POLITECNICO DI TORINO

Department of Management and Production Engineering

Class LM-31 Degree: Management Engineering

Master's Degree Thesis

Business Intelligence: the implementation of a BI solution to a case study

Thesis supervisor: Candidate:

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Academic Year 2021-2022

To my family

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Introduction

Business intelligence (BI) includes activities, processes and technological skills which fall under the scope of the *corporate IT system*. Over the years, the latter has been playing an increasingly important role due to the needs of the "Information Age" (aka Computer Age/Digital Age) applied to the economy and management.

In a business context, the ability to analyze large amounts of data produced by business processes is of fundamental importance: data often comes from different and heterogeneous sources and therefore there is a need to unify structures and formats. Furthermore, data can be redundant, inaccurate, incomplete and there may be the need for "cleaning", or they just might not be easy to integrate and use and therefore it might be necessary to transform them into easy-to-read information for the company actors.

The Business Intelligence system, therefore, has the purpose of enhancing company data with the aim of analyzing current and historical data and improving strategic decision-making providing a competitive advantage.

The objective of this thesis is to present the work I did during my curricular internship at the consulting firm Bios Management std, headquartered in Santa Vittoria d'Alba (CN). The thesis is structured in four chapters:

- In the first chapter, a general overview of the history of BI and the architecture of a BI system is given.
- In the second chapter, I focused in more detail on the BI software BOARD, of which I learned the main functionalities during my curricular internship.

- In order to get a more practical idea of consulting through the use and implementation of BI solutions, a case study was presented in the third chapter: a project I worked on supervised by some Senior Consultants.

- Finally, in the last chapter, an analysis was carried out on the job of the BI consultant. Also, a QFD (Quality Function Deployment) analysis and a Q-Bench algorithm were applied to identify the Technical Specifications on which should be best to focus on for an eventual new version of the current model of BOARD.

CHAPTER 1

Business Intelligence

In order to be able to manage in an efficient and profitable way, both from the productive and economic point of view, the constant growth of information available today, techniques, technologies, as well as tools, such as to make it possible to obtain valid and objective support in the decision-making field arose.

The analysis of both internal and external resources, in more generic terms than **Big Data**, is useful and indispensable today, proving to be increasingly crucial for monitoring the status of functions and activities, until reaching the multitude of goals and objectives.

The *identification of any correlations between data* therefore means obtaining a potential advantage: a correct filtering, using relevant analytical techniques, means having a more robust analysis and *more solid indications for sensitive choices*. Moreover, it's of significant importance to *summarize* and allow the flow of the contents and resources in critical and exhaustive *visualizations forms* to safeguard and manage information and its correct use.

One of the main basic characteristics that highlights the effective ability to pursue the goals set by BI is the integration of *resources of different origin and structure*, allowing the prospects of a greater refinement and accuracy of the final answers.

1.1 History of Business Intelligence.

The first written evidence that we have about "Business Intelligence" comes from the pre-digital era, in particular from 1865, in the work of *Richard Miller Devens*: "*Cyclopaedia of Commercial and Business Anecdotes*" of 1865.

These words were used by the author to describe the way with which a banker, Sir Henry Furnese, had managed to succeed in his career. Furnese was able to understand the economic/political situation and the market ahead of its competitors, by collecting, analyzing and using information at his disposal to help him making sound and sensible business decisions.

Furnese used the information in its possession for fraudulent purposes and then went down in history as a "corrupt financier", but this was the first idea of gathering information for the evaluation of a business.

The importance of Devens' use of the concept of "business intelligence" lies in the fact that he applied it to describe the use of data and empirical evidence, rather than gut instinct or superstition, to inform business strategy.

It was necessary to wait until mid-twentieth century, during the dawn of the Digital Revolution, to have an important development in the sector. Technology began to be considered to support BI: in 1956 IBM invented the hard disk, particularly relevant to BI as it gave way to the replacement of physical filling systems for digital ones.

In 1958, *Hans Peter Luhn* wrote a seminal paper in the IBM Systems Journal titled "*A Business Intelligence System*".

"*The ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal*": using the Webster's dictionary definition of "intelligence", Luhn described something that is very close to the concept of BI that we have today. Luhn's research did not just provide

theoretical arguments, but he also developed practical methods that were used in the first analytical systems made by IBM.

The 1960's saw a significant increase in the introduction and use of computers especially in the business world and consequently the creation of the first Database Management Systems (DBMS), also generically renamed Decision Support Systems (DSS).

In the 70s, the first BI vendors began to appear (SAP, Siebel and JD Edwards, the last two now part of the Oracle Corporation), which made available on the market tools for managing and organizing data in more effective ways. Nevertheless, the technology was new and difficult to use and because of its high cost, its market was limited to large companies.

To obtain meaningful information from data, organizations needed to run reports on a single version of data, so the problem of integrating sources arose. In the early 1980s, Ralph Kimball and Bill Inmon found the solution in the **data warehouses**.

Data warehouses are used as centralized structure of integrated data from one or more different sources. They store current and historical data coming from different business departments in one single centralized repository that is used for creating analytical reports. Today they are considered a core component of BI.

The term business intelligence began to spread on a large scale late in the day 1990s and early 2000s, also thanks to the introduction of new software suppliers into the market. The technology adopted, however, had the main problem of the complexity of use: many of the business projects were still handled by the IT department, and it emerged that end users were not yet able to perform activities of BI independently. Existing tools were meant for experts, and intensive analytical training was required for the acquisition of

knowledge. Over the years also tools for less technical users began to be developed, but this change happened slowly. This development phase was also called **Business Intelligence 1.0**.

The 2000's added more speed to BI development: greater simplicity of use was introduced by the new technologies. New tools allow real-time processing: data is inserted into the data warehouse when generated by business activities, allowing companies to make decisions with the most recent information available.

This phase, called **Business Intelligence 2.0**, was driven strongly by the exponential grown of the Internet. A more web-oriented and browser-oriented approach was used and the birth of social networks such as Facebook, Twitter and Blogs provided a new way for users to share ideas and opinions.

The growing networking of the business world led companies to keep pace with the competition: it was necessary to understand the opinions and needs of consumers. BI was no longer considered as an add-on tool or an advantage, but it was becoming a must for the businesses which wanted to remain competitive and attractive on a new data-oriented market.

Today, BI is considered a standard tool for every enterprise and is going through a continuous and intense refining process. Some of the new visualization tools have evolved and got closer to the end users: the goal is to provide them with a powerful tool for full access to data, so that they can explore it independently, without any type of training.

Emerging BI Trends for 2022 aren't just about the WHAT, but also on the WHY: modern BI landscape is focused on taking data from the past and find reasons why something happened, so that is possible to predict what may happen in the future and make suggestions about it.

In order to achieve this goal, a BI system that can do more than just crunch numbers is needed.

Experts are looking to **augmented analytics** as a solution for BI so that the identification of trends and the connection of the dots to reveal causation can be possible.

Another trend is to make BI tools that are flexible enough to offer an individualized experience for each user, regardless of the level of technical skills, increasing accessibility. One of the ways BI systems are starting to deploy is **Natural Language Processing**: users could query the system by asking questions in natural language, like using any search engine (through the use of keywords, questions, …).

Moreover, BI is moving towards mobile tools: users should not need to be stuck to a desk when they want to get insights and analysis, they should be able to do business from everywhere through the mobile phone offering a more efficient experience.

1.2 Advantages and limitations of data-driven

The *information transmission* within any company is an aspect which influence the complexity of the organization. The need of coordination and compactness of information, as well as their frequency and their contents, reflects the organizational structure which may be divided into different types in a functional or divisional key.

The greater the dynamism of the surrounding environment, the greater the demand for flexibility and cohesion in the communication of information between the different components of the organization. All this, in fact, has an impact on the timeliness of the responses and the inertia to external changes.

Any interpretation not based on data is to be defined as subjective. In business and corporate management, decisions must be taken and the consequences must be predicted as precisely as possible.

Data from which to draw information, their storage, their manipulation, analysis and synthesis, therefore, become increasingly decisive fields, proportionally with the development of digitalization, *to obtain or maintain a competitive advantage*.

The terminal information, and consequently the choice undertaken, will therefore turn out to be increasingly focused on data: the concept of ***data-driven*** consequently indicates the desire to mark the direction of an organization built on the objectivity and empiricism of the use of data.

A data-related planning will be a constant support to countless considerations necessary for the pursuit of the objectives and expected results in the different layers of the organization, at the base of every final project.

Studies confirm the effectiveness of the data-driven approach: companies that make data-driven decisions have a 200% higher chance of achieving better financial performance in their industry. On the other hand, it's important to underline that subjectivity is not an error, nor a necessarily harmful element. Subjectivity remains a determining part of strategy and decision-making. Data, therefore, cannot be considered as the only decision-making tool within the company. There are blind spots in the aggregation and analysis of data, which must be known and integrated with a broader approach.

Like any tool, an overestimation of the possibilities of data can expose the team to real risks and consequent strategic errors:

- ***Literal interpretation of data***: each analysis is a snapshot of the current situation and does not provide clear answers about future events, using

data obtained literally can therefore lead to completely incorrect assumptions. Instead, data must be interpreted critically, integrating it with all the strategic skills of the team.

- **_Poor representativeness of user behavior_**: very often small variations to the product or service involve a gradual change and disaffection in the attitude of the public. By relying only on data, you risk discovering relevant facts about our users too late.

- **_Data-dependent approach_**: one of the fundamental problems of a data-driven approach is the total dependence that can be developed towards the information obtained. When, for any problem, you are left without data or with only partial data, you risk the paralysis of the decision-making process.

- **_Inability to grasp trends immediately_**: trends are elements that data cannot easily and promptly identify.

- **_Tendency to immediately use data for micro-optimizations_**: having a lot of data available in a constant way could induce the company to implement, from time to time, micro corrections and optimizations. However, such an attitude risks undermining the understanding of future developments and the interventions applied. Any change, on the other hand, must be part of the strategy and, if implemented, be subject to confirmatory monitoring.

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 behavior 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.

1.3 Architecture of a BI system

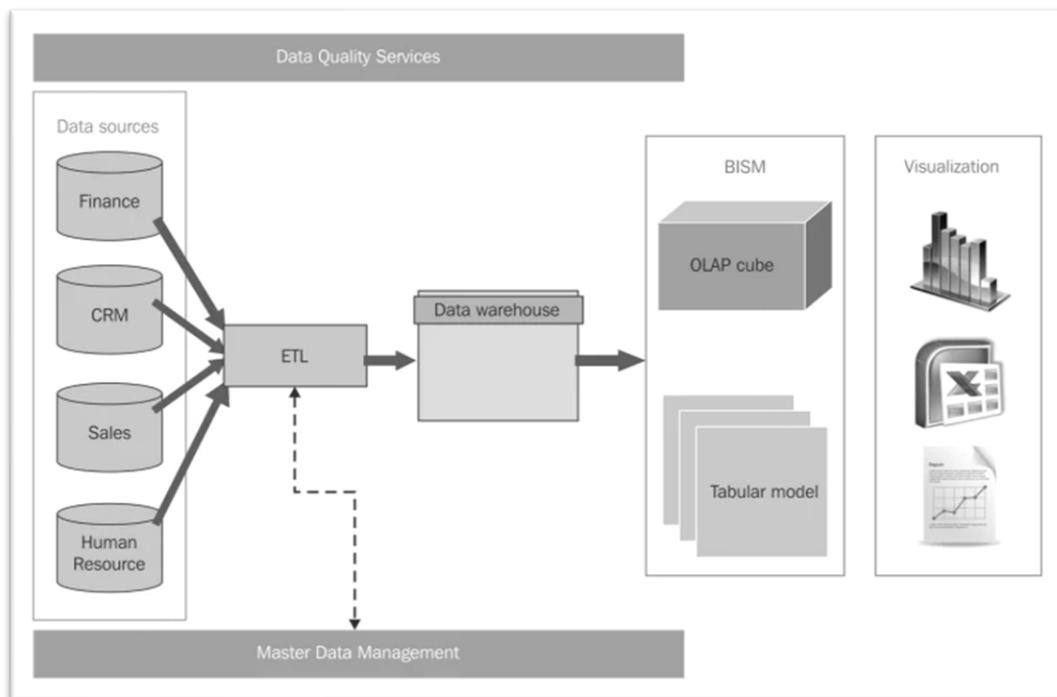In Figure 1.1 it's shown the generic architecture of a BI system.

Figure 1.1: *Conventional architecture of a BI system.*

BISM is the acronym of Business Intelligence Semantic Model and represents the model with which data of a DW will be stored

Depending on the environment and the software used, the architecture of a BI system may vary, however there are some components which are usually present in all of them:

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- Operational sources;

- ETL process;

- Data Warehouse (DW);

- Data model;

- Data analysis.

1.3.1 Operational Sources

The first macro area is that of data sources: data comes from various systems whose main purpose is to provide support for the execution of business processes. These are called

DBMS (Data Base Management Systems).

For example, the Sales System maintains information related to orders, shipments, and returns, or the Human Resources System captures information related to employee promotions or layoffs. To facilitate business operations, they must allow different forms of interaction with the database such as insertions, updates or deletions. These systems require a well-trained staff and specific resources in IT to allow the maximization of their performance.

In the field of business intelligence, it is necessary in particular to distinguish divergences

between two types of DBMS, respectively with *OLAP* and *OLTP* techniques.

- **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.

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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 analyzed in the following section.

1.3.2 ETL process

It's a key step in the construction of the DW: within a company, there are multiple systems that play the role of sources for the BI system. It is therefore necessary to perform data *extraction* from each of them, *transform* them into a form that is suitable for the DW, and finally *load* them. This process is called *Extract Transform and Load (ETL).*

This allows through special tools and procedures, to standardize data of the different sources, so that there is homogeneity, correctness, consistency and robustness of what will be the content of the data warehouse.

There are numerous tools on the market that enable you to perform these operations, within the Microsoft domain, the ETL tool is called SQL Server Integration Services (SSIS).

It is included with the SQL Server DBMS and can handle the integration of different types of sources, such as Oracle DB, text files, XML, Web and DB services of the same SQL Server.

An additional element, supporting ETL processes, is the "*Staging Area*" or "*Operational Data Store*" (ODS) which is a transit area that allows separating the extraction, cleaning and transformation from the loading.

It can guarantee a level of fault tolerance. If, for example, the transformation step failed, it would not be necessary to perform the extraction again.
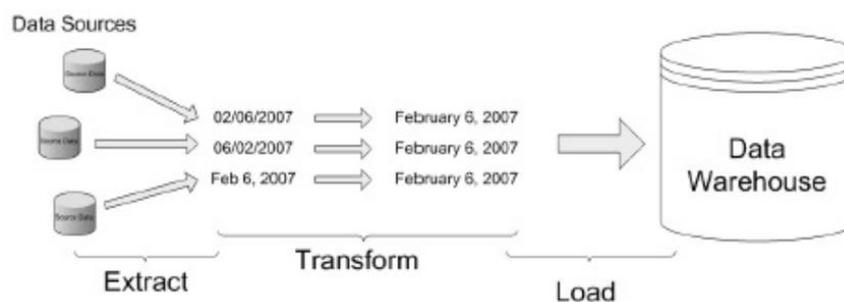

Figure 1.2: *Example of an ETL process.*

Below, the four main operations of ETL process will be analyzed:

- *Extraction*. Data is extracted, mainly from heterogeneous operating systems. The main objective of the process is to extract only data of interest using the least number of resources possible, so any set that is not purely relevant is omitted.

  In most cases occurs in the background or performed at times of low activity, such as night hours. This is in order not to adversely affect the performance of the production systems.

  The extraction can be *static*, which represents a snapshot of the information contained in the operational sources and is usually performed for the first DW population, or *incremental*, information

about previous extraction is kept and only those records that have undergone changes since the date of last extraction are updated.

- *Cleaning*. It's done with the aim of improving accuracy and consistency of data by removing duplicate data, erroneous or missing data and by correcting any inconsistency between values.

- *Transformation.* The different sources store information in different formats, consequently in order to carry out integration it is necessary to transform data into a uniform one. Series of transformations are applied to convert from the source to the target format.

- *Loading*: it's the last stage of the ETL process, data is loaded in the Data Warehouse.

  There are mainly two loading modes: *refresh*, the DW is completely reloaded by deleting old data to make room for new data (this mode is usually used to perform the first loading of the DW) and *update:* only those data that have changed since the date of the last loading are loaded into the DW.

1.3.3 Data Warehouse

Data from the different sources, once processed through ETL tools and processes, are stored in a specific database: the Data Warehouse.

It is a fundamental element of a BI system, its main objective is to enable data analysis and data reporting, supporting decision and strategy making.

In order to fulfill 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.

