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Final Thesis

**Business Intelligence as  
a Management Tool**

A case study on a  
Performance Dashboard  
Implementation

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*"It is estimated that by 2020 there could be four times more digital data than all the grains of sand on Earth."*

Bernard Marr

*"Without big data analytics, companies are blind and deaf, wandering out onto the web like deer on a freeway."*

Geoffrey Moore

*"Torture the data, and it will confess to anything."*

Ronald Coase



## ABSTRACT

Nowadays, the ability to manage Big Data properly represents, for all organizations, a strength and an opportunity at the same time.

Technological developments of the last decades provide us with the needed tools to manage Big Data. Business Intelligence, which includes Performance Dashboard, is an important tool to manage Big Data.

I came in touch with Business Intelligence subject in 2014 while I was experiencing an Internship at the Municipality of Vicenza. At that time, I was given the task to prototype a Performance Dashboard containing KPIs (Key Performance Indicators), with the aim to monitor Public Administration performance. The task was difficult because it required advanced skills in database programming, which were beyond my capabilities, but thanks to their help I succeeded. The dashboard prototyped was connected to the database and provided real-time information in fancy looking graphics.

At the beginning of 2017, I had another Internship experience within a company operating in the metal industry. In this case, I was given the task to update some monthly KPIs related to the company performance (sales, quantity, price etc.). The problem was that the update was manual, so I had to extract data from SAP and insert in an Excel sheet, losing in this way four-five days.

The main aim of the following thesis, is to explore a solution to that problem using Business Intelligence tools. The idea is to prototype a Performance Dashboard, containing KPIs, that would be able to provide managers and employees with important and timely information, allowing them to manage data in a proactive way. In this way, they would be facilitated in the decision making process by monitoring performances and by taking corrective actions before it is too late.

The following thesis is an attempt to explore the subject of Business Intelligence and to illustrate it by providing a concrete example on how to implement a Performance Dashboard using a BI software.



## **ACKNOWLEDGEMENTS**

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Last but not least, I would like to thank my family for moral support during the studies. Since without them all this work wouldn't have been possible, I dedicate the following thesis to my family hoping to make them a little bit proud.



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## CHAPTER 1. INTRODUCTION

Since the 1990s our society has been transformed from a society based in agriculture and industry to an information and knowledge society<sup>1</sup>. This means that intangible goods (including Information Technology) became more important than before.

According to Carlo Vercellis, this transformation of the society is due to two factors. The first is *Globalization*, high interdependence among different economies and high level of integration between them, made possible the growth of a single global economy. The second is the new *Information Technologies*, the massive spread of internet and sophisticated communication technologies made possible high-speed transfer of huge amount of data.

Carlo Vercellis claims that different actors have gained several advantages: Individuals can get news faster; Enterprises can understand better customer needs and develop new products to meet those needs; Public administrations are able to improve services delivered to the citizens.

Businesses around the world acknowledge these advances in Information Technology systems, regardless of geographical location, industry sector, company size or longevity. As a result, the top strategic priority of almost all businesses (especially the big ones) is digital transformation, as revealed by the *Digital Evolutions* survey "*The Digital Transformation Agenda 2016*"<sup>2</sup>. Digital disruption is seen by business leaders as a reinvention of business practices in order to obtain the maximum value from digital technologies, but also as an opportunity to achieve competitive advantage or improve their competitive position. Indeed, the survey revealed that business leaders see the digital transformation more as an opportunity to improve organisational agility than a threat.

The survey shows a negative trend related to the decision makers who are neglecting the role of digital technologies in productivity by giving low priority to employee's experience. Another negative aspect is related to the fact that executives in senior positions are not taking an active role in the implementation of this digital transformation, as their peers would like, mainly because of lack of confidence. If companies fail to find that confidence or to meet this transformation, their performances will be at stake.

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<sup>1</sup> Carlo Vercellis, *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009

<sup>2</sup> <http://digitalevolution.eiu.com/the-digital-transformation-agenda-2016>

In this socio-economic environment, those enterprises that will be able not only to use tools for querying, visualization and reporting (passive BI analysis) but also to transform the information in knowledge (active BI analysis), are those that will make quick effective decisions, allowing enterprises to reach their competitive advantage.

Nowadays the technological changes in digital era are accelerating more than ever before. Intuition in decisions doesn't work anymore and using intuition may be too risky because of the complexity of the organizations, instead we should use a scientific and rational approach by using mathematical models.

## 1.1.The evolution of Information Systems

The first digital computer was developed in the 1940s<sup>3</sup>, since then there was a latent need for an information technology system able to process data. At that time, different applications were developed to help companies implement automation in routine operations.

In the 1970s the complexity of the organization increased and with it also the needs for more sophisticated software applications. In those years' companies needed timely and useful information for decision makers. Those needs couldn't be fulfilled because of the state of the technology at that time which consisted in a lack of graphic interfaces and communication capabilities. The development of the digital computer was slower than the needs of the companies. Another problem arises from the organization structure which was centralized, rigid and react slowly to the change.

According to Carlo Vercellis, in the 1980s the first personal computer with an improved graphic interface and interaction tools such as the mouse, was introduced. Thanks to this technology evolution now it was possible to make graphic presentation of results, providing the decision makers with a real support. Also, the organization became more flexible since the workers could rely on computer-based information rather than on centralized ones, allowing quick changes in a relatively short period of time. This led to the creation of the local databases and spreadsheets, making workers more proactive. This can be considered to be the beginning of the Business Intelligence era.

Finally, at the end of the 1990s the term Business Intelligence began to be used widely to address models used to transform data into information and information into knowledge.

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<sup>3</sup> Carlo Vercellis, *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009, p.35



## CHAPTER 2. BUSINESS INTELLIGENCE

### 2.1. What do we mean with Business Intelligence

Today businesses compete in complex, hyper-competitive, and highly dynamic environments. Business leaders have to survive in this context by making rational decisions. To do so, businesses need to evaluate quickly a huge amount of data.

Business Intelligence tools provide the needed support in this direction.

In 1958 Hans Peter Luhn used the term Business Intelligence for the first time. He defined intelligence as: "the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal"<sup>4</sup>.

"Business intelligence may be defined as a set of mathematical models and analysis methodologies that exploit the available data to generate information and knowledge useful for complex decision-making processes"<sup>5</sup>.

According to Carlo Vercellis, the term Business Intelligence is used also to identify the use of sophisticated tools of data analysis made on a database which is formatted especially for that use (ex. Data Warehouse). Business Intelligence is designed to collect, aggregate, manipulate and organize substantial data, transforming them into useful information for the decision maker. BI tools, basically convert the raw data in information and the information in knowledge. Then the information is presented through intuitive interfaces, allowing business leaders to understand them. The BI is useful particularly for the businesses that have to manage big quantity of data (e.g., multinationals, public administrations).

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<sup>4</sup> Hans Peter Luhn, *A Business Intelligence System*, IBM Journal of Research and Development, 1958

<sup>5</sup> Carlo Vercellis, *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009, p.3

## 2.2. Difference between BI and BA

BI and BA are two topics which are highly connected between them, but since they may create confusions it is useful in this stage to describe them by finding similarities and differences between them<sup>6</sup>.

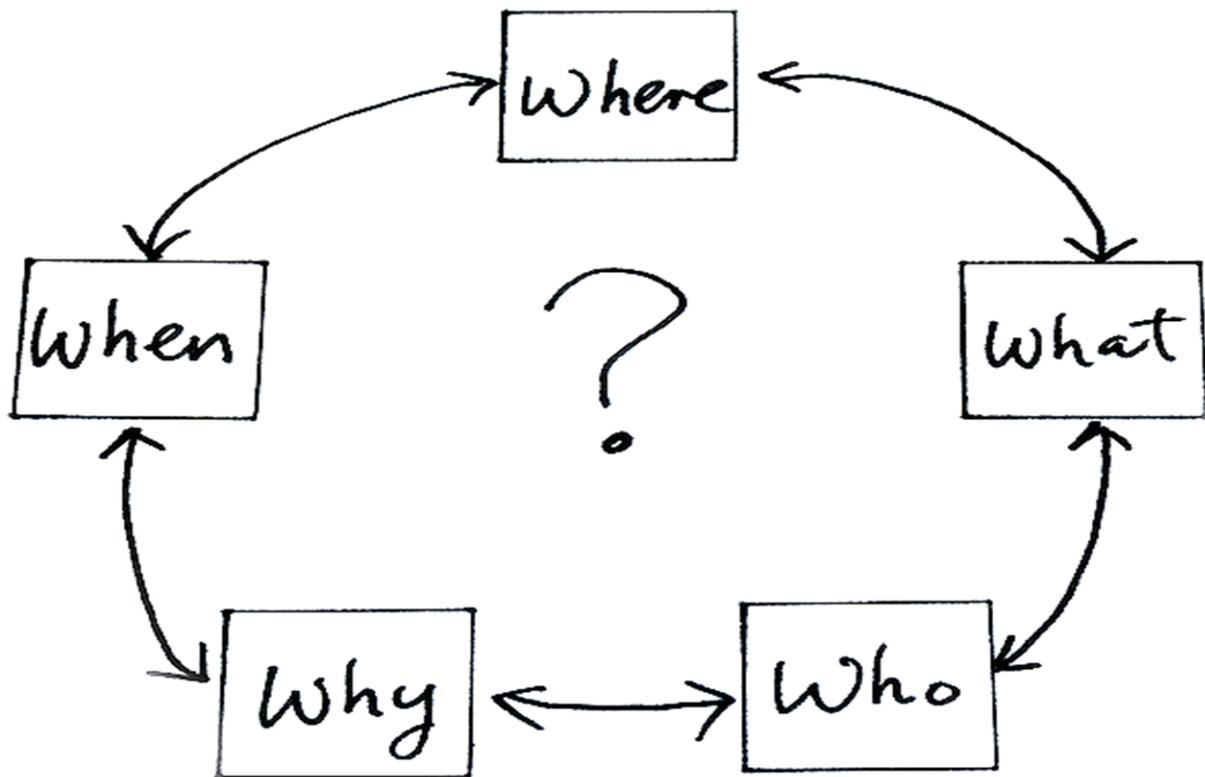
The main similarity consists in the fact that both have the same starting point, i.e. the observation and analysis of informational heritage of the company. But while the BI, following the rules and with pre-defined indicators, aims to measure if a strategy was successful so that it could eventually undertake the needed actions to improve, the BA can help the company understand the reasons that stand behind a failure or a success but it can also make assumptions regarding future best scenarios, based on the data collected. Business Analytics deals with the activity of strategic analysis in order to generate competitive advantages for the companies. The BA could be defined through the following sentence: "give the right decisional support to the right people at the right time". BA initiatives are implemented in order to strengthen the ability of businesses to move in the right direction towards their objectives. We can also say that BA is the continuous interactive exploration and analysis of business performance of the past, in order to discover and improve the actual and future process of business planning, through the research of exceptions and anomalies (the so-called management by exception). The BA optimise the customer lifetime value, which is used to evaluate the customer value over time. Customer lifetime value matches the net present value of present and future customer contributions, considering the whole life of relationship with the company. With BI, we tend to see information as aggregate data, large amounts of data catalogued on the basis of defined attributes, summarised in KPI, while with BA before we aggregate, we have to make a detailed analysis to use statistical formulas: once this step is done we would be able to find correlations. More generally, we would be able to create some models.

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<sup>6</sup> <http://www.techeconomy.it/2012/05/31/business-analytics-centra-qualcosa-con-la-business-intelligence/>

### 2.3.The Five W's of Business Intelligence

In order to understand better the issue of BI it is recommended to answer to the five W's<sup>7</sup> i.e. Who, Where, When, Why and What.



Source: <http://www.techeconomy.it/2012/04/19/le-5-w-della-business-intelligence/>

Picture 1

WHO needs BI?

BI is useful for any business industry which works keeping in mind their objectives (Sales, HR, Supply Chain, Production etc.). The higher is the degree of decentralization of the decision-making power, the better the BI works. This is due to the fact that the more managers or employees have decision making power, the more they will use BI tools.

WHERE does BI produce positive results?

Not necessarily the company that wants to apply BI needs to have huge dimensions, with enormous quantity of data to manage. Indeed, BI can be applied also in the context of Small and Medium Enterprises when the variables that influence the decision-making power have a complexity such that it is not possible to manage them individually or in a

<sup>7</sup> <http://www.techeconomy.it/2012/04/19/le-5-w-della-business-intelligence/>

disorganized way. For example, companies with a lot of employees and data to manage.

WHEN is it possible to use BI?

BI is used both in upstream and downstream of decision making process. In upstream it is used as a preparatory step before the strategy formulation to give some ideas, suggestions to the decision, based on the data of continuo observation of processes. In downstream BI provides data to evaluate whether the strategy previously defined was respected or not, and to what extent (using KPIs).

WHY should we use BI?

The informative heritage present in company's archives is a resource which, if properly organised, can provide the input to deal successfully with numerous challenges faced by the company, especially in critical periods.

WHAT is BI for?

The fundamental elements needed for a successful application of BI approach are:

- Objectives should be clear, without knowing what are our goals or targets we can't work.
- Flexibility in the processes to which the targets are linked, in order to apply structurally the feedback received from the observation phases.
- An electronic form (software) that allows the standardization of heterogeneous data, the subsequent grouping in predefined sets, and testing from different points of view.

## 2.4. BI Integration Level

Business Intelligence integration level is useful to understand the ways in which the business organization can absorb a BI methodology.

When we ask how BI tools are used in the company, three typical situations may arise<sup>8</sup>. All of them match different levels of understanding of BI's potentials and integration with business strategy:

The first case corresponds to a minimal, almost non-existent integration level. These all are cases where BI is used at most to produce on demand reports made ex-post. Very often, the true value of the collected information is not even properly acknowledged and exploited, since managers are more focused on solving each single problem rather than on process optimization.

For completeness, it is also necessary to include in this group the cases in which the size of the business does not justify the use of an external information management system: even so BI method actually is applied but with a very special configuration, that is where the decision-making process, upstream data analysis and KPI verification are made by a single actor who is the owner of the company.

The second case involves a greater degree of integration but still very low, where reporting is linked to the indicators defined with the strategy and it is used to keep all business processes under control. This is a systematic but still one-directional (from strategy to control) use of BI, which gets input from the strategic plan. However, the potential of the method has not yet been understood or applied to such a degree as to change the strategic plan from which various reports and controls are originated.

