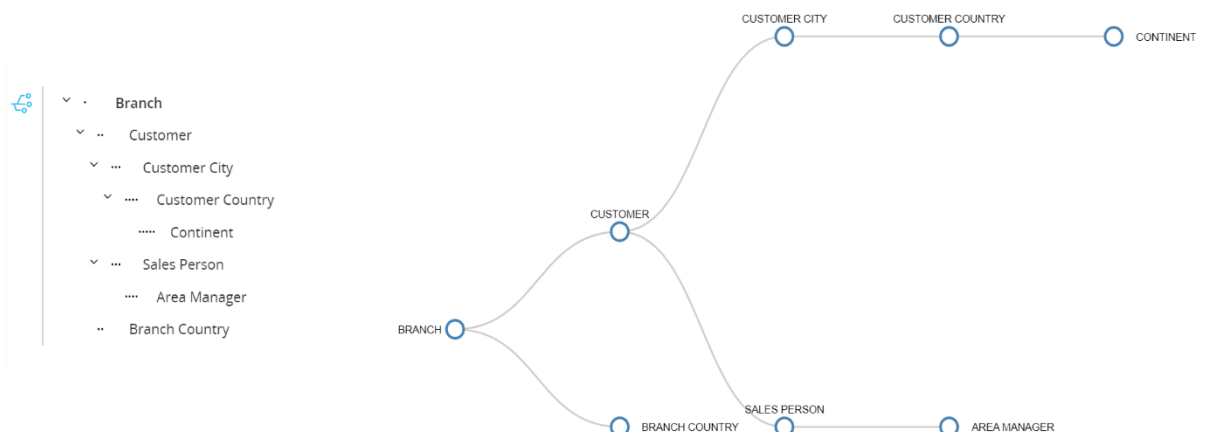


Figure 3.11b: Graphical view of Relationships^[46]

3.5.3 Cubes

A cube, which is represented in a multidimensional or relational format, holds data—not just numerical data, but also text, photos, and files in various forms. Cubes may be seen and studied according to their many hierarchy levels and dimensions. The dimensions of a cube define its capacity to display, dig down into, slice, and dice data as well as its level of granularity. Data types, data natures, versions, and architectures can all vary throughout cubes. A Cell is the smallest single unit that makes up a Cube. Every cell in the Cube represents the distinct logical intersection (coordinate) of a single member from each dimension.^{[46.8][46.9]}

Remember that the dimension of a Cube can be an Entity or a Relationship (the entities Customer, City, and State are hierarchically related and therefore form a unique dimension called Customer because it is the most detailed level).

Example: Consider the Cube “Sales” contains sales values in its cells and could be viewed by various dimensions such as Product, Customer and Month. These three dimensions are Entities previously defined. In *Figure 3.12* it is represented the situation:

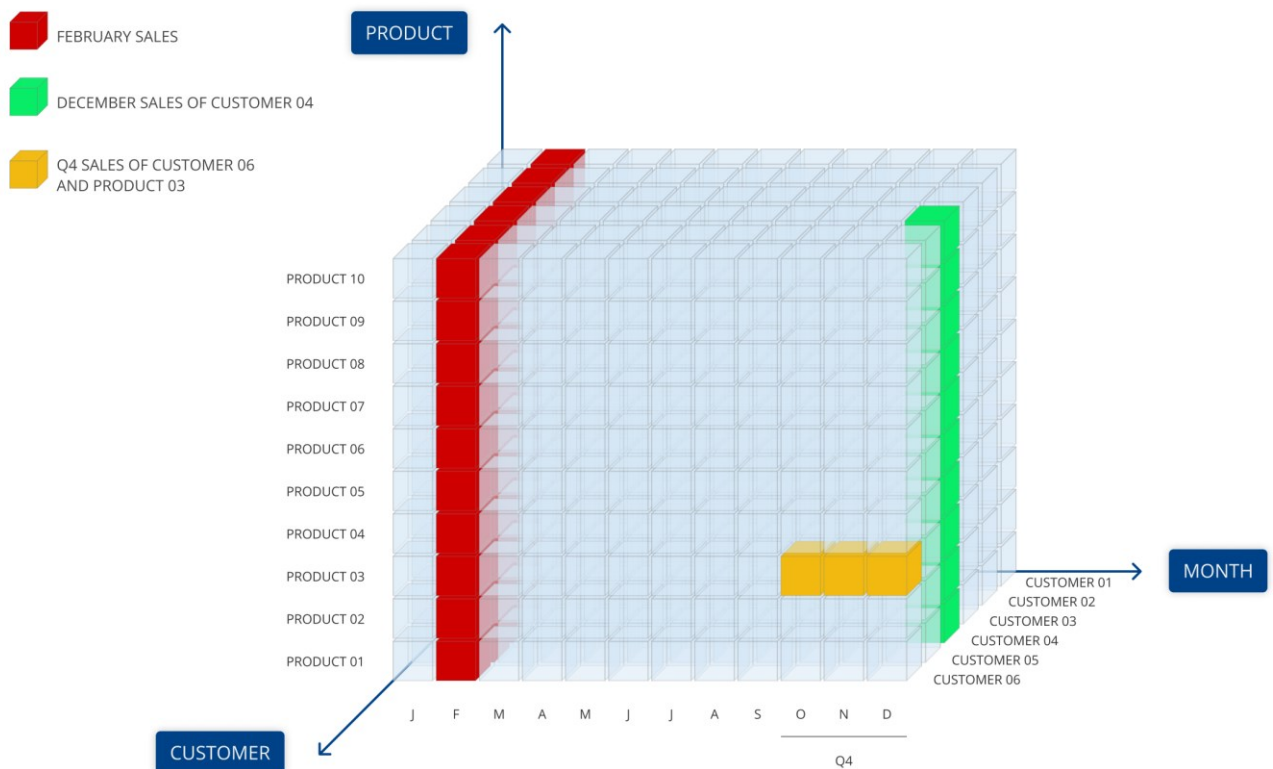


Figure 3.12: representation of a Cube^[46]

The Sales Cube can be viewed based on any of its dimensions (axes), such as total sales by Product, total sales by Month, or by Customer. It can also be viewed based on any of the intersections of its dimensions, such as sales by Product for a specific Customer or in a particular Month. The Sales Cube has three dimensions: Month, Product, and Customer. A Cube can be seen at any aggregate level of a Relationship when one of its dimensions is included in the Relationship. Every potential intersection between two or more Entities that are members of distinct Relationship trees may be readily constructed as views.

In the previous example, you can view total sales by:

- Quarter or Year, as they aggregations of the Month Entity
- City or by State, as they aggregations of the Customer Entity
- Product Group or Product Type, as they are aggregations of the Product Entity

A Cube can be of different types according to the data it contains: ^[46.10]

- Numeric Cube: data are numbers and according to the length of the numbers, this kind of Cube can be Single (each cell occupies 4 bytes), Double (8 bytes), Integer (only integer numbers allowed) and Currency.
- Text Cube: Text data may be stored in an unformatted text format using Text Cubes. For instance, a Cube containing just the client Entity may be used to store client addresses, while a Cube containing the Product and Country Entities can be used to record product names, which can change based on the nation's language. Text Cubes don't support aggregation because they only hold text.
- Date Cube: dates are kept there for service level analysis purposes. For instance, the number of days between two dates is returned by the difference between two date Cubes. It is not possible to aggregate Date Cubes.
- BLOB Cube: a Binary Large Object (BLOB) Cube stores files in its cells. A collection of documents, including commentary, photos, and other attachment kinds, may be handled in several dimensions using BLOB Cubes. For instance, you may utilize a BLOB Cube in a Financial Planning application to let users connect an Excel spreadsheet or a long remark to a certain account (like Revenues) for a specific month (like February). Images, PDFs, Custom files, and MS Word, Excel, and PowerPoint can all be stored there.

Every possible combination (cell) of members within its dimensions can have a value stored in a cube. A cube with three dimensions, for instance, contains a cell for each possible combination of those dimensions.

A Cube's maximum number of cells is its virtual size. For instance, the virtual size of a Cube with the dimensions Month, Product, and Customer in its structure and 24 months, 500 items, and 1,000 customers, respectively, would be $24 \times 500 \times 1000 = 12$ million cells.

Only a small portion of the Cube's cells really hold data when data is loaded. Cube density is the ratio of data-containing cells to total cells in the Cube (obtained by multiplying the total number of members of each dimension together).

The Cube density implies that the Cube's structure can be Dense or Sparse:

- Dense Structure denotes that all of the Cube's cells are filled with data, making the Cube extremely memory-intensive and causing computations to take longer.
- Sparse Structure denotes that certain cells are genuinely inhabited while the remaining ones are left vacant. Disk space overhead is reduced when a sparse structure is constructed because only the sparse combinations generated during loading are given disk space.

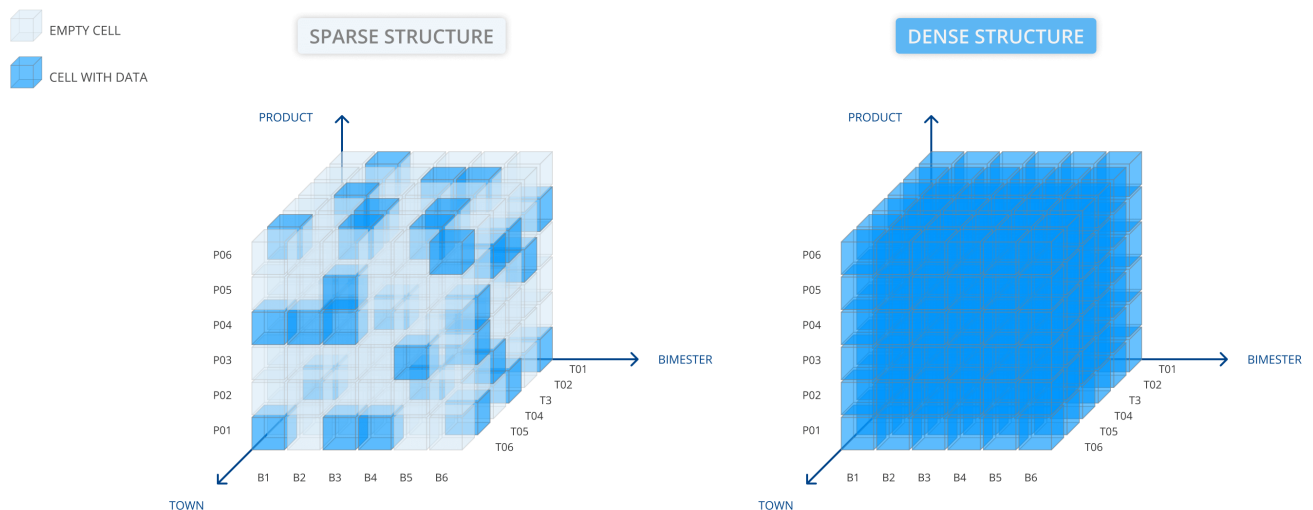


Figure 3.13: Cube Density [46]

Example: Consider a food and beverage firm that supplies a wide range of clients, including hospitals, schools, restaurants, hotels, catering services, small retail stores, and so on.

Depending on the type of consumer, a hospital may purchase different things from a hotel than from a school. In this case, a typical customer would likely order only a short list of

products from the total store. We refer to the customer and product entities as sparse if not all customers purchase all goods that are available and vice versa. The C1-P1 combination is referred to as a "sparse combination" if client C1 purchases product P1.

A combination of two or more hierarchically unrelated entities for which there are much less unique combinations of the current values than there are possible combinations overall is referred to as a sparse structure.

However, when creating a Cube, Board automatically assigns the density to each entity of its structure and rarely the user has to change it. Usually, the only Entities that are dense are the temporal ones (year, month, etc.) , while the others are sparse.

Finally, a Cube can be a MDB (Molap) Cube or a RDB (Rolap) Cube:

- A Cube with data physically stored in the Board multidimensional data model is called an MDB Cube.
- An RDB Cube is one whose data isn't physically stored in the Board multidimensional data model, but rather in a table of an external relational database. A data reader protocol called the RDB Cube definition associates the dimensions of the Cube with the fields of an external relational table.

You can also create different versions of the same Cube by changing the structure of the Cube itself. To each structure corresponds a version.

Example: the Cube "Sales Report" has the following versions:

- Version 0: Day, Shipper, Sales Report Line, Product, Branch
- Version 1: Month, Product group, Branch Country
- Version 2: Week, Shipper, Product division, Customer

In *Figure 3.14* is reported the screenshot of a Cube summary, which appears once you have created the Cube. In this example, the Cube “Forecast” is an MDB Cube, Single Data Type. The Structure is Month (dense, identified by the blue flag), Customer and Product (sparse, identified by the green icon). Memory usage “In RAM” is set by default by Board.

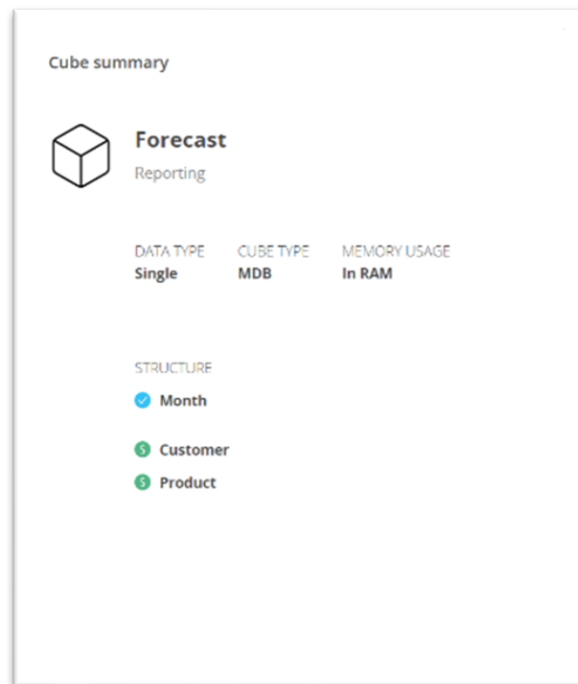


Figure 3.14: Cube summary ^[46]

3.5.4 Data Readers

Data Readers allow the user to import data into data model from different external data sources, such as:

- Text files
- SQL
- SAP

For the scope of this Thesis, only the first two Data Reader’s categories are analysed.

A data reader protocol specifies the fields of a file or table in a relational database that should be fed into particular Entities and Cubes. In other words, it establishes how external data has to be mapped to Entities and Cubes and how it has to be imported into the relevant Board Data model.^[46.11]

Multiple Entities and Cubes can be fed simultaneously by a data reader protocol, and in a similar vein, multiple data reader protocols can load Entities and Cubes simultaneously.

For instance, you may design a special data reader protocol that loads both Cubes simultaneously if you need to supply the Sales Amount and Sales Quantity Cubes in your transactional system with data that is stored in the same database. Alternatively, you may design two protocols that load data into the same Cube but connect to distinct data sources if you need to feed the Cube from two different transactional systems. This is helpful, for instance, if you need to combine data from several subsidiaries with different ERP systems.