1.3.4 Multidimensional model

The *Entity-Relationship (ER)* model traditionally used for the conceptual database design, cannot be adopted for DW implementation. Such a model is not suitable because of its complexity in understanding and navigation inefficiency: it does not express concepts such as multidimensionality or the hierarchy of aggregation levels.

Data of the different sources, in order to be as uniform, structured and aggregated as possible, follow a precise composition determined by the corresponding conceptual design of multidimensional nature.

The most widely used model in this context turns out to be the ***Dimensional Fact Model (DFM)*** created by Rizzi and Golfarelli in 1998.

The main purposes of the system are:

- Provide conceptual design support.

- Create an environment where users can query intuitively and formally.

- Promote communication between designers and users in order to formalize the project requirements.

- Build a stable logical design platform.

- Provide clear and effective documentation.

The DFM model therefore refers to multidimensional analysis which can be interpreted by means of n-dimensional cubes whose constituent concepts turn out to be

mainly three:

- ***Fact***: it's an item of interest for the organization and models a set of events that occur within the business environment. In the DFM it is represented by a rectangular box, defining it through many-to-many

associations between its *measures* of *fact attributes,* which are usually called *dimension attributes.*

- **Measurement**: it's 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.

- **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 analyzable.

In the Figure 1.3 (a) below, we can see a data cube defined for the analysis of measures along the dimension *product*, *store* and *time*. The measurements might be for example the quantity sold, the price of the product, the cost of the product.

The definition of **hierarchies** of the dimensions it's crucial as it provides the basis for subsequent data analysis.
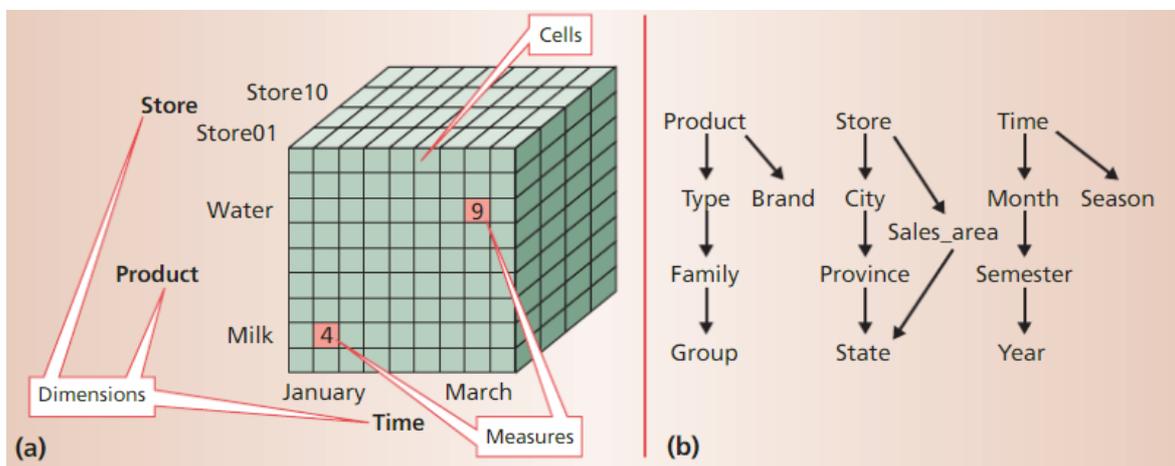
Figure 1.3. (a) Example of a multidimensional model data cube. (b) Classification hierarchies of the dimensions which define the cube (product, store, time).

Also, alternative path hierarchies might be created through the decomposition of dimension attributes in more than one sub-dimension. For example, for the *product* dimension we can find two different hierarchy paths:

- o Product – Type – Family – Group
- o Product – Brand

1.3.5 Data Model

To ensure an excellent ratio between processing speed and response time to queries it is necessary to introduce an additional layer in a BI system: the Data Model. It contains a template based on files or data memory and aims to provide fast answers when executing queries.

There are two technologies offered by the Microsoft's solution for the data model:

- *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 with the consequent reduction of the hierarchy.

- *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.

1.3.6 Data Analysis and visualization

It represents the front-end part of a BI system: after collecting, transforming, integrating and saving data within the data warehouse you need to use it for decision making.

There exists different tools and methods for visualization and reporting on the market. Some examples are detailed or consolidated reports, KPIs and dashboards.

The Excel tool, presents the opportunity to connect to an OLAP cube and to carry out free analysis, inserting indicators and descriptive information or varying the level of detail of the analysis. Other instruments which allow granting great results are Performance Point, as part of the instrument Microsoft SharePoint, and Microsoft SQL Server Reporting Services, which allows the advanced creation of reports from different data sources.

CHAPTER 2

BOARD

During my curricular internship at the company **Bios Management Ltd**. I experienced a five-week training period on the software **Board**, during which to the trainee is given the opportunity to learn all the basic functions, followed by a four-week period in which real cases were analyzed by supporting consultants during their working days.

Figure 2.1 *Board's Logo*

Bios Management Ltd is an IT consulting firm with headquarters in Santa Vittoria D'Alba which has been providing consulting services in the field of *Business Intelligence, Performance Management* and *Digital Transformation* since 2004 (Figure 2.2: Bios Management Ltd Logo).

The company has strong skills ranging from the development of innovative Business Analytics solutions to the design of Process Management applications.

Figure 2.2 *Bios Management Ltd Logo*

Through software such as Board, Arxivar, Qlick and Power BI it works collaborating with clients, supporting them in defining business strategies, supporting them in the processes of concrete implementation of their objectives. Specifically, it develops operational improvement plans through the revision and enhancement of internal processes, with the goal of the company's organizational growth by valorizing its human assets.

2.1 What is Board?

Board is one of the major decision-making platforms which enables thousands of companies worldwide to transform their business through the implementation of Business Intelligence, Analytics and Performance Management applications in a single comprehensive solution. The software allows to intuitively manipulate data and create a comprehensive view of the information so that it allows to achieve a full control of performance across the company.

Board can be accessed in two different ways, in the Cloud or locally:

- *Board Cloud*: it's supported by Microsoft Azure and offers all the features of the platform with the addition of the benefits that a powerful cloud infrastructure can offer in terms of reliability, security and world-class performance. Also, updates, installation and development will be handled directly by the Board in Cloud team.

- *Locally*: it's necessary to install the various services, with which you will work directly from your PC.

2.2 Board's main sections

After logging into Board, the user is directed to the home page of the Capsules area (which will be explained in more detail in section 2.2.1) in which there

are some navigation elements which are present in the whole Board platform like the *Main Menu* (Figure 2.3 below).

The Main Menu shows up when the mouse pointer is directed over the blue square in the top left corner of the page, and it allows the navigation through the main areas present in Board. These main areas, which will be analyzed in more detail in the following paragraphs, are:

- Capsules
- Presentations
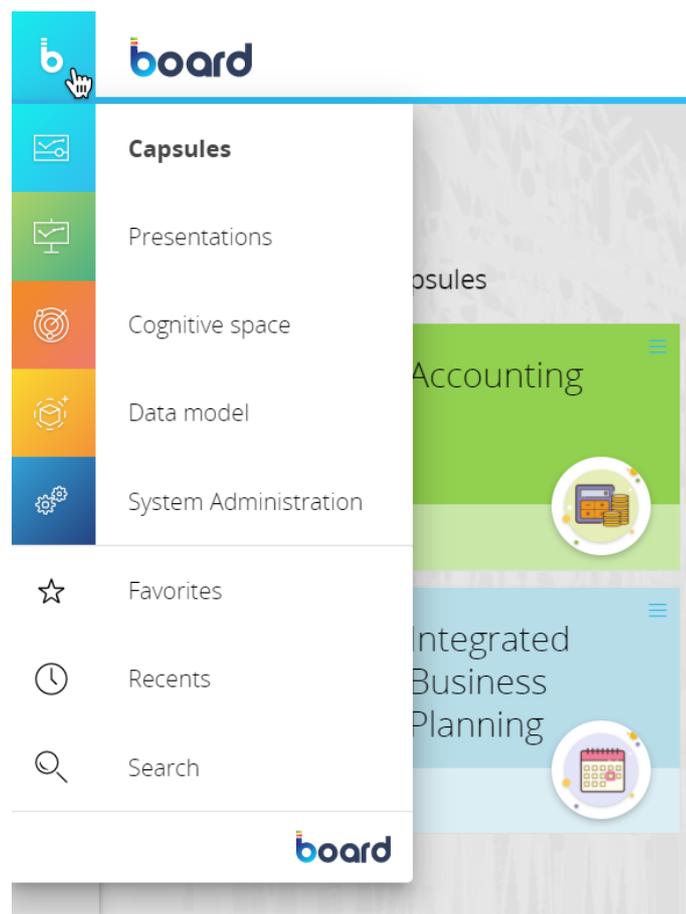- Cognitive space
- Data model
- System administration.

Figure 2.3 *Main Menu*

2.2.1 Capsules

In the Capsules' area we'll be able to access different Screens with which the end-user will be able to interact by manipulating data and updating the correspondent Data Model.

A Capsule can be seen as a set of *Screens and Procedures* and in each Screen multiple objects like visualization tools (tables, charts,…), text annotations and buttons (which may allow Capsule navigation or the initiation of a procedure) can be present. An example of Screen will be shown in Figure 2.4 below.

Figure 2.4 *Example of a Screen.*

According to the objects presents in the various Screens, Capsules can be created for different purposes for example:

- Capsules created for the purpose of *analysis* will mainly include *charts and tables.*

- Capsules created for the purpose of *CPM (Corporate Performance Management) and Business Intelligence* will mainly include the combination of *reporting* with *data-entry* and *simulation Screens*.

Also Capsules with the purpose of administration of applications settings might be created.

2.2.2 Presentations

Board allows the configuration of a presentation which can be easily shared with other users in different formats.

It's possible to create a presentation by adding Screens, even from different Capsules and arrange them in the order desired. Each Screen will be added with all its Objects, which will continue to be interactive.

A presentation can be modified simultaneously by many users, provided they have the necessary authorizations, without the need of using other software.

2.2.3 Cognitive Space

A very innovative and efficient interaction between users and data is allowed by Board: through the presence of search strings, it's possible to communicate directly with the system and interact with it, just like a common search engine. The Cognitive Space area of Board allows saving time by providing a truly web-like search experience: the user has the possibility to easily obtain all information conveniently highlighted for him/her thanks to the translation of speech into queries.

Board will look for Capsules and reports which best match the request. Results will include Analysis and Capsules sections (as shown in Figure 2.5 below):

- Analysis is a chart automatically created by Board which shows search results by pulling data from Entities and Cubes in Board.

- The Capsules section will show a list of the Screens which match the user's search, in order of relevance.
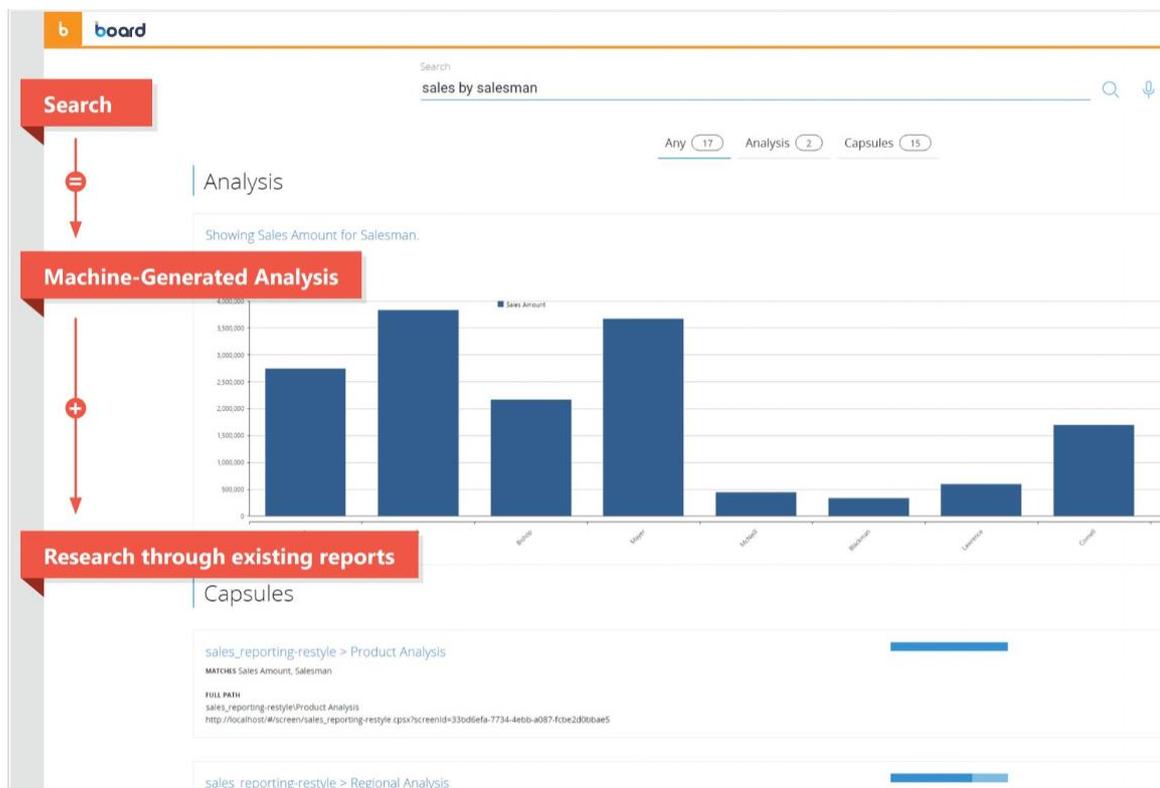

Figure 2.5 *Example of a research in the Cognitive Section of Board.*

2.2.4 Data Model

Board's Data Model technology allows the management of huge volume of data through the implementation of multidimensional techniques.

A multidimensional Data Model works through the creation of *Data Cubes,* made of cells each one of them representing a unique logical intersection of all dimensions of the Cube. Cube's dimensions are called *Entities*.

The user has the possibility to establish *hierarchical structures* between them, allowing the view of data at different aggregation levels. There are some phases of Data Model implementation, which should be followed in a specific order since each one strictly depends on the previous one.

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The main ones are:

1. *Creation of the new Data Model*: in the Data Model Area there's the chance to create a new Data Model through the "+ Data Model" as shown in Figure 2.6 below and assigning it a title. Once it's created, it's possible to access it by clicking on the title and each specific Data Model will offer different sections, relevant ones are Time Range, Entities, Relationships, Cubes, Procedures and Data reader (Figure 2.7).
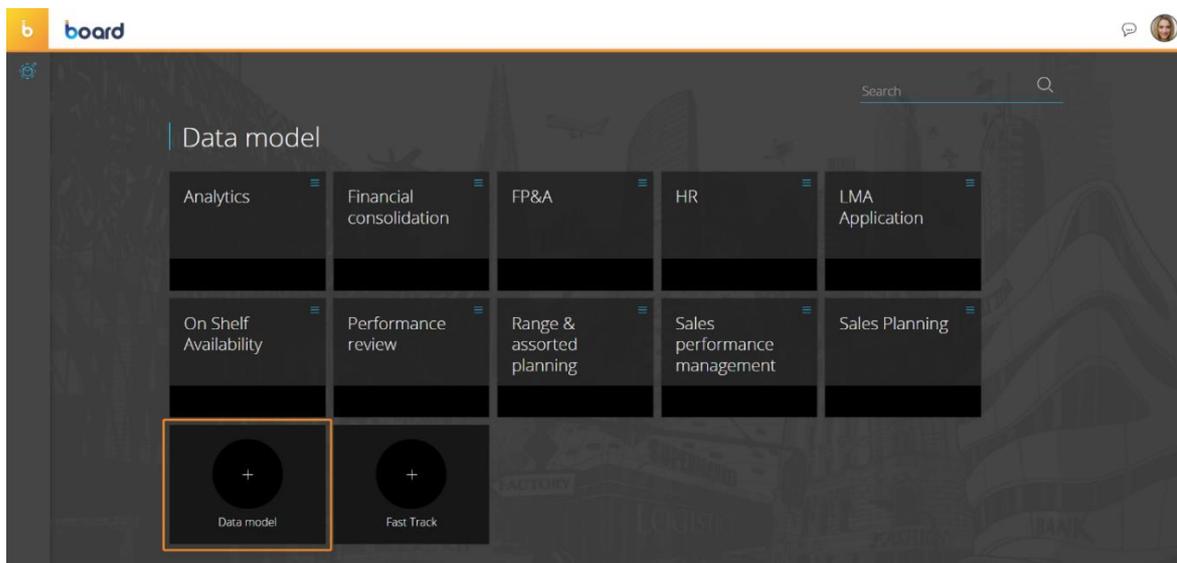
Figure 2.6 *Creation of a new Data Model (Fast Track tool automates data preparation and modelling and will not be analyzed in detail).*

Figure 2.7 *Sections available when accessing a Data Model.*

2. *Definition of the Time Range*: through the Time Range section, it's possible to perform this operation. The Time Range is the interval of time of existing data time and expand it for few years in the future for planning purposes.