The last case corresponds to a complete or almost complete integration level, where the information that has been collected in previous monitoring and performance management cycles is used as a key element for strategic choices (upstream data) and where each defined process is monitored with the additional aim of providing feedback to be used to review the decisions taken.

This case may have a level of analytical depth similar to the one in the previous case, but it differs fundamentally from an organizational aspect, i.e. the possibility that the same guidelines that originated the audits are challenged and possibly modified.

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<sup>8</sup> <http://www.techeconomy.it/2012/05/03/business-intelligence-how/>

## 2.5. Business Intelligence Maturity Model

In the previous paragraph, we have analysed the integration of the BI method within the company, identifying three basic levels that we can summarize as a minimal, partial or total integration.

The next step to deepen the knowledge of the BI method is to understand what it takes to move from one level to another and how to evaluate the degree of maturation. On the subject, we have different schools of thought, some of which belong to consulting firms and others to independent organizations, based on both a technological maturation approach and on the knowledge management bases.

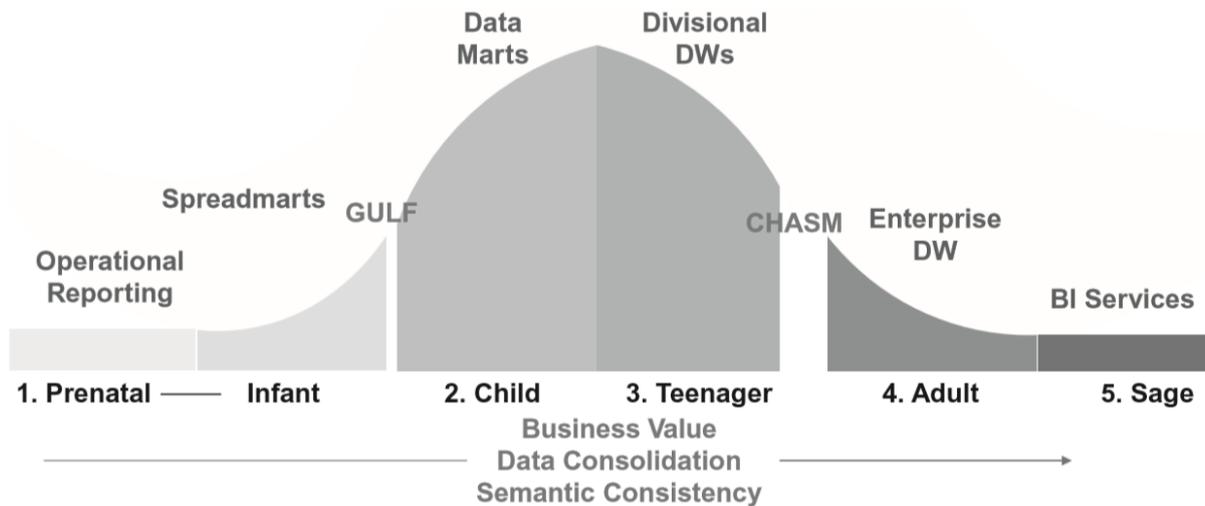
The common ground can be identified in the method described in the LOBI (Ladder of Business Intelligence) that helps in creating "intelligent" organizations within which the most commonly used technology systems are designed and built to generate successful stories. Specifically, the LOBI envisages a degree of maturity of BI articulated in six levels, identified starting from the analysis of the interaction between people, processes and technology within the company.

This split approach in a fairly large number of levels (in the most popular models we can identify at least five) indicates that the BI development path is very long and complex. An element of further complication is found in the distance between some of the levels described.

Let's see two of these models, in particular the TDWI (The Data Warehousing Institute) and Gartner BI maturity model.

### 2.5.1. The Data Warehousing Institute maturity model

According to TDWI, BI maturity model is shaped in a bell curve, as depicted in Picture 2. As depicted in the picture, the model is organized in five stages<sup>9</sup>:



Source: Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2nd edition 2010, p.58

**Picture 2**

1) Prenatal and Infant are treated as a single stage because there are only few differences between them. In this stage, there is a lack of interactive reporting which leads to the creation of spreadmarts, which is a trait of Infant stage. In this stage reports are edited and maintained entirely by hand, therefore, it takes several days or weeks to create a new report or to custom an existing one. This creates delays in providing information which frustrate users.

For this reason, users usually try to get the needed information by their self, extracting data from the source and loading them into spreadsheets located in their desktops (spreadmarts). Each spreadmart contains a unique set of data which is not aligned with the rest of the organization's data. Consequently, employees will lack a single version of the truth, and managers lose a significant amount of time trying to find the right data.

Spreadmarts jeopardise the consistent view of the business activity and it is difficult to substitute them because they are cheap and easy to use.

<sup>9</sup> Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2nd edition 2010, p.58

Organizations need to jump through the Gulf to move to the child stage. The Gulf represents the challenges companies need to face when they start to implement BI solution.

The first challenge represents the sponsorship which is critical to the success of BI. In the case of sponsorship, we have two types of executives. Enlightened executives that appreciate and view BI as a tool to decrease the mental effort needed to run the business. Then we have also traditional executives that endorse projects only when they see tangible benefits and a favourable ROI. Enlightened executives are excellent sponsors and implement easier BI, traditional executives, on the contrary, want to be sure on the returns before the project is undertaken which is difficult to demonstrate. Cost saving may be used to justify the investments in BI tools.

Another challenge is represented by the data which in some cases are good enough for day to day transactions but inadequate for analytical tools. This because the data is not standard so it is difficult to merge and aggregate data with different formats and coming from different sources, it is even more difficult to identify which source is reliable.

Spreadmarts, finally, represent a threat because even if the project has sponsors, funds and has been launched, it may fail due to the continuous reliance of users on spreadamrts.

2) Child. In this stage, BI managers provide timely information not only to the executives but also to the knowledge workers. Local and independent data marts (a tool used to gather and manage data) are created to support each department needs. BI tools are purchased so that users can analyse data contained in data marts. But data marts have the same problem of spreadmarts. They have a unique structure and rules to extract data which supports local needs but is useless in cross-departmental analysis. In this stage, BI serve only a small number of users because not all have the technological capabilities to manage a database.

3) Teenager. The success of independent and unique data marts allows their proliferation. Executives recognize that managing each single data mart independently is expensive and jeopardise a single view of the business. Therefore, in this stage, executives start consolidating independent data marts into a single data warehouse. By standardizing and collecting data in a single data warehouse, managers transform redundant extract programs into a simplified extract process. This divisional data warehouse which unifies and consolidates data is a hallmark of this stage. At this stage, BI project is not independent anymore but it is managed

by BI expert managers who hire a team of specialists to create solutions. Differently from the Child stage, where most of the benefits were reaped by knowledge workers, in Teenager stage general causal users benefit more thanks to the Performance Dashboard created by the BI team.

The Chasm represents a big step forward which unfortunately is not taken by many BI teams. The Chasm represents the challenge of migration from a departmental view to a single enterprise view of information, providing all users with a single set of analytical tools. Having an enterprise data warehouse is important because users can make cross departmental queries allowing them a wider view and deeper analysis. But even with an enterprise data warehouse, most users never exploit it because they continue to rely on their department data warehouse which represents a mental silo. To fully exploit this tool, BI managers should educate users by making clear the benefits they can obtain.

Another challenge represented by the Chasm, is the standardization of terms and definitions, such as sale, revenue, return and so on, used in the information systems. This standardization is critical to obtain a single and consistent view of information system.

The environment is dynamic and change constantly, adapting to the new contextual situation is another challenge represented by the Chasm. Each change brings new questions and this can make useless our data. Therefore, BI managers need to change the whole infrastructure of information system to align data with the new requirements. Most BI teams are trying to be more flexible and agile in order to adapt to the change faster.

Another challenge is represented by the redundancy in the reports. BI provide self-service tools, this allows users to create their reports. With so many reports users can't find what they need so they re-create again reports and as a result the organization fall into report chaos.

Finally, BI team has to justify the investments dedicated to the BI project and in this stage cost saving is not a valid justification. BI managers need to use the strategic value of BI tools within the organization to justify investments which is impossible to do, unless the organization has enlightened executives.

- 4) Adult. In this stage, the organization overcame all challenges represented in the Chasm and BI represents a strategic asset for the organization. BI team isn't involved anymore in deciding which projects to prioritize, a business committee decides the which path to follow. BI team, in this stage creates a BI center of

excellence providing users with best practices for BI solutions. The center of excellence provide consultative service and shares knowledge. BI sponsors itself, by providing value to the organization, therefore converting executives and users to the BI. Organizations have operational, tactical and strategic dashboard which translates strategy in KPIs and targets reminding each level of the organization what are the main priorities. Organizations move beyond simple reports to sophisticated predictive models thanks to the ability to explore large amount of data. Data warehouse is re-designed to deliver near-real-time data which provide fraud detection systems among other applications. BI team, has also acquired the needed expertise to standardize even operational data.

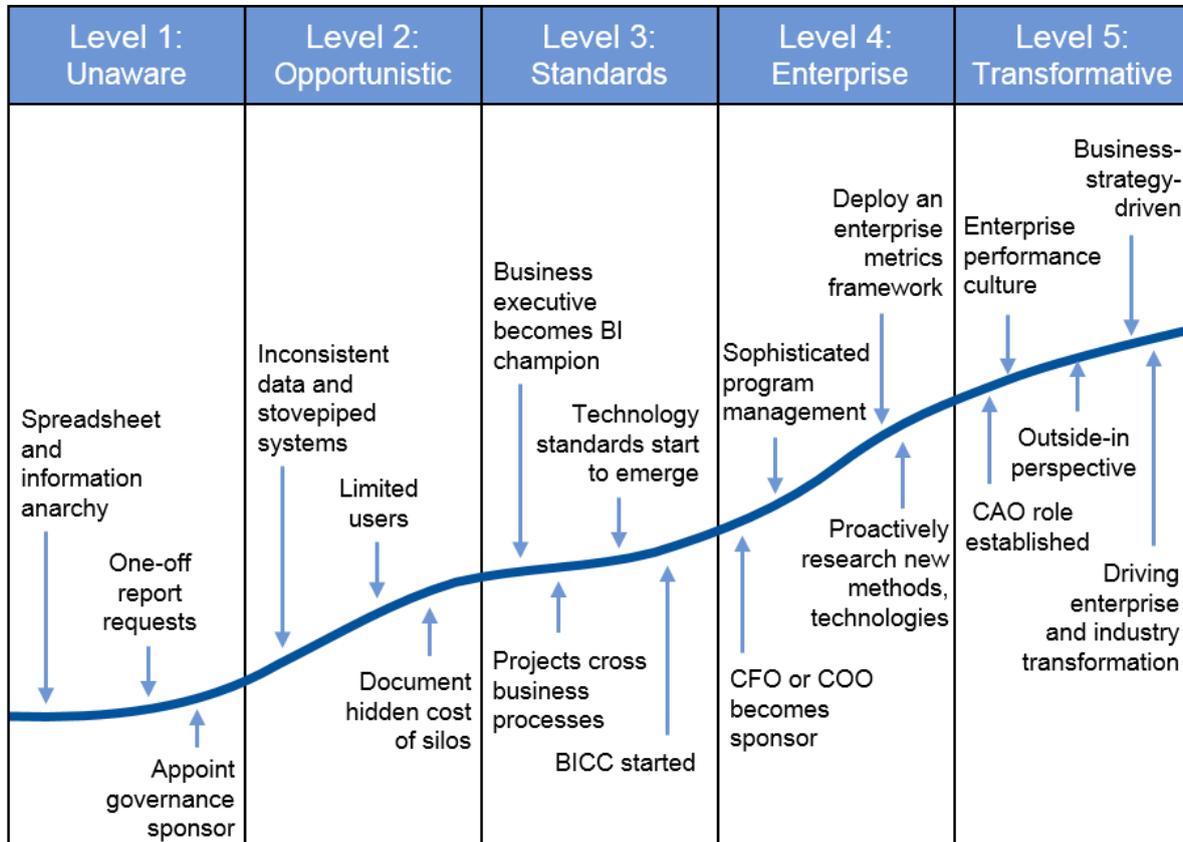
- 5) Sage. At this stage, the organization start to exploit the value delivered by the BI tools. BI team help customer and supplier manage their operation increasing efficiency, as a return the organization gets an improvement in their loyalty. If the organization charges a cost for the BI service provided to customers and suppliers, then data warehouse turns to be a revenue center instead of being a cost center. Sage stage turns BI from a reporting tool to an analytical tool that drives company decisions. But BI team itself represents a challenge, namely bottleneck. Departments must be empowered to build their own data warehouse and BI solution, therefore independent. BI managers must let go, but rather than let go they would prefer grip tighter the steering wheel because they are afraid to lose the data consistency which has been hard to achieve in the previous stages. BI managers must trust standards developed by the BI Center of Excellence, educate and train departmental BI staff. BI Center of Excellence help each department to develop their own BI system without undermining the consistency of enterprise information.

According to this model, Performance Dashboards are deployed only in Stage three where the data infrastructure makes it possible, without a lot of additional investments.

If we compare this model with the integration levels we had previously described above, we see how they perfectly match the three zones separated by the two holes: these are essentially the stages of stagnation of the maturity model and to get from one to the other, usually economic interventions are needed, possibly supported by staff with a specific professionalism and a management with a strong motivation for change.

## 2.5.2. Gartner maturity model

The Gartner model is organized in five levels of maturity<sup>10</sup>, as depicted in Picture 3 here below.



BI = Business intelligence

BICC = BI competency center

Source: <https://www.gartner.com/doc/3136418/itscore-overview-bi-analytics#a-1122147190>

**Picture 3**

- 1) Unaware. Information structure doesn't exist, therefore it can't be a formal decision making process. Data analytics occur ad hoc when needed, using any application at disposal.
- 2) Opportunistic. At this level, each business unit creates its own BI applications, therefore these applications proliferate. Each business unit manages information infrastructure, applications and performances independently. Separate data marts and simple data integration tools are created to support different applications. Results are delivered via ad hoc queries, reports and dashboards.