Validation criteria and transformation formulas that are automatically applied to incoming data can be included in a data reader protocol. The Data Reader Configuration Area's ETL section is used to specify these rules and formulas (see *Figure 3.15*).

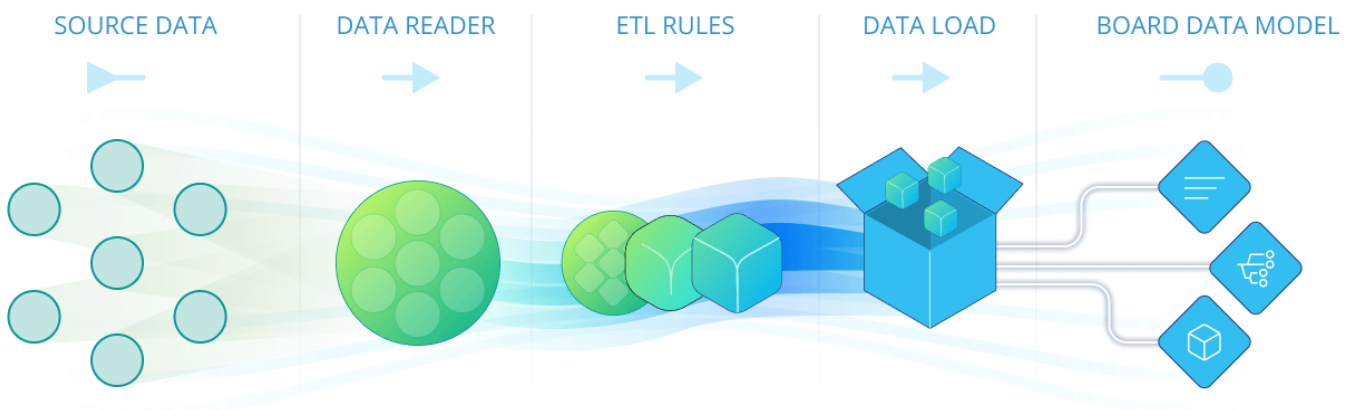


Figure 3.15: Data Reader schema^[46]

Two of Board's primary data intake capabilities are the mapping and ETL parts of the Data reader. These features result in noticeable project implementation savings. Most of the time, it is able to feed the Board data models straight from the source system (such as an ERP, CRM, or other operational tools) thanks to the strength and flexibility of the Data reader. This eliminates the need for intermediary data staging layers like a data mart or data warehouse. This is distinct from the majority of other BI systems, which usually ask for cleaning and structuring the source data into a star or snowflake structure. Although this procedure might be expensive to accomplish, it is frequently disregarded.

The Data reader section of the Data model or a procedure can be used to initiate data reader protocols. Board Data models are typically updated every day via an overnight procedure that executes all necessary reading protocols.

- SQL Data Reader

In *Figure 3.16* an example of SQL Data Reader is shown. In this case, the aim of the Data Reader is to populate the Entity “Sales Reps” (which stands for “Sales Representative”, so a particular category of employees). The Entity is, as always, composed of a Code and a Description. The goal is to automatically fill the fields, avoiding the manual input.

Suppose that the information about the Sales Reps are provided in a SQL database.

Once the user has established a connection between Board and the SQL server, the next step is to map the data reader. So, the Code and Description of the Entity are associated with the relative SQL query (see *Figure 3.16*).

Mdb Item	Rdb Item	Mode	Σ
# Sales Reps	Cast(dbo.Employees.EmployeeID as VARCHAR)	DISCARD NEW ITEM	
≡ Sales Reps	CONCAT(dbo.Employees.FirstName,dbo.Employees.LastName)	REPLACE	

Figure 3.16: Mapping of an SQL Data Reader

The result is shown in *Figure 3.17*:

The table above is automatically provided by Board and it allows the user to verify if the Data Reader he/she just created works properly.

The only limit of this type of Data Reader is that it needs a minimum of SQL knowledge.

Code	Description
# Sales Reps	≡ Sales Reps
1	Nancy Davolio
2	Andrew Fuller
3	Janet Leverling
4	Margaret Peacock
5	Steven Buchanan
6	Michael Suyama
7	Robert King
8	Laura Callahan
9	Anne Dodsworth

OK

Figure 3.17: Browse section of an SQL Data Reader

- Text Data Reader

This type of Data Reader is appointed by Board as “ASCII Data Reader”. The most popular character encoding system for text data on computers and the internet is called ASCII (American Standard Code for Information Interchange). There are distinct values for 128 alphabetic, numeric, or special extra characters, as well as control codes, in normal ASCII-encoded data.^[49]

First of all, the user has to indicate the path in which the text file is contained, in order to make the connection between Board and the data source. Then, there is the mapping phase in which the user indicates for each Entity the corresponding field in the text file.

For example, the user needs to pass in Board the day of the week associated to a date. He/she has an Excel file in which, in the first column there is the date in numeric format and in the second one there is the corresponding day of the week (see *Figure 3.18*) starting from 01/01/2018.

	A	B
1	20180101	Monday
2	20180102	Tuesday
3	20180103	Wednesday
4	20180104	Thursday
5	20180105	Friday
6	20180106	Saturday

Figure 3.18: The file Excel data source

The next step is the Mapping, so the Entities “Day” and “Day of the week” are associated to the relative field in the Excel file (see *Figure 3.19*). The Column A in the Excel corresponds to the Field#1 in Board and the Column B corresponds to the Field#2 in Board.

Field	Field	Mode	Divide by
Day	Field#1		20180101
Day of the week	Field#2	ADD NEW ITEM	Monday

Figure 3.19: Mapping of an ASCII Data Reader

The result is shown in *Table 5* below:

Field#1	Field#2
20180101	Monday
20180102	Tuesday
20180103	Wednesday
20180104	Thursday
20180105	Friday
20180106	Saturday

NOTE: if the date format was not correct (so different from `yyyymmdd`) the problem can be solved by ETL, in the Date Reader editor, directly on Board.

...

Table 5: Result of ASCII Data Reader

3.5.5 Procedures

A Procedure is an adaptable series of Actions, also known as Steps, that can be used for a variety of purposes. It can be used to update a Board Data model, process, extract, or print data, carry out calculations, broadcast reports, and navigate Capsules and Screens, to name just a few. They may also be utilized for data-processing hidden tasks, ranging from straightforward Cube value computations to intricate allocation processes needed for business models including profitability models, forecasting, planning, budgeting, and business simulations in general. [46.12]

The basic phases of a procedure are referred to as actions, and they may be categorized into different action groups based on their intended use. In addition to many other things, an action can execute a Data Reader protocol, carry out a Dataflow calculation step on a Cube, and extract data from Board. While many operations may be left to run unattended, others are interactive and call for users to interact with Board, such as by being asked to make a selection.

In *Figure 3.20* the summary of every type of actions in Board is reported. [46.13]

Select action			
 Screen Navigation and interaction	Go to capsule	Show message	Refresh screen
 Select Limit/Expand selection filters	Selection Remove all selections Reset to current screen	Interactive selection Remove selection on entity Save current selection	Select entity based on cube Remove selection on tree Restore selection
 Calculation Cube calculation	Dataflow Cube align	Nexel writeback	Clear cube
 Data reader Import external data	SQL Data reader	Text File Data reader	SAP Data reader
 Execution flow Procedure actions sequence	Go to group Exit procedure Rest API call	If then else Wait	Call procedure Server command
 Extract Extract data to file	Extract cube Export Data View to file Bulk insert to SQL Table	Extract entity Export layout to XML	Extract tree Export Dataset

Figure 3.20: Procedure action type selection

A Procedure can be executed by different ways, such as by clicking on a button, or by the Procedures home page, rather than being time scheduled and so on.

Board Procedures can be saved in a Capsule or in a Data model. Regardless of where the Procedure is located, the activities that may be carried out are mostly the same.

In the *Table 6* below, the major differences between Capsule and Data model Procedures are listed:

Capsule Procedures	Data model Procedures
They can be triggered only from Screens of the same Capsule, although they can function on numerous Data models.	They can be called from several Capsules, but they can only act on that same Data model.
Suited to Capsule-near actions (Screen interactions, Calculations for a screen, etc.)	Suited especially to DB-near actions (Data reader, Backup/Restore, etc.)
They may be moved across contexts via the Capsule and are not dependant on the data.	They can only be moved with the whole data model to a different environment.
They are able to perform all possible actions	Some Capsule specific actions are unavailable
They can only be invoked from the Capsule and cannot be scheduled	They can be scheduled

Table 6: Capsule Procedures vs Data model Procedures

The most important Procedures (Capsule or Data model) is the Dataflow, belonging to the Calculation group in the Procedure action type selection, since it allows to make computations between two Cubes.

Let's make an example of Dataflows: the starting Cubes are "Quantity" (dimensioned by Month, Product and Customer) and "Product Standard cost" (dimensioned by Year and Product). The user wants to calculate the Cost of Goods Sold, by simply multiplying the quantity by the cost.

Then, the target Cube "Cost of Goods Sold" (dimensioned by Month, Product and Customer) is obtained by multiplying the values in the Cube "Quantity" by the values in Cube "Product Standard cost" with a Dataflow.

Board assigns the letters a,b,c,... according to the order in which the Cubes are put in the Dataflow. In this case, Quantity is a, Product Standard cost is b and Cost of Goods Sold is c, so $c = a * b$.

Figure 3.21 shows the creation of this Dataflow taken as example.

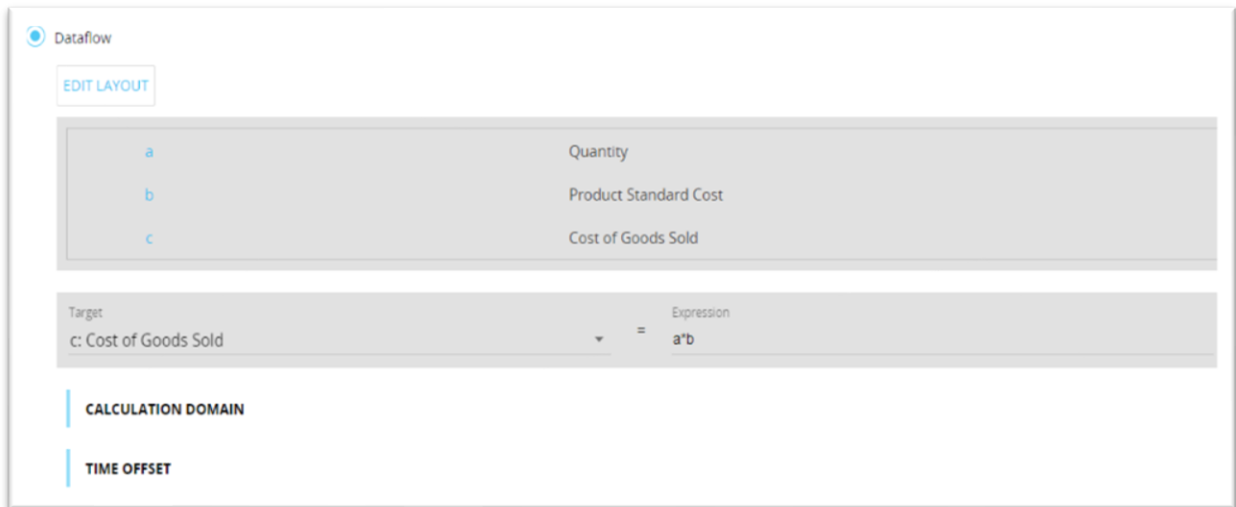


Figure 3.21: COGS Dataflow^[46]

Board verifies if the cubes involved in the calculations are structurally congruent before proceeding with the calculations. The cubes "Quantity" and "Cost of Goods Sold" are dimensioned by month, while the cube "Product Standard Cost" is based on the Time Entity "Year". In this instance, Board computes the difference between Cubes with a different structure automatically using the "Month-Year" connection. The following is an explanation of what the Dataflow will do: "Multiply the Quantity by the Product Standard Cost of the Product considered in the Year to which the Month belongs for each combination of Month, Product, and Customer."

The "Calculation Domain" section serves to extend the calculation to those Entities which are dimensions of the target Cube, but not for the starting Cubes.

The "Time offset" section serves to shift Cube values on the time dimension. For example, if the user wants to visualize the data of the previous year, the Time offset is set on the Previous Year Value.

Other common Procedures are the Backup of the Data model, the Data Reader Procedures, the Interactive Selection, the Export of a dataview to a file and much more.

3.6 System Administration

Administrators of a single Platform have their own area of Board dedicated to System Administration.

A user with the required permissions may manage and examine licenses, security profiles, users, the Platform's graphical motif, and much more from the administrative section.^[46.14]

The User license and Role determine access to the System Administration part: only Developer license holders with the proper security profile may view and access the System Administration section.

Let's briefly see the Board licenses.

1. Lite: the user can only visualize the application, but no edits are allowed. [€]
2. Lite Plus: the user has the ability to enter data in Dataviews. [€€]
3. Power User: the user can also edit the Capsules and Screens. [€€€]
4. Developer: the user can also modify the Data model. [€€€€]

Figure 3.22 shows the System Administration home page.

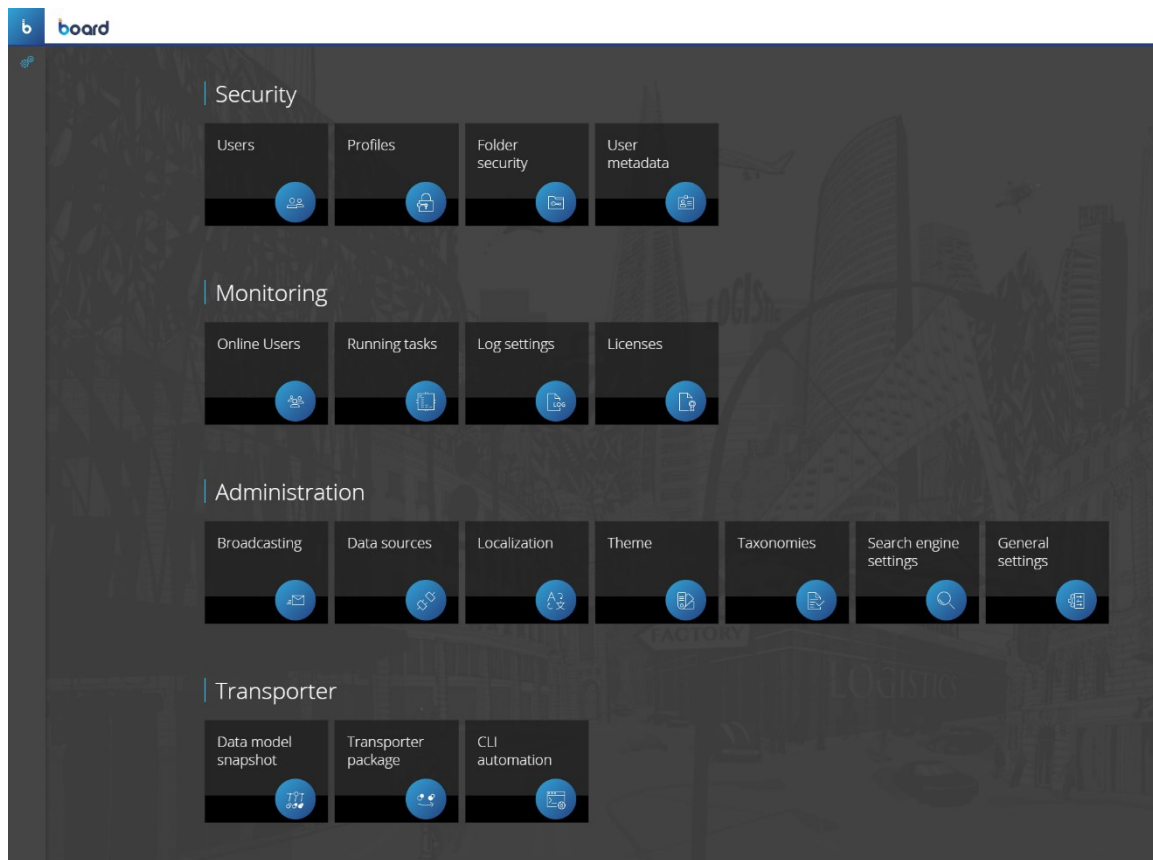


Figure 3.22: System Administration home page

- Administrator may specify user permissions for folder access, capsule access and editing, and data model access and editing under Security section.
- Reviewing user activity, seeing the tasks that are executing at the moment (including layout executions, dataflows, and data readers), and configuring system logs are all accessible under Monitoring section.
- The Broadcasting function can be managed under Administration section, enabling the scheduled email delivery of a Board Presentation to a list of recipients. Other features include configuring data sources for Data models, translating text strings into specific languages, defining user interface visual elements, uploading taxonomies, and configuring the Board's internal search engine.
- Data model snapshots may be taken under Transporter section, allowing for metadata changes to be applied from a source data model to a destination data model and comparison between the two. It is possible to transfer entities, cubes, and relationships but not real data.