3. The *creation of Entities*: to perform this operation (as shown in Figure 2.8 below) it's necessary to click on "+ ENTITY" in the Entities section of the Data Model area and then "SAVE CHANGES" when done. There are some Entity properties which must be filled:

    - *Name*: when a new Entity is created, a unique internal identifier (UID) for that Entity is assigned by Board.

    - *Group*: it's possible to group Entities for the only purpose of understanding and searching improve.

    - *Code and Description width*: maximum number of characters that the Code and Description of each member can contain.

    - *Max Item Number*: when creating an Entity, it's necessary to specify the amount of members which can be held by it. It can also be set to "Auto", in this case the value will be defined automatically by Board's optimization algorithm.

    - *Sort by*: it's the way in which the Entity members are displayed. The options are None (displayed in the order of creation), Code (according to code field in ascending/alphabetical order), Desc (according to the description field in ascending/alphabetical order), Custom (manually from the "CONTENT" tab, elements can be moved in the desired position in a list).

    - *Display*: it's the default display behavior of the members. The options are Desc (displays the description of the member), Code (displays the code of the member) and Both (displays code and description for each member).
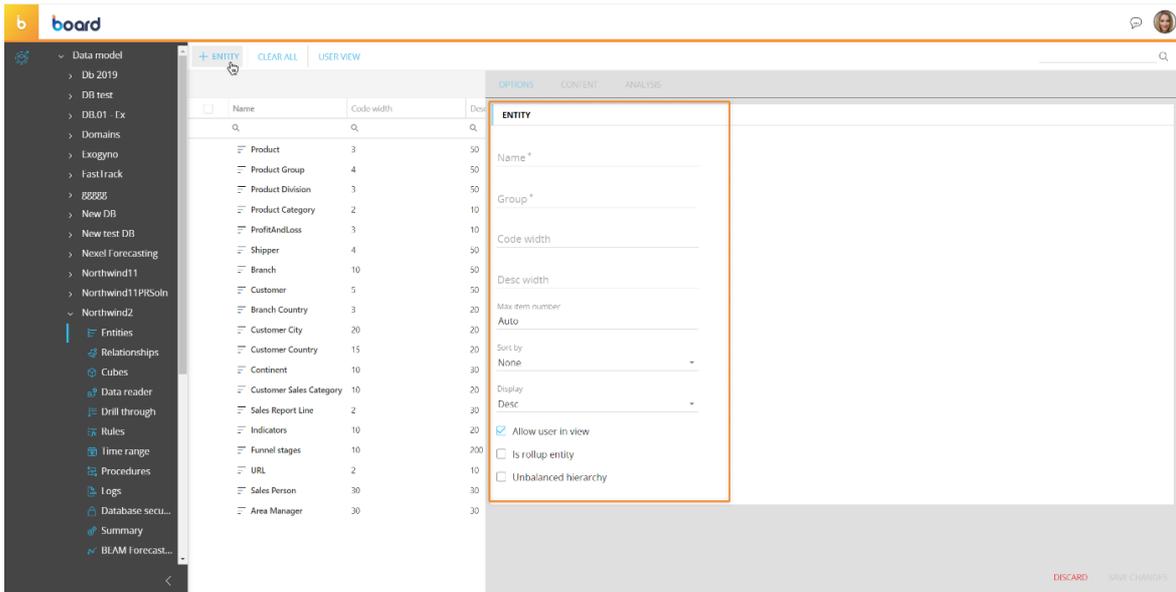
Figure 2.8 *Creation of an Entity.*

4. The *creation of hierarchies*: in the Relationships section through the definition of many-to-one relationships between two Entities, that we can refer to as *parent Entity* and *child Entity*. An example of a typical relationship is shown in Figure 2.9 below: customer and customer category are respectively child and parent Entities as a customer can only be in one customer category and one customer category includes several cities.
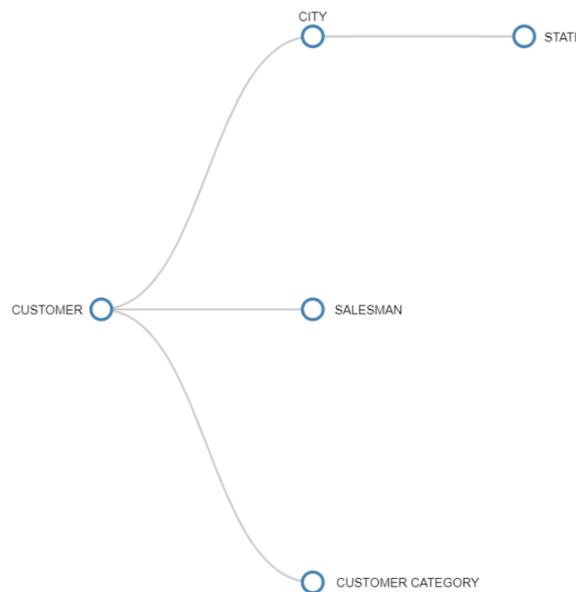

Figure 2.9 *Example of a typical relationship between Entities.*

The absence of hierarchical structures may lead to inconsistency and redundancy of data.

5. The *creation of Cubes*: to perform this operation it's necessary to click on "+ CUBE" in the Cubes section. Like for the creation of Entities, it's possible to assign a Name and logically group cubes for improving understanding.

   Each Cube can have a structure from 1 to 32 dimensions, but it's always suggested not to exceed the number of 8 dimensions because otherwise it would be hard for end-user to understand.

6. *Loading of data*: to import data into Board, *Data Readers* are created (in the Data Reader section of the Data Model), which also allow the mapping of data to Entities, Relationships and Cubes.

   Board allows to connect and integrate data across different sources like Excel, CSV, TXT files, enterprise applications (e.g. SAP ERP), relational databases and Data Warehouses, Web Services, cloud based sources.

2.2.5 System Administration

The access to all these areas presented in previous paragraphs is managed through different categories of licenses and other security settings specified in the System Administration area, which give you an overview about the status of your Board Cloud subscription.

There exist different types of *licenses* in Board and each one of them allows the access to certain services and functionalities defined for that specific license. There most commonly used are:

- *Lite*: one has the ability to view the various environments, without being able to edit;
- *Lite Plus*: one has the ability to do data entry, that is, to enter data in Data Views;

- ***Power User***: one has the ability to change the design of the environment and do data entry;
- ***Developer***: one has the ability to change the design, do data entry and modify the database.

In the Board there's a specific "*Licenses*" section in the System Administration area (Figure 2.10 below) which allows you to check your *License Status* and how many days are left before it expires. Also, it's possible to see the amount of users associated to each one of those types of license and their maximum capacity available.

For example, "5/50" means there exists five registered users at the moment, consuming the Developer license, out of a maximum of fifty.

Figure 2.10 *Licenses section in Board*

CHAPTER 3

Business Case: UTIL Accounts Closing Flow, Forecast & Budget Flow, Master Reporting

The following chapter will analyze a Business Case, related to a project of economic and management development of the *UTIL* company, a client of Bios Management Std., with a specific look at the Accounts Closing Flow, Forecast and Budget aspects, and Final Reporting, by using the platform Board. Three Capsules (shown in Figure 3.1) created specifically for the customer will be analyzed in detail.
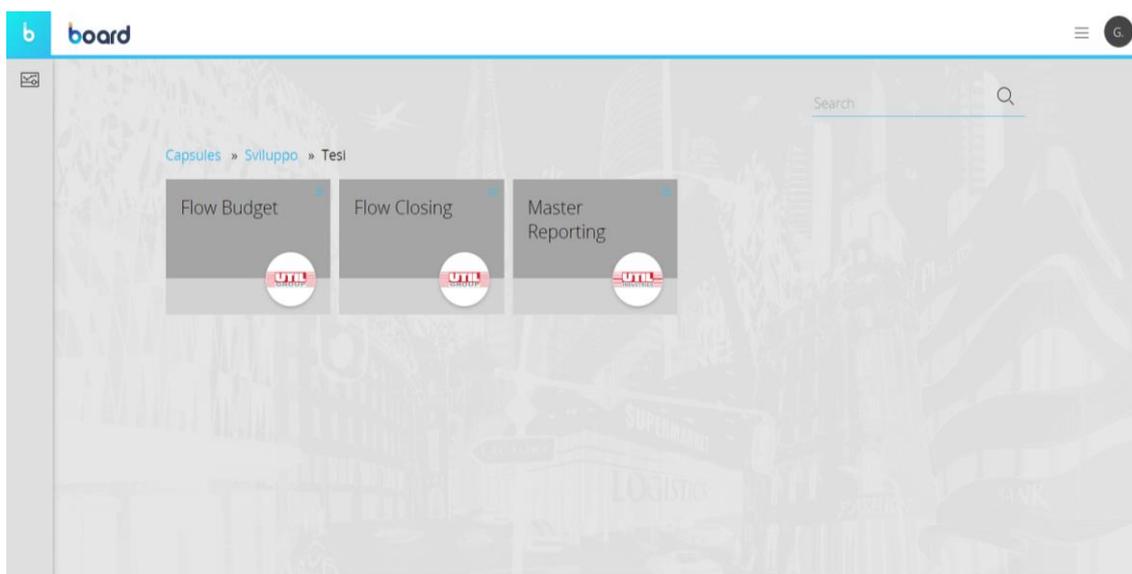
Figure 3.1 Capsules created for UTIL company.

UTIL is a company founded in 1959, involved in the production of parts for brake systems for the automotive sector mainly, but also developing technologies and innovative products for agricultural and earthmoving machines, construction, household appliances, electrical mobility.

Some of the values have been hidden and those numerical values shown, have been adjusted by a multiplicative factor for privacy reasons.

3.1 Accounts Closing Flow

By clicking on the *"Flow Closing"* Capsule the user accesses Screens which allow him to perform data imports and accounts closures. The latter represent a snapshot of the accounting situation, which can be performed both for the Income Statement and the Balance Sheet.

The first Screen (shown in Figure 3.2 below) allows a first choice of performing closing operations on values of Income Statements or Balance Sheet.
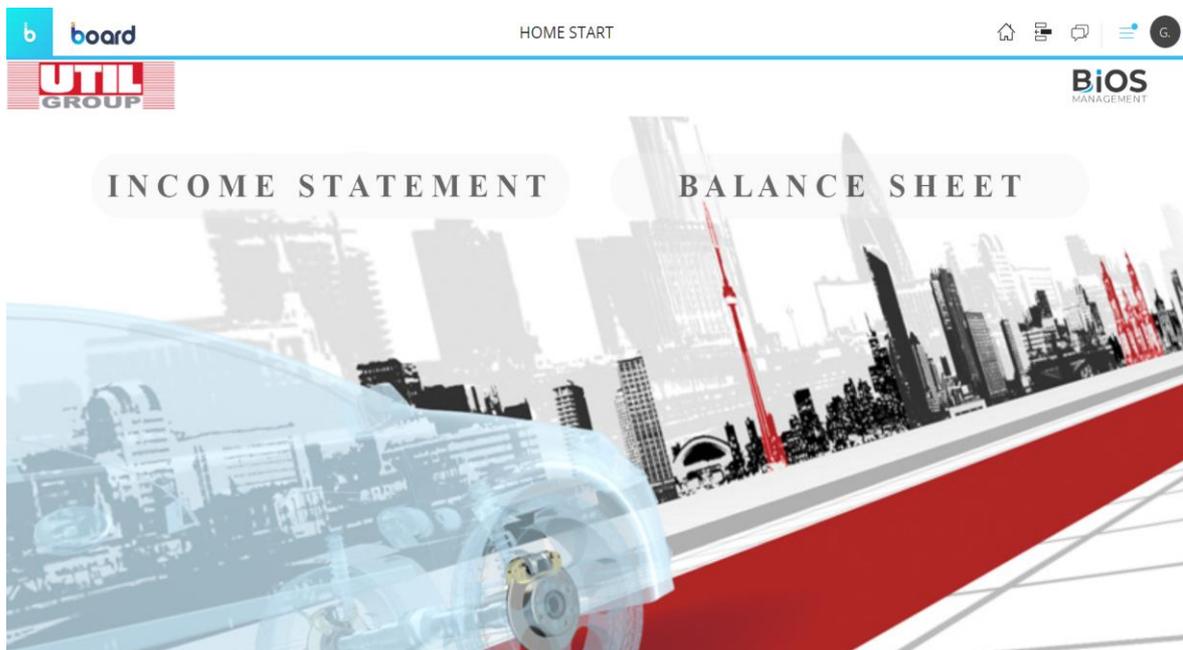
Figure 3.2 First Screen of choice between performing closing operations on the Income Statement or on the Balance Sheet.

By clicking on one of the two Labels, a "Go to Screen" action is activated and in both cases the user switches to a Home Page Screen (as shown in Figure 3.3).

The flow will be the same both for Income Statement and Balance Sheet values, so only Screens for the Income Statement accounts closures will be presented, considering it identical for the Balance Sheet accounts closures.

All Labels present in the Home Page Screen will activate "Go to Screen" actions. Each landing Screen will allow to perform a flow of operations which will be analyzed in detail in next paragraphs.
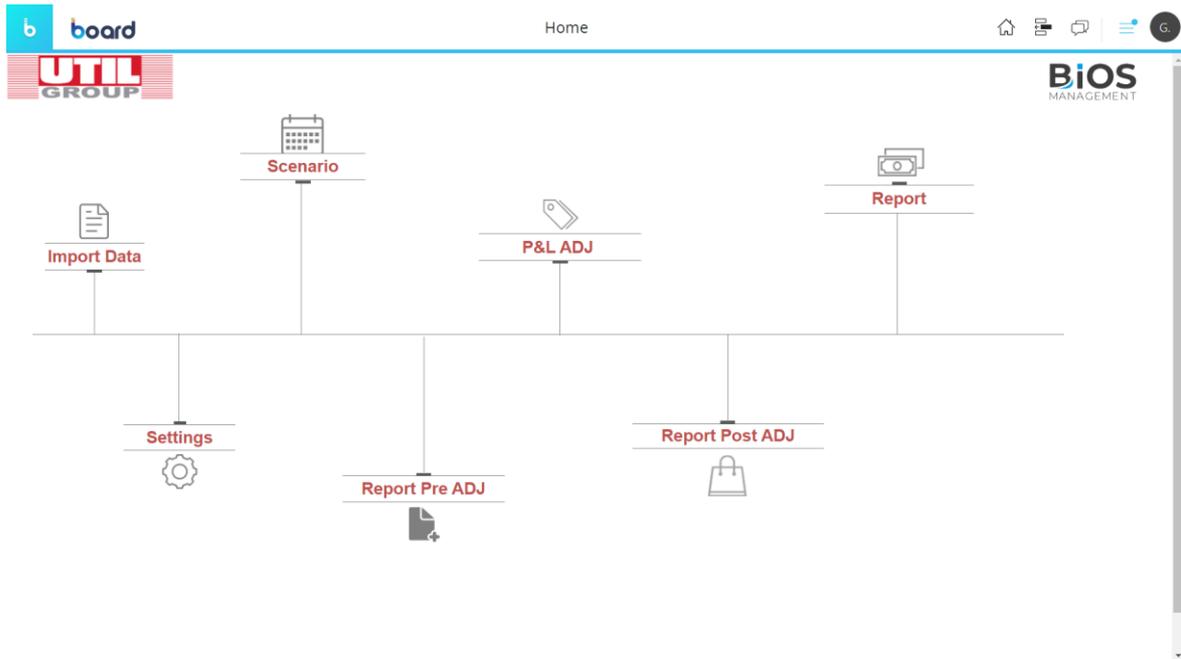

Figure 3.3 *Home Page Screen for both the Income Statement and Balance Sheet choice.*

There are some elements which will be present in every Screen accessible through the Home Page Screen and those elements are defined in a *Mask* (Figure 3.4 below).

Screen Masks allow an easy configuration of some graphical properties of Screens, providing some common elements and a common style. Whenever a Mask is updated, all Screens will reflect the change applied.

In this case the Mask applied contains:

- The *logo of the client company* (Util Group) in the upper left corner and the *logo of the consulting company* (Bios Management). Usually to the logo of the client company is associated a "Go to Screen" action to the Home Page.

- A synthetic version of the *navigation bar* present in the Home Page, which will allow the switching between the different Screens.