<sup>10</sup> Cindi Howson, Alan D. Duncan, *ITScore Overview for BI and Analytics*, Gartner, 2015

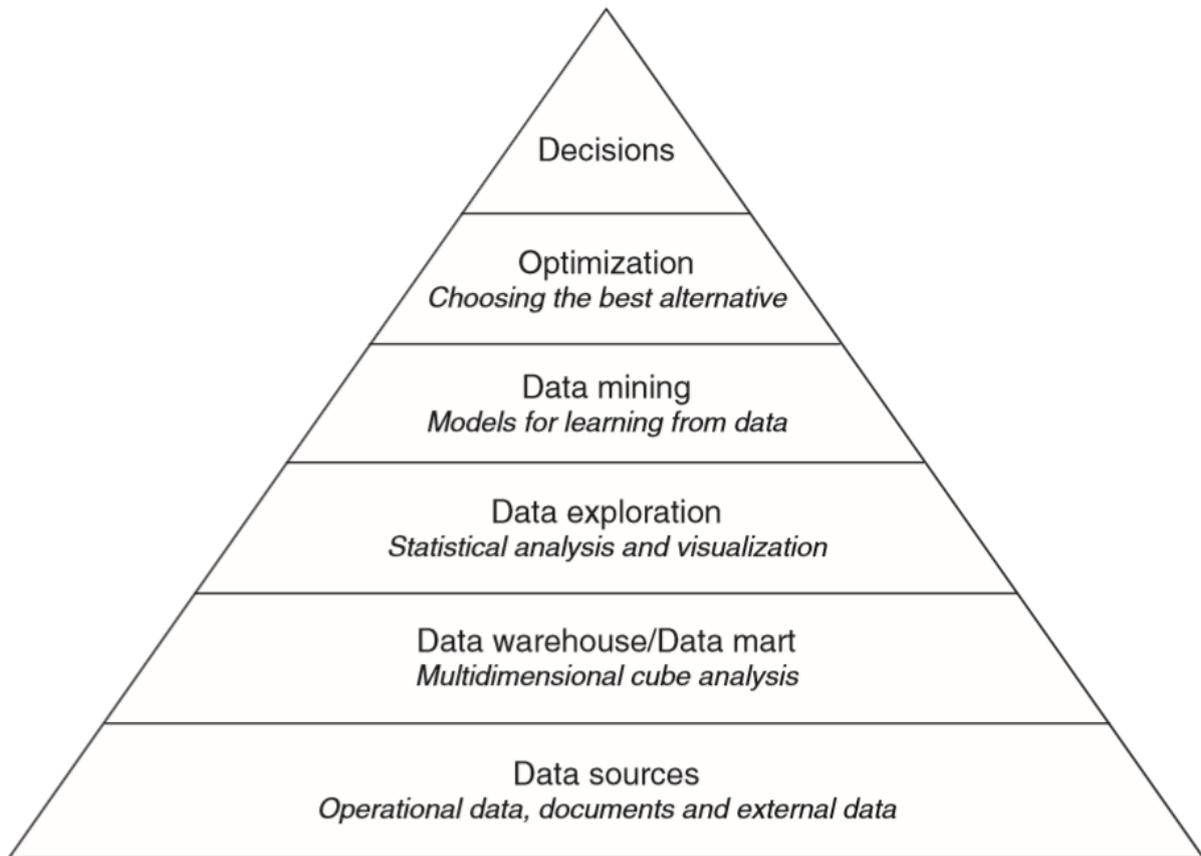
- 3) Standards. At this point, a manager is usually nominated as the enterprise champion for BI and analytics to carry on the BI project. A BI competency center (BICC) is usually implemented to share expertise and improve data consistency. The organization starts sharing information, processes and technologies, improving, in this way, coordination and information consistency of the organization. Standards in information infrastructure, start to emerge. Despite that, only few analytic and decision processes are shared.
- 4) Enterprise. Senior executives are directly involved by becoming the sponsors and supporting the BI project. The organization has created some metrics to guide the company activity towards its objectives. This framework supports the decision-making process at the company level. The same BI framework is used by all users. Sophisticated processes and skills are created to support different processes, allowing flexible and rapid prototyping. Information redundancy is minimized thanks to the common data models and analytics.
- 5) Transformative. Finally, BI generates revenues, efficiency and improves customer service, becoming in this way, a strategic asset for the company supported and managed by the top-management. Customers and suppliers are included in the performance metrics framework. All users rely on the information provided by BI models to make important decision to pursue strategic goals. Standard processes and models emerge allowing univocal data.

In both models, the complexity of the evolution between the different levels is highlighted. This evolution deals at the same time with technological changes and non-technological ones (people and processes changes). The biggest challenge in both models is represented by the lack of homogeneity between the various units of a company, which may have different maturity levels among them.

BI maturity model presentations are considered to be therapeutic and make people feel comfortable knowing that others have faced the same challenges. Presentations are also a perfect tool to make clear BI potential to sponsors, in this way, they can evaluate the investment in BI project.

## 2.6.BI Structure

Business Intelligence system is made of different components<sup>11</sup>, Picture 4 illustrates better the building blocks of the whole pyramid shaped system.



Source: Vercellis C., *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009, p.10

**Picture 4**

Data sources:

The heterogenous data is stored in different sources (primary, secondary), in a first stage those data need to be gathered and integrated. The sources are made by data belonging mostly to operational systems, but they can contain also unstructured documents (e-mails and external data).

Data warehouses and data marts:

Using a tool called ETL (extract, transform, load) the data is extracted from different

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<sup>11</sup> Vercellis C., *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009, p.9

sources and stored in databases, called data warehouses and data marts, made specifically for the Business Intelligence Analysis purpose.

**Data exploration:**

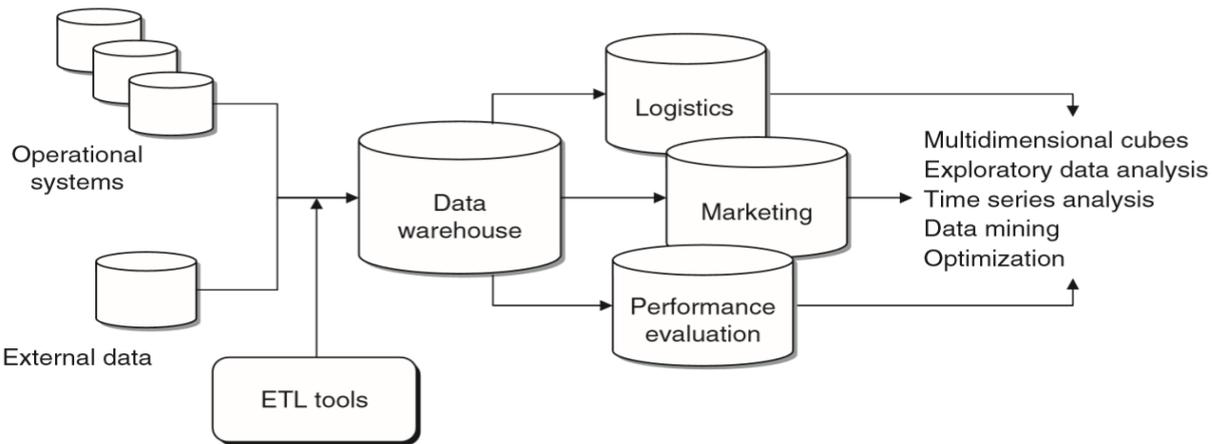
This level of Business Intelligence system is considered to be part of the passive Business Intelligence analysis. The main reason is the fact that decision makers, usually have already made their prior hypothesis and they use reporting systems, statistical analysis and queries in order to confirm or disconfirm their original idea. For instance, a manager has noticed a problem related to the revenue of a product in a specific country and he/she uses data exploration to see whether he/she was right or wrong.

**Data mining:**

Unlike the previous level, this level includes active Business Intelligence analysis, whose main aim is that of transforming data in information and knowledge using mathematical models. This level unlike the previous one, doesn't require prior hypothesis already formulated to be than confirmed or not, instead it expands the knowledge of the decision maker.

**Optimization:**

The upper level, with the respect to the data mining, is the Optimization level, which deals with the evaluation of a large number of alternatives and the determination of the best solution among those alternatives.



Source: Vercellis C., *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009, p.9

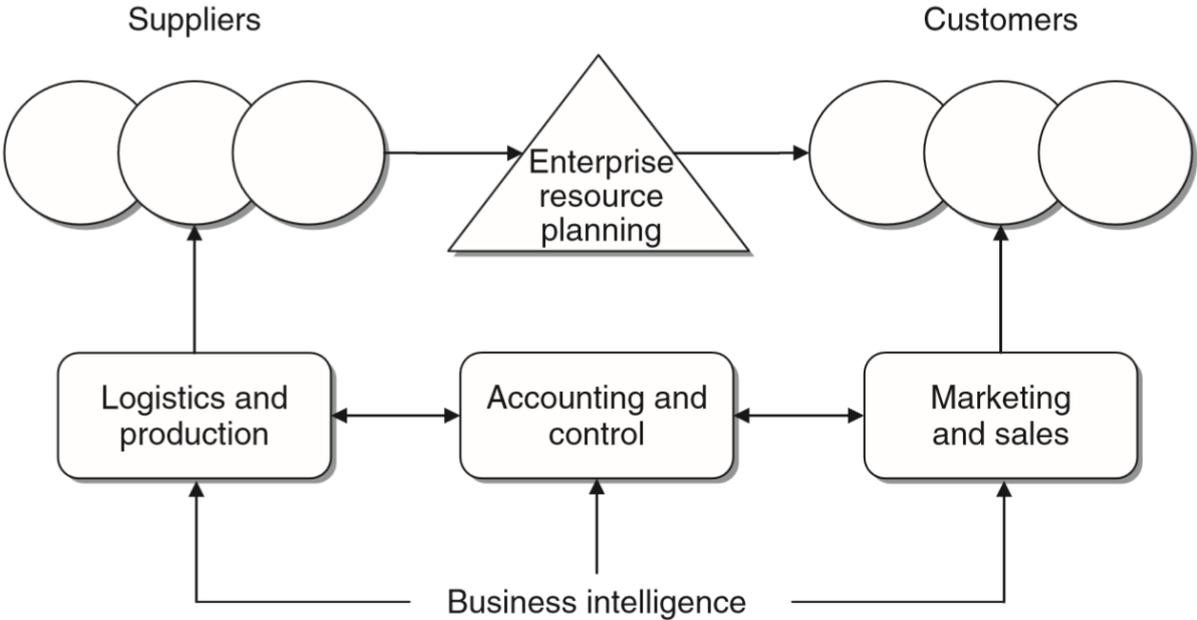
**Picture 5**

Optimization is useful to mitigate the limited rationality of humans, since people usually evaluate only a small number of choices ignoring the best alternatives. This step consists in the use of those data to create mathematical models and to make different analysis in order to support the decision makers (multidimensional cubes, exploratory data analysis, time series analysis, data mining and optimization).

**Decision:**

On the top of the pyramid, we find the final step which is the Decision. After the evaluation of different alternatives, we make a choice which in this case represents the decision. Even with a mature Business Intelligence system, we can't make the final decision basing our choice only in mathematical models. Decision maker considers also informal and unstructured information (ignored by mathematical models) to make the final decision, in a nutshell, a decision maker has always the final say.

Business Intelligence may be used by different organizations, however if we restrict our attention to enterprises, we can find Business Intelligence within the following departments (see Picture 6): marketing and sales, logistics and production and accounting and control.



Source: Vercellis C., *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009, p.12

**Picture 6**

## 2.7.BI Analytics Market

According to Gartner<sup>12</sup>, the global revenue in the business intelligence and analytics software market has experienced a growth of 7.3% from 2016 and reached \$18.3 billion in 2017. The growth is expected to continue and reach \$22.8 billion by the end of 2020. However, the growth has decelerated from 63.6% growth in 2015 to an estimated 19% in 2020. Gartner believes that this deceleration is due to the fact that data analytics are becoming a mainstream among organizations and as a result, there is an increasing competition and pricing pressure. The market is expanding in terms of users but the revenues are increasing less than proportionally due to the price decrease. Reduced differentiation and pricing pressure suggest the maturity of the market.

According to Gartner, the dynamics that influence the rapidly growing of the new BI market are:

- The new buying will be driven and dominated by those BI software solutions that can provide greater accessibility, agility and analytical insight by keeping at the same time the ease of use.
- Smart data discovery capabilities reduce the manual nature of data exploration and highlighting, findings in data without the user's need to build models by themselves. The ability of the new start-ups to introduce this market disruption and the capability of old BI vendors to adapt to this innovation will drive the market.
- The ability to analyse multistructured data, coming from different data sources and data models, on a timely basis is another important element to expand the use.
- Pervasive adoption of analytics is also driven by the ability of BI vendors to embed and extend analytics content in the user experience.
- BI vendors have to offer buyers a single platform containing a combination of real-time actionable insight and other data sources.
- The active marketplaces where buyers and sellers exchange analytic applications and where different solutions can be sold to the customers, is an important driver for the market growth. The end-user organization will benefit the most from this mature marketplace.
- The ability to shift from data stored in hardware "data gravity" to the data stored

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<sup>12</sup> <https://www.gartner.com/newsroom/id/3612617>

in the clouds will increase the adoption. Cloud deployments reduce costs of ownership and the time of deployment.

- In the next years significant investments in innovation will be made, however organizations should limit their debt by developing a formal strategy to evaluate different investment alternatives.

The Magic Quadrant depicted in Picture 7 represents Gartner’s market research<sup>13</sup>.



Source: <https://www.gartner.com/doc/reprints?id=1-3TYE0CD&ct=170221&st=sb>

**Picture 7**

<sup>13</sup> Gartner Inc. is the world's leading information technology research and advisory company. Gartner delivers the technology-related insight necessary for its clients to make the right decisions, every day.

Gartner's Magic Quadrant provides market analysis and compares BI platform vendors, based on Gartner's standard criteria and methodology. To depict the market and evaluate vendors, the report uses a two-dimensional matrix based on Completeness of Vision and Ability to Execute.

The Ability to Execute is determined by the ability of vendors to make their vision a market reality and to deliver a positive customer experience which includes sales experience, support, product quality, user enablement, availability of skills and ease of upgrade/migration. When evaluating the Ability to Execute Gartner attempts to answer to the following questions: How easy to use and visually appealing is the product? What is the vendor's financial health and its likelihood to invest in product and service innovation? What are vendor's sales capabilities in pricing, negotiating and contracting? Is the vendor succeeding in the market and is this success limited to one geographic region? Does the vendor enable its customers with training and tutorials?