4. Business Case

The following chapter concerns a real project developed by me in Board during the Internship at Bios Management ltd. in fall 2023.

The aim of this Business Case is to put into practice the theory concepts explained in the previous chapters and to show the reader how a BI and CPM application is built and how it actually works.

Since the project is quite vast, only the most significant elements (Entities, Relationships, Cubes, Data Readers, Procedures, Screens) have been reported.

For the purpose of this thesis, the real name of the customer company has been removed for privacy reasons and it has been replaced by a fictional firm operating in the food and beverage distribution called A&R Group. Alongside the names, the data too has been altered in order to guarantee the respect of any privacy policy and they do not have to be considered as reliable and truthful in any case.

Any reference to real persons and/or to real products is purely coincidental.

Any figures represented in the following pages are screenshots of the Board application, they are not copied from any source.

4.1 Bios Management ltd.

Bios Management ltd. is a consulting firm, born in Santa Vittoria d'Alba (Cuneo, Italy) in 2004. Currently, the company counts about 170 professionals globally.

The mission is to free companies potential, by accelerating automation with Digital Solutions for finance and decision-making processes related to Corporate Performance Management such as Financial Planning & Consolidation, Cost Allocation, Fast Closing Budget, Forecasting, Profitability & Performance Modelling.

Customers are located worldwide and Bios has different branches around the world.

The headquarter is in Santa Vittoria d'Alba and currently the offices are based in Turin, Milan, Vicenza, Bologna, Roma, Paris, London, Madrid, Barcellona, Lugano, Singapore and New York.

Bios Management offers different services:

- **Management Consulting:** collaboration with customers to define business strategies aimed at creating value. More in detail: Strategic Plan and Business Plan, Digital Strategy Development and Digital Transformation, Project Management, Redesign of the organisational structure and control model and much more.
- **Analytics and Digital Solutions:** it is the core of the company and it consists of different divisions: Enterprise Performance Management (EPM), Data Analytics, Business Process Management (BPM), Sales Forces Automation, Human Capital Management and Data Governance & DWH.

The largest division is EPM and its role consists in creating digital solutions for the customers, by employing specific BI software.

The most used tool is Board, because it is the only product on the market that offers a unified architecture for Business Intelligence, Analytics and Performance Management.

The others BI software used within Bios are Microsoft Power BI, Qlik and Tableau.

Bios Management's customers operate in different industries, such as Food & Beverage, Fashion & Beauty, Utilities & Public Administration, Services, Healthcare, Banking & Collector, Manufacturing, Automotive and Tourism & Leisure.

For further information, the link to Bios Management website is available at reference [50].



Figure 4.1: Bios Management logo^[50]

4.2 Introduction to the Business Case

A&R is a (fictional) firm operating in Food & Beverage distribution.

The top management wants to replace the countless Excel spreadsheets with a unique platform in which all the actors of the firm can visualize and manipulate their division data.

The solution is implementing a Business Intelligence platform which is able to:

- produce dashboard to visualize the company's KPI;
- provide screens in which the CFO can evaluate the sales performance, the productivity of the Sales Reps and their profitability;
- make forecasts (financial and inventory);
- produce the Profit and Loss (P&L) report and the Cost of Good Sold (COGS) report;
- export data.

The software that matches the customer's requirements is Board.

4.3 Development in Board

The project starts with the creation of the Data model, which implies the setting of the Time range, the Entities, the Relationships, the Cubes, the Datareaders and the Procedures.

4.3.1 Data model

First of all, the Time range has to be set: according to the customer's needs, the Starting Year is fixed to 2018 and the Ending Year is 2026 (the latter can always be extended without any consequences). The time granularity chosen is Day (that is the maximum level of detail about time entities).

Automatically, Board creates the following natives Time Entities:

- Year, which contains the members 2018,2019,...,2026.
- Month, with the 12 months belonging to each year.
- Day, containing each day of each month of each year.
- Fiscal Year, which considers the year according to the customer's needs (for example, the year starts on April instead of January).

Moreover, one custom Time Entity has been created, called "Day of the week" (Monday,..., Sunday).

Finally, all these Time Entities has been related with each other's. The result of this first fundamental step has been reported in *Figure 4.2*.

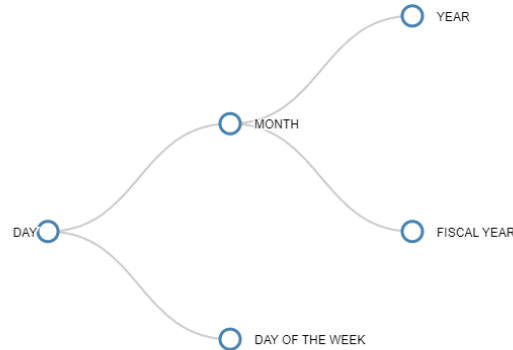


Figure 4.2: Time Entities. Day is the children entity (the max detail level)

Once the Time Range has been set and the Time Entities has been defined, the next step is to create the Entities.

Generally, when developing an application, the admin does not know all the Entities they have to create from the beginning, but they come out gradually while the project improves.

For the purpose of this thesis, all the Entities created during the various stages of the project in different time periods are shown in *Figure 4.3*.

Name	Code width	Desc width	Item number	Physical name	Group ↑	Saturation	Max item number
Q	Q	Q	Q	Q	Q	Q	Q
Area Manager	2	150	2	E_000211	Customers	4%	50
Customers	10	150	89	E_000208	Customers	17%	500
Continent	20	20	5	E_000206	Customers	100%	7
Country	20	20	21	E_000205	Customers	21%	100
City	20	20	69	E_000204	Customers	34%	200
Sales Reps	3	30	9	E_000203	Customers	18%	50
Historical Sales Re...	3	30	9	E_000216	Historical Sales Re...	18%	50
P&L	8	50	29	E_000218	IBP	58%	50
Number Order	6	6	1517	E_000215	Number Order	30%	5000
ProductPrice	4	4	42	E_000217	Products	42%	100
Convert	4	20	2	E_000214	Products	10%	20
Division	20	20	3	E_000213	Products	10%	30
Packaging	20	20	8	E_000212	Products	40%	20
Unit of Measure	4	20	10	E_000210	Products	20%	50
Suppliers	3	150	28	E_000209	Products	14%	200
Products	4	150	79	E_000202	Products	7%	1000
Categories	4	150	8	E_000201	Products	8%	100
ManageProcess	30	30	3	E_000219	Security	40%	10
Shipper	3	150	3	E_000207	Shipper	3%	100

Figure 4.3: Entities

To better understand the scope of an Entity, let's analyse the Entity Group "Customers".

As the reader can see in the figure above, there are several entities belonging to this group. To facilitate the visualization, the zoom of this set of data is represented in *Figure 4.4*.

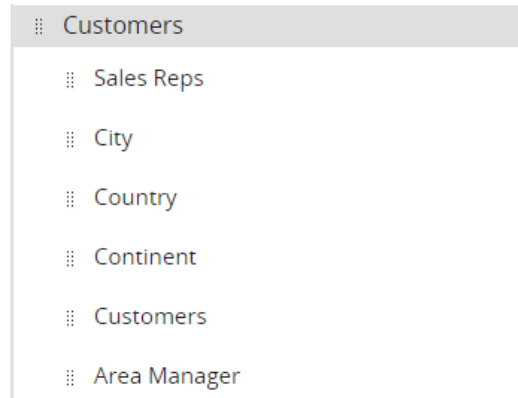


Figure 4.4: Customers Entity Group

The Customers group is composed by six Entities and it contains all the data regarding the customers of A&R Group. Let’s see these Entities individually.

- Customers: it contains the code and the description of all the company’s customers.
- City: it contains the cities in which the customer belongs to.
- Country: it groups all the cities by the country.
- Continent: it groups all the countries by the continent.
- Sales Reps: it contains the Sales Rep of A&R Group who assists the Customer.
- Area Manager: it contains the Area Manager who manages the Sales Rep.

By making this example, it is possible to see two clear relationships: one for [City – Country – Continent] and the other for [Sales Reps – Area Manager]. Obviously, all these Entities are related to the Customers.

Figure 4.5 shows the result of the construction of a relationship tree in Board, always referring only to the Customers Entity Group.

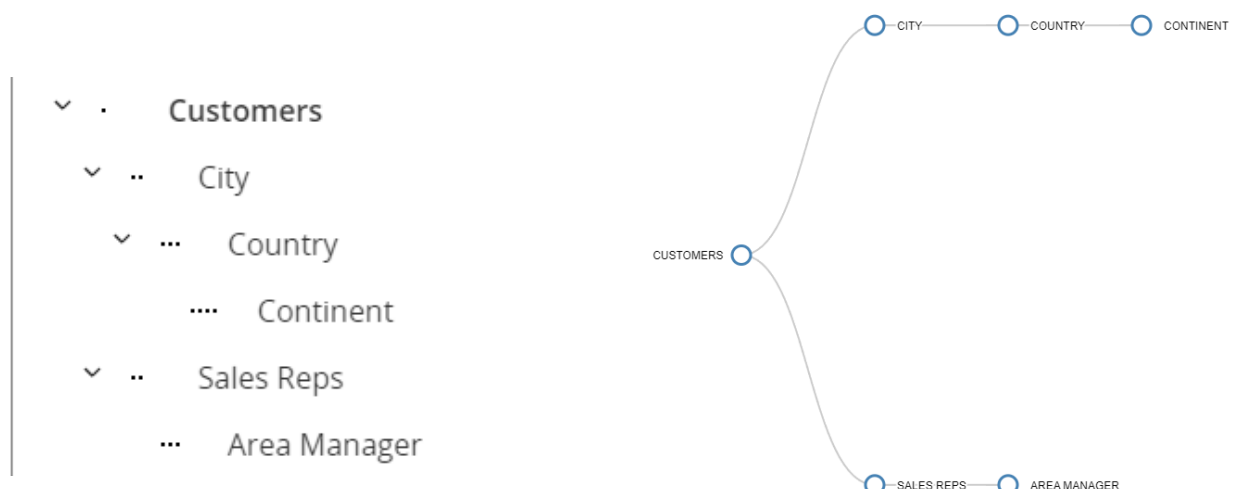


Figure 4.5: Customers Relationships

Clearly, the tree Customers cannot be populated manually by the developer, since it is a huge amount of data.

So, a Data Reader called Tree Customer has been created for this aim.

In this case all the information about the customer (name, city, sales rep, etc.) is contained in a database that A&R Group passed to Bios Management, so the Data Reader is an SQL type.

The structure of the Tree Customer Data Reader is represented in *Figure 4.6* and the result of this operation is visible in *Figure 4.7*.

#	Field Name	SQL Expression	Action
#	Sales Reps	Cast(dbo.Employees.EmployeeID as VARCHAR)	ADD NEW ITEM
≡	Sales Reps	concat(dbo.Employees.LastName, ' ', dbo.Employees.FirstName)	REPLACE
#	Country	dbo.Customers.Country	ADD NEW ITEM
≡	Country	dbo.Customers.Country	REPLACE
#	Customers	dbo.Customers.CustomerID	DISCARD NEW ITEM
≡	Customers	dbo.Customers.CompanyName	REPLACE
#	Area Manager	Cast(dbo.Employees.[Area Manager] as VARCHAR)	ADD NEW ITEM
≡	Area Manager	Cast(dbo.Employees.[Area Manager] as VARCHAR)	REPLACE
#	City	dbo.Customers.City	ADD NEW ITEM
≡	City	dbo.Customers.City	REPLACE

```

1 SELECT Cast(dbo.Employees.EmployeeID as VARCHAR), concat(dbo.Employees.LastName, ' ', dbo.Employees.FirstName), dbo.Customers.Country, dbo.Customers.Country, dbo.Customers.
2 FROM dbo.Employees, dbo.Customers
3 WHERE dbo.Customers.EmployeeID = dbo.Employees.EmployeeID
  
```

Figure 4.6: Structure of Tree Customer data reader

# Sales Reps	≡ Sales Reps	# Country	≡ Country	# Customers	≡ Customers	# Area Manager	≡ Area Manager	# City	≡ City
4	Peacock Margaret	Italy	Italy	FRAN1	Franchi S.p.A.	2	2	Firenze	Firenze
6	Suyama Michael	Italy	Italy	VINE1	Vins et alcools Chevalier	2	2	Siena	Siena
3	Leverling Janet	Finland	Finland	WART1	Wartian Herkku	5	5	Oulu	Oulu
3	Leverling Janet	Italy	Italy	WART2	Wartian Herkku	5	5	Pesaro	Pesaro
3	Leverling Janet	Denmark	Denmark	WART3	Wartian Herkku	5	5	Århus	Århus
1	Davolio Nancy	Germany	Germany	ALFKI	Alfreds Futterkiste	5	5	Berlin	Berlin
1	Davolio Nancy	Mexico	Mexico	ANATR	Ana Trujillo Emparedados y helados	5	5	México D.F.	México D.F.
1	Davolio Nancy	Mexico	Mexico	ANTON	Antonio Moreno Taquería	5	5	México D.F.	México D.F.
3	Leverling Janet	UK	UK	AROUT	Around the Horn	5	5	London	London
4	Peacock Margaret	Sweden	Sweden	BERGS	Berglunds snabbköp	2	2	Luleå	Luleå

Figure 4.7: population of Tree Customer

Remember that “# Name” means the Entity’s code, while “≡ Name” means the Entity’s description. Often the two are the same.