- On the left side of the Mask there's a label "@Screen", which will report the name of the Screen in which the User is in, and some *Selectors*. Selectors elements allow the User to make some selections associated to an Entity: it's particularly useful on Screens with limited space or when the associated Entity contains a large number of members. The first one is a Selector of the type "Vertical List" on the Entity called "Legal Entity", the second and third are Selector of type "Pop-up window" on "Cost Center" and "Analysis Item" Entities and then there's another one of "Vertical List" type on "Year". On the bottom, thanks to the label "@Selection" it's possible to show *active selections* in all Screens.
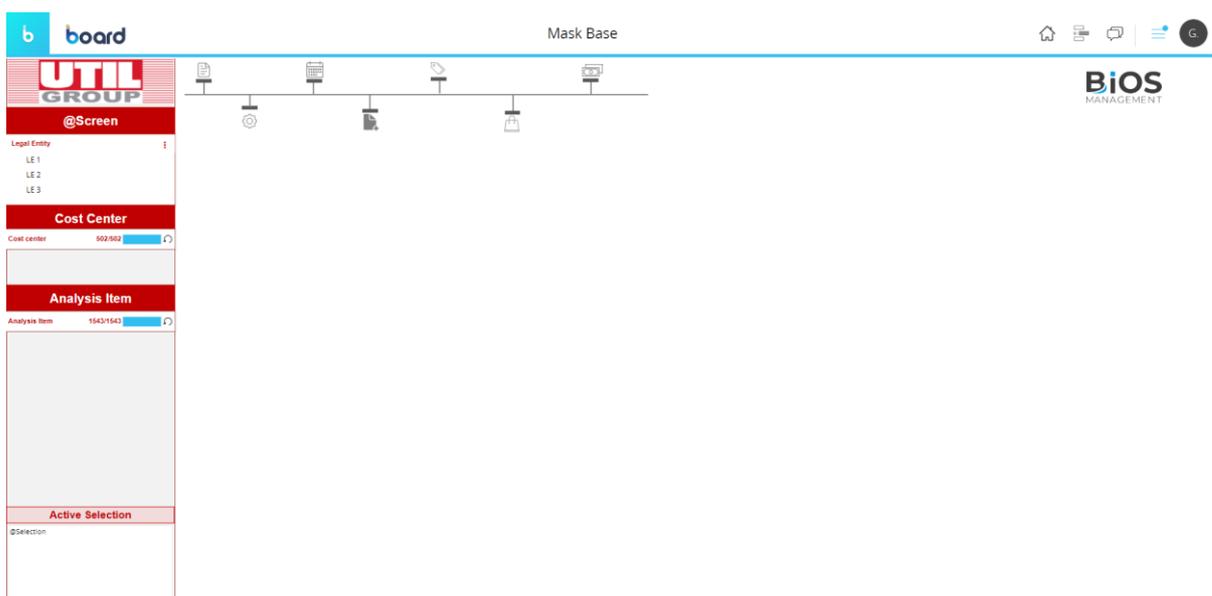
Figure 3.4 *Mask applied to all Screens of the "Closing Flow" Capsule.*

3.1.1 Import Data

By clicking on "Import Data" Label in the Home Page, it's possible to access the first Screen (Figure 3.5) in which we can find two elements: a Label and a Data View.
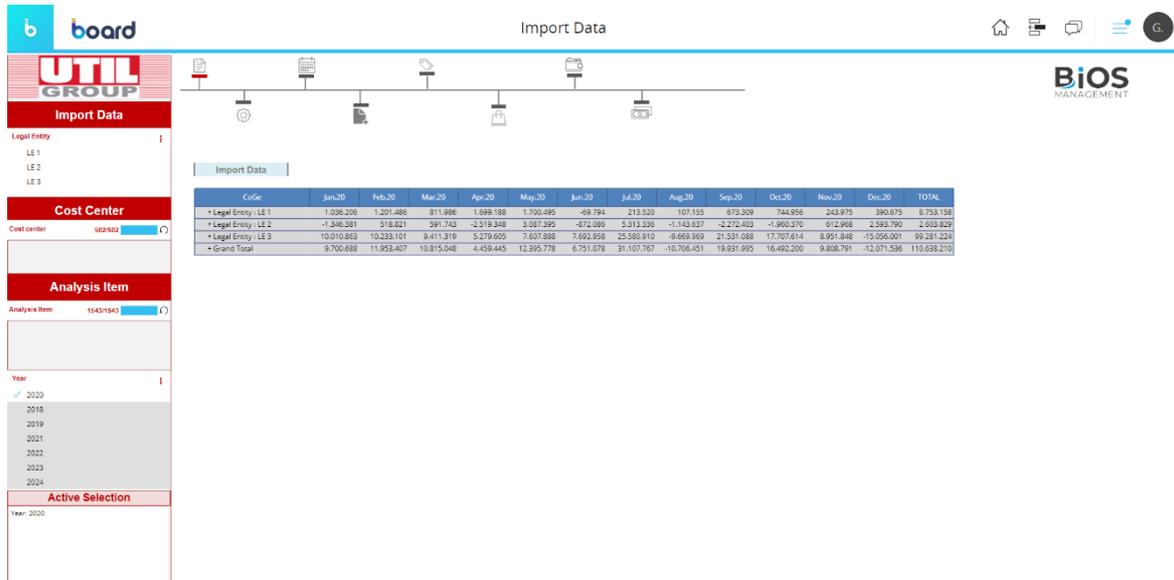

Figure 3.5 *Import Data Screen.*

If the User click on the Label captioned "Import Data", a "Run Procedure" action will start. In the settings of the Label, the Data Model of reference and the name of the Procedure should be specified.

The Procedure has been developed in the Procedures section of the Data Model area of Board and it consists in the import of general ledger data in a Cube called "C001_CoGe" (structured by the Entities: Month, Analysis Item, Account Number, Legal Entity and Cost Center), also represented in the Data View present in the Screen.

In the settings of the Data View (shown in Figure 3.6) it's possible to see the Cube represented and also the Entities that have been set by row (Legal Entity and Analysis Item in this case) and those set by column (Month in this case).
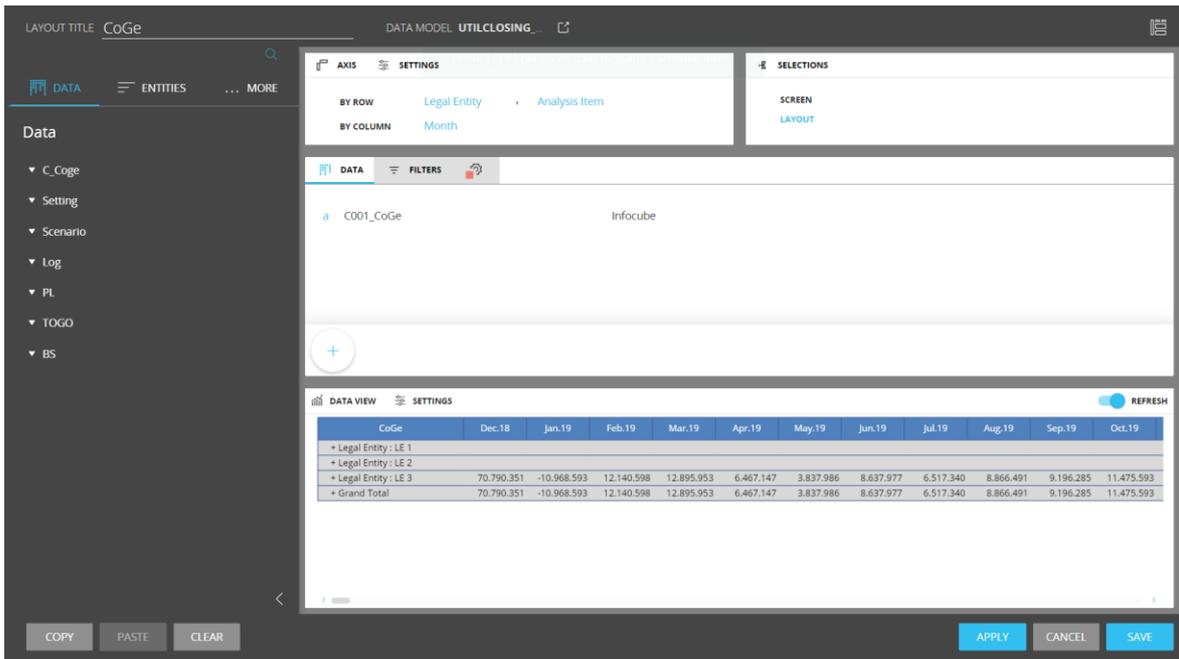
Figure 3.6 *Settings of the Data View.*

3.1.2 Settings

In the Settings Screen (Figure 3.7), to the User is given the possibility to associate to each value of Analysis Item and Cost Center a specific line of the Income Statement (Profit & Losses Statement).

The element present in the Screen is a Tab, which allows the presence of more sheets in the same element: in this case in the first sheet (shown in Figure 3.7) the User can see in the Data View the associations already present, in the second sheet (shown in Figure 3.8) there's a Data View having by row Cost center and Analysis Item.

The setting of the Data View shown in the second sheet allows to perform a "Drill Down" operation by double clicking on each check box to make associations.

Figure 3.7 Settings Screen showing the first sheet of the Tab element.

Figure 3.8 Settings Screen showing the second sheet of the Tab element.

A window as shown in Figure 3.9 will show up and it will be possible to check the "PL Line" of the Income Statement desired.
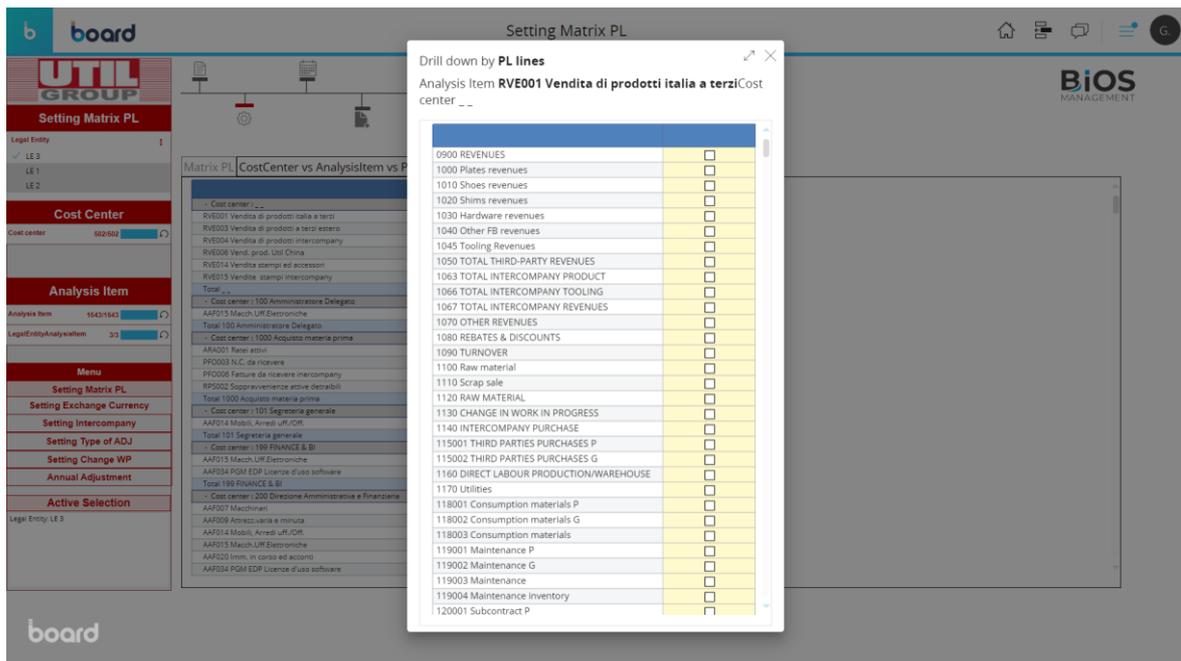
Figure 3.9 *Drill down operation which allows the association.*

3.1.3 Scenario

The Scenario Screen (Figure 3.10) consists of three parts:

- The first one is made up of an Entity Editor element which allows the *creation of a new member of the Entity called "Scenario"* by clicking on the "+". A window will show up asking for a Code a Description. Also, because there exists a relationship between "Scenario" and "Type Scenario" Entities, the user should also choose which value of the "Type Scenario" Entity chose between 3 options: Work, Comparison and Other. There will be one Scenario in Work and it will be possible to choose another one for Comparison.

- In the second section of the Screen, there are two Data Views. The Data View on the left shows the list of the members of the Entity "Scenario" and by clicking on yellow cells it's possible to change the "Type Scenario" state.

For the Scenario in Work, thanks to the Data View on the right, it will be possible to chose months of reference: for example, if the Scenario in Work is "202107_01 July closing 2021", months from January to July 2021 included will be checked in the yellow column.

- In the third section, a Label captioned "Initialize Scenario" allows the run of a Procedure. The Procedure has been developed in the Procedures section of the Data Model area of Board and it consists in passing data in a new Cube equal to C001_CoGe but having the Entity "Scenario" in addition, in which accounts closures will be saved.

Figure 3.10 *Scenario Screen.*

3.1.4 Report Pre-Adjustments, P&L Adjustments, Report Post-Adjustments and Consolidated Report.

The following Screens of the Accounts Closing Flow will be:

- *Report Pre-Adjustment* (Figure 3.11), which will show a Data View representing the Cube initialized in the "Scenario" Screen before,

showing for each Legal Entity (by column) the Income Statement for the Scenario in Work and for the one in Comparison.

Also, a column with values in % and a column showing the delta between the two is present.

- *P&L Adjustments* (Figure 3.12), which will allow to insert some manual adjustment to all the values in the "PL lines" of the Income Statement (totals excluded) for the Scenario in Work. This is done thanks to the Data Entry option which has been configured for the "ADJ" column.

  The "TOTAL" column will show the value updated with the adjustment. Thanks to the Label captioned "Save ADJ" all changes will be saved thanks to a dedicated procedure.

- *Report Post-Adjustments* (Figure 3.13), which will contain a Data View representing the Income Statement with "ACT+ADJ" values for the Scenario in Work, for each Legal Entity.

  Also, two Cartesian objects are present on the right part of the Screen, configured as bar diagrams and showing the % of Gross Margin on Revenues and the % of EBITDA on Revenues for the three Legal Entities.

- *Consolidated Report,* which will contain a Tab object showing in the first sheet (Figure 3.14) the Income Statement actual and after adjustment in the local currency of each Legal Entity, in the second sheet (Figure 3.15), actual and after adjustments values of the Income Statement for the three Legal Entities have been converted in the group currency, which is the Euro, and summed.
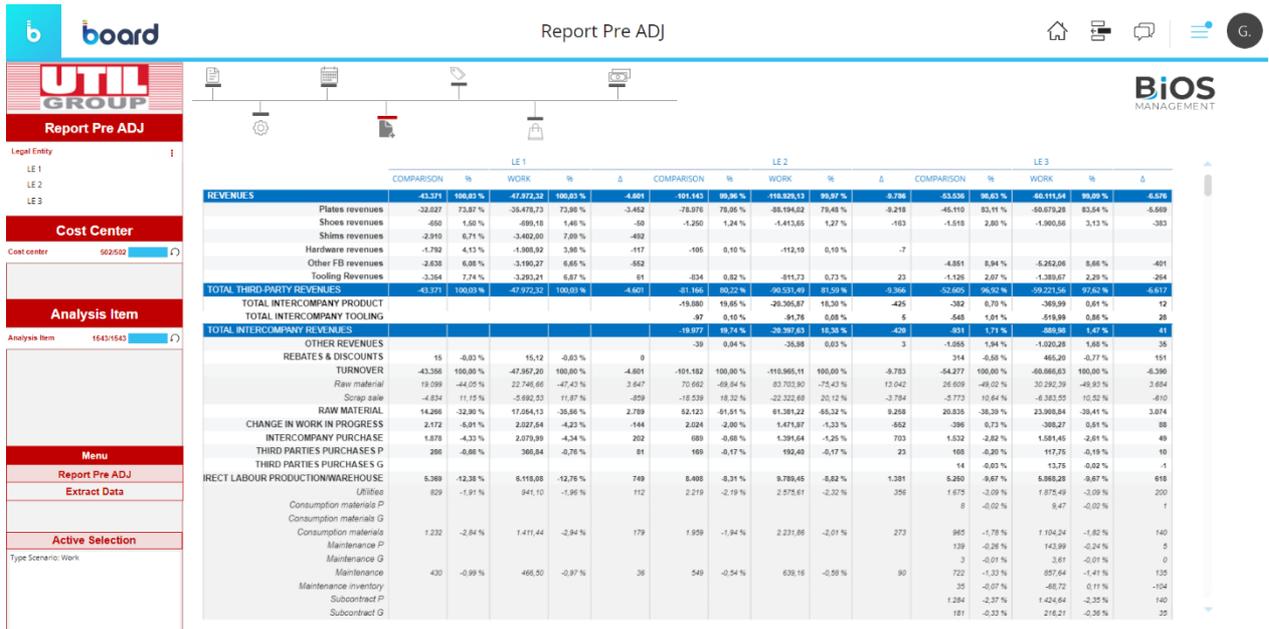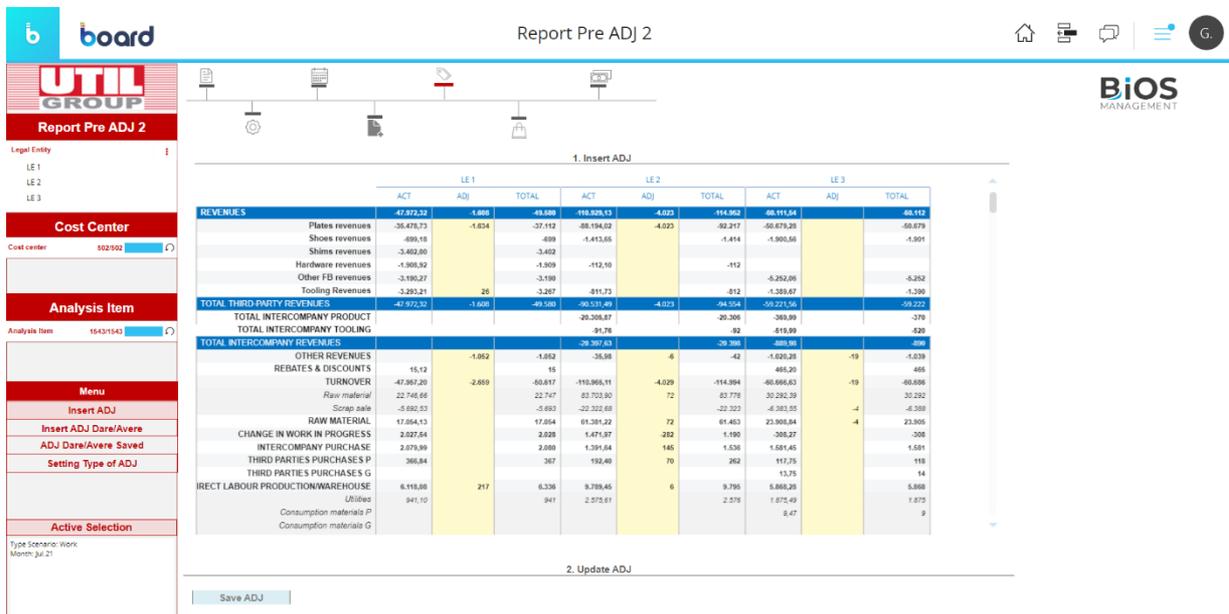
Figure 3.11 Report Pre-Adjustments Screen.