Completeness of Vision is related to the capability of vendors to understand how to exploit market forces to create value for customers and create opportunities for themselves. Gartner evaluates vendors ability to support key trends that will drive business value. When evaluating the Completeness of Vision Gartner attempts to answer to the following questions: Is the vendor able to understand and translate customer needs into a product or service? Is the vendor generating differentiation? Does the vendor have a clear sales strategy (attractive pricing)? Does the product delivery and development emphasize differentiation? Is the vendor's product and service compatible with various industries (finance, manufacturing)? Is the vendor investing in innovation to achieve a competitive advantage? Is the vendor able to meet the needs of locations outside its native country?

As depicted in Picture 7, Gartner divided the market in four segments: Leaders, Challengers, Visionaries and Niche Players.

Leaders understand fully product capabilities, are committed to satisfy buyers' needs and aim to make customers succeed. Leaders provide the market with modern BI analytics which are becoming a mainstream in the organizations. Modern BI analytics are easy to use, provide clear business value and allow users with limited expertise in IT to use them without involving IT department. Leaders have to demonstrate investments in innovation in a rapidly evolving market, protecting in this way, the investments made by different buyers today.

If we consider the actual situation, there are three vendors in the Leaders quadrant which

are challenged by heavy investments in innovative analytics made by Visionaries. Indeed, next year the number of Leaders is expected to grow if this trend continues. Challengers are characterized by a lack of coordination across the different products they may also lack geographic presence and marketing efforts. Challengers are limited to specific cases. However, challengers are well established in the BI market. This year the Challengers quadrant is empty because there is no company able to challenge market Leaders. Probably the next year some vendors will be positioned here due to the pressure they are putting to the leaders with their investments in innovation.

Visionaries are vendors that offer products that doesn't provide broad solutions but are well equipped with functionalities for the areas they address. Visionaries lack the ability to grow and large-scale adoption among users. The Visionaries quadrant is populated by nine vendors, some of which offer modern products backed by a customer base, while others offer an innovative and disruptive product combined with a lack of visibility.

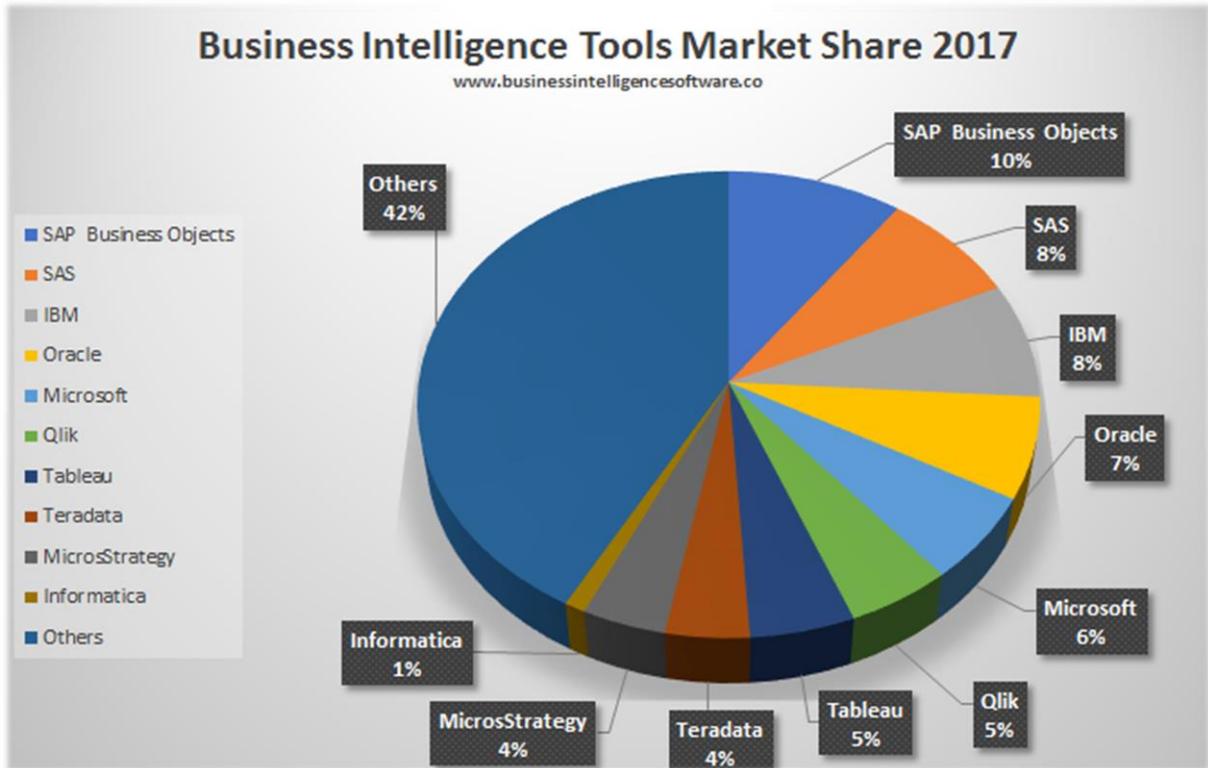
Niche Players are vendors that concentrate their efforts in a specific domain of the BI, while lacking to innovate and develop other aspects of the BI analytic platform. Niche Players may also have a broad BI solution but the implementation may be limited in a narrow geographical area or in a specific industry. The market position hold by Niche Players is not solid. If we look at the Gartner's Magic Quadrant we can see that half of the vendors are included in Niche Players quadrant. All 12 vendors have differentiated their capabilities to meet the rapidly evolving market needs.

According to Steve Thomson<sup>14</sup>, in 2017 the top 10 BI software vendors accounted around 58% of the whole BI analytics market. As depicted in Picture 8, the biggest players in this market are: SAP Business Objects with 10% of market share, SAS with 8%, IBM with 8%, Oracle with 7%, Microsoft with 6% and so on.

Compared to the last year, Microsoft has gained 1% of market share, SAS instead has lost 1% of market share.

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<sup>14</sup> <https://www.businessintelligencesoftware.co/bi-tools-market-share-2017.html>



Source: <https://www.businessintelligencesoftware.co/bi-tools-market-share-2017.html>

**Picture 8**

## 2.8.BI within ERP

Business Intelligence is a component/module of ERP, therefore it is important to figure out the relationship between them. Firstly, we need to understand what ERP is. ERP stands for Enterprise resource planning, other names used to refer to the same issue are: Enterprise Information Systems (EIS), Enterprise Wide Systems (EWS) and Enterprise Systems (ES).

“Enterprise systems are commercial software packages that enable the integration of transactions-oriented data and business processes throughout an organization (and perhaps eventually throughout the entire interorganizational supply chain)”<sup>15</sup>.

“Enterprise resource planning systems serve as the organization’s backbone in providing fundamental decision-making support. In the past, departments made decisions independent of each other. ERP systems provide a foundation for collaboration between departments, enabling people in different business areas to communicate. ERP systems have been widely adopted in large organizations to store critical knowledge used to make the decisions that drive performance.

The heart of an ERP system is a central database that collects information from and feeds information into all the ERP systems or individual application components (called modules), supporting diverse business functions such as accounting, manufacturing, marketing, and human resources. When a user enters or updates information in one module, it is immediately and automatically updated throughout the entire system”<sup>16</sup>.

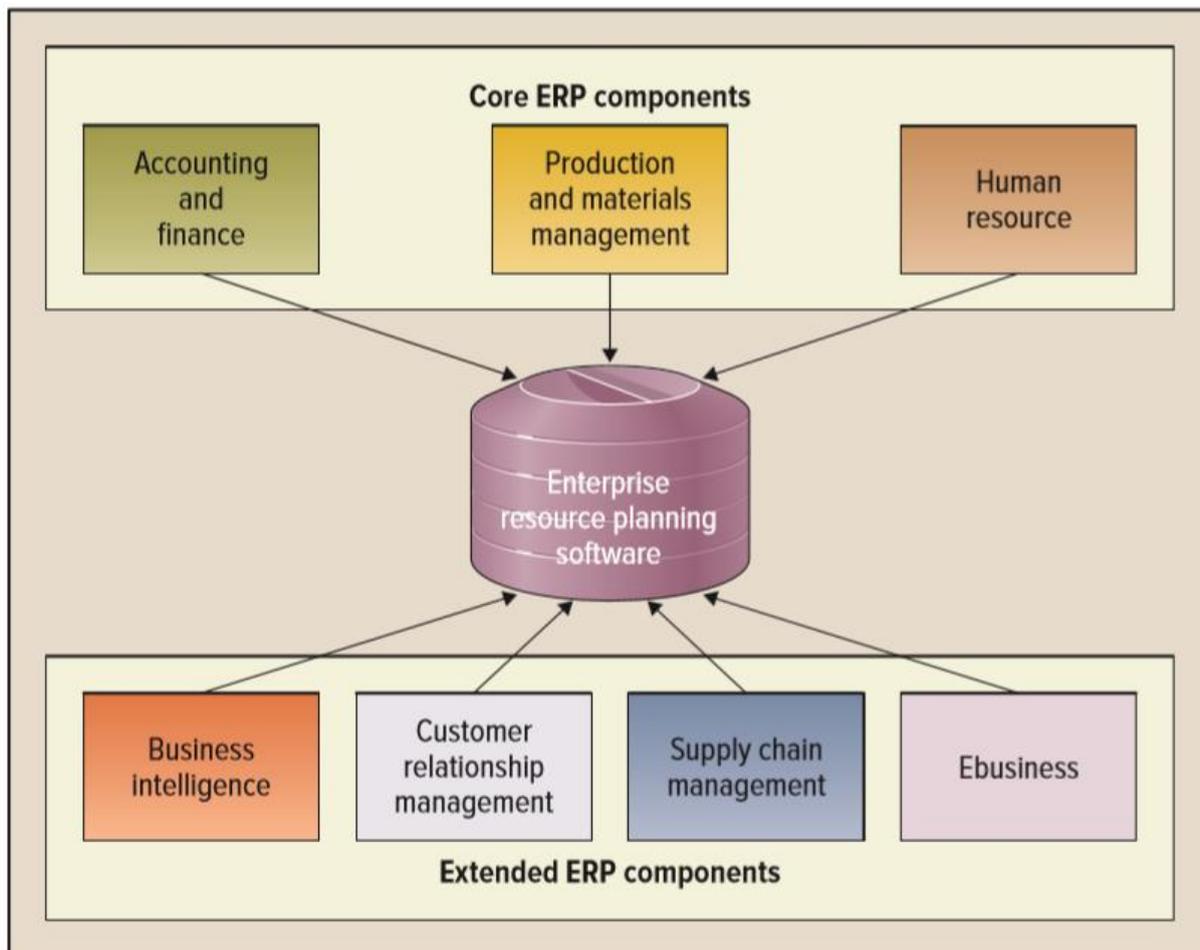
By providing one information backbone, many organizations invested millions of dollars thinking that ERP systems will solve all problems related to the information needs. However, ERP systems are far from being a perfect solution or a universal remedy. Indeed, Paige Baltzan in her book “*Business Driven Technology*”, 2017, p.222, shows five famous ERP failures.

According to Paige Baltzan, these systems are good at gathering and storing data, while they are very difficult and complex to manage and they have low reporting capabilities. To overcome these limits, organizations must supplement ERP systems with additional components. Picture 9 depicts an ERP system with its Core and Extended components.

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<sup>15</sup> Markus and Tanis, *The Enterprise System Experience From Adoption to Success*, 2000, p. 176

<sup>16</sup> Paige Baltzan, *Business Driven Technology*, seventh edition, McGraw Hill, 2017, p.209



Source: Paige Baltzan, *Business Driven Technology*, seventh edition, McGraw Hill, 2017, p.214

**Picture 9**

Core ERP components focus on internal operations and are traditionally included in most ERP systems, while Extended ERP components focus on external operations and cover those limits represented by Core components.

Picture 9 confirms what we have said at the beginning of this paragraph, i.e. Business Intelligence is an Extended component of ERP.

Since the following thesis is an attempt to explain the impact of Business Intelligence tools in management, I will focus on one Extended component, i.e. Business Intelligence, more precisely in Performance Dashboard.

ERP systems measure and control operations that occur within an organization, but if we add the powerful BI system, ERP systems can be enhanced and provide greater value. BI collect and organize information and apply analytical tools. The most popular extension provided to the ERP systems is data warehouses, adopted by over 2/3 of US

manufacturers<sup>17</sup>.

BI applications help companies realize tangible returns on their ERP investments and the bigger is the amount of data the greater the probability that BI will derive value from ERP installations. BI separates wheat from chaff, structure and optimize information for fast and accurate decision making. But what do senior executives want from ERP? They probably expect to empower employees allowing them to make timely and right decisions. This is not possible without intuitive and easy to use interfaces. To succeed BI, the data must be purified and accurate, the IT infrastructure must provide a clear path to BI information and the data visualization must be highly intuitive and user centric. BI, moreover, allow users to create report structures, without over reliance on programmers. That's why BI validates ERP investments and derives value from them. According to Paige Baltzan, BI optimizes ERP investments by offering:

- Direct access to many types of data sources;
- Quick and simple analysis;
- Multidimensional presentation of data;
- User-focused application creation.

BI facilitates decision making in each hierarchical level. All it takes is a click and a dashboard will pop up to give you timely and important information to support your decision. BI makes critical knowledge easy and accessible and in the long run it turns to be a smart investment for companies implementing ERP. Instead of losing time in searching data, senior executives can spend their time in analysis and taking decisions. In a nutshell BI make ERP investments more accessible, powerful and valuable.

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<sup>17</sup> Paige Baltzan, *Business Driven Technology*, seventh edition, McGraw Hill, 2017, p.216



### **CHAPTER 3. BUSINESS INTELLIGENCE AND DECISION MAKING**

“A decision support system (DSS) is an interactive computer-based application that combines data and mathematical models to help decision makers solve complex problems faced in managing the public and private enterprises and organizations”<sup>18</sup>. The decision support system can be regarded as an integral part of Business Intelligence system. Indeed, DSS is crucial in the development of the Business Intelligence Architecture.