Recap: up to now, the time range has been set, the Entities have been created, correlated between them and populated by means of data reader. The next step is the creation of the Cubes. As before, not all the cubes will be analysed, but only the most significant ones in order to provide the reader a practical example of what a Cube is.

The general rule says that every time there is a number, that number is an element of a Cube. Therefore, if we need to see a number we need to create a Cube.

Let's show what this rule implies from a practical point of view.

The customer would like to have a report in which for every product it is shown the corresponding stock in inventory. The three necessary data (Product ID, Product Name, Flash Inventory) are all available in the customer database which is passed to Bios Management.

So, an SQL Data Reader called "Mov_Inventory" has been created with the aim to populate the Cube "Flash Inventory" with the products' stock dimensioned by Product.

In *Figure 4.8* the structure of the data reader is shown. The Cube is illustrated in *Figure 4.9*.

# Products	Cast(dbo.Products.ProductID as VARCHAR)	ADD NEW ITEM
☰ Products	dbo.Products.ProductName	READ
123 I001_Flash Inventory	dbo.Products.UnitsInStock	REPLACE TIME SLICE

```
SELECT Cast(dbo.Products.ProductID as VARCHAR), dbo.Products.ProductName, dbo.Products.UnitsInStock
FROM dbo.Products
```

Figure 4.8: Mov_Inventory Data Reader

Note: "123 Name" means that it is a Cube.

I001_Flash Inventory	
1 Chai	39
2 Chang	17
3 Aniseed Syrup	13
4 Chef Anton's Cajun Seas	53
6 Grandma's Boysenberry	120
7 Uncle Bob's Organic Dri	15
8 Northwoods Cranberry	6
9 Mishi Kobe Niku	29
10 Ikura	31
11 Queso Cabrales	22
12 Queso Manchego La P.	86
13 Konbu	24
14 Tofu	35
15 Genen Shouyu	39
16 Pavlova	29
18 Carnarvon Tigers	42
19 Teatime Chocolate Bisi	25
20 Sir Rodney's Marmalac	40

Figure 4.9: Flash Inventory Cube. For each Product ID there is a corresponding Product Name and the relative stock

Another interesting and common function is creating a Cube to collect and show the results of a mathematical operation performed by means of Data Readers.

In the A&R Group Business Case:

The request is to perform a Sales Analysis considering the following parameters for each product and each customer:

- Price
 - Quantity
 - Gross Sales = Price * Quantity
 - Discount %
 - Net Sales = (1 - Discount%) * Gross Sales
- } Price is an Entity
- } Cubes populated by Data Reader

The structure of the Data Reader is shown in *Figure 4.10*, while the Cubes are in *Figure 4.11*.

Month	Convert(CHAR(6), dbo.Orders.[Order Date], 112)	
# Products	Cast(dbo.OrderDetails.ProductID as VARCHAR)	ADD NEW ITEM
# Customers	dbo.Orders.CustomerID	ADD NEW ITEM
# Historical Sales Reps	Cast(dbo.Orders.EmployeeID as VARCHAR)	ADD NEW ITEM
↳ S001_Net Sales	(1-(dbo.OrderDetails.[Discount %]))*dbo.OrderDetails.UnitPrice*dbo.OrderDetails	REPLACE TIME SLICE
↳ S003_Gross Sales	dbo.OrderDetails.UnitPrice*dbo.OrderDetails.Quantity	REPLACE TIME SLICE
↳ S004_Discount	dbo.OrderDetails.[Discount %]*100	REPLACE TIME SLICE
↳ S002_Quantity	dbo.OrderDetails.Quantity	REPLACE TIME SLICE
# ProductPrice	Left(Cast(dbo.OrderDetails.UnitPrice as VARCHAR), 4)	DISCARD NEW ITEM

Figure 4.10: Computations in a Data Reader

	Quantity	Price	Gross Sales	Discount %	Net Sales
- Products : Chai					
Suprêmes délices	10	18	180,00		180,00
Chop-suey Chinese	15	18	270,00	15,00%	229,50
Wellington Importa	41	18	738,00	5,00%	701,10
HILARION-Abastos	20	18	360,00	15,00%	306,00
Rattlesnake Canyon	18	18	324,00		324,00
Blondesdsl père e	50	18	900,00		900,00
Wartian Herkku	26	18	468,00	40,00%	280,80
QUICK-Stop	105	18	1.890,00	20,00%	1.512,00
Tortuga Restaurant	20	18	360,00		360,00
Berglunds snabbk	70	18	1.260,00	50,00%	630,00
Lehmanns Marktst	120	18	2.160,00	55,00%	972,00
Hungry Owl All-Nig	30	18	540,00	50,00%	270,00
Die Wandernde Ku	15	18	270,00	15,00%	229,50
Godos Cocina Típic	10	18	180,00		180,00
Lonesome Pine Re:	20	18	360,00		360,00

Figure 4.11: the resulting Cubes

Obviously, the most efficient way to make computations on Board is not by mean of Data Reader as shown above, but by using the Procedures.

A&R Group wants to make a prevision about the Net Sales growth. There are the following Cubes:

- Net Sales (Current Year)
- Net Sales (Previous Year)
- Growth % (the percentage difference between the two values)

Since it is a forecast, there is an amount of uncertainty, so the Management would like to be able to modify the Growth % with a more accurate one and wants to calculate the new value of Net Sales which is called Net Sales Budget.

Clearly, if there are not adjustments on the Growth % the Net Sales remain unchanged.

Therefore, two more Cubes are created:

- Growth ADJ % (in which the user can digit values)
- Net Sales BDG (the final result)

This operation can be performed by using a Data flow Procedure. In *Table 7* the general scheme of this Procedure is reported.

General Name	Board Name	Procedure Element
Net Sales (Current Year)	DF_NetSales	a
Net Sales (Previous Year)	S001_Net Sales	b
Growth %	UNNECESSARY	
Growth ADJ %	DE_Percentage	c
Net Sales BDG	PROC_NetSales	d

Table 7: general structure of the procedure

Putting the Procedure elements of the table above in formulas:

$$\frac{a-b}{b} = \text{Growth \%}$$

$$\frac{d-b}{b} = \text{Growth ADJ \%} = c \rightarrow d = b * (1 + c)$$

The condition to be satisfied is:

$$\left[\begin{array}{l} \text{if } c = 0 \rightarrow d = a \\ \text{if } c \neq 0 \rightarrow d = b * (1 + c) \end{array} \right. \quad \begin{array}{l} \text{In Board the if operator has the same syntax as in} \\ \text{Excel} \end{array}$$

The Procedure in Board is shown in *Figure 4.12* and the final result in *Figure 4.13*.

Figure 4.12: Data Flow Procedure to calculate Net Sales BDG

	Net Sales €	Net Sales PY €	Growth %	Growth ADJ %	Net Sales BDG €
- Month : Jan.24					
Beverages	7.292	4.466	63,29	70,00	7.592
Condiments	17.054	23.280	-26,74	50,00	34.919
Produce	4.372	3.289	32,96	-50,00	1.644
Meat/Poultry	6.220	8.365	-25,64	30,00	10.875
Seafood	9.010	1.694	431,98	5,00	1.778
Dairy Products	17.621	9.851	78,87		17.621
Confections	11.265	10.216	10,26	-10,00	9.195
Grains/Cereals	10.816	3.586	201,65		10.816

Figure 4.13: final result

There are a lot of different types of Procedures and each one has different functions, they do not just make computations. Following the previous case, suppose that the customer wants to have the data view in *Figure 4.13* as a PDF file (but also as Excel). This can be performed by using an Export Procedure, as shown in *Figure 4.14*.

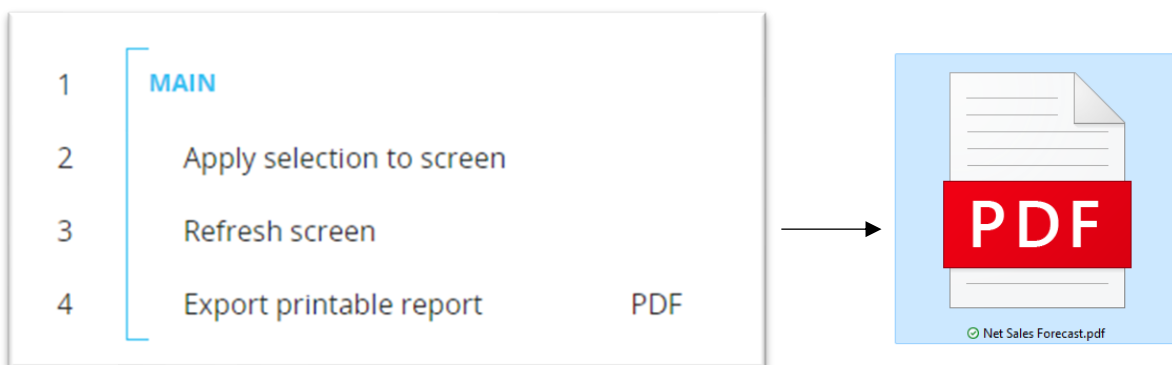


Figure 4.14: Export Procedure and generation of a PDF

4.3.2 Capsules

Referring to Chapter 3.5, all the main elements of a Data Model have been discussed from a practical approach in the current chapter. Now, the A&R Group application has to be implemented in terms of dataviews, charts and dashboards; in other words, the front-end part the final user interacts with.

In the introduction to the Business Case (Chapter 4.2), the customer requirements has been listed:

- to produce dashboard to visualize the company’s KPI;
- to provide screens in which the CFO can evaluate the sales performance, the productivity of the Sales Reps and their profitability;
- to make forecasts (financial and inventory);
- to produce the Profit and Loss (P&L) report and the Cost of Goods Sold (COGS) report with the possibility of exporting data.

All the data and information necessary to satisfy these requests have already been uploaded and manipulated in the Data Model. The next step is to make these data visible to the final users and useful to their analysis.

The first thing to do is creating the Screens in which all the data are contained. For the A&R Group the following Screens (*Table 8*) have been implemented, belonging to the same unique Capsule:

Capsule	Folder	Screens
A&R Group Capsule	Home page	Home page
	Sales	Sales Performance
		Sales Productivity
		Profitability Analysis
	Planning	Sales Budget
		Sales Reps Commissions
		COGS
	Logistic	Forecast Inventory
		KPIs
	Sales Previsions	Sales Previsions
	IBP	Matrix Allocation
		P&L
	Marketing	Marketing
Security	Security	

Table 8: A&R Group Screens

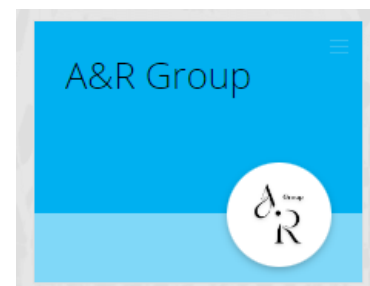


Figure 4.15: A&R Group Capsule icon with the company logo

→ Not visible except for the Administrator

To navigate from one Screen to another, there is a Menu object and each folder is achievable from the Home page.

Let's see the most important Screens.

4.3.2.1 Homepage

The application automatically starts with the Home page (*Figure 4.16*). In this screen the A&R Group logo is reported in the top left corner, while the links to the main sections are on the top right one. The background chosen represents the area in which the company has been established.

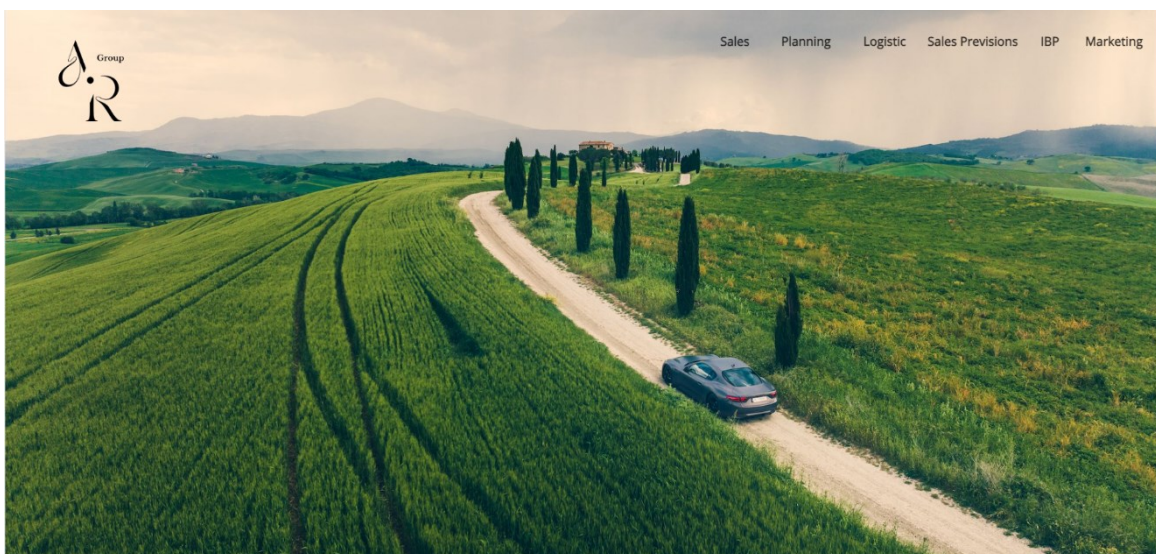


Figure 4.16: Home page

The Mask which lays on the background of each Screen is composed by:

- the Selections area: on the left there is a light blue coloured rectangle which contains all the objects which allow the user to make the selections (Selectors and Pagers). Immediately below, there is a label which reports the active selections.
- The company logo: on the top left corner of the Screen, the A&R group logo is always visible and, by clicking on it, the user will come back to the Home page.
- The Menu object: on the top centre of the Screen there is the Menu which allows the user to navigate within the application.
- The Bios Management logo on the top right corner.

The Background colour chosen for all the Screens is a light grey which highlights the various dataview and charts that are white instead.