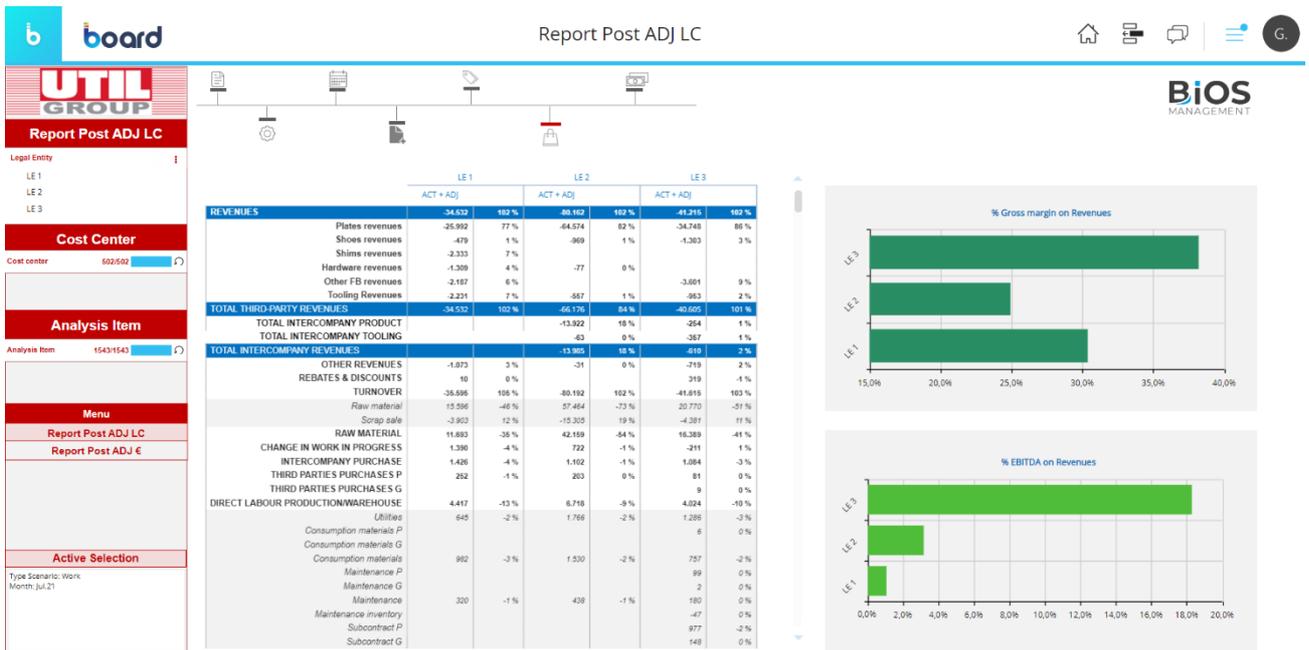*Figure 3.12* Insert Adjustments Screen.

Figure 3.13 *Report Post-Adjustments Screen.*
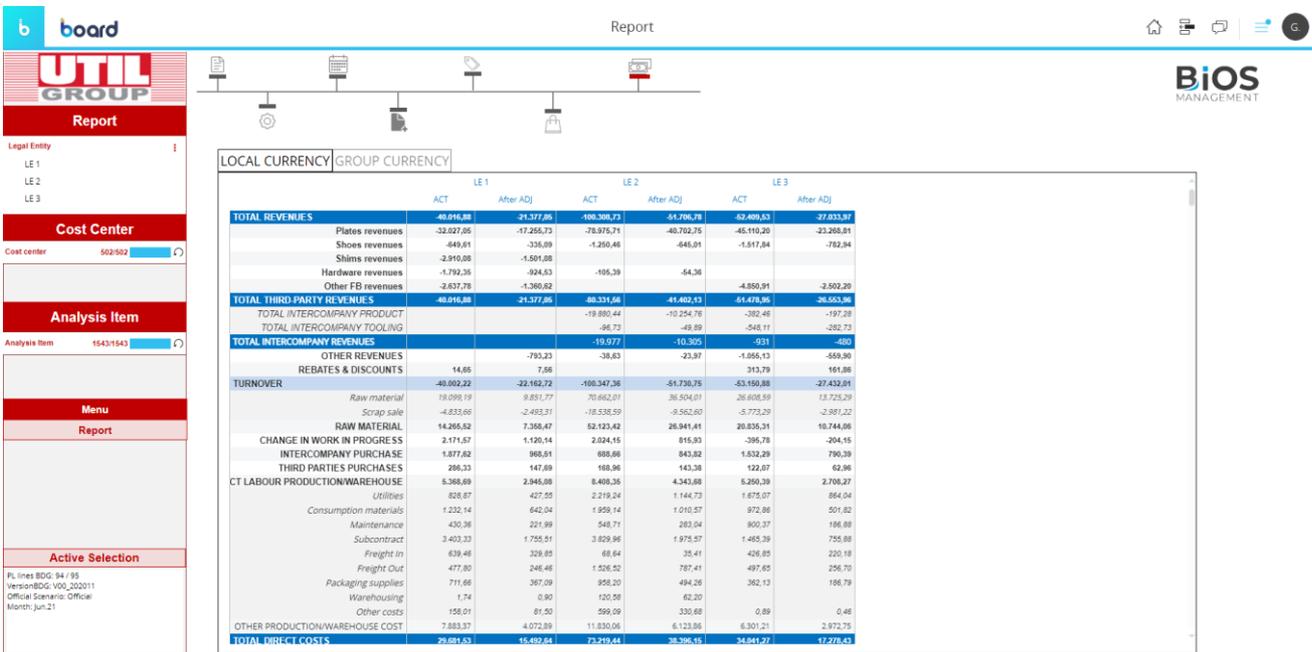
Figure 3.14 *Consolidated Report Screen, Local Currency sheet.*

Figure 3.15 *Consolidated Report Screen, Group Currency sheet.*

3.2 Forecast & Budget Flow

By clicking on the "*Flow Budget*" Capsule (Figure 3.1 at the beginning of Chapter 3) the user accesses Screens which allow him to calculate the Forecast and the Budget. Both are fundamental tools for management control activities, but they differ in the period of analysis: the Budget is a foresight made on the following year, the Forecast is a foresight on the current year.
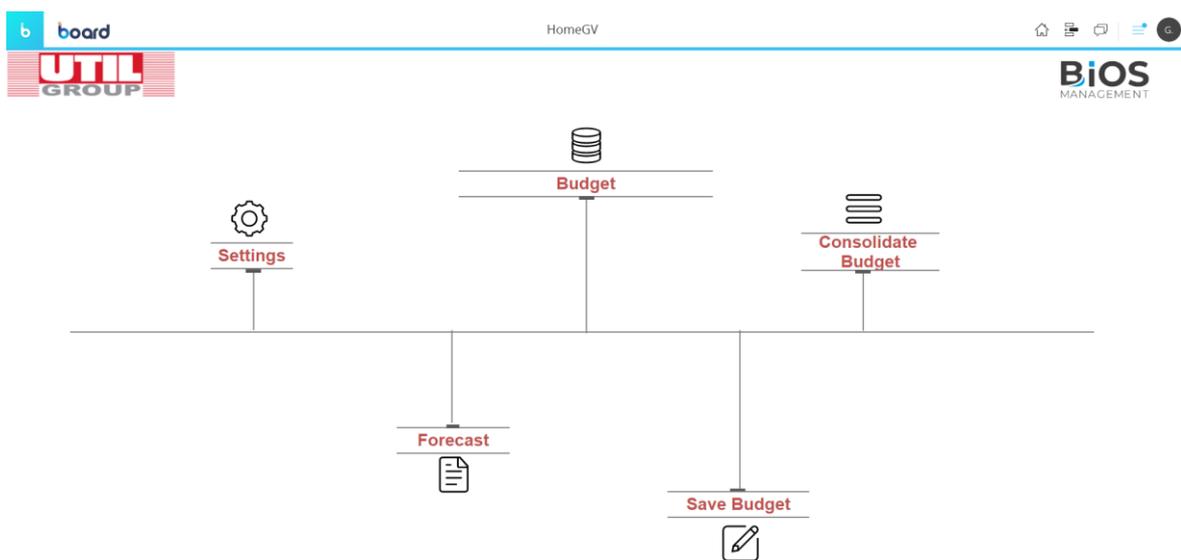
Figure 3.16 *Home Page Screen for the "Flow Budget" Capsule*

The first Screen (shown In Figure 3.16 above) is a Home Page Screen and all Labels present will activate "Go to Screen" actions. Each landing Screen will allow to perform a flow of operations which will be analyzed in detail in next paragraphs.

There are some graphical properties and elements which will be present in every Screen accessible through the Home Page Screen and those elements are defined in a *Mask* (Figure 3.17 below).
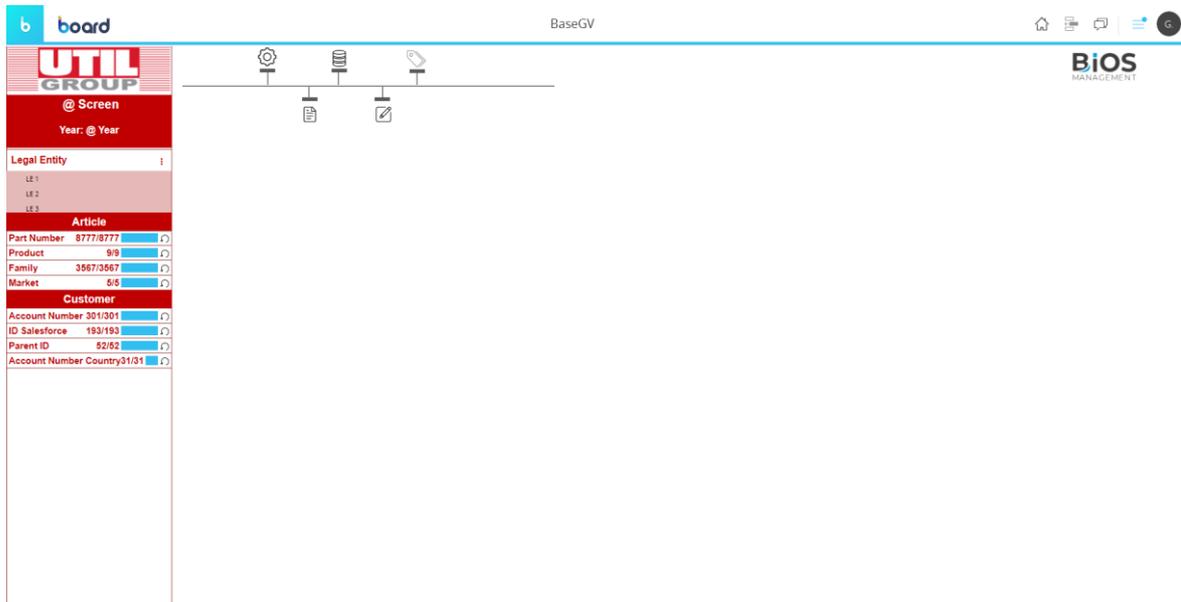
Figure 3.17 *Mask applied to all Screens of the "Flow Budget" Capsule.*

For the "Flow Budget" Screens, the Mask applied contains:

- The *logo of the client company* (Util Group) in the upper left corner and the *logo of the consulting company* (Bios Management) in the upper right corner. Also in this case, the logo of the client company is associated a "Go to Screen" action to the Home Page.

- A synthetic version of the *navigation bar* present in the Home Page, which will allow the switching between the different Screens.

- On the left side of the Mask there's a label "@Screen", which will report the name of the Screen in which the User is in, and "@Year", which will show the active selections on the Entity "Year". Then, some *Selectors* are present: one of the type "Vertical List" on "Legal Entity" and a series of "Pop-up window" Selectors on many different entities ("Part Number", "Product", "Family", "Market", "Account Number", "ID Salesforce", "Parent ID", "Account Number Country").

3.2.1 Settings

The first Screen of the "Flow Budget" Capsule is about Settings (Figure 3.18 below).
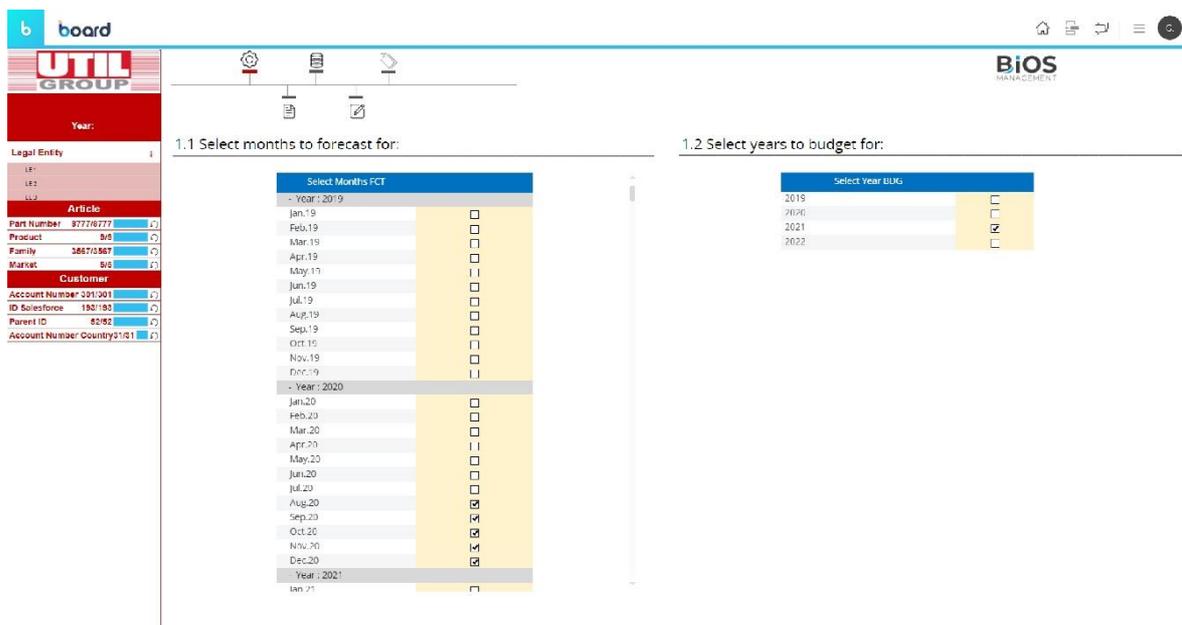
Figure 3.18 *Settings Screen.*

This Screen is composed by two different parts: in the first part it's required to perform a selection on the months for which the user wants to run the forecast, in the second part it's required to select years to budget for.