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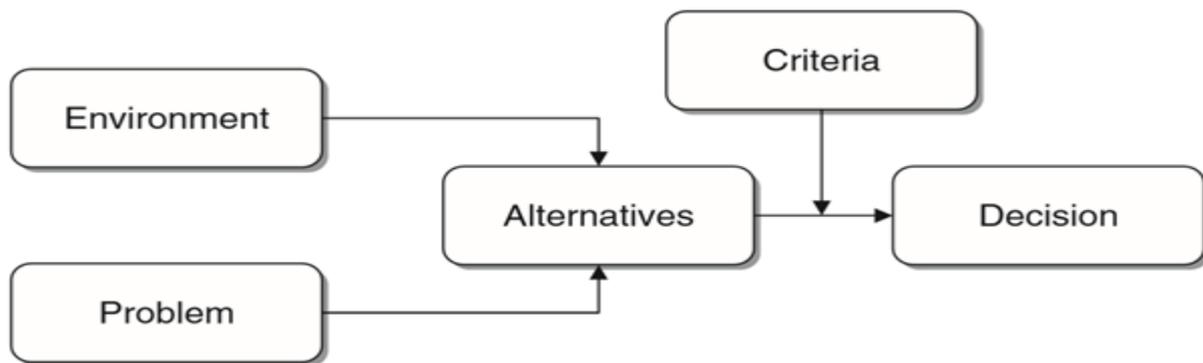
<sup>18</sup> Carlo Vercellis, *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009, p.21

### 3.1. Problem solving

When we have a problem we usually evaluate the different alternatives in order to solve it, after we have evaluated the different alternatives, we make a decision with a fair degree of rationality. All of us face many decisions on continual basis, either from professional life or from personal life, some of which are more important than others.

The decision-making process is part of the problem solving which is a broader subject. According to Carlo Vercellis, the problem solving is a process through which individuals try to overcome the difference between the actual conditions of a system (as is) and the possible improvement that could be achieved in the future (to be). Different obstacles should be passed to make this difficult transition. For each problem, decision makers usually identify different alternatives and chose that which is a result of the comparison between advantages and disadvantages, after having considered their feasibility. After the decision, the option must be put into practice to verify whether it is effective on reaching the prefixed goals or not. If the final step fails, the whole process should be repeated again. The problem-solving process is depicted in Picture 10.

The alternatives are the possible solutions to a given problem or the possible ways to achieve the goal. In some cases, the number of alternatives are too small, for instance, if we have to decide whether to enter or not into a new market we have only two alternatives. In other cases, the number of alternatives may be very large or even infinite, for example, if we want to implement a strategy we may do so in many different ways.



Source: Carlo Vercellis, *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009, p.24

**Picture 10**

According to Carlo Vercellis<sup>19</sup>, criterias are the metrics used to evaluate the effectiveness of different options, for example, economic criteria are usually emphasized in decision making within businesses. In a nutshell, we tend to prefer choices with best performances in fulfilling our objectives. However, Carlo Vercellis claims that there are also other factors that may influence our choice.

- Economic: Efficiency is the one of the most overweighed factors within a decision-making process. Companies prefer those options with lower ratio input/output, in other words companies aim to minimize costs and maximize profits.
- Technical: Feasibility is another important criterion to keep in mind when we made a choice, since not all our ideas, even though brilliant, are possible. For instance, if our aim is to increase the production with the aim to reduce average cost but we have already reached the maximum production capacity of our plants then the idea is not feasible.
- Legal: Compliance is also very important aspect which shouldn't be under evaluated. Before taking any action, decision makers must check whether they are in compliance with the local legislation or not.
- Ethical: It is not enough following the law, decisions must respect also ethical principles and social rules of the local community.
- Procedural: A decision may respect all the factors mentioned above, but it won't work well if the procedures are not easy and simply.
- Political: Each decision has some political consequences on the stakeholders which needs to be evaluated.

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<sup>19</sup> Carlo Vercellis, *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009

### 3.2.Kinds of decisions

In classifying the decisions, Carlo Vercellis uses two types of dimensions, i.e. nature and scope, then each of them is subdivided in three categories<sup>20</sup>.

If we take into consideration the first dimension, which is nature, we can classify decisions in structured, unstructured and semi-structured.

- **Structured:** A decision can be defined structured if there is a prior, well-defined procedure. Usually structured decisions are ideal for automation since the tasks are mostly repetitive. Even if decisions are structured, sometimes decisions makers need to cope with unexpected or unusual events.
- **Unstructured:** A decision is considered unstructured if it contains at least one element that is not well known and that can't be defined in a sequence of steps. This kind of decision is usually faced when we cope with some problems for the first time or rarely. In this case, Business intelligence may provide timely and versatile information to support the decision makers.
- **Semi-structured:** As the word suggests, semi-structured decisions are composed at the same time by structured and unstructured phases. Most of the decisions faced in the real working experience are semi-structured, both in private and public companies. Business Intelligence can support this type of decisions in two ways. In the unstructured decisions, Business Intelligence play a passive role by providing timely and versatile information. While in the structured decisions, Business Intelligence play an active role using mathematical models and algorithms to allow automation in the process of decision making.

So far, we have used the dimension of the nature to classify the decisions, now we are going to use the scope to obtain different rank. Using the scope, we classify decisions in strategic, tactical and operational.

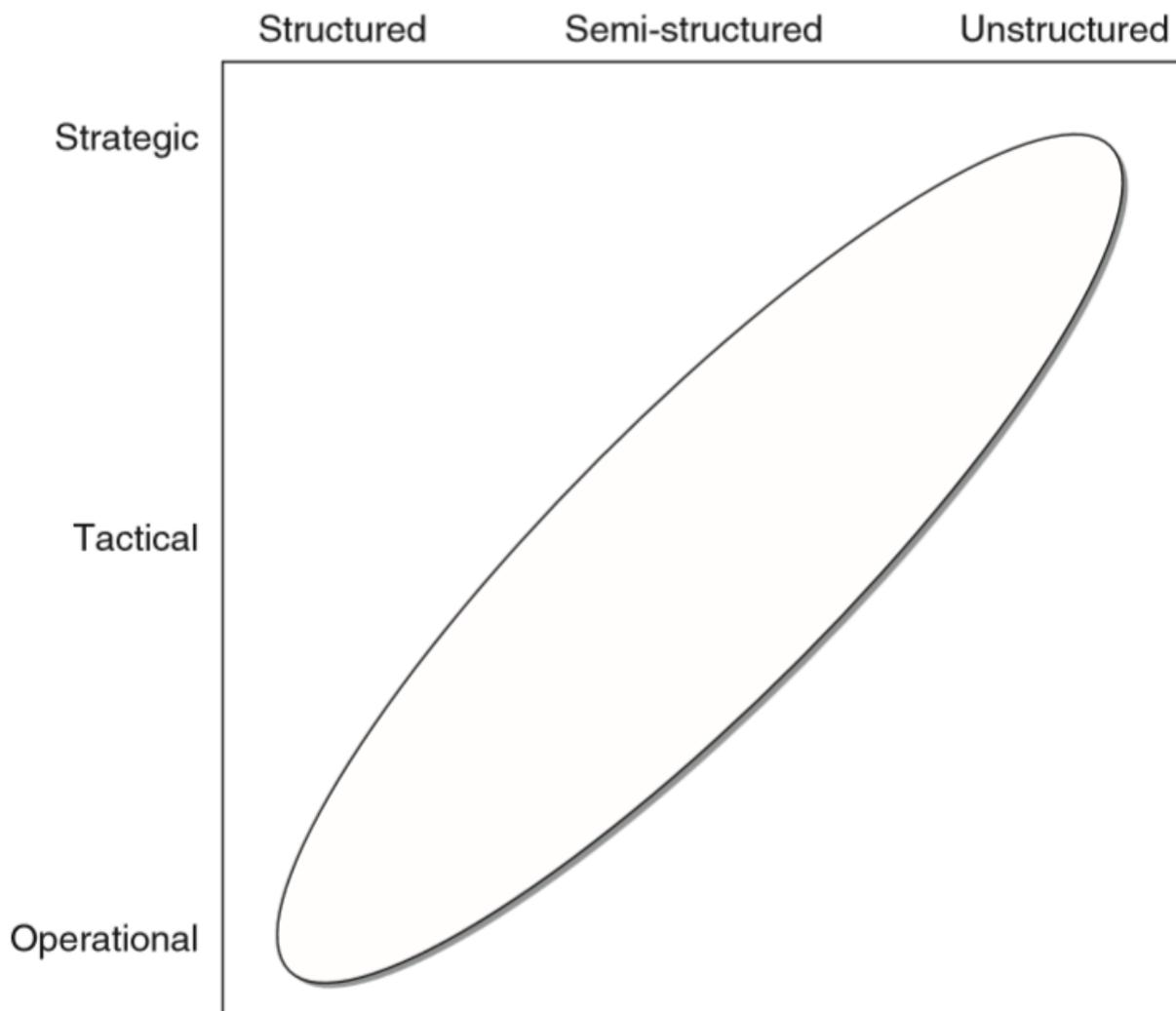
- **Strategic:** Decisions are considered to be strategic when they involve the whole organization or a significant part of it for a long period of time. Since strategic decisions affect company goals and behaviours, they are considered to be important so the decisions are taken by the top management.
- **Tactical:** Tactical decisions usually affect only a single department or a single part

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<sup>20</sup> Carlo Vercellis, *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009, p.29

of the enterprise for one year at most. This type of decision is usually taken by the middle managers, such as department managers.

- Operational: This kind of decision has a low impact on the company performance since it affects only a specific activity, rather than a department or the whole organization. Strategic and tactical decisions shape somehow operational decisions, therefore lower level managers or knowledge workers are able to make this kind of decision.



Source: Carlo Vercellis, *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley, 2009, p.29

**Picture 11**

In the real-world, nature and scope are not perfectly correlated but most of the decisions fall within the ellipse depicted in Picture 11.

It is very important to understand what is a DSS (Decision Support System), because the

main aim of the BI is to support the decision-making process.

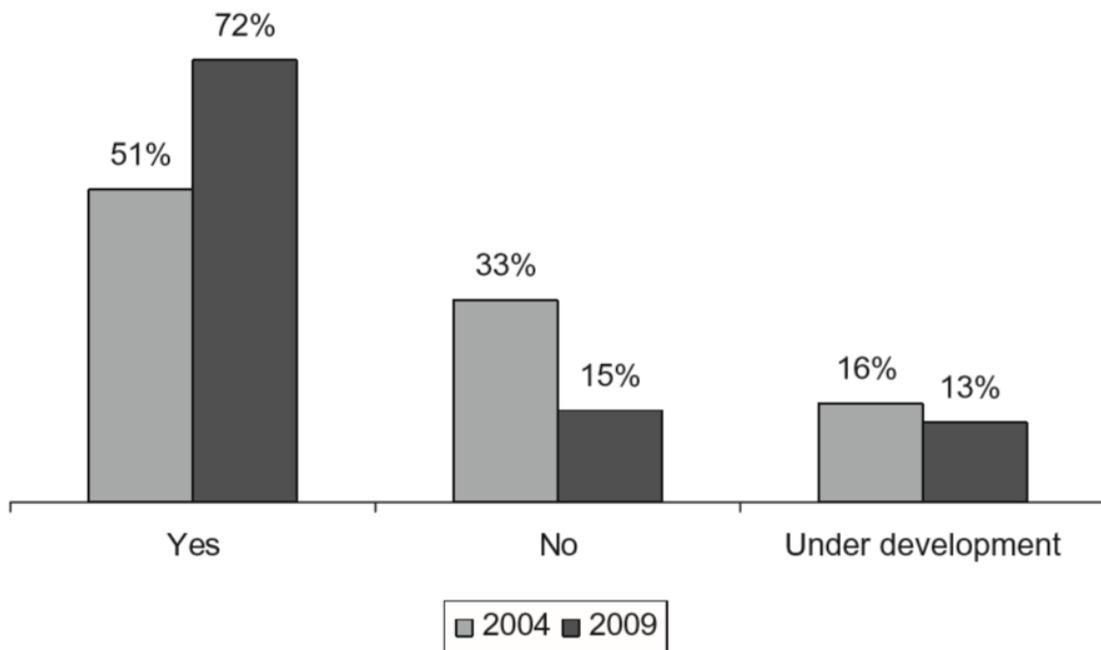
The main support that a BI tool can give to a decision-making process is represented by the information provided both, before and after a decision is made. Before, because it provides the decision maker with insights and information useful to create different alternatives. After, because it helps decision makers to evaluate decisions made in the past. Performance Dashboard, which will be described in the next chapter, represents an important BI tool which supports decision makers.

## CHAPTER 4. PERFORMANCE DASHBOARDS AS A BI TOOL

Performance dashboard is one of the most important tools of BI and the main aim of this thesis is to create a Performance dashboard with a BI software on a real case study. But what is a Performance Dashboard?

“If you drive a car or fly an aircraft, vital information about speed, oil pressure, temperature, and so on is available to you through the dashboard in front of you. Gauges, red and green lights, and odometers are strategically positioned so that with a quick glance, without losing focus on where you are going, you know if everything is okay (or not) and can make decisions accordingly”<sup>21</sup>.

In the same way as drivers rely on dashboards to drive the car, managers are increasingly making use of business or Performance Dashboards to run their businesses. A study made by The Data Warehousing Institute in 2004 and then repeated in 2009 confirms the increasing trend as showed in Picture 12.



Based on 437 and 495 respondents respectively.

Has your organization implemented a Performance Dashboard?

Source: Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2<sup>nd</sup> edition 2011, p. 6.

Picture 12

<sup>21</sup> Nils Rasmussen, Claire Y. Chen, Manish Bansal, *Business Dashboards: A Visual Catalog for Design and Deployment*, John Wiley & Sons, 2009, p.3

A Performance Dashboard translates strategy into objectives and provides timely and important information to the decision makers, allowing them and employees to work proactively, improve decisions and focus on the key activities necessary to achieve the objective.

“A Performance Dashboard is a layered information delivery system that parcels out information, insights, and alerts to users on demand so they can measure, monitor, and manage business performance more effectively”<sup>22</sup>.

It doesn't represent just some cool looking graphics but instead, it helps the company to achieve important goals.

According to Eckerson, a dashboard provides three main functionalities:

- Monitoring performances against targets consistent with strategy. If we are monitoring operational activities on a daily basis, for instance manufacturing, then we are speaking about the dashboard. While if we monitor weekly, monthly, quarterly or annually the progress toward general strategic goals, we are talking about scorecards. An important element of the monitoring process are alerts which notify managers or employees when they exceed predefined thresholds.
- Analysis allows users to explore data and find the cause of an exception found in the monitoring process. Different technologies, such as online analytical processing (OLAP), ad hoc reporting, predictive analysis and so on, can be used for this purpose. A necessary condition for data exploration process, is a data infrastructure.
- The management is able to use this tool in different meetings to foster collaboration, review strategy and performance. Managers can quickly access to the data they need, print and annotate them.