4.3.2.2 Sales Performance

By clicking on the “Sales” label in the home page, the following Screen appears (Figure 4.17)

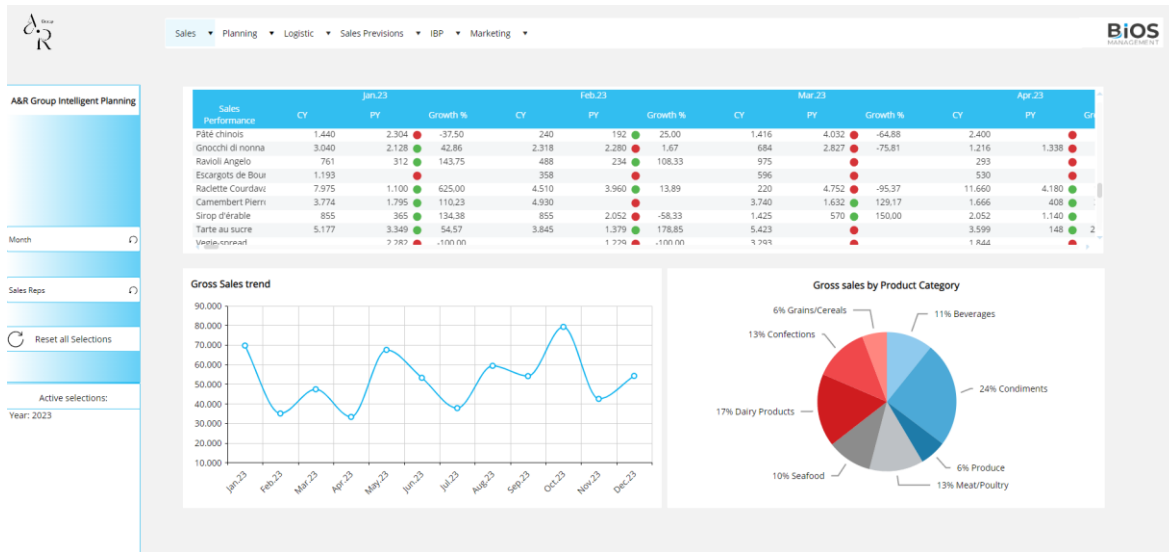


Figure 4.17: Sales Performance Screen

The Sales Performance Screen is composed of:

- A dataview in which the product sold by A&R Group are compared in terms of Gross Sales both in 2023 (current year – CY column) and 2022 (previous year – PY column). Then, the Growth % is calculated and there is an alert that highlights if the product has performed well respect to the previous year (Growth % > 0 → green flag) or the opposite (Growth % < 0 → red flag).
- A cartesian chart in which the overall gross sales of the company are reported with respect to the year 2023, highlighting the most redditive months (in this case October 23 with a revenue of almost 80.000 €).
- A pie chart in which the overall gross sales are split among the product categories to see which is the most redditive one (in this case it is the Condiments Category).

Behind all these objects there is the Cube “Gross Sales”, which has been populated by means of the data reader reported in Figure 4.10 and Figure 4.11 at page 70.

In Figure 4.18 the structure of the dataview is shown:

a	S003_Gross Sales	CY	Infocube
b	S003_Gross Sales	PY	Infocube Previous year
c	$((a-b)/b)*100$	Growth %	Algorithm [Num... Alert

Figure 4.18: Gross sales dataview structure

4.3.2.3 Sales Productivity

Carrying out the analysis from the Sales Reps perspective, the Screen “Sales Productivity” (Figure 4.19) reports the performance of the commercial employees.

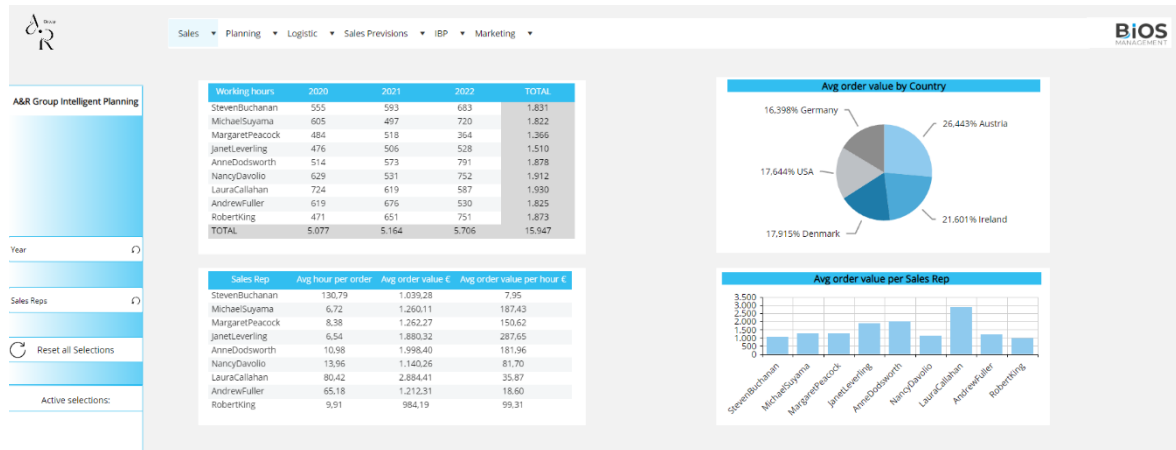


Figure 4.19: Sales Productivity Screen

The first dataview reports the hour worked by each Sales Rep during the year 2020, 2021 and 2022. From this analysis we can see that the Laura Callahan has worked the most in 2020, Andrew Fuller in 2021 and Anne Dodsworth in 2022.

This dataview is constructed on the Cube “Timesheet”, which contains the monthly hours worked by each Sales Rep. It is populated by means of a text data reader - shown in Figure 4.20 – in which for every month a specific Sales Rep identified by Sales Rep ID has associated the corresponding hours of work.

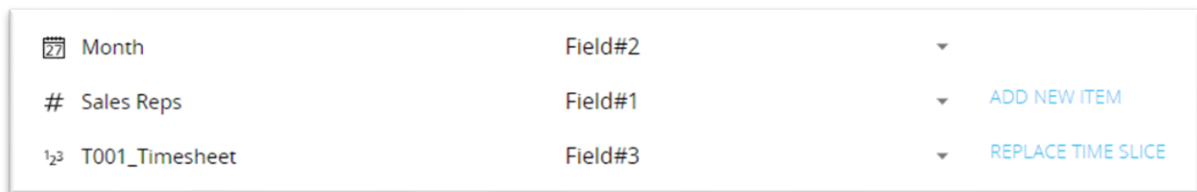


Figure 4.20: Timesheet data reader

The other dataview reports the average hour spent per order (Michael Suyama is the fastest at closing an order), the average order value (Laura Callahan closed the richest deals) and the average order value per hour (Janet Levering has closed the richest deal in the minor time).

All these values came from algorithms:

- Avg hour spent per order = Cube Timesheet / Cube Number Orders
- Avg order value = Cube Net Sale / Cube Number Orders

- Avg order value per hour = Cube Net Sale / Cube Timesheet

In *Figure 4.21* the implementation in Board is reported.

a	T001_Timesheet		Infocube	Hidden
b	S005_Number Orders		Infocube	Hidden Filter
c	a/b	Avg hour per order	Algorithm [Num...	
d	S001_Net Sales		Infocube	Hidden
e	d/b	Avg order value	Algorithm [Num...	
f	d/a	Avg order value per hour	Algorithm [Num...	

Figure 4.21: Algorithms for Sales Reps Performance indicators

Finally, thanks to the two charts on the left of the Sales Productivity Screen, it is possible to know which is the Country where A&R Group gets the more revenues (in this case it is the Austria) and it is possible to have a visual representation of the Avg order value indicator.

4.3.2.4 Sales Reps Commissions

Let's move on to the Planning folder and let's focus on the Sales Reps Commissions Screen.

The aim of this Screen is to calculate the Sales Reps Commission according to the amount of Net Sales BDG realised (The Net Sales minus a percentage of discount decided by the Sales Rep to close the deal) compared to the Net Sales.

The management choses three values of commissions: low, medium and high; then, the following rule is applied:

- If Net Sales BDG <= 75% of Net Sales → the low commission is applied
- If 75% < Net Sales BDG <= 95% of Net Sales → the medium commission is applied
- If Net Sales BDG >= 95% of Net Sales → the high commission is applied

The three thresholds are inputted by the user in a dedicated dataview.

The final commission is calculated as the low/medium/high commission * Net Sales.

Example:

Consider just one Sales Rep, for example Michael Suyama. The management of A&R Group decided that the low target is 6%, the medium is 7% and the high is 8%.

The Net Sales target is the one of the Previous Year and the Net Sales BDG is calculated as (Price * Quantity) - Discount.

Price, Quantity and Discount are inputted by the user as well as the three thresholds.

Make reference to *Figure 4.22*.

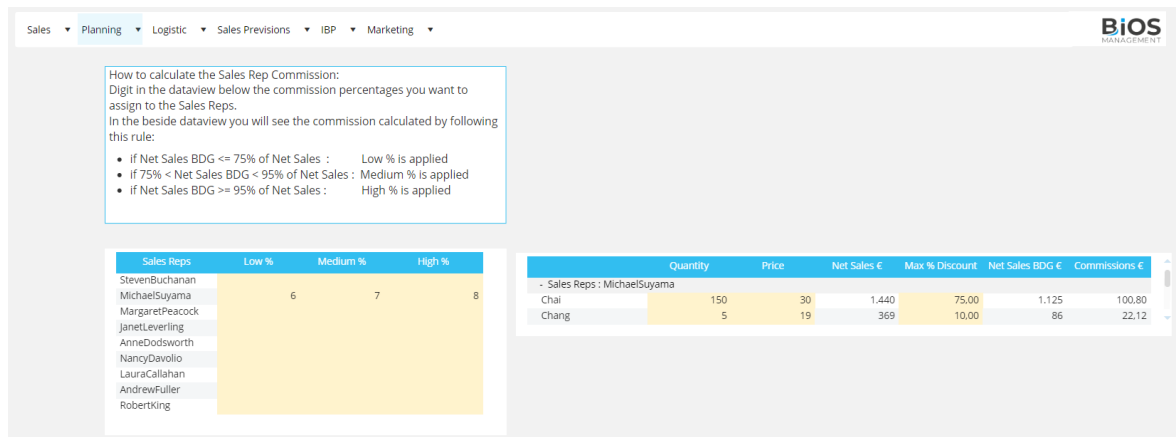


Figure 4.22: Sales Rep Commissions Screen

In the left dataview there are the three level of commissions assigned to the Sales Rep Michael Suyama: low = 6% , medium = 7%, high = 8%. Remember that where the background of a cell is pink (as in this case), it means that the final user can make data entry (that is inputting a value).

In the right side, the user has to digit the values of quantity, price and max % discount and the algorithms provide the results.

- For the Product “Chai”:

Input: *price = 30, quantity = 150, max % discount = 75%, Net Sales = 1440*

*Price * quantity = 4500*

4500(1-75%) = 1125 = Net Sales BDG*

1125/1440 = 78% → medium threshold =7% applied

Output: *7% * 1440 = 100,8 = final commission*

- For the product “Chang”:

Input: *price = 19, quantity = 5, max % discount = 10%, Net Sales = 369*

Price quantity = 95*

95(1-10%) = 86 = Net Sales BDG*

$86/369 = 23\% \rightarrow$ low threshold =6% applied

Output: $6\% * 369 = 22,12 =$ final commission

The implementation in Board is shown in *Figure 4.23*.

a	DE_Quantity	Quantity	Infocube	Data entry
b	DE_Price	Price	Infocube	Data entry
c	S001_Net Sales	Net Sales €	Infocube	Previous year Previous Year Value Filter
d	DE_discount	Max % Discount	Infocube	Data entry
e	$(a*b)*(1-(d/100))$	Net Sales BDG €	Algorithm [Num...	Sort
f	e/c		Algorithm [Num...	Hidden
g	TA_TargetLow		Infocube	Hidden
h	TA_TargetMedium		Infocube	Hidden
i	TA_TargetHigh		Infocube	Hidden
j	$\text{if}(\text{and}(f < (0.75), f > (0.00001)), (g/100) * c, \text{if}(f > (0.95), (i/100) * c, \text{if}(f = (0.0), 0, h/100 * c)))$		Algorithm [Num...	

Figure 4.23: Algorithms for Sales Rep Commissions

The block j is the one that controls the appointment of the thresholds. Below the full transcription of the if condition:

$\text{if}(\text{and}(f < (0.75), f > (0.00001)), (g/100) * c, \text{if}(f > (0.95), (i/100) * c, \text{if}(f = (0.0), 0, h/100 * c)))$

If Net Sales BDG <= 75% of Net Sales → the low commission is applied
If Net Sales BDG >= 95% of Net Sales → the high commission is applied
If 75% < Net Sales BDG <= 95% of Net Sales → the medium commission is applied

4.3.2.5 Forecast Inventory

Let's move on to the Logistic Folder.

The Forecast Inventory Screen has the goal to predict if, for a certain product at a certain month, there will be a shortage.

To do so, the A&R Group management adopted the following strategy.

For each product, the yearly moving average is calculated on 3, 12 and 18 months.

(In statistics, a moving average is a calculation to analyze data points by creating a series of averages of different selections of the full data set).

Then these three values are compared to the past month value and the minimum difference (in absolute terms) obtained is the Forecast Quantity.

If the Forecast Quantity is less than the Inventory, there will be a shortage of that product, else there will be a surplus of it.

In Board, this can be performed by activating the Yearly Moving Average function on the Cube Quantity, then an algorithm calculates the absolute differences and takes the minimum. Finally, another algorithm controls if there will be a shortage or not and, if so, it activates a visual alert.

The implementation in Board is shown in *Figure 4.24*.

a	S002_Quantity	YMA 12	Infocube	Yearly Moving Average
b	S002_Quantity	YMA 18	Infocube	Cycle 18 Yearly Moving Average
c	S002_Quantity	YMA 3	Infocube	Cycle 3 Yearly Moving Average
d	S002_Quantity	PM	Infocube	Previous Period Value
e	abs(a-d)		Algorithm [Num...	Hidden
f	abs(b-d)		Algorithm [Num...	Hidden
g	abs(c-d)		Algorithm [Num...	Hidden
h	min(e,f,g)	Forecast Quantity	Algorithm [Num...	
i	I001_Flash Inventory	Inventory	Infocube	
j	i-h	Delta Forecast	Algorithm [Num...	Alert

Figure 4.24: Algorithms for Forecast Quantity

The Forecast Inventory Screen (*Figure 4.25*) presents a dataview which is based on the above algorithms and a chart which represents the most critical products.

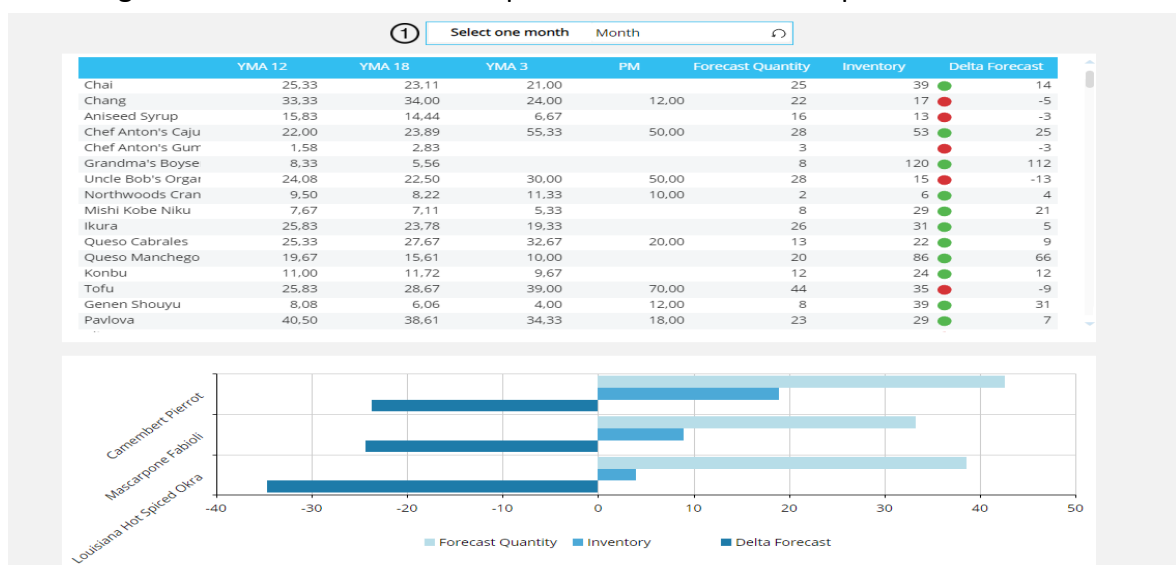


Figure 4.25: Forecast inventory screen

4.3.2.6 Sales Previsions

The next Screen is the Sales Previsions. Here the scope is exploiting a forecast on Net Sales.