Both the selections are performed via two Data Views, having by rows the Entities "Year" and "Month" for the one on the left and "Year" for the one on

the right, thanks to the Data Entry setting. For example, if in the "Closing" Capsule the Closing Scenario in Work is referred to July 2020, the months to be selected for the Forecast are those from August to December 2020 (as in Figure 3.18) and the year selected for the Budget is 2021.

3.2.2 Forecast

The Forecast Screen (shown in Figure 3.19 below) allows to perform a foresight on the current year, on months selected in the previous Screen of Settings. The Screen is composed by a first part which allows the choice of the type of Forecast and a second part which shows the Forecast result.

Two Forecast options can be selected due to the presence of two Labels captioned "Forecast 1" and "Forecast 2":
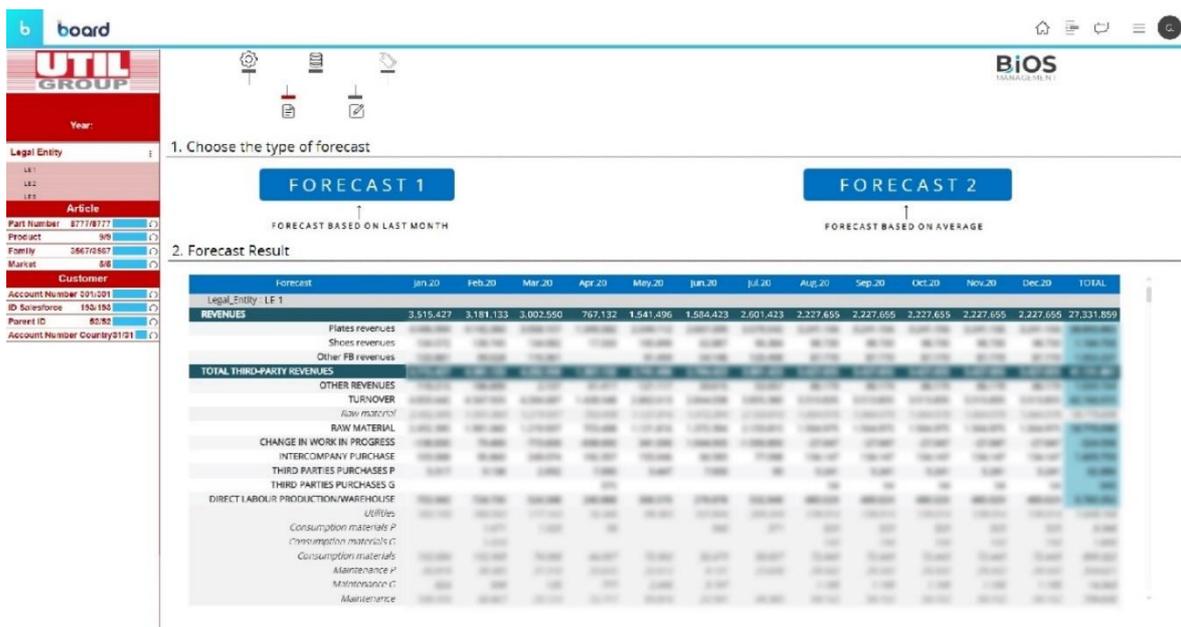
Figure 3.19 *Forecast Screen showing the result of "Forecast 1" Procedure.*

- "Forecast 1" choice allows the run of a Procedure which consists in a very simple Forecast: the value of last Month available in the Closing Scenario in Work is assigned to all months for which the Forecast has to be performed.

In Figure 3.19 it's show the result from the choice of this type of Forecast, in fact, being in Work the Closing Scenario referred to July 2020, from this month onwards we can find the same value of Revenues for the months selected for the Forecast (from August to December). The same is for all the other P&L lines of the Income Statement.

The Procedure, named "Forecast_1", developed in the Procedures section of the Data Model area of Board, is shown in Figure 3.20 below and will be explained more in detail. It is composed by different actions:

1. First of all, a message is shown asking "Do you want to execute Forecast 1?". A Yes/No answer is required to the user and in case of "No" Board will exit from the Procedure execution.

2. The Scenario in Work is selected.

3. Cubes "A005_AppoggioFORECAST" and "C007_Forecast" are cleared, so that they will result as empty.

4. A Data Flow action populates the Cube "C007_Forecast" with the values contained in the Cube of Closings (in particular, with those of the Scenario in Work, because of the Selection performed previously).

5. A dynamic Selection on last month available (July 2020 in this case) on the Cube "C007_Forecast" is performed.

6. A Data Flow action populates the Cube "A005_AppoggioFORECAST" with the values contained in the Cube of Closings (in particular, with the value of July 2020 selected previously in all the months from January to December).

7. A "Select entity based on cube" action is performed on the Cube "A003_SelectMESI_FCT", which contains the months selected for the Forecast in the Screen of Settings.

8. A Data Flow action populates the months selected in the previous action of the Cube "C007_Forecast" with the values of the Cube "A005_AppoggioFORECAST".

9. The Screen is refreshed so that the result will be the one shown in Figure 3.19.

10. The message "Forecast 1 executed!" is shown.

11. Board will exit from the Procedure execution.

Figure 3.20 "Forecast_1" Procedure

- "Forecast 2" choice instead allow the run of a Procedure which consists in a Forecast based an average calculated on the months of the Closing Scenario in Work.

3.2.3 Budget

The Budget Screen (shown in Figure 3.21 below) allows to perform a foresight for the year selected in the previous Screen of Settings.
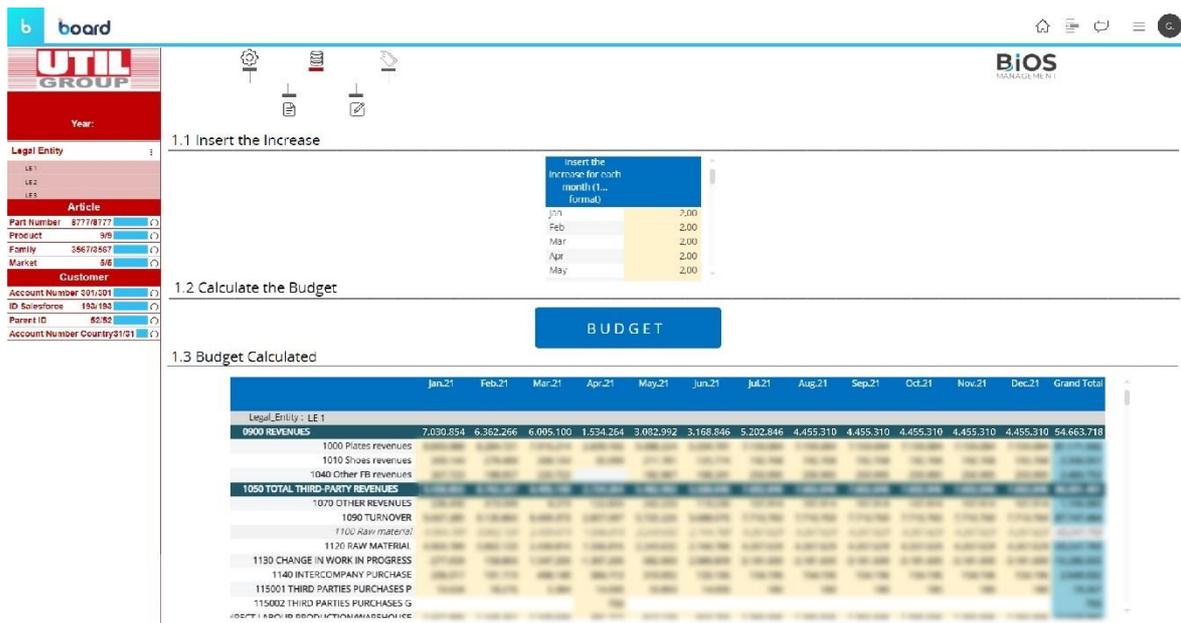
Figure 3.21 *Budget Screen*

The Screen is composed by three different parts:

- In the first part, the user has the chance to insert an increase for each month (in the format 1,…) thanks to a Data Entry setting applied to the Data View showing the Cube "C010_Incremental". In Figure 3.21, the user has inserted 2,00 for all the months, so he wants to double all the values of Forecast.

- In the second part a Label captioned "BUDGET" is present and by clicking on it a Procedure will be executed. The Procedure, named "Budget", developed in the Procedures section of the Data Model area of Board, is shown in Figure 3.22 below and will be explained more in detail. It is composed by different actions:

  1. First of all, a message is shown asking "Do you want to execute Budget?". A Yes/No answer will be required to the user and in case of "No" Board will exit from the Procedure execution.

  2. The Scenario in Work is selected.

  3. Cube "C008_BDG" is cleared, so that it will result as empty.

4. A Data Flow action populates the Cube "C009_FORECASTNoAnno" with the values contained in the Cube "C007_Forecast". The difference between the two Cubes is that "C007_Forecast" has the Entity "Month" in is its structure, while "C009_FORECASTNoAnno" has the Entity "MeseNoAnno", which contains all the Months, disjointed from the year of reference.

5. A "Select entity based on cube" action will be performed on the Cube "A004_SelectANNO_BDG", which contains the year selected for the Budget in the Screen of Settings.

6. A Data Flow action will populate the Cube "C008_BDG" with the values of the Cube "C009_FORECASTNoAnno" multiplied by the Cube "C010_Incremental".

7. The Screen will be refreshed so that the result will be the one shown in Figure 3.21.

8. The message "Budget executed!" is shown.

9. Board will exit from the Procedure execution.

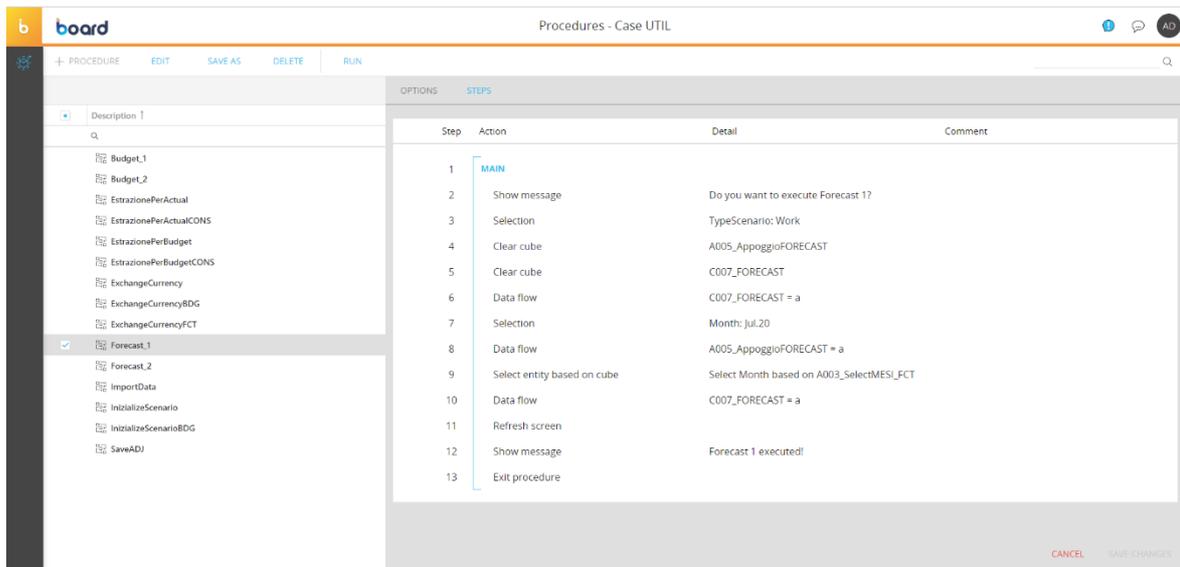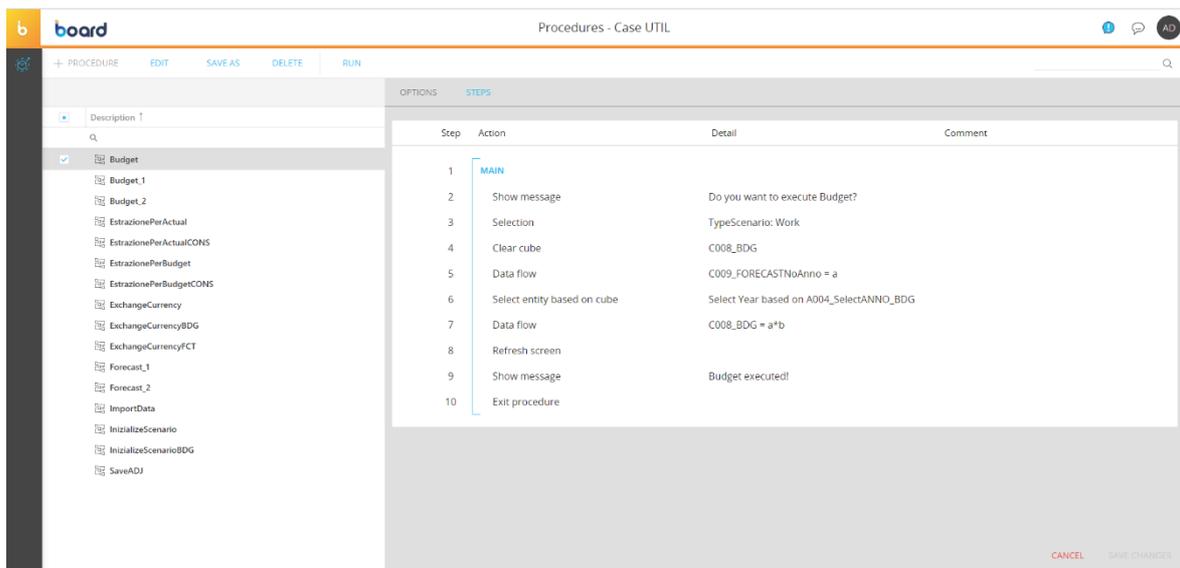*Figure 3.22* "Budget" Procedure.

- In the third part, the result of the Budget execution will be shown in a Data View.

3.2.4 Save Budget
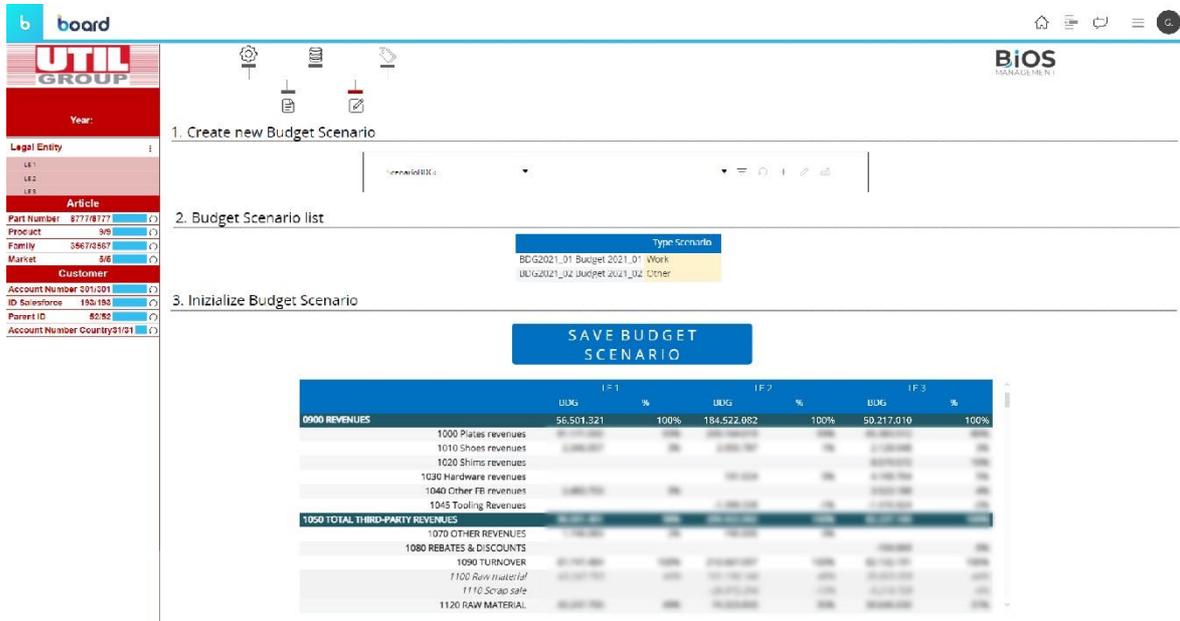
Figure 3.23 *"Save Budget" Screen.*

The Save Budget Screen (Figure 3.23 above) consists of three parts:

- The first one is made up of an Entity Editor element which allows the *creation of a new member of the Entity called "ScenarioBDG"* by clicking on the "+". A window will show up asking for a Code a Description.
  Also, because there exists a relationship between "ScenarioBDG" and "TypeScenarioBDG" Entities, the user should also choose which value of the "TypeScenarioBDG" Entity chose between 2 options: Work and Other.
- In the second section of the Screen, there's a Data View which shows the list of the members of the Entity "ScenarioBDG" and by clicking on yellow cells it's possible to change the "Type Scenario" state.