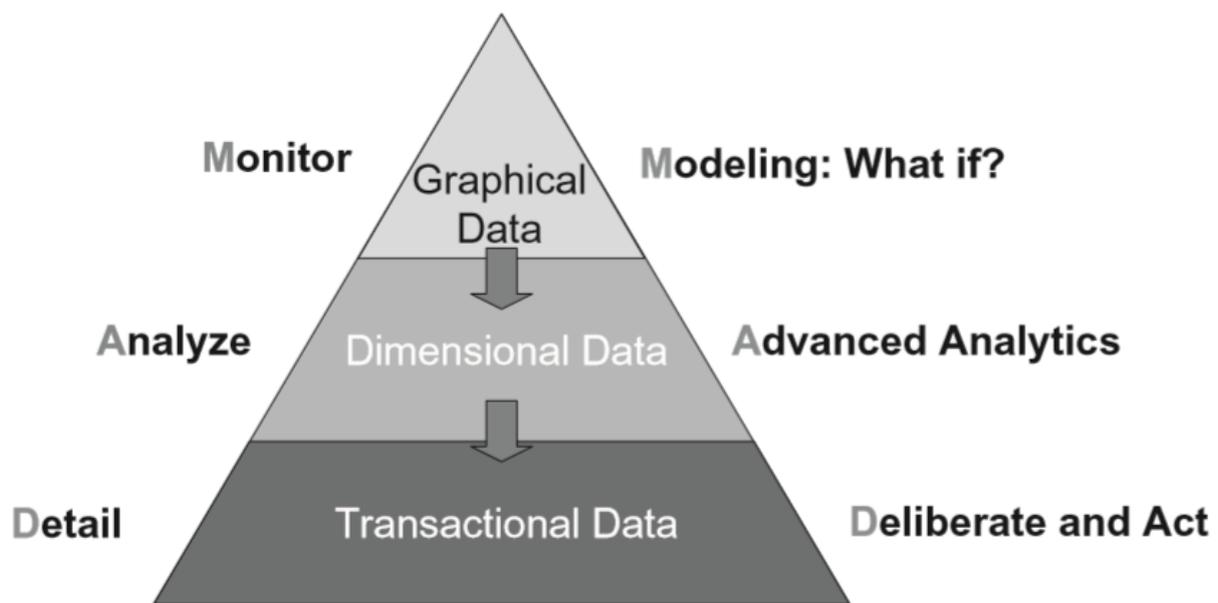
Eckerson claims that a Performance Dashboard is made up of three layers of information and the deeper you go the more details you get. The three layers depicted in Picture 13 are:

- Graphical, metrics data. Performance is showed in graphics in the form of charts and alerts. Beyond a threshold or when an exception occurs, the dashboard alert users with a pop-up message, coloured icons (usually red), animations or e-mails.

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<sup>22</sup> Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2<sup>nd</sup> edition 2011, p. 10.

- Summarized, dimensional data. This layer allows users to view or extract the data by subject, such as, geography, age, sex etc. Users can view the data from any perspective they want.
- Detailed, transactional data. Users view detailed data related to operational activities, for instance, invoices and different transactions which are usually stored in databases, in our case in data warehouses. Users need detailed data because they need to understand the cause-effect relationship of a problem.



Source: Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2<sup>nd</sup> edition 2011, p. 14

**Picture 13**

Users usually don't want to have huge amount of detailed data frequently, they would rather prefer summary data, then when a problem comes they can get the details needed to discover the source of the problem and take corrective actions.

There are three types of Performance Dashboard<sup>23</sup>:

- Operational: Front-line employees can rely on refreshed detailed data to manage and control daily operations. Operational dashboards emphasize the monitoring function.
- Tactical: Deals with projects and processes that occur within departments. Tactical

<sup>23</sup> Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2<sup>nd</sup> edition 2011, p. 105.

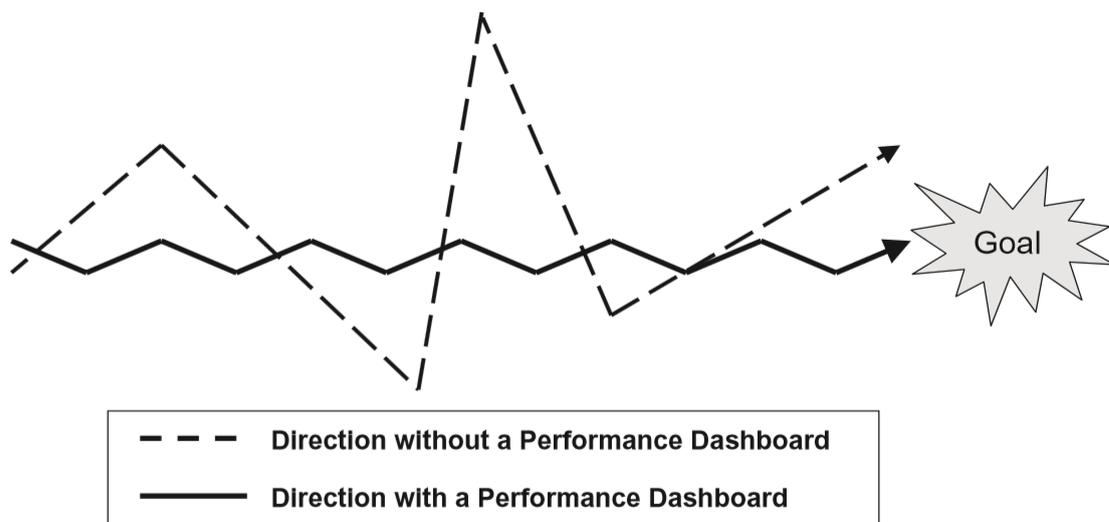
dashboards are used by managers to monitor processes, while executives use it to benchmark the performance. Tactical dashboards tend to emphasize the analysis function.

- Strategic: Monitor whether the pre-set objectives have been reached using the pre-set strategies. Strategic dashboards usually implement balanced scorecard and are used by executives to communicate strategy and monitor performance. Strategic dashboards emphasize management.

## 4.1.Benefits

At the beginning of this chapter, we have mentioned an increasing trend toward the adoption of Performance Dashboards among the organizations. But why is this trend increasing? Mainly because Performance Dashboard brings many benefits listed here below<sup>24</sup>.

- **Communicate strategy:** Performance Dashboards translates strategy into targets and users can monitor the progress made towards the strategic objectives. When there is no progress, users are informed about what kind of actions to take to solve the specific problem.
- **Refine strategy:** We can't predict the future, so each strategy we made regarding the future, needs to be changed because of the unpredictable events. Top managers use dashboards as a steering wheel to change the direction according to the contextual changes. The Picture 14 illustrates better the issue.



Source: Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2<sup>nd</sup> edition 2011, p. 7

**Picture 14**

- **Increase visibility:** Dashboards provide timely information about daily operations. Executives and managers can predict future performances, based on the past, without being surprised because of the information provided by the dashboard.
- **Increase coordination:** Some targets might require the contribution of different

<sup>24</sup> Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2<sup>nd</sup> edition 2011, p. 7

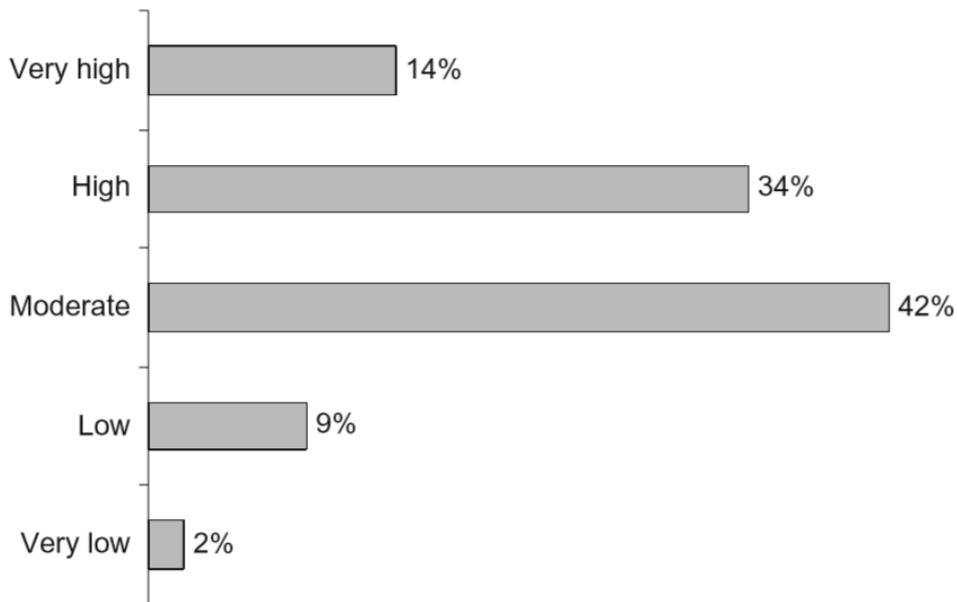
people, working in different departments. Dashboards foster collaboration, dialogue and working together between employees of different departments. Employees are usually involved in the process of setting targets, so dashboards somehow foster the dialogue also between managers and employees.

- Increase motivation: A dashboard contains performances and results, users by seeing a screen with fancy performance graphics will be more motivated, productive and competitive among peer groups.
- Consistent view of the business: Performance Dashboards integrates and standardize information coming from different sources in one common version using the same definitions and meanings. In this way, it is possible to avoid misunderstanding of information and conflicts related to the different version of the information.
- Reduce costs and redundancy: By standardizing the information, organizations avoid having the same information from different sources. Besides, dashboards can cut investments made in different independent reporting systems. In this way, the organization will have a Performance Dashboard based on a single version of business information.
- Empower users: With the Performance Dashboard, users are more independent from IT department because they are provided with self-service access to the information system. Performance dashboard provide users with guides making easy for average people to access to the information.
- Deliver actionable information: Timely information provided by the Performance Dashboard is useful to solve a problem or catch an opportunity before it is too late. It also allows the organization to save time when searching information.

In short, Performance Dashboards deliver the right information to the right users at the right time to optimize decisions, enhance efficiency, and accelerate bottom-line results<sup>25</sup>. In 2009 TDWI (The Data Warehousing Institute) conducted a research in which organizations were asked the degree to which their Performance Dashboards had had a positive impact on business results. As depicted in the Picture 15, almost half of the responders (48%) said either high or very high.

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<sup>25</sup> Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2<sup>nd</sup> edition, 2010



Based on 495 respondents, 2009

To What Degree Has Your Dashboard Had a Positive Impact on Business Results?

Source: Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2<sup>nd</sup> edition, 2010, p.9

**Picture 15**

Although there is an increasing trend in the adoption of the Performance Dashboards with different benefits, according to Eckerson, not all of them succeed. The failure in the implementation of Business Intelligence and data integration technologies are due to different factors.

One reason derives from the fact that companies use software solutions like Microsoft Excel or Microsoft PowerPoint that might look fancy but are not able to show the source of the problem highlighted in the indicator.

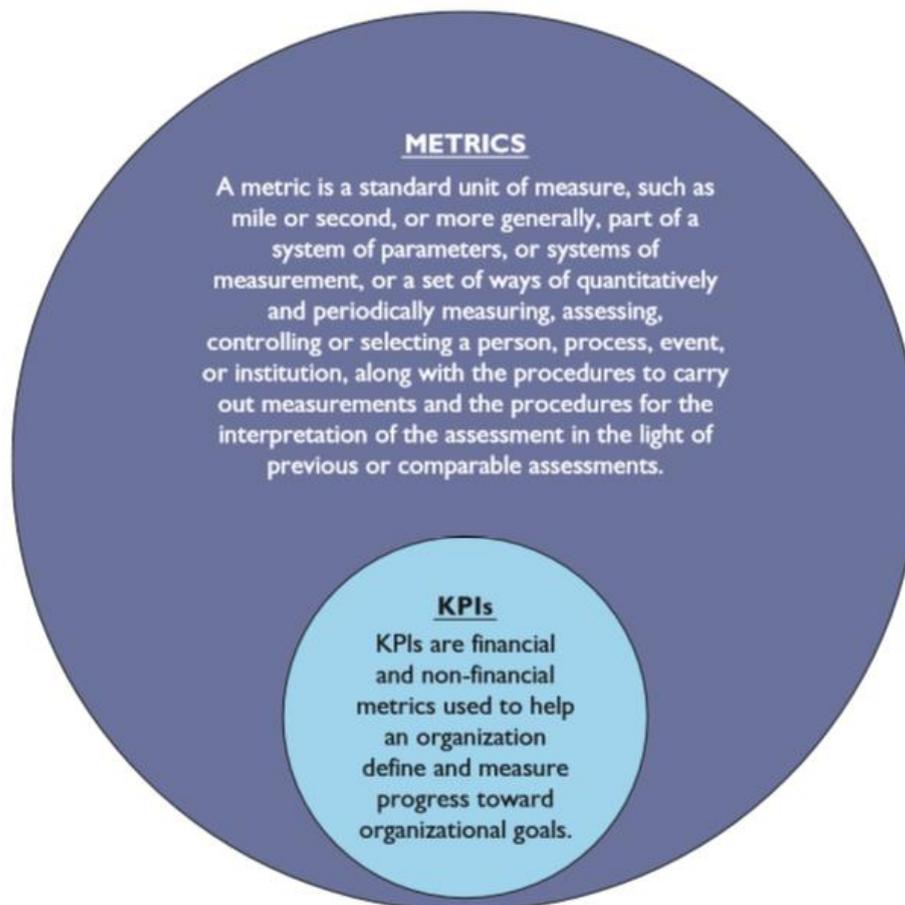
Another reason comes from the failure to automate the data collection process. Some companies don't connect the dashboard to the database but instead, they insert manually the information in the dashboard. In this way decision makers lose a lot of time that would otherwise have been used to analyse the information.

Finally, the failure can be attributed to the data source which in some cases is limited to a single information system, providing a narrow view of the business. Besides, this data sometimes is not coherent with the rest of the organizations leading to confusion.