Forecasting is a technique that uses historical data as inputs to make informed estimates that are predictive in determining the direction of future trends.

Businesses utilize forecasting to determine how to allocate their budgets or plan for anticipated expenses for an upcoming period of time.

In this case, the historical data are the values of Net Sales of previous years which are employed to forecast the future level of Net Sales.

Before starting, let's define the concepts of Closed and Open Months.

The Closed months are the ones that are already passed, so the data are actuals; the open months are the ones that have yet to come, so the data are previsionsal.

If we imagine that we are on July 1 2024, then the months from January to June 2024 are Closed, while the months from July to December are Open.

So, in the Closed months we consider the Net Sales realised in such periods, while in the Open months we consider the Net Sales realised in the same months but of the previous year. Look at *Table 9*:

January 2024	Closed	Net Sales January 2024
February 2024	Closed	Net Sales February 2024
March 2024	Closed	Net Sales March 2024
April 2024	Closed	Net Sales April 2024
May 2024	Closed	Net Sales May 2024
June 2024	Closed	Net Sales June 2024
July 2024	Open	Net Sales July 2023
August 2024	Open	Net Sales August 2023
September 2024	Open	Net Sales September 2023
October 2024	Open	Net Sales October 2023
November 2024	Open	Net Sales November 2023
December 2024	Open	Net Sales December 2023

Table 9: Net Sales in open/closed months

To implement this scenario in Board, it is necessary a Selection Based on Cube (SBO).

The SBO consists in creating a Cube in which the user select which member of an entity wants to use and which not. In this case, we need two Cubes, one for the Closed months

and one for the Open months, with the “column appearance” setting flagged on “checkbox” for both of them. The result is shown in *Figure 4.26*.

1) Select which months are closed and which ones are open

	Closed months	Open months
Jan.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Feb.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Mar.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Apr.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
May.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Jun.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Jul.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Aug.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Sep.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Oct.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Nov.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Dec.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Go

Figure 4.26: Cubes of SBO

The button “Go” triggers the Procedure that assigns to the Closed months the corresponding Net Sales, while to the Open ones it assigns the Net Sales of the previous year.

The Procedure works thanks to two SBO action and two data flow: the SBOs put the selected month in the cube “SBO_Months” or “SBO_MonthsNotAvailable” and the dataflow copy the Current/Past Net Sales (cube “S001_Net Sales”) in the cube “DF_NetSales”.

The implementation in Board is shown in *Figure 4.27*.

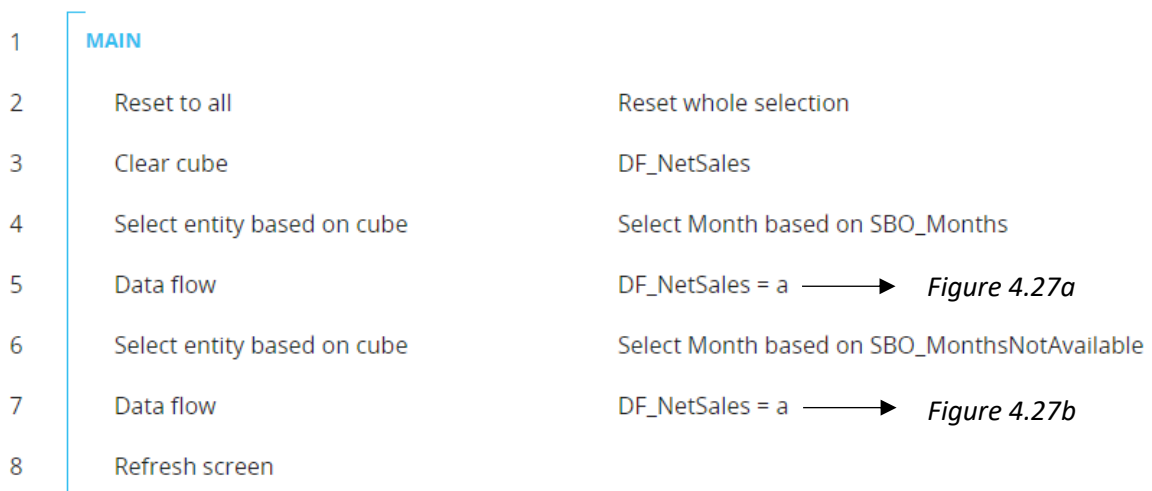


Figure 4.27: SBO Procedure

The detail of the data flow in case of Closed months is reported in *Figure 4.27a*, while the dataflow for the Open months is reported in *Figure 4.27b*.

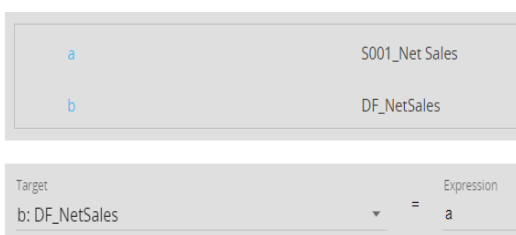


Figure 4.27a: Data flow Closed months

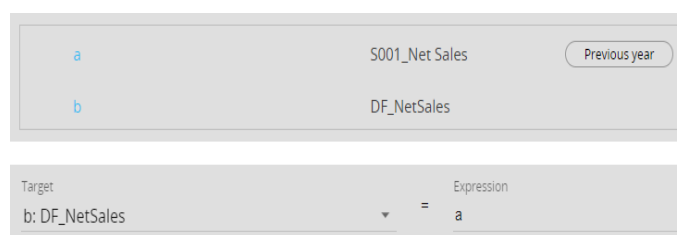


Figure 4.27b: Data flow Open months

Once the Net Sales have been calculated for each month (Closed and Open), the forecast goes on as explained at page 71-72, where this Screen has been taken to see how a Procedure works in practice. The whole Sales Previsions Screen is reported in *Figure 4.28*.

The screenshot shows two panels for configuring sales previsions.

Panel 1: Select which months are closed and which ones are open

Month	Closed months	Open months
Jan.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Feb.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Mar.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Apr.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
May.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Jun.24	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Jul.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Aug.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Sep.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Oct.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Nov.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Dec.24	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Panel 2: Insert your Growth% (if any) to calculate the sales previsions

	Net Sales €	Net Sales PY €	Growth %	Growth ADJ %	Net Sales BDG €
- Month : Jan.24					
Beverages	7.292	4.466	63,29	70,00	7.592
Condiments	17.054	23.280	-26,74	50,00	34.919
Produce	4.372	3.289	32,96	-50,00	1.644
Meat/Poultry	6.220	8.365	-25,64	30,00	10.875
Seafood	9.010	1.694	431,98	5,00	1.778
Dairy Products	17.621	9.851	78,87		17.621
Confections	11.265	10.216	10,26	-10,00	9.195
Grains/Cereals	10.816	3.586	201,65		10.816
- Month : Feb.24					
Beverages	10.973	2.019	443,43		10.973
Condiments	38.432	4.954	675,76		38.432
Produce	552	1.588	-65,24		552

Figure 4.28: Sales Previsions Screen

4.3.2.7 Integrated Business Planning

The next section is IBP which stands for Integrated Business Planning.

IBP is a process that translates intended business results into the amount of money and other resources needed for operations and finance, with the main goal being to reduce risk and maximize profit and/or cash flow. The following kinds of goals can be used to convey the business results that IBP procedures are centred around: Service levels, Inventory levels, Revenue and demand, Cash flow and Profits and Losses.

For the A&R Group a Profit and Loss (P&L) statement has been prepared, with the auxilium of a matrix allocation.

The function of the matrix is to allocate the percentages of some fixed costs to every product or service sold by A&R Group. These values are provided by the company itself, but they can be changed by the final user whenever he/she wants.

Six types of costs have been taken into account: Depreciation, Direct Staff and Cooperatives, Industrial & Consumption Costs, Marketing Expenses, Total Logistic Costs and Total Technical Staff Costs.

The allocation matrix has by row the goods/services sold by A&R Group and by column these six costs. The numbers in the cells are all percentages.

The first step is to create six Cubes - one for each category of cost – and populate them by text data readers, since the data are passed to Bios Management through Excel spreadsheets.

Example: considering Depreciation, the Cube “P&L_CubeDepreciation” has been created with just the Entity Product as structure and the following text data reader has been set (Figure 4.29):

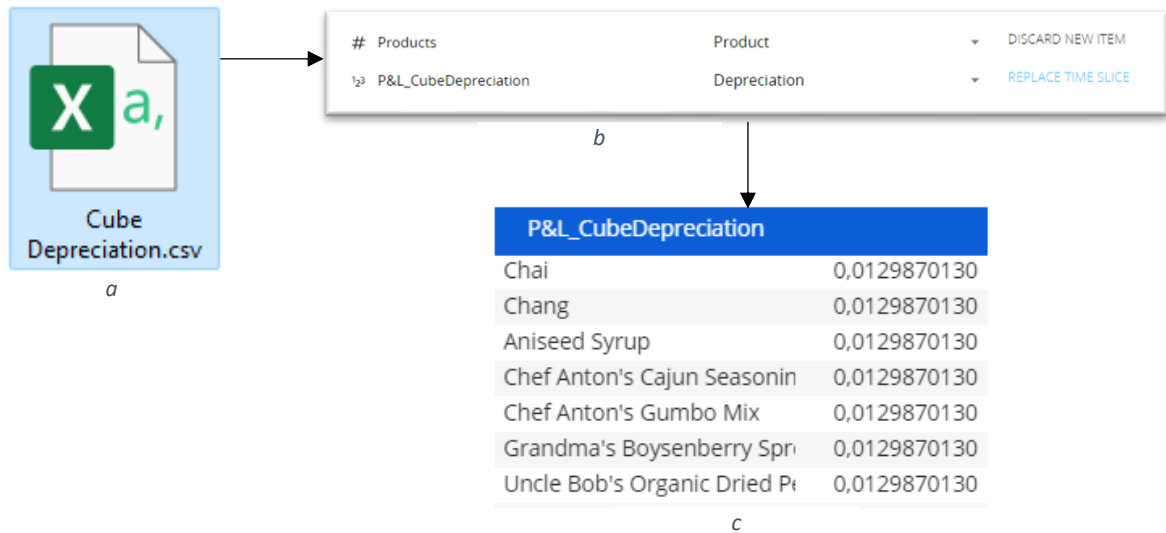


Figure 4.29: a: the file Excel containing all the Depreciation percentages; b: the text data reader; c: the Depreciation Cube populated in Board

The allocation matrix screen (Figure 4.30) is composed of a dataview (the matrix) -in which the user can make data entry changing the percentages to each product - and a brief explanation of what these six costs are.

	Depreciation	Direct Staff & Cooperatives	Industrial & Consumption costs	Marketing expenses	Total Logistic costs	Total Technical Staff costs
Chai	0.012987	0.010402	0.012990	0.022196	0.016658	0.012987
Chang	0.012987	0.011893	0.012990	0.013969	0.019264	0.012987
Aniseed Syrup	0.012987	0.002314	0.012990	0.009848	0.006234	0.012987
Chef Anton's Cajun Seasoning	0.012987	0.007182	0.012990	0.005126	0.009424	0.012987
Chef Anton's Gumbo Mix	0.012987	0.004090	0.012990	0.027215	0.005588	0.012987
Grandma's Boysenberry Spread	0.012987	0.005662	0.012990	0.026745	0.005838	0.012987
Uncle Bob's Organic Dried Pears	0.012987	0.014738	0.012990	0.024939	0.012760	0.012987
Northwoods Cranberry Sauce	0.012987	0.010672	0.012990	0.013529	0.007714	0.012987
Mishi Kobe Niku	0.012987	0.006073	0.012990	0.001027	0.001981	0.012987
Ikura	0.012987	0.016666	0.012990	0.022308	0.014636	0.012987
Queso Cabrales	0.012987	0.010489	0.012990	0.018239	0.014302	0.012987
Queso Manchego La Pastora	0.012987	0.009499	0.012990	0.007394	0.006630	0.012987
Konbu	0.012987	0.003778	0.012990	0.076925	0.016909	0.012987
Tofu	0.012987	0.006125	0.012990	0.000974	0.007672	0.012987
Genen Shouyu	0.012987	0.001500	0.012990	0.002544	0.002544	0.012987
Pavlova	0.012987	0.014244	0.012990	0.015774	0.023810	0.012987
Alice Mutton	0.012987	0.024912	0.012990	0.006812	0.018472	0.012987
Carnarvon Tigers	0.012987	0.022729	0.012990	0.010051	0.010404	0.012987
Teatime Chocolate Biscuits	0.012987	0.004598	0.012990	0.016844	0.014136	0.012987
Sir Rodney's Marmalade	0.012987	0.017875	0.012990	0.013093	0.006192	0.012987
Sir Rodney's Scones	0.012987	0.007482	0.012990	0.013836	0.020766	0.012987
Gustaf's Knäckebröd	0.012987	0.005473	0.012990	0.013080	0.006651	0.012987
Tunnbröd	0.012987	0.003761	0.012990	0.012831	0.011738	0.012987
Guaraná Fantástica	0.012987	0.003543	0.012990	0.025396	0.022017	0.012987
NuNuCa Nuß-Nougat-Creme	0.012987	0.002831	0.012990	0.014005	0.006067	0.012987
Gumbär Gummibärchen	0.012987	0.014344	0.012990	0.009036	0.013844	0.012987
Schoggi Schokolade	0.012987	0.011213	0.012990	0.006660	0.006776	0.012987
Rössle Sauerkraut	0.012987	0.020216	0.012990	0.010401	0.012509	0.012987
Thüringer Rostbratwurst	0.012987	0.067538	0.012990	0.019205	0.015553	0.012987

Calculation logics applied during the calculation of the percentages of the allocation matrix:

- **DEPRECIATION** - manually inputted by the user as a stationary percentage (%)
- **DIRECT STAFF AND COOPERATIVES** - calculated by performing the ratio of sales arising from specific product against total sales
- **INDUSTRIAL & CONSUMPTION COSTS** - manually inputted by the user as a stationary percentage (%)
- **MARKETING EXPENSES** - calculated by performing the ratio of 2021 and 2020 product sales growth (%)
- **TOTAL LOGISTIC COSTS** - calculated by performing the ratio of quantity of specific product sold against total quantity sold
- **TOTAL TECHNICAL STAFF COSTS** - manually inputted by the user as a stationary percentage (%)

N.B The Total row must be always equal to 1 for each column

Figure 4.30: Allocation matrix Screen

All these values contained in the allocation matrix are annual, while the P&L is monthly. So, the six cost cubes just created have to be divided by 12 before being uploaded into the P&L report. This operation is performed by a Procedure.