- In the third section, a Label captioned "Save Budget Scenario" allows the run of a Procedure. The Procedure, named "InitializeScenarioBDG" has been developed in the Procedures section of the Data Model area of Board and it consists in passing data in a new Cube equal to C008_BDG, but having the Entity "Scenario" in addition, in which Budget Scenarios will be saved. This Cube is called "C011_BDGScenario" and is also represented in a Data View having by columns the different Legal Entities.

3.2.5 Consolidated Budget

The last Screen of the Forecast & Budget Flow it's the Consolidated Budget Screen, shown in Figure 3.24 below. It will contain a Data View object showing the values of the Cube "C011_BDGScenario" converted in the group currency, which is the Euro, and summed (so, no longer splitted by Legal Entity).

Figure 3.24 *"Consolidated Budget" Screen.*

3.3 Master Reporting

By clicking on the "*Master Reporting*" Capsule (Figure 3.1 at the beginning of Chapter 3) the user accesses Screens which allow him to have an overview of the Company's situation through a series of reporting Screens.

The first Screen (shown In Figure 3.25 below) is a Home Page Screen.

Figure 3.25 *Home Page of the Master Reporting Capsule.*

All Labels present will activate "Go to Screen" actions. It's possible to access to three different sections (Actual, Budget and Variances) for both Local values (divided by Legal Entity, in their local currency) and Consolidated values (in the group currency which is Euro).

There are some graphical properties and elements which will be present in every Screen accessible through the Home Page Screen and those elements are defined in a *Mask* (Figure 3.26 below).

Figure 3.26 *Mask applied to all Screens of the Master Reporting Capsule.*

For the "Master Reporting" Screens, the Mask applied contains:

- The *logo of the client company* (Util Group) in the bottom left corner and the *logo of the consulting company* (Bios Management) in the bottom right corner. Also in this case, the logo of the client company is associated a "Go to Screen" action to the Home Page.

- In the blue bar on the top of the Mask there's a *Label named "@Screen"*, which will report the name of the Screen in which the User is in. Then, three labels named "Actual", "Budget" and "Variances" will allow a fast switch through Local and Consolidate Screens.

- Below, some *Labels and Selectors* are present : from right to left it's possible to find a Label named "Selected Period: @Selection_Ex(Entity="Month",Interval="Range") which always indicates the reference period, two Labels named "CM" (which stands for "Current Month") and "PM" (which stands for "Previous Month") which allow to choose the period shortcut and a "Pop-up window"

Selector on "Month". Also, some space is left empty, so that in every Screen there will be some specific Labels/Selectors.

Screens of Local Actual, Budget and Variances are presented in Figures 3.27, 3.28, 3.29 below.

In the *Screen of Local-Actual Master Reporting* (Figure 3.27 below) we can find different elements:

- On the left, there's a Data View showing Income Statement (P&L values).

- On the right, two Cartesian objects are present configured as bar diagrams and showing the Monthly Distribution of Direct Costs and the Monthly Distribution of Revenues and EBITDA. The first one has a Layout Selection on values of Direct Costs of the "P&L Lines" Entity ("Raw Material", "Change in Work in Progress", "Intercompany Purchase", etc.), the second one has a Layout Selection on values of "Revenues" and "EBITDA" of the "P&L Lines" Entity.

Figure 3.27 *Screen of Local-Actual Master Reporting.*

In the *Screen of Local-Budget Master Reporting* (Figure 3.28 below) we can find different elements:

- On the left, there's a Data View showing Income Statement (P&L values).
- On the right, there are two different elements. On the top, there are some values highlighted (Revenues, EBITDA, EBIT and Net Profit) for all the different Legal Entities; all these elements are Labels. On the bottom, there's a Cartesian object configured as a bar diagram, showing the Trend of the EBITDA across months.
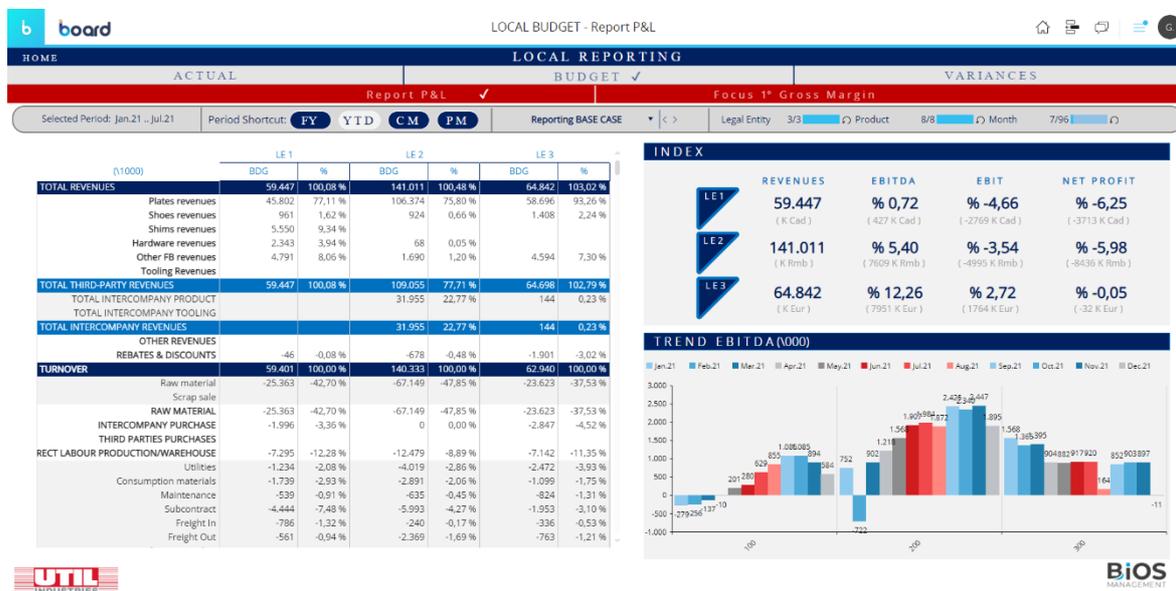
Figure 3.28 *Screen of Local-Budget Master Reporting*

In the *Screen of Local-Variances Master Reporting* (Figure 3.29) we can find different elements:

- On the left, there's a Data View showing Income Statement (P&L values). In Figure 3.29 the selected period is July 2021, which is the value of ACT (Actual), BDG (Budget) is referred to July 2022 and the PY (Previous Year) is referred to July 2020. Columns "PY vs BDG" and "ACT vs BDG" will show the variances.

60

- On the right, there are different elements. On the top, there are two Gauge elements, showing the values of ACT and BDG of Revenues and EBITDA for the Entity selected (in Figure 3.29 is LE3). On the bottom, there are two Cartesian objects configured as a bar diagram, showing Revenues by Product and the detail of Direct Costs.
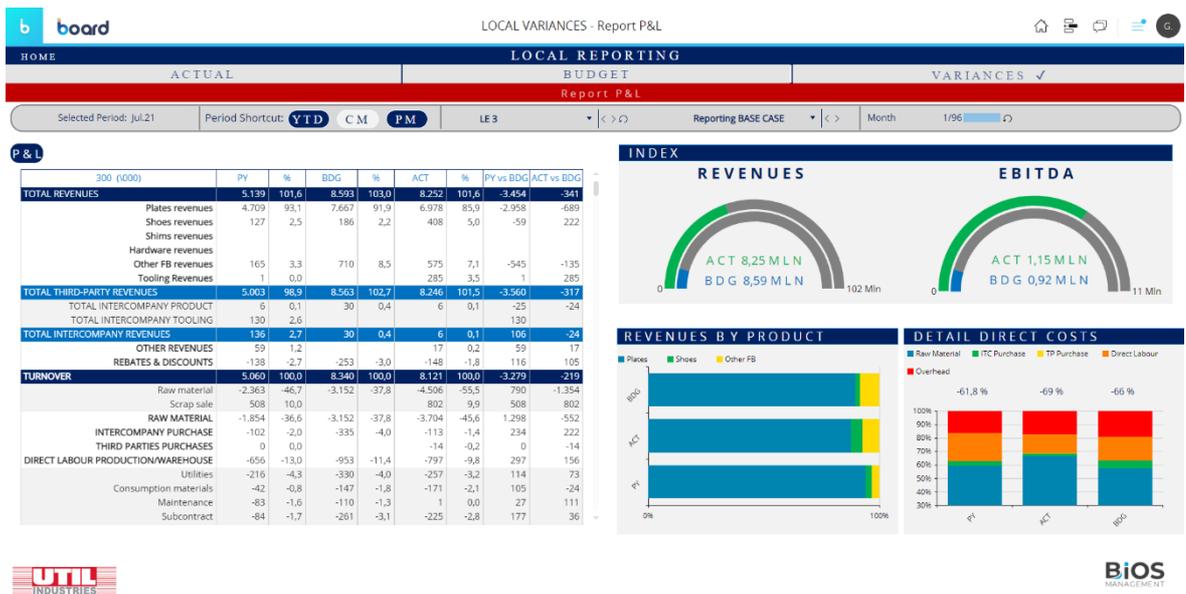
Figure 3.29 Screen of Local-Variances Master Reporting

CHAPTER 4

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

4.1 The job of the BI consultant

Most companies do not have the in-house technical and engineering skills to undertake a BI project on their own. *It is common for them to engage a consulting firm to support them in this transformation process*, which significantly impacts their ability to respond to the market and thus their competitiveness.

The consultant's role consists in analyzing the information handled in the company and creating reports used for decision-making or performance measurement activities. He provides clients with logical or technical solutions for organizing and reprocessing the company's data in a way that ensures an increase in business organization capabilities.

In particular, the consultant must mainly carry out these activities:

- Identify the databases to be used and ensure that the data are complete and up-to-date.
- Organize in different applications the implementation ensuring to meet the needs expressed by the customer.
- Set up the data cleaning and transformation phase
- Define the data structure, then choose the dimensions and metrics to be used and the most appropriate model to use.
- Manage for each database the correct update time and check consistency of schedules.

- Manage the visibility of the different data areas by assigning, to each user/user type, complete access to a certain page or object of analysis or that restrict its view.

So, to carry out a Business Intelligence project you start with the main problem, check the data you need, and propose a possible solution. Next, one or more applications are built depending on the project, and the result is tested; this phase can also be performed with the client, who can provide examples and propose any changes. Finally, once the prototype has been validated, access rights are assigned to all users in the company, and it is released to them. After release, a maintenance phase often follows to incorporate changes and optimizations that the customer requests as they learn to use the tool.

4.2 Choosing the right BI vendor.

The market of Business Intelligence Tools is expected to grow at a significant rate between 2022 and 2029. Furthermore, COVID-19 had a positive impact on demand across all regions subject to the pandemic: BI tools gave the chance to implement advanced analytics to improve decision-making by providing real-time status.

Some of the key players in the BI market includes SAP, Oracle, SAS, IBM, Microsoft and Qlik, each of them with its own strengths and weak points.

The choice of the right software platform, and so it's very different from the purchase of a product or service, there are many points to take into consideration also because of the fact that a software needs maintenance and continuous updating.

New customers, who have no experience using/purchasing BI tools, generally base their choice on a ranking of the technical features that best meet their needs. There are some questions that managers need to ask themselves:

- What is the reason behind the desire to implement BI?
- What the company requirements?
- What is the expected Return on Investment (ROI)?

4.2.1 QFD, HOQ and Q-BENCH Algorithm

Quality Function Deployment (QFD) is a structured format with the goal of *translating client needs into company requirements and technical features*. The basic idea behind is to chase the goal of collecting and directing the design of a product toward the real needs of users; in this sense, the QFD is a valuable tool for a structured approach to design by preceding the development, industrialization and production activities of new products or services.

From an application point of view, the QFD consists of a series of modules each representing schematically the relationships existing between different types of information. The most important module is the ***House of Quality – HOQ***, which is used to *understand customer needs and translate them into the "language of engineers"*.

The construction of the HOQ, goes through several consecutive stages (Figure 4.1 below):

1. ***Customer Needs/Requirements*** (A. in Figure 4.1): this step is referred to as the WHATs. The development of this part requires a sequence of well-organized activities: the determination of customer needs, their location, the prioritization among them, and the evaluation of user perceptions.

2. ***Technical Specifications/Requirements*** (C. in Figure 4.1): also known as HOWs, this step is aimed at the translation of the HOWs into technical

characteristics. The TRs are in fact identified by a team of experts in different disciplines.

3. **Relationship Matrix** (D. in Figure 4.1): during this step, the team of experts assesses what influences exist between each technical feature and each request of the customer by assigning a weight that is translated into symbols and inserted into the intersections of the "matrix" (usually the symbols used correspond to a cardinal scale 1 - 3 – 9).

4. **Technical Correlation Matrix** (E. in Figure 4.1): the relationships that exist between the TRs are highlighted in in the "roof of the matrix" through + or - symbols depending on whether the interaction is positive or negative.

5. **Planning Matrix / Benchmarking Assessment** (B. in Figure 4.1): the parameters and methodologies for quality control of production processes are defined followed by a comparison with other similar products in order to understand which product is the best in the market.

6. **Technical Matrix** (F. in Figure 4.1) is a *ranking of Technical Specifications*: in this step the team identifies those that deserves the most attention since they're the one related to the more influential Customer Requirements.

In this section, it's possible to identify the Technical Specifications which are the best for an ideal model, eventually a new version of the current model. While defining the target requirements for the new model, there are some considerations to take into account:

- The Budget is limited: improvements should be focused on predominant Technical Specifications.
- Improve those Technical Specifications in which weakness is perceived compared to competitors.

- Consider correlations between Technical Specifications (the roof of the HoQ): it's not possible to maximize conflicting Technical Specifications.

There's some kind of subjectivity in this process and there are some techniques supporting this phase, one of those is the **Q-Bench Algorithm.**
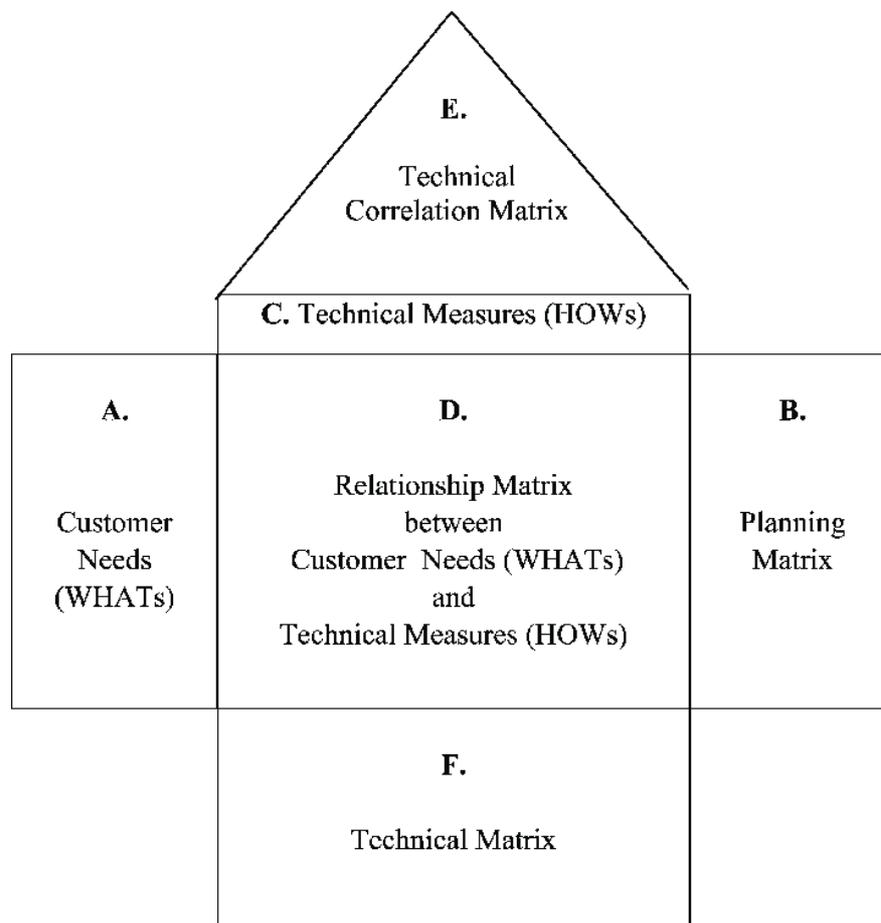
Figure 4.1 *House of Quality (HoQ) scheme.*