In a nutshell, the success of a Performance Dashboards depends on how well a company is organized (coordination, central control, clear strategy, metrics-driven culture, information infrastructure etc.).

## 4.2.KPIs

A Performance Dashboard is composed by different KPIs (Key Performance Indicator). KPIs make clear to everyone what is important and how the work you are doing currently will affect the future. But what are KPIs? According to Eckerson: “A KPI is a metric measuring how well the organization or an individual performs an operational, tactical or strategic activity that is critical for the current and future success of the organization”<sup>26</sup>. Eckerson has defined a KPI as a metric and usually people tend to interchange these two words which in fact have different meanings as showed in Picture 16.



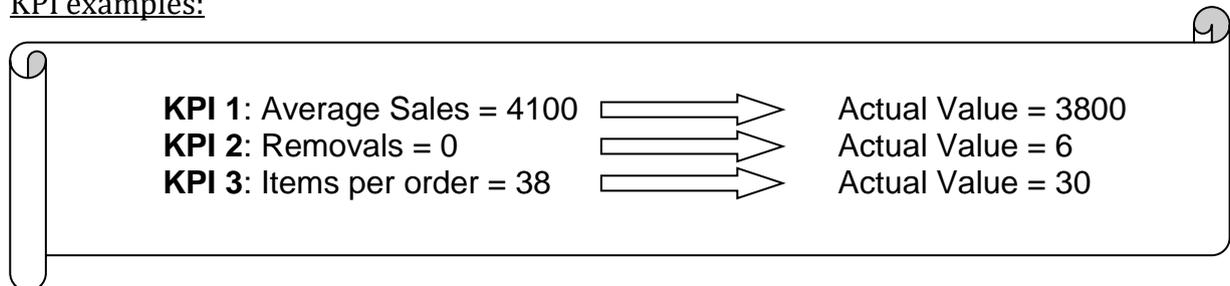
Source: Nils Rasmussen, Claire Y. Chen, Manish Bansal, *Business Dashboards: A Visual Catalog for Design and Deployment*, John Wiley & Sons, 2009, p.24

**Picture 16**

<sup>26</sup> Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, Hoboken, John Wiley and Sons, 2006, p. 294.

A KPI is a metric and not necessarily the opposite. A metric is more generic, whereas a KPI is more specific. The business strategy (vision, mission, objectives), is usually translated in KPIs, with the aim to measure the degree of success.

KPI examples:

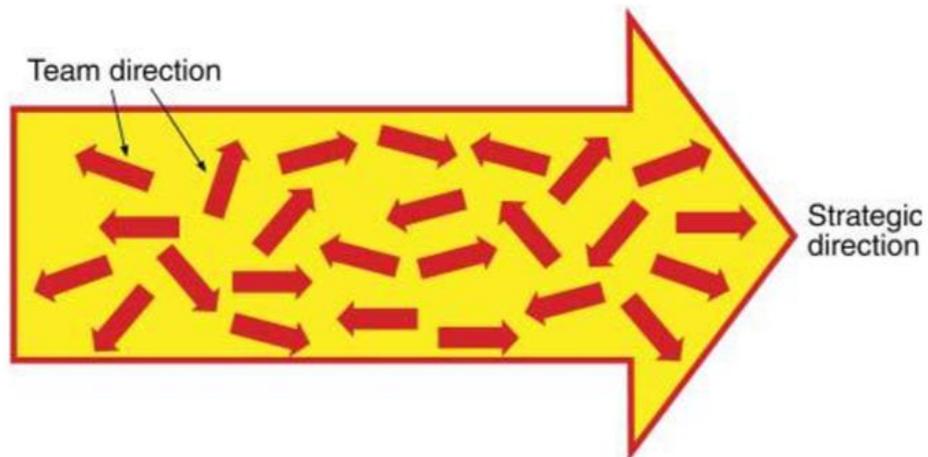


In many cases organizations fail to create successful KPIs because they implement some measures which doesn't have any link to the organization's critical success factors. Another reason which can bring to the failure of KPIs is due to the fact that sometimes KPIs are old. We live in a highly competitive and dynamic environment, therefore, old KPIs (even just few days) are useless.

But if the organization succeed in the implementation of successful KPIs it will gain different benefits. Benefits related to the KPIs can be summarized in three headings<sup>27</sup>:

- Alignment of strategic objectives with daily operations. As showed in Picture 17, different teams of an organization may follow different directions toward the strategic objective, even though the objective is the same. This discordance may create conflicts between teams making the organization less effective and less efficient.

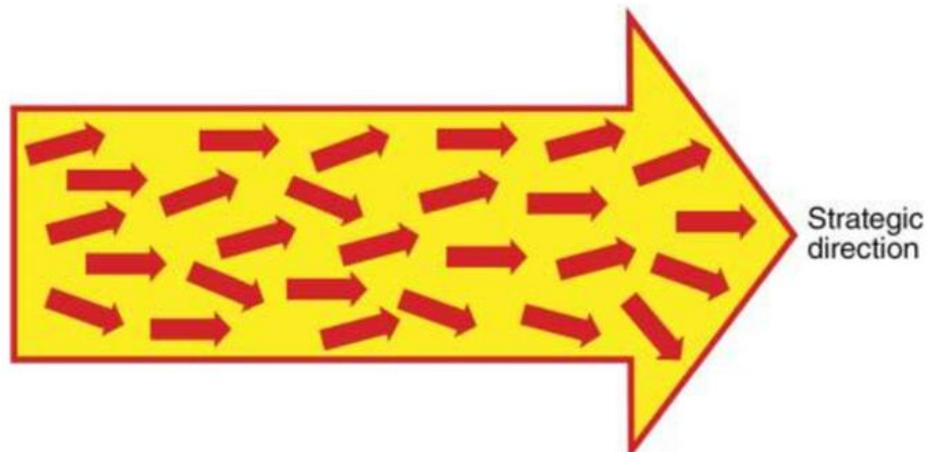
<sup>27</sup> Parmenter David, *Key Performance Indicators: Developing, Implementing, and Using Winning KPIs*, Wiley, third edition, 2015, p. XV



Source: Parmenter David, *Key Performance Indicators: Developing, Implementing, and Using Winning KPIs*, Wiley, third edition, 2015, p. XVI

**Picture 17**

The ability of an organization to align daily activities with strategic objectives, as shown in Picture 18, makes the difference between a good and a great organization.



Source: Parmenter David, *Key Performance Indicators: Developing, Implementing, and Using Winning KPIs*, Wiley, third edition, 2015, p. XVI

**Picture 18**

This alignment is crucial because people are prone to do what managers measure not necessarily what managers expect from them.

- Improve Performance. With the right KPIs, the performance should improve because it motivates people, focus attention on what matters, judge objectivity, improves consistency of performance, provide feedback and warning signals and improve business intuition and decision making.
- Create wider ownership, empowerment and fulfilment. Enables supervisors to communicate expectations and to give directions to the staff and let them the autonomy on daily decisions to ensure the progress.

According to David Parmenter, success or failure of the KPI project is determined by the presence or absence of these seven foundation stones<sup>28</sup>:

- 1) Partnership with the staff and third parties. A partnership with stakeholders is needed to successfully improve performances. Partnership means mutual acceptance and understanding, commitment to implementation of arrangements and involvement of key customers/suppliers in the development of a strategy. It is natural to discuss with customers their expectations and to communicate your expectation to suppliers.
- 2) Transfer of power to the front line. Improvement in performance requires also the empowerment of the employees engaged in operational activities. Delegation of the authority is important because it allows employees to take timely decisions, leading to a lean and agile organization.
- 3) Measure and report only what matters. In some cases, organizations generate a lot of useless reports. It is important to create an integrated framework of reports which covers the critical success factors.
- 4) Source KPIs from the critical success factors. Critical success factors measure the alignment of the daily activities with the strategy and have a significant impact in the organization, therefore, they should be the source of KPIs.
- 5) Abandon processes that do not deliver. The ability to recognise and accept that some initiatives will never work, is very important. It is better to face the reality as soon as possible in order to limit the time dedicated to a failing project, therefore, limiting the costs.
- 6) Appointment of a home-grown chief measurement officer. It is worthy to dedicate resources for a measurement expert in-house (chief measurement officer) which would increase the level of expertise and clarity in measuring performances.
- 7) Organization-wide understanding of the winning KPIs definition. It is crucial for organization success that all the staff and managers understand well the meaning of KPIs. It should be clear to the staff what a KPI is and what is the aim of a KPI.

Successful KPIs are crucial to the creation of a successful Performance Dashboard, since without them confusion and chaos will reign in organizations.

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<sup>28</sup> Parmenter David, *Key Performance Indicators: Developing, Implementing, and Using Winning KPIs*, Wiley, third edition, 2015, p. 109



## CHAPTER 5. BI CONTEXT: BUSINESS PERFORMANCE MANAGEMENT

For a better understanding of Performance Dashboards, we need to examine performance management which represents the context within which the Performance Dashboard is inserted.

“Today, the industry seems to have settled on the generic term performance management to describe the combination of processes and technologies that help an organization measure, monitor, and manage its business to optimize performance and achieve goals. More succinctly, performance management is a series of organizational processes and applications designed to optimize the execution of business strategy.”<sup>29</sup>

According to Eckerson, Business Performance Management includes the following disciplines:

- Dashboards;
- Planning;
- Budgeting;
- Financial consolidation;
- Reporting;
- Forecasting;
- Scorecards.

Once the BPM is introduced, some confusion may arise among managers which exclaim “We’ve been doing that for years”. But, only few companies have integrated all the disciplines in a cohesive way and conduct the organization towards common objectives. Indeed, Eckerson claims that today most companies implement BPM disciplines independently. This means that while an organization may succeed in Planning and Budgeting, it may fail in Reporting and Dashboards.

Eckerson also says that an integrate BPM makes the organization more flexible, in this way the organization can adapt quickly to the change. Thanks to the continuous monitoring of the KPIs, through a Performance Dashboard, organizations know immediately how the new market conditions will impact organization’s performance. Each department adjusts its initiatives to adapt to the change. Even the whole business strategy can be changed by executives, if this change brings better results.

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<sup>29</sup> Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2nd edition 2011

## 5.1.BPM Obstacles and Benefits

Executives set strategy, managers develop plans to achieve the strategy set by executives, and staff executes the plan. All of them, then monitor progress through analytical tools. BPM has also some obstacles<sup>30</sup>, one of the BPM obstacles is the strategy gap. Defining and executing a strategy are two different things. Executives deliver a well-made strategy hoping that it will be executed and bring success. However, in many cases inertia reigns and organization doesn't execute the pre-set strategy.

Another BPM obstacle is represented by the process of planning and budgeting which in most cases is useless because it is too slow to meet business dynamics of today and not so flexible. Indeed, in most cases planning and budgeting are out of date before they are completed.

Last BPM obstacle derives from the fact that reporting and analysis are not aligned with strategy and objectives. This is due to the high number of reports measuring things of little importance and to the inconsistent use of definitions for common entities.

If we are able to overcome these obstacles we will benefit from BPM in many different ways.

Eckerson says that BPM doesn't simply improve performances in general as most people think, instead it improves performances in the right direction. People within the organization may work hard, with enthusiasm and spending a lot of time, but if all these efforts are directed towards the wrong processes, services or products than everything is useless. A company with BPM in place, can work more effectively, not just more efficiently. BPM help organizations focus on few important activities or processes that provide long term value to the business.

According to Eckerson, performance management bridges the gap between strategy and execution, allowing the organization to improve the following aspects:

- Communication of the strategy and objectives from executives to managers and employees is improved through dashboards and scorecards.
- Coordination is improved due to a more effective exchange of ideas and information within the organization and among business units.
- Control over the activities and processes generates up to dated information

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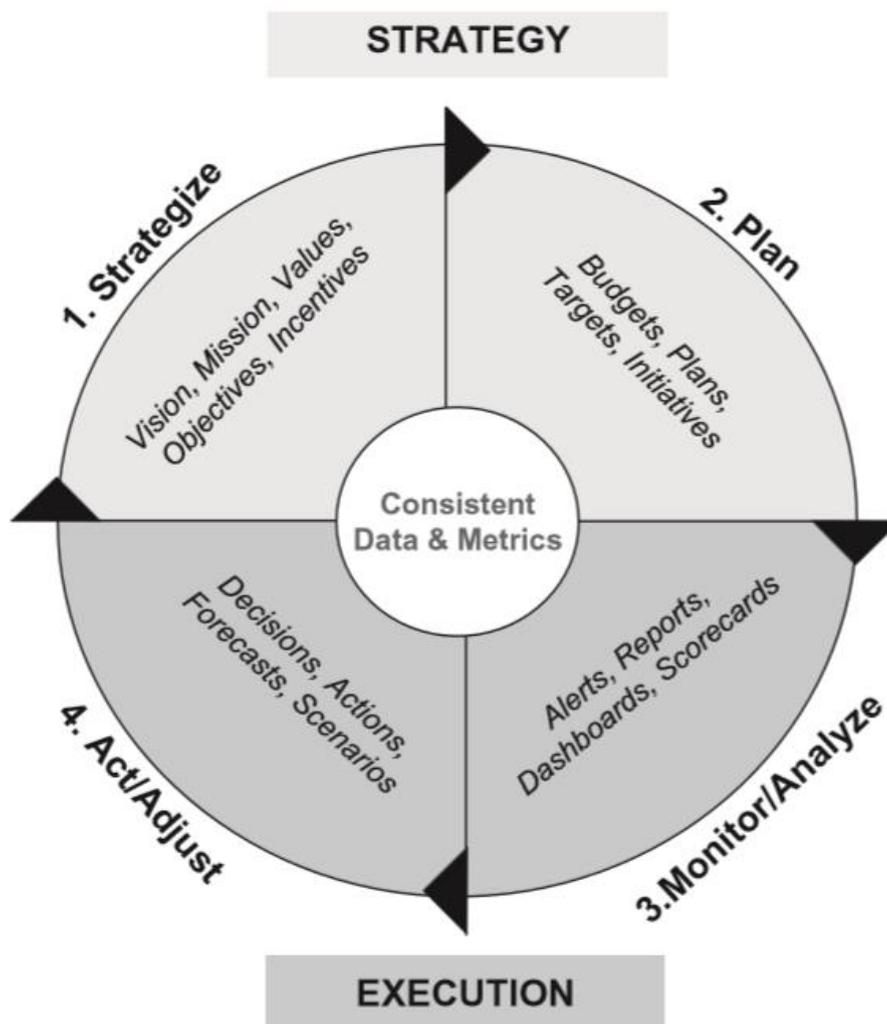
<sup>30</sup> Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2nd edition 2011, p. 25

allowing employees and lower level managers to make timely and effective adjustments.