Up to now, there is not a P&L report, nor a P&L cube or a generic P&L structure. To do so, the algorithm is the following:

1. To create a P&L Entity and populate it by data reader with all the elements that constitute a P&L report (Net Sales, Discount, Taxes, etc.);
2. To create the Cube P&L having as structure the Entities Month, P&L and Product and put it into a dataview to make it visible;
3. To create procedures to populate the voices of the P&L;
4. To create a Rule to complete the voices of the P&L (the definition of a Rule and how it works will be provided in the next pages).

For what concerns the P&L Entity (*Figure 4.31b*), the voice of the financial statement are listed into a database provided by A&R Group, so the following SQL Data Reader (*Figure 4.31a*) has been created to populate the Entity:

# P&L	dbo.AnagReclassified.RiclShortCode	ADD NEW ITEM
≡ P&L	dbo.AnagReclassified.RiclShortDesc	REPLACE

Figure 4.31a: P&L Entity data reader

And this is the result:

Code	Description		
000300	NET SALES	005800	Property Rental Cost
000450	Discounts	008000	Tot. administrative and general costs
000900	NET SALES 1	008100	Fixed costs
001000	Promotions	008700	Marketing Expenses
001300	NET SALES 2	008800	RIS. OPERATIVO ANTE AMM (EBITDA)
001700	-Raw materials, packaging, finished goods	008900	Depreciation
002000	- Industrial and consumption costs	009000	RIS. OPERATIVO (EBIT)
002300	-Direct staff + cooperatives	009900	Extra-feature management
003100	- Total staff cost direct - indirect	010000	RIS.Before Taxes
003200	Cost of sales	010100	Taxes
003300	GROSS MARGIN	010500	Net Income
004200	Distribution costs		
004300	MARG. CONTRIBUZIONE		
005000	Total technical staff cost		
005400	Total business costs		
005700	Total Logistics Cost		

Figure 4.31b: P&L Entity content

The Cube P&L (*Figure 4.32*) has three axis: Month, Products and P&L and, in order to be clearer, a Template has been applied on it so that the partial results of the P&L assessment are highlighted in light blue:

	P&L (€)
000300 NET SALES	
000450 Discounts	
000900 NET SALES 1	
001000 Promotions	
001300 NET SALES 2	
001700 -Raw materials, packaging, finished goods	
002000 - Industrial and consumption costs	
002300 -Direct staff + cooperatives	
003100 - Total staff cost direct - indirect	
003200 Cost of sales	
003300 GROSS MARGIN	
004200 Distribution costs	
004300 MARG. CONTRIBUZIONE	
005000 Total technical staff cost	
005400 Total business costs	
005700 Total Logistics Cost	
005800 Property Rental Cost	
008000 Tot. administrative and general costs	
008100 Fixed costs	
008700 Marketing Expenses	
008800 RIS. OPERATIVO ANTE AMM (EBITDA)	
008900 Depreciation	
009000 RIS. OPERATIVO (EBIT)	
009900 Extra-feature management	
010000 RIS. Before Taxes	
010100 Taxes	
010500 Net Income	

Figure 4.32: P&L Cube

Clearly the Cube is empty since no Data reader or Procedure has been created yet.

Given that A&R Group did not provide Bios Management a file containing the P&L's values, the Procedure shown in *Figure 4.33* has been developed. Its scope is to make computations starting from the Cubes already created during the project and to write the results into the P&L Cube.

Moreover, another Procedure has to be created in order to import into the P&L the costs contained in the allocation matrix (*Figure 4.37*).

	MAIN	
1		
2	Clear cube	DF_P&L (€)
3	Selection	P&L: 000300 NET SALES
4	Data flow	DF_P&L (€) = a*b
5	Selection	P&L: 000450 Discounts (Reset previ...
6	Data flow	DF_P&L (€) = -(a*b*(c/100))
7	Selection	P&L: 001000 Promotions (Reset pre...
8	Data flow	DF_P&L (€) = -o
9	Selection	P&L: 001700 -Raw materials, packa...
10	Data flow	DF_P&L (€) = -(a/12)

Figure 4.33: P&L calculation Procedure

Looking at the image above, we can see that the data flow at step 4, 6, 8, 10 performs the calculations and provide the filling of the P&L report. Let's see, for example, how step 4 and 6 works.

- At step 3 there is a selection on the first voice of the P&L "000300 NET SALES", so this is the voice which is going to be populated. The data flow at step 4 calculates the "000300 NET SALES" as the multiplication of quantity and price as shown in *Figure 4.33a*.

a	DE_Quantity
b	DE_Price
c	DF_P&L (€)

Target	Expression
c: DF_P&L (€)	= a*b

Figure 4.33a: dataflow to calculate Net Sales

- At step 5 there is a selection on the second voice of the P&L "000450 Discounts", so this is the voice which is going to be populated. The data flow at step 6 calculates the "000450 Discount" by applying the percentage of discount to the "000300 NET SALES" computed in the previous step (*Figure 4.33b*).

a	DE_Quantity
b	DE_Price
c	DE_discount
d	DF_P&L (€)

Target	Expression
d: DF_P&L (€)	= -(a*b*(c/100))

Figure 4.33b: dataflow to calculate discount

To calculate the third voice of the P&L “000900 NET SALES 1”, which is given by the algebraic sum of “000300 NET SALES” and “000450 Discounts”, a Rule is applied.

Rules are sets of formulas defined on members of the same Entity. Using a Rule, you can define the value of a Cube cell for a specific Entity member as the result of a formula involving other members of the same Entity, regardless of any Selection that may be active on that Entity. ^[46.15]

Every Cube that has that Entity as a dimension in its Structure can utilize (or apply) a Rule, which is always linked to a single Entity.

Let’s calculate “000900 NET SALES 1” by using a Rule:

Rules can be created in the data model at the voice “Rules”. First of all, a name is required (in this case the Rule has been called “P&L”); then it is necessary to specify the Entity to which the Rule is applied (in this case it is the P&L Entity). Finally, in the formula field, you have to write the formula that makes computations among the various Entity Members.

In *Figure 4.34* the calculation of “000900 NET SALES 1” by using the Rule is shown and the final result in *Figure 4.35*.

000300	NET SALES	
000450	Discounts	
000900	NET SALES 1	[000300]+[000450]

Figure 4.34: Rule to calculate Net Sales 1

	P&L (€)
000300 NET SALES	9.619
000450 Discounts	-5.897
000900 NET SALES 1	3.723

Figure 4.35: Results on P&L Cube

By adding formulas to the Rule, the P&L Cube is getting populated progressively; in *Figure 4.36* the whole Rule is reported.

Code	Description	Formula
000300	NET SALES	
000450	Discounts	
000900	NET SALES 1	[000300]+[000450]
001000	Promotions	
001300	NET SALES 2	[000900]+[001000]
001700	-Raw materials, packaging, finished goods	
002000	- Industrial and consumption costs	
002300	-Direct staff + cooperatives	
003100	- Total staff cost direct - indirect	[002300]
003200	Cost of sales	[001700]+[002000]
003300	GROSS MARGIN	[001300]+[003200]
004200	Distribution costs	
004300	MARG. CONTRIBUZIONE	[003300]+[004200]
005000	Total technical staff cost	
005400	Total business costs	
005700	Total Logistics Cost	
005800	Property Rental Cost	
008000	Tot. administrative and general costs	
008100	Fixed costs	
008700	Marketing Expenses	
008800	RIS. OPERATIVO ANTE AMM (EBITDA)	[004300]+[005000]+[005400]+[005700]+[005800]+[008000]+[008100]+[008700]
008900	Depreciation	
009000	RIS. OPERATIVO (EBIT)	[008800]+[008900]
009900	Extra-feature management	
010000	RIS.Before Taxes	[009000]+[009900]
010100	Taxes	0.3*[010000]
010500	Net Income	[010000]+[010100]

Figure 4.36: P&L Rule

The last thing to do to complete the assessment is creating the Procedure to import the costs contained in the allocation matrix.

As said before, these costs needs to be divided by 12 since they have to be transformed from annually to monthly.

The procedure is built as follows. There is a Selection which picks the cost voices of the P&L (“002000 – Industrial and consumption costs”, “002300 – Direct staff + cooperatives”, etc) and, to each selection, a dataflow take the Cube containing the value of the costs of the matrix allocation and it divides such value by 12. See *Figure 4.37* and *4.37a* to better understand the process.

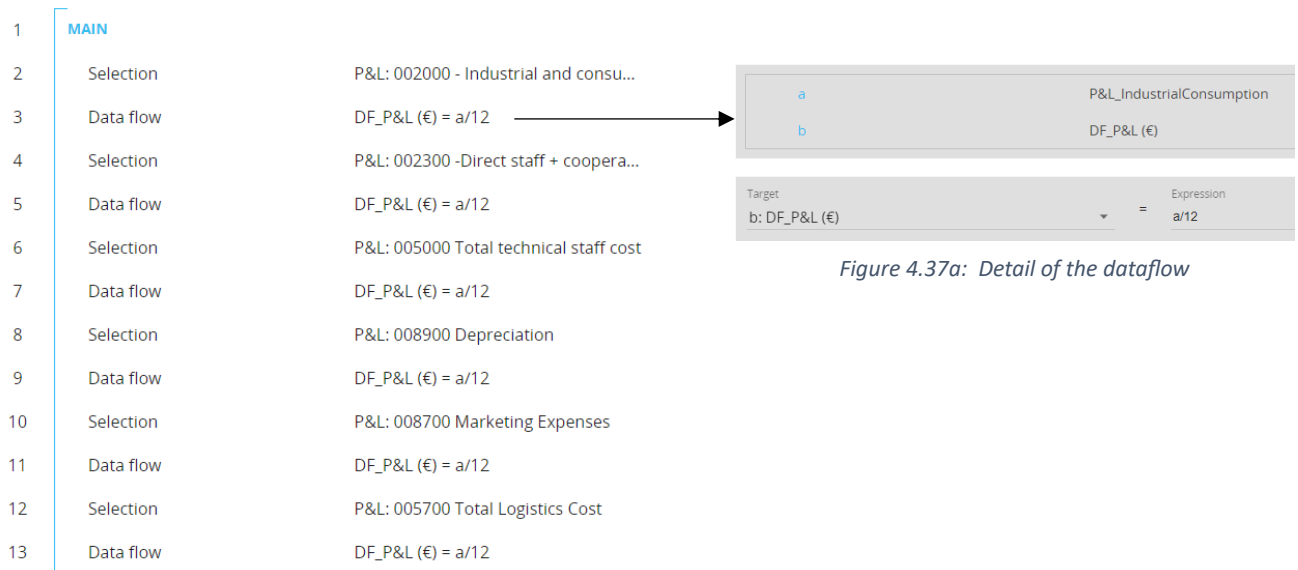


Figure 4.37a: Detail of the dataflow

Figure 4.37: Procedure to import the six costs of matrix allocation

Since A&R Group operates worldwide, it could be a great idea to visualize the assessment also in dollars, by applying a conversion rate to the P&L just calculated.

So, a Cube structured by Month is created, with the data entry function enabled (in this way the user can input the conversion rate). Once the user has digitied the rate for each month, a Procedure (Figure 4.38) will perform the multiplication as follows:

$$P\&L(\$) = conversion\ rate * P\&L(\text{€}).$$

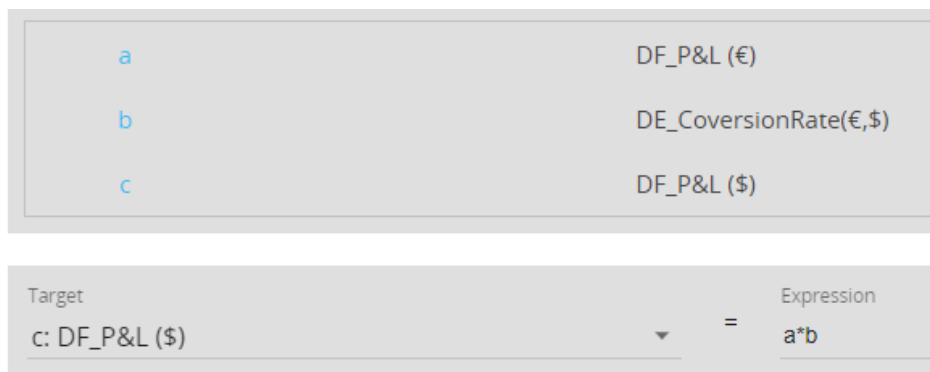


Figure 4.38: Procedure to calculate P&L(\$)

Suppose the Change rate is equal to 2. The P&L Screen resulting is shown in *Figure 4.39*.

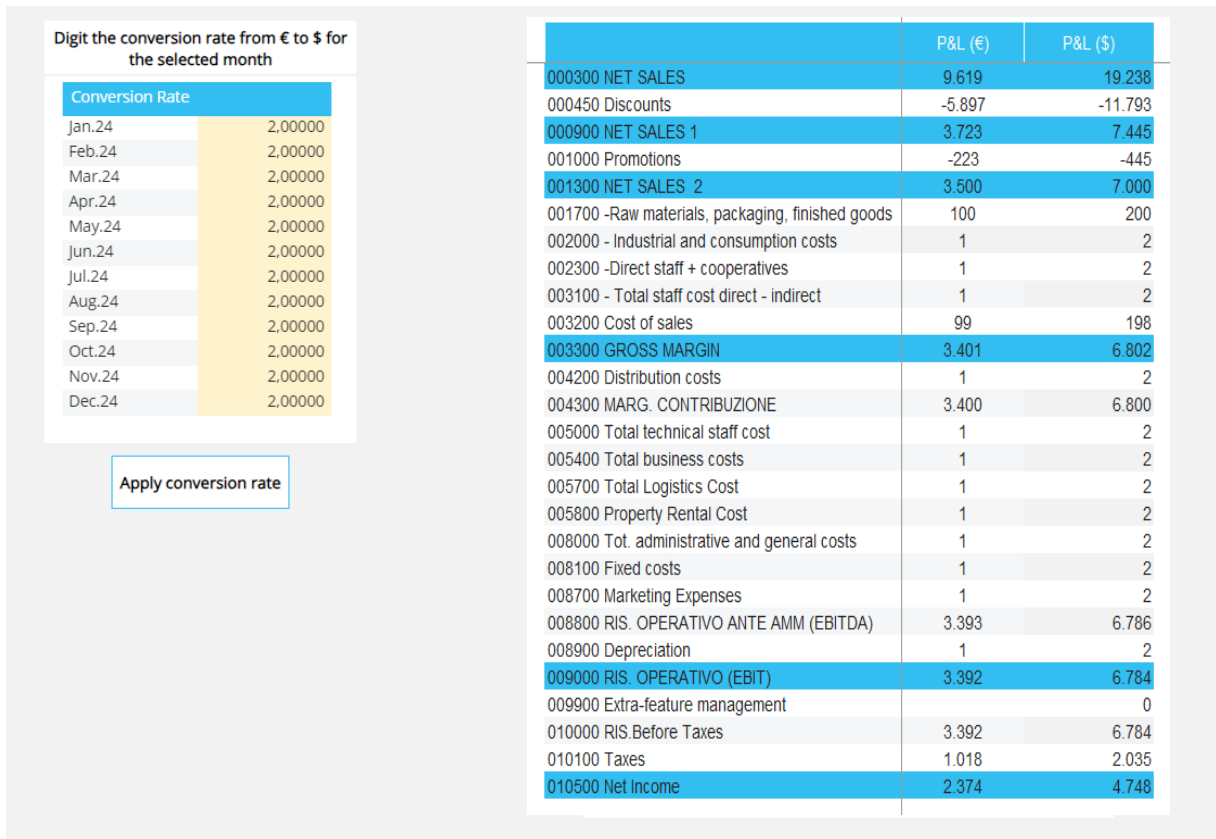


Figure4.39: P&L Screen

4.3.2.8 Marketing

Concerning the Marketing Screen, it simply consists of two buttons which trigger an interactive selection where the user chooses a Product and/or a Customer and the correspondences are listed into two dataviews. Then, there is a Procedure which export these dataviews into a PDF file.