The Q-bench Algorithm is a method used during the design phase of a service or product, with the goal of selecting a winning profile among competitors. The flow chart of the algorithm is shown in Figure 4.2 below.
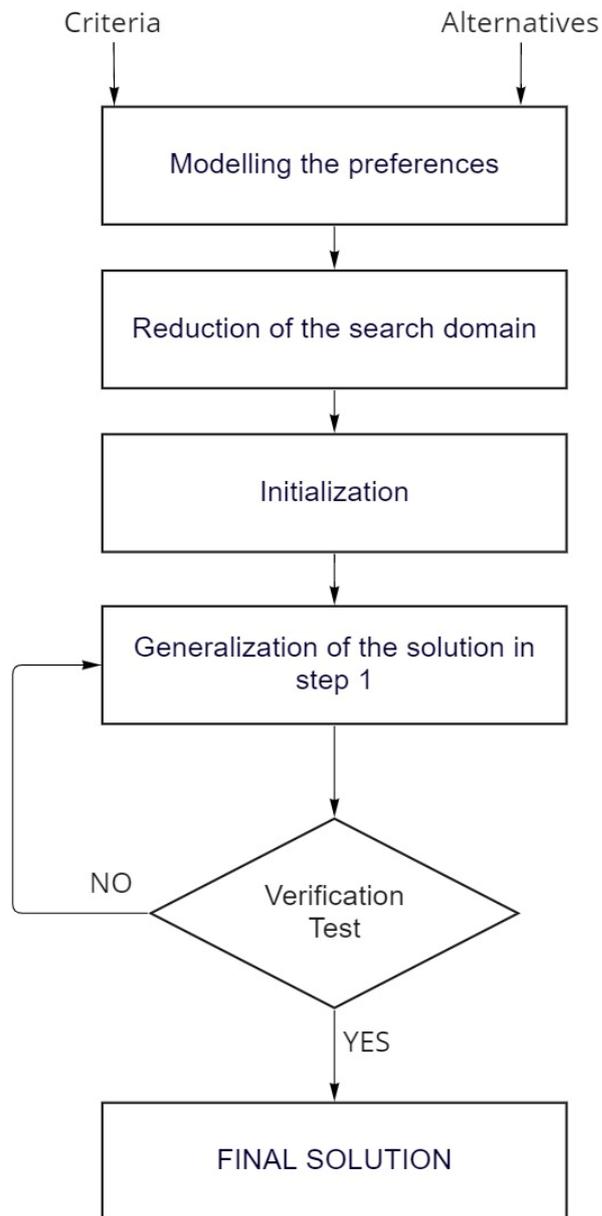
Figure 4.2 *Flow chart of the Q-Bench Algorithm.*

- *Modelling of preferences*: it's about selecting and organizing Data of Input, so *Criteria (G)*, which are the Technical Specifications, and *Alternatives (A)*, which are the solution offered by various Competitors.

$$G = \{gj \mid j = 1, 2 \dots m\}$$

$$A = \{a1, a2, a3, \dots., ai\}$$

- *Reduction of the search domain*: it's about finding a reasonable range for each Technical Specification.

- *Generation of an initial solution:* by maximizing the performance of most relevant Technical Specifications while minimizing the performance of the remaining ones.

- *Verification Test*: through the implementation of the ELECTRE II Method, which allows the comparison of alternatives based on multiple Criteria.

4.3 Application to BOARD.

This paragraph tries to conduct the comparison between different BI software, according to the evaluation of Customer Requirements and Technical Specifications, and tries to identify the Technical Specifications on which should be best to focus on for a new version of the current model of BOARD.

- QFD is used for the identification of Customer Requirements and Technical Specifications for BI vendors

- ISM (Independent Scoring Method) is applied to for each Technical Specification and Customer Requirement, to obtain a weighted sum of the Relationship Matrix coefficients and using weights of Customer/Marketing Requirements.

  Absolute importance of the Technical Specification:

$$w_j = \sum_{i=1}^{n} d_i * r_{i,j}$$

  Relative importance of the Technical Specification:

$$w_j^* = \frac{w_j}{\sum_j w_j}$$

- Q-Bench Algorithm is applied.

First, Customer Requirements and Technical Specifications for BI software have been defined through internet research and the experience of workers in the company where I carried out my internship (Bios Management Std.), who are in daily contact with customers and know their needs so that it has been possible to identify as detailed as possible what a customer expects from BI software.

Customer Requirements		Technical Specifications	
R1	Human–computer interface	A1	ETL (extraction, transformation, loading)
R2	Business query & reporting	A2	Data visualization (dashboard & scorecards)
R3	Business analytics & simulation	A3	Database compatibility & integrity
R4	Database & data warehousing	A4	Database maintenance & recovery
R5	Data mining & statistics	A5	Performance monitoring & management
		A6	Statistical regression
		A7	Temporal forecasting
		A8	Affinity association
		A9	Unsupervised clustering
		A10	Supervised classification
		A11	Feature extraction & selection
		A12	Causality reasoning & corporate diagnoses

Figure 4.3 *Marketing Requirements and Technical Specifications for BI software.*

The *Relationship Matrix* (Figure 4.6 below) has subsequently been built to connect Customer Requirements to Technical Specifications. To do this, a scale of powers of 3 converted to symbols with the following meaning was used:

- Δ = 1 (Weak correlation).
- o = 3 (Medium correlation).
- • = 9 (Strong correlation).

Relationship Matrix and results of the ISM Method

Customer Requirements / Technical Specifications		Customer importance	Relative importance	A1 ETL	A2 Data visualization	A3 Database compatibility & integrity	A4 Database maintenance & recovery	A5 Performance monitoring & management	A6 Statistical regression	A7 Temporal forecasting	A8 Affinity association	A9 Unsupervised clustering	A10 Supervised classification	A11 feature extraction & selection	A12 Causality reasoning & corporate diagnoses
R1	Human-Computer interface	3	15.8%		●	●	▷	○	▷	▷	▷	▷	▷	▷	○
R2	Business query & reporting	4	21.1%	○	○	○		○	○	○	○	○	○	▷	○
R3	Business analytics & simulation	5	26.3%		○			●						●	●
R4	Database & data warehousing	3	15.8%	●		●	●								
R5	Data mining & statistics	4	21.1%	▷	▷		▷	▷	○	○	○	○	○	●	▷
		19	100.0%												

Coefficients

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
	3	9	9	1	3	1	1	1	1	1	1	3
	9	3	9	9	9	3	3	1	1	1	9	9
		3	3	9	3	3	3	1	1	1	1	9
		1			1	1	1	3	3	3	9	1
						3	3	3	3	3		3

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
(Technical) Absolute importance	2.053	3.053	2.368	1.632	3.684	1.789	1.789	1.263	1.263	1.263	4.632	5.105
(Technical) Relative importance	6.87%	10.21%	7.92%	5.46%	12.32%	5.99%	5.99%	4.23%	4.23%	4.23%	15.49%	17.08%

	Absolute Importance	Relative Importance
	3.3	11%
	5.9	20%
	10.3	34%
	4.7	16%
	5.7	19%

Figure 4.4 Relationship Matrix and results of the ISM Method.

Also, a *degree of importance* has been given to each Customer Requirement. ISM is applied to for each Technical Specification and Customer Requirement, to obtain *Absolute* and *Relative Importance*.

For the Q-Bench Algorithm application, it has been considered BOARD (a1) and some competitors as SAP (a2), SAS (a3) and Microsoft (a4) and the Data Pool is shown in Figure 4.5.

Technical Attributes should be measurable objectively, in this case since we're dealing with BI software and it's hard to find a unit of measure for them, a rating of 1 to 10 was given to make them measurable.

Sense of preference	Technical Specifications	a1 BOARD	a2 SAP	a3 SAS	a4 Microsoft
⇧	g1	9	7	5	9
⇧	g2	8	9	6	8
⇧	g3	9	8	6	9
⇧	g4	9	9	4	8
⇧	g5	8	9	6	6
⇧	g6	7	5	9	6
⇧	g7	8	4	8	7
⇧	g8	7	5	7	7
⇧	g9	8	5	8	7
⇧	g10	7	5	7	8
⇧	g11	6	3	7	6
⇧	g12	5	6	4	5

Figure 4.4 *Data Pool of Competitors.*

g1	a1~ a4 > a2 > a3	w1	6,87%
g2	a2 > a1 ~ a4 > a3	w2	10,21%
g3	a1~ a4 > a2 > a3	w3	7,92%
g4	a1~ a2 > a4 > a3	w4	5,46%
g5	a2 > a1 > a3 ~ a4	w5	12,32%
g6	a3 > a1 > a4 > a2	w6	5,99%
g7	a1 > a3 > a4 > a2	w7	5,99%
g8	a1 > a3 ~ a4 > a2	w8	4,23%
g9	a1 ~ a3 > a4 > a2	w9	4,23%
g10	a4 > a1~ a3 > a2	w10	4,23%
g11	a3 > a1 ~ a4 > a2	w11	15,49%
g12	a2 > a1 ~ a4 > a3	w12	17,08%

Figure 4.5 *Ranking for each Technical Specification and weights.*
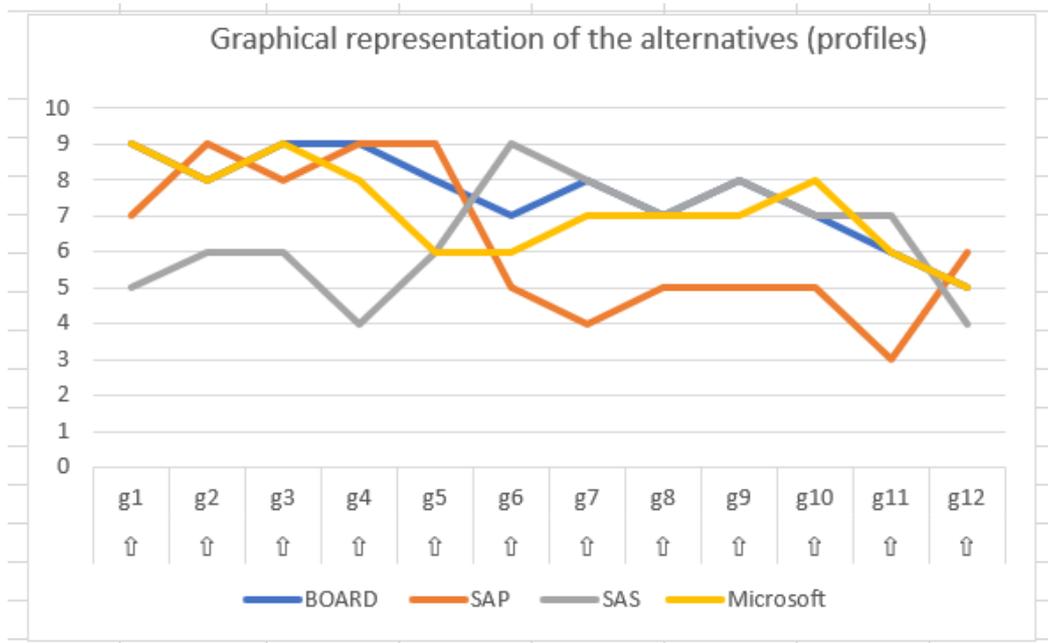
Figure 4.6 *Graphical representation of the alternatives (profiles).*

Once we have the initial solution, Verification Test is performed by applying ELECTRE II method (Figure 4.7 below). The Verification Test is satisfied when we have that a1 (Board in our case) outranks all other competitors (a2, a3, a4). To outrank a competitor two conditions must be satisfied:

$$(1) \quad \frac{W^+ + W^=}{W} \left(\geq \frac{2}{3} \right)$$

$$(2) \quad \frac{W^+}{W^-} \ (\geq 1)$$

Where:

- W^+ is referred to the sum of weights of those Technical Specifications belonging to the J$^+$ family (where the first alternative is better than the second alternative).

- W^- is referred to the sum of weights of those Technical Specifications belonging to the J- family (where the first alternative is worse than the second alternative)

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- $W^=$ is referred to the sum of weights of those Technical Specifications belonging to the $J^=$ family (where the first alternative is performing in the same way as the second alternative).

VERIFICATION TEST on the Initial solution						
	J^+	$J^=$	J^-	$\frac{W^+ + W^=}{W}\left(\geq \frac{2}{3}\right)$	$\frac{W^+}{W^-}(\geq 1)$	aOa'
a1;a2	1,3,6,7,8,9,10,11	4	2,5,12	NO	YES	NO
a1;a3	1,2,3,4,5,12	7,8,9,10	6,11	YES	YES	YES
a1;a4	4,5,6,7,9	1,2,3,8,11,12	10	YES	YES	YES
	W^+	$W^=$	W^-	$W^+ + W^=$	W^+/W^-	
	54,93%	5,46%	39,61%	0,604	1,387	
	59,86%	18,66%	21,48%	0,785	2,787	
	33,98%	61,80%	4,23%	0,958	8,042	

Figure 4.7 ELECTRE II application: Verification Test on initial solution.

In this first iteration we do not find the winning solution as a1 doesn't outranks a2. As consequence, we update the initial solution by maximizing the performance of the predominant Technical Specification, in this case g12 (Causality reasoning & corporate diagnosis).

A value of 6 (as the best competitor in the market for that Technical Specification) has been given to a1 and then ELECTRE II has been applied again (Figure 4.8).

1st iteration MAXIMIZE predominant TS (g12= 6)						
	J^+	$J^=$	J^-	$\frac{W^+ + W^=}{W}\left(\geq \frac{2}{3}\right)$	$\frac{W^+}{W^-}(\geq 1)$	aOa'
a1;a2	1,3,6,7,8,9,10,11	4,12	2,5	YES	YES	YES
a1;a3	1,2,3,4,5,12	7,8,9,10	6,11	YES	YES	YES
a1;a4	4,5,6,7,9,12	1,2,3,8,11	10	YES	YES	YES
	W^+	$W^=$	W^-	$W^+ + W^=$	W^+/W^-	
	54,93%	22,54%	22,54%	0,775	2,438	
	59,86%	18,66%	21,48%	0,785	2,787	
	51,06%	44,72%	4,23%	0,958	12,083	

Figure 4.8 ELECTRE II application: Verification Test on 1st iteration.

As shown in Figure 4.8, in this case the Verification Test is satisfied.

To become a leader in the market, Board should focus its upgrades on Technical Specification g12 (Causality reasoning & corporate diagnosis), at least to be at the same level of its main competitors.

4.4 Why, dealing with BI, consulting beats the software?

Today, in the market there are numerous Software Houses, each one with specific characteristics, which try to convince customers that their solution is the best for improving company's decision making.

What is really important about applying BI solutions in a company is that collecting and processing data only makes sense if there's a clear purpose and if this data can really inspire functional decisions for that purpose.

Most Software Houses lack consulting skills and approaches: they are not BI advisors. Choosing a BI software solution does not solve the real problem that exists in all companies that try to use Business Intelligence solutions, which is that discrepancy between those who have to prepare data for analysis and those who have to use this same data to make decisions.

Business intelligence Consulting is the most relevant area because it enables the implementation of a strategy based on the client's needs and does not bound those needs to a set of predetermined, same-for-everyone capabilities. Technological innovations matter, but it is skills that make the difference. *Developing, managing, and evolving a comprehensive BI consulting project requires a set of ingredients, methods, and knowledge that is not easy to come by and that's where the Consulting firm makes the difference*.

Conclusions

The market of Business Intelligence Tools has been playing an increasingly important role: it is expected to grow at a significant rate between 2022 and 2029. Furthermore, COVID-19 had a positive impact on demand across all regions subject to the pandemic: BI tools gave the chance to implement advanced analytics to improve decision-making by providing real-time status and competitive advantage.

They are now indispensable within a company: only the constant measurement of performance enables process optimization, resulting in consequent saving of resource; also, only a clear and detailed picture of the state of the company and of all its internal processes can enable the implementation of an effective strategy.

What is really important about applying BI solutions in a company is that collecting and processing data only makes sense if there's a clear purpose and if this data can really inspire functional decisions for that purpose.

Most companies do not have the in-house technical and engineering skills to undertake a BI project on their own and so it is common for them to engage a consulting firm to support them in this transformation process: Business intelligence Consulting is the most relevant area because it enables the implementation of a strategy based on the client's needs.

Technological innovations matter, but it is skills that make the difference. Developing, managing, and evolving a comprehensive BI consulting project requires a set of ingredients, methods, and knowledge that is not easy to come by and that's where the Consulting firm makes the difference.

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ACKNOWLEDGEMENTS

First of all, I would like to thank my thesis advisor Mastrogiacomo Luca for his time and help during the writing of this thesis.

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

I thank my sister Martina for her good advices and my grandparents for being always my number 1 fans.

I thank 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.

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