Managers use BPM mostly to gain greater visibility into the business, but also to execute strategy, improve efficiency, flexibility and strategic planning.

## 5.2.BPM Framework

What are processes, components and technologies required to make work the BPM? Performance management is made of the following four steps<sup>31</sup>: strategize, plan, monitor/analyse and act/adjust, which are depicted in Picture 19. Once all those steps are executed properly, organizations can gain improvement in coordination, communication and control. BPM keeps organizational steering wheel to direct it towards the right direction.



Source: Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2nd edition 2011, p. 29

**Picture 19**

<sup>31</sup> Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2nd edition 2011, p. 29

Let's give a close look to all these steps:

- 1) **Strategize.** In this step, the organization defines the strategy, i.e. vision, mission and values. This step is important also because short-term and long-term objectives and goals are defined. In other words, the first step defines what are the key drivers of business value (customer satisfaction, product quality etc.) and how to measure them. The key drivers of business value are also referred to as KPIs. Everybody in the organization is committed and direct their efforts to be aligned with the business strategy.
- 2) **Plan.** The second step consists in developing a plan to implement business strategy and allocate the needed resources (people, knowledge, technology, equipment, and money) to execute it. Developing a plan means developing new initiatives but also refining the existing ones. The main tool of this step is the budget which is used to allocate resources. In this step, the general corporate objective is split into targets and each level of the organisation is committed to reach those targets. Unfortunately, in most cases, budgeting process projects the coming year on the activities of the last year and this projection is rarely corrected or changed as the conditions change. By doing so, the budget is out of date and provide little value. The lack of shared definitions and a standard planning and budgeting process makes almost impossible a consistent view of the business. Experts agree that organizations should move from a top-down approach on budgeting and planning to a more collaborative one. This process should be more dynamic, forward-looking and base the coming year projections on the actual performance.
- 3) **Monitor and Analyse.** Once the strategy and the plan are defined, performances should be monitored and analysed in a timely manner. The third step allows organizations to realize whether the organization is going in the right direction or not. In the second case, organizations should act proactively to achieve goals. An important tool of the monitoring and analysis process is represented by the Performance Dashboard. A Performance Dashboard is a BI tool used by organizations for reporting purpose and to analyse information (see "CHAPTER 4. PERFORMANCE DASHBOARDS AS A BI TOOL" for more details).

- 4) Act and Adjust. The last step represents the most critical part of the performance management. To be constantly aligned with the business strategy, workers need to correct the path followed by the organization before it is too late and exploit new opportunities before they vanish.

Performance Dashboard is the main tool used by the organizations to alert users of the potential problems on a timely manner and provide them with details for a better solution. Indeed, providing just metrics is not enough, it is quite natural that if a problem arises users want more information.

Organizations also need to adapt to quick change of the market conditions, and to do so they need to be flexible, have a lean structure and a decentralized decision making process. Performance Dashboard provides the needed support in this direction.

Performance Dashboard is a result of the combination of the performance management and Business Intelligence. For this reason, it is crucial to fully understand the concept of performance management and BI.

## **CHAPTER 6. CASE STUDY: Steel Italy S.p.A.**

The previous chapters reviewed BI literature to explain what BI is and how it can support decision making process. However, to fully understand and have an idea of how a BI solution might look like, a real case study is needed. The following chapter will describe my own personal experience.

In November 2016, I started an internship in a business unit of a multinational company which lasted up to April 2017. In that period, senior executives from the company headquarters were asking different insights and information to different business units to gain greater visibility over the whole organization. The business unit where I was experiencing the internship wasn't excluded. Among different information they asked, there was also a report incorporating different KPIs, such as turnover, sold quantity, price, productivity and so on.

Among different tasks assigned to me by the CEO of the business unit, there was also this report. Each time I had to refresh the report, I had to find and extract the data from SAP CO module in an excel sheet, clear and make consistent the data with the report and finally insert the data in the report. The whole process was made manually, for this reason it was taking a lot of time, from three up to five days to create the report and the process was open to possible human mistakes.

Since I already knew BI issue from my past experiences, I thought to use BI tools to create this report automatically and the whole idea of this thesis came from this suggestion.

The main aim of this case study is to show how a BI tool, such as Performance Dashboard might look like, when applied in a real case study.

Firstly, the report will be presented how it was actually made by the business unit where I was experiencing the internship i.e. using Microsoft Excel and without the use BI tools. Then, the next chapter will show how the report might look like, when using a BI tool, namely the Performance Dashboard, in this way it will be possible to see and compare the two versions.

## 6.1. Company Overview

An overview of the company is useful to understand its history and the industry in which it operates.

For privacy reasons, the real name of the company can't be used, therefore the name Steel Ltd and Steel Italy S.P.A will be used to refer respectively to the multinational group and to the business unit.

Established in 1972, Steel Ltd is a group which focuses on high quality products and solutions made of steel and other metals. Steel Ltd is a multinational company with different business units spread in more than 50 countries on five continents and the headquarters are based in Linz.

Steel Ltd with its top-quality products and services, is a leading partner in automotive and consumer goods industry in Europe and also aerospace, oil and gas industries worldwide. The company makes huge investments in research and development, not only to make products more innovative but also for an environmentally friendly manufacturing process.

Steel Ltd's revenues in the business year 2016/2017 were equal to € 11.3 billion with an operating income (EBITDA) equal to € 1.5 billion and counted about 50'000 employees. Steel Italy S.P.A, where I experienced an Internship, belongs to this big multinational group.

Situated in North of Treviso Steel Italy S.P.A is a leading company in Italy for producing sophisticated wire solutions. It produces five wire categories:

- Cold heading and premium wire;
- Freecutting steel wire;
- Iron wire;
- Shaped wire;
- Coated wire (nickel, copper, zinc).

The success of Steel Italy S.P.A is assured by excellent employees and high-quality standards and products.

In 2016 this business unit has registered revenues for € 41'183'611 thanks to its 90 employees.

## 6.2.Quantity Report

From this point forward, my personal experience will be presented to share the way I used to make the report while I was experiencing the internship in Steel Italy S.P.A.

The following pages will show different KPIs I made for the company, starting from the quantities sold.

	<b>Till today 15th</b>
<b>TON</b>	<b>November 2016</b>
<b>Product</b>	<b>ACT</b>
<b>Automatic Steel</b>	<b>30</b>
Automatic steel	30
<b>Bright Wire</b>	<b>457</b>
Wire C4D/C9D Bright	457
<b>Cold Headed Wire</b>	<b>1.015</b>
Wire KGK	573
Wire GK	250
Wire K	192
<b>Subcontracting</b>	<b>241</b>
Subcontracting	241
<b>Wire Rod</b>	<b>525</b>
Wire rod untreated	6
Wire rod pickled	154
Wire rod pickled annealed	365
<b>Coated Wire</b>	<b>308</b>
Copper	95
Nichel	176
Zinc	37
<b>Profile</b>	<b>42</b>
Profile	42
<b>Others</b>	<b>95</b>
Scrap	80
2nd Choice	15
<b>Total</b>	<b>2.713</b>
Today	15/11/2016
Working days	10
Remaining days	11

Source: Personal elaboration

**Picture 20**

Since the deadline to submit the report was the 15<sup>th</sup> of each month, I had to make some projections to predict the quantity produced and sold at the end of the month.

The starting point were the projections of the quantities sold in November. The quantities were expressed in tonnes.

In the first column of the Picture 20, there are different product categories, such as Automatic Steel, Bright Wire, Cold Headed Wire, Subcontracting, Wire Rod, Coated Wire, Profile and Others. Then, for each category, there are different products sold by the company.

In the second column, we have the actual quantity, ACT stands for actual, produced and sold till the middle of the month i.e. 15<sup>th</sup> of November 2016. These data have been extracted from SAP to an excel sheet, cleared and inserted in this layout using a VLOOKUP formula in excel, as showed in Picture 21.

TON	November 2016
Product	ACT
Automatic Steel	30
Automatic	=VLOOKUP(A5;SAP!\$C\$3:\$O\$21;2;0)
Bright Wire	457

Source: Personal elaboration

Picture 21

The projections for the end of November 2016 were made using the data represented in Picture 20.

If we assume that today is 15/11/2016, referring to the bottom of Picture 20, we can say that till today the company has produced 2'713 tonnes of wire using only 10 working days and now the production of the remaining 11 days has to be projected. How to do that?

The starting point were the quantities produced by each product until 15/11/2016, then those quantities were divided by the days used to produce them i.e. 10 and finally multiplied with the remaining 11 days of November, as showed in Picture 22.

To project the quantities sold at the end of the month, the following formula was used:

$$\text{Quantity} + \left\{ \left( \frac{\text{Quantity}}{\text{Working Days}} \right) \times \text{Remaining days} \right\}$$

Quantity and Working Days until the middle of the month 15/11/2016

$$30 + \left\{ \left( \frac{30}{10} \right) \times 11 \right\} = 63$$

Projection for the end of the month	
TON	November 2016
Product	PROJECTION
<b>Automatic Steel</b>	<b>63</b>
Automatic steel	63
<b>Bright Wire</b>	<b>960</b>
Wire C4D/C9D Bright	960
<b>Cold Headed Wire</b>	<b>2.132</b>
Wire KGK	1.203
Wire GK	525
Wire K	403
<b>Subcontracting</b>	<b>506</b>
Subcontracting	506
<b>Wire Rod</b>	<b>1.103</b>
Wire rod untreated	13
Wire rod pickled	323
Wire rod pickled annealed	767
<b>Coated Wire</b>	<b>647</b>
Copper	200
Nichel	370
Zinc	78
<b>Profile</b>	<b>88</b>
Profile	88
<b>Others</b>	<b>200</b>
Scrap	168
2nd Choice	32
<b>Total</b>	<b>5.697</b>

=B5+(B5/\$B\$30)\*\$B\$31

Source: Personal elaboration

Picture 22

Once I have projected the quantity sold at the end of November, the next step is to update the report when the month ends.

We have to assume now that November is gone and it is the 01/12/2016. In December, we have the actual data of November (not the projection) and the report needs to be updated by extracting the actual data from SAP and inserting this data in the column related to November 2016, as depicted in Picture 23.

<b>Actual quantities sold</b>	
<b>TON</b>	<b>November 2016</b>
<b>Product</b>	<b>ACT</b>
<b>Automatic Steel</b>	<b>57</b>
Automatic steel	57
<b>Bright Wire</b>	<b>978</b>
Wire C4D/C9D Bright	978
<b>Cold Headed Wire</b>	<b>2.275</b>
Wire KGK	1.236
Wire GK	658
Wire K	381
<b>Subcontracting</b>	<b>405</b>
Subcontracting	405
<b>Wire Rod</b>	<b>915</b>
Wire rod untreated	30
Wire rod pickled	344
Wire rod pickled annealed	541
<b>Coated Wire</b>	<b>656</b>
Copper	244
Nichel	357
Zinc	55
<b>Profile</b>	<b>59</b>
Profile	59
<b>Others</b>	<b>238</b>
Scrap	197
2nd Choice	41
<b>Total</b>	<b>5.583</b>

Source: Personal elaboration

**Picture 23**

If we put all the steps together, as described in Picture 24, we can get a better idea of the whole process. We can't predict the future, indeed there is a little difference showed in the last column between what we have forecasted and the real data. This difference is due to the fact that the quantities sold by the company have not a linear distribution, or said in other words, the company doesn't sell each day the same quantity. However, even if the model can't forecast the exact quantity sold, it gives us an idea about what will be the amount of wire sold at the end of the month, considering the result of the first half of the same month. This is really useful for executives to detect, correct and prevent problems that may arise before it is too late.

The whole process was repeated for each month.

TON	November 2016			
Product	Till 15th	PROJECTION	ACT	ACT - PROJECTION
<b>Automatic Steel</b>	30	63	57	-6
Automatic steel	30	63	57	-6
<b>Bright Wire</b>	457	960	978	18
Wire C4D/C9D Bright	457	960	978	18
<b>Cold Headed Wire</b>	1.015	2.132	2.275	144
Wire KGK	573	1.203	1.236	33
Wire GK	250	525	658	133
Wire K	192	403	381	-22
<b>Subcontracting</b>	241	506	405	-101
Subcontracting	241	506	405	-101
<b>Wire Rod</b>	525	1.103	915	-188
Wire rod untreated	6	13	30	17
Wire rod pickled	154	323	344	21
Wire rod pickled annealed	365	767	541	-226
<b>Coated Wire</b>	308	647	656	9
Copper	95	200	244	45
Nichel	176	370	357	-13
Zinc	37	78	55	-23
<b>Profile</b>	42	88	59	-29
Profile	42	88	59	-29
<b>Others</b>	95	200	238	39
Scrap	80	168	197	29
2nd Choice	15	32	41	10
<b>Total</b>	2.713	5.697	5.583	-114
Today	15/11/2016	↔ Difference ↔		
Working days	10			
Remaining days	11			

Source: Personal elaboration

Picture 24

When we reveal and examine the quantities sold by the company, we need to evaluate them. To evaluate whether the quantity of a product sold by the company is positive or negative, we need to compare it with our expectations. But how do we define our expectations? For this purpose, we use the budget.

The budget was made by considering the quantities sold last year (2015) for each customer. Firstly, customers were listed, then the quantities of each product acquired by each customer in one year were defined, as depicted in the first table of Picture 25. For simplistic reasons, there are only five customers and six products but the procedure is the same also for the remaining customers and products.

Then the total amount of each product category was divided with 12 to allocate an equal quantity of each product to each month in a year. The Picture below includes only the last six months but the allocation is the same for all the 12 months. Before the allocation, some assumptions can lead to a non-linear distribution of quantities sold in different months of the year, but for simplistic reasons we excluded those assumptions.

TON	Automatic steel	Wire C4D/C9D Bright	Wire KGK	Wire GK	Wire K	Subcontracting
Customer 1	120	2000	3600	900	900	1050
Customer 2	135	1800	2200	1100	1280	980
Customer 3	145	1900	2600	2080	800	1115
Customer 4	105	2750	3352	1650	1000	1039
Customer