In *Figure 4.41* an application of this Screen is reported: suppose the marketing wants to reward the customers who bought the product "Ipoh Coffee" with a voucher. All they have to do is to activate the interactive selection (*Figure 4.40*) by clicking on the button "Select Product", then choosing from the list "Ipoh Coffee" and look at the dataviews. If they want to export this data, they just have to click on the button "Export data" and the Procedure starts.

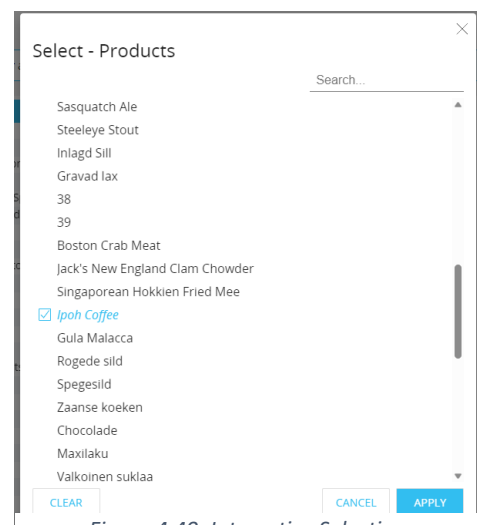


Figure 4.40: Interactive Selection

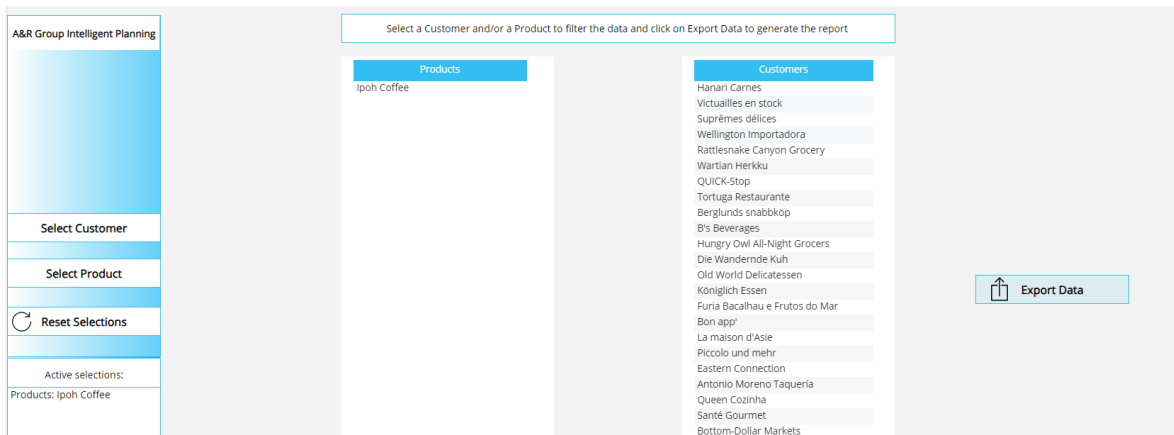


Figure 4.41: Application of the Marketing Screen

4.3.2.9 Security

The last Screen left is the Security Screen. This is a particular screen since it can only be seen by the Administrator.

It is simply made of a dataview in which three Screen are listed (Sales Rep Plan, Commission Costs and COGS) and beside them there is a checkbox. If the checkbox is flagged (green background), then the corresponding screen is accessible, else (not flagged → red background) it is not visible and if the user try to go on such screen, an error message will appear and the Home page shows off. This is managed by a Procedure (Figure 4.43).

For example, in Figure 4.42 the COGS Screen is blocked, then the error will occur and the user is brought to the Home page.

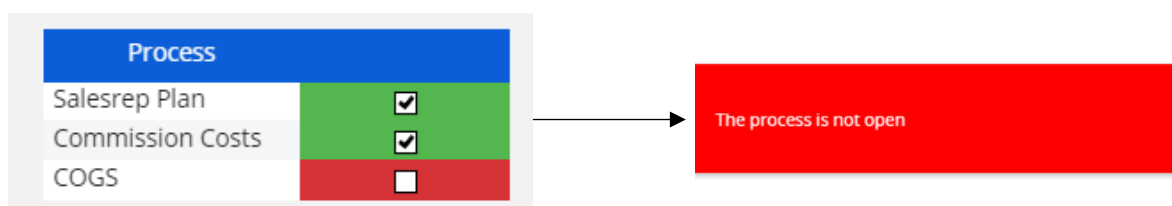


Figure 4.42: Screen not accessible

1	MAIN		
2	If then else	If DE_ManageProcess = 1 Then "Go...	If the Checkbox is not flagged, this equals to the value 0 in the Cube, else 1. The if operator says that if the Cube = 1 then the Screen is accessible, while if the Cube = 0, the error message appears along with the Home page and the Procedure ends.
3	ALLOW		
4	Go to screen	COGS	
5	DENY		
6	Show message	The process is not open	
7	Go to screen	Home	
8	Exit procedure		

Figure 4.43: Security Procedure

4.3.2.10 Dashboard KPI

To conclude the presentation of the Business Case, let's consider the Dashboard concerning the KPIs.

Recalling the definition, a dashboard is a means of centrally displaying several kinds of visual data. A dashboard's typical purpose is to present various, yet connected, information in a way that is simple to understand. This frequently consists of indices such as key performance indicators (KPIs) or other crucial company measures that stakeholders must quickly view and comprehend.^[51]

The screens that have been seen thus far are reports, not dashboards. Reports, in general, tend to focus more narrowly. They are useful for giving an in-depth look at a data collection and often focus on one thing at a time.

On the other hand, dashboards are designed to address a specific topic and often provide a high-level view of a large quantity of data. You may ask something general like, "How was our company performance last month?" Or something more precise like "how many units did we sell?".

The A&R Group Dashboard is shown in *Figure 4.44*.

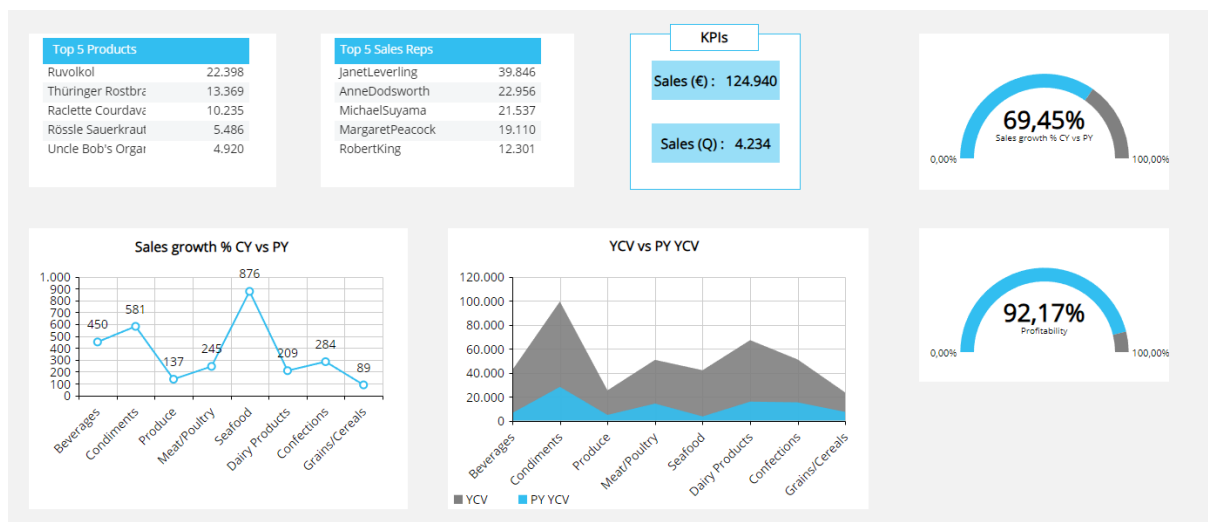


Figure 4.44: A&R Group Dashboard

As the reader can see in a unique Screen there are seven crucial metrics that the Company's management wants to periodically monitor at a glance.

The easiest way to represent data in a very intuitive way is by means of charts and little dataviews, usually representing a ranking.

Indeed, the first dataview in figure represents the top five products in terms of trade. It is simply the Net Sales Cube with the Entity Product by row and the filter on the five greatest values.

Same for the top five Sales Reps in terms of performance. Here the Cube is always Net Sales but this time the Entity by row is Sales Rep.

Looking at the KPIs box, there are two labels: the first one reports the total amount of Net Sales in monetary terms, while the second one in quantitative terms. The first label has the Cube Net Sales as structure, while the second has the Cube Quantity.

The top right object is called “gauge” and represents in an original manner a percentage. In this case, the value is obtained by making the variation % between the current and previous year level of Net Sales.

The other gauge represents the indicator called “Profitability”, which is given by the ratio between Net Sales and Gross Sales.

The bottom right chart represents the Product which is grown the most in terms of Net Sales with respect to the previous year.

The last chart represents the yearly cumulated values of Net Sales, considering the product categories, with respect to the previous year.

Looking at this intuitive Screen the user can easily make some considerations about, for example, the products sold. Grains/Cereals are the category who has grown the less, so the management should think about the profitability of such goods and understand if it is convenient to remain on this market or it is better to leave. On the other hand, Beverages is performing very well and the management could decide to improve the company’s presence on this market segment and maybe become a leader.

Thanks to this simple example, the competitive advantage of having a structured Dashboard connected with the entire database is clearly spotted.

This concludes the explanation of how to implement a Board Intelligent Planning to a small/medium sized enterprise.

5. Conclusions and future developments

Starting from the roots of the Business Intelligence, passing through the description and the application of a modern BI software as Board, the natural conclusion of this Thesis is describing the future developments of this tool.

Nowadays the most discussed technology is the artificial intelligence (AI), since its potential could revolutionize the idea of work and our habits. Artificial intelligence has seen several cycles of excitement over the years, but even among doubters, the launch of OpenAI's ChatGPT (2022) appears to signal a sea change.

At its simple form, AI is a subject which combines computer science and robust datasets to enable problem solving and to simulate human intelligence processes.

Among other things, AI finds application also in the Business Intelligence field. Its use in this sense is currently limited, but it is going to become more and more widespread with the improvement of the technologies. ^{[52][53][54]}

AI is being used to enhance BI in different ways:

- AI-powered BI tools can automate many of the manual tasks involved in BI, such as data preparation, cleansing, and analysis. This can free up BI professionals to focus on more strategic tasks, such as developing new insights and recommendations.
- AI is also being used to make BI more insightful. AI-powered BI tools can identify patterns and trends in data that would be difficult or impossible for humans to find on their own. This can help businesses to identify new opportunities, improve their operations, and make better decisions.
- AI is making BI more accessible to a wider range of users, since Business Intelligence tools can be used by users who do not have any coding or technical expertise. This is because AI - powered BI software can understand and respond to natural language queries.

All these features are beginning to be implemented in many Business Intelligence tools and the advantages are clearly recognizable.

Regarding the software Board, as already mentioned in Chapter 3.4, the AI is exploitable in the "Cognitive Space" tab.

While there are many benefits to using Artificial Intelligence in BI, there are also some challenges, including:

- Data quality: AI - powered BI tools need high quality data to produce accurate results.
- Cost: this technology can be expensive to implement and maintain.
- Moral question: AI can credibly substitute the human work, leaving people without an employment.

In conclusion, the main topic of this Thesis is to describe and to demonstrate how BI positively impacts the companies' activities, like extracting as much information as possible from their raw data, detecting the positive/negative trends and allowing users to understand in advance which actions should be taken in order to gain a competitive advantage.

Especially, a Business Case has been shown to put into practice what explained in theory about BI and CPM. The A&R Case points out the effects of the implementation of Board, such as the acceleration of the forecast and budget processes, or the simplification of creating dashboards starting from a unique database common to all the company's divisions.

The customer does not need countless Excel spreadsheets anymore, where each department writes down their data, getting them from different sources and generating inconsistencies at the top management level which receives the overall data from each division of the company.

Thanks to Board, the only action the customer has to do is sharing the database with the Consulting firms, setting up the operating conditions and looking at the results. All the calculations previously done by writing the formulas on a spreadsheet, with the probability of errors and the time consumption, now are immediately performed by Procedures implemented by the EPM Consultants.

The implementation of Board for A&R Group results in an improvement of the efficiency and in a time saving in the process of financial closing, in forecasting and budgeting and in the generation of reports and dashboards.

Furthermore, the Intelligent Planning has brought to a remarkable reduction of labour cost regarding all the resources previously appointed to prepare the financial closing and the provisions. Indeed, the work earlier performed by a team of people now can be easily done just by one person who has just to run the procedures and extract the reports generated by Board.

Being Board a software set by several EPM Consultants, it is likely that some data are inaccurate or that the performance are diminishing gradually. That's the reason why Bios Management offers to their customers – and so to A&R Group too - a service of maintenance and updating in case new versions of Board are released.

Currently, the A&R Group is evaluating the possibility to implement the Business Intelligence also in their Human Resources processes, that can be easily done thanks to the great flexibility of Board.

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Acknowledgements

First of all, I would like to thank my thesis supervisor Professor Giulia Bruno for her time and help during the writing of this thesis and Bios Management Ltd.

I would like to express my sincere gratitude to my family for always believing in me over the years and never letting me lack their support.

I thank Andrea and my friends who have shared this challenging journey with me, thank you for your support and encouragement, without you this would have not been possible.

Finally, I would like to thank myself for never giving up.

I really hope that this accomplishment will be a starting point for all the goals I want to achieve in my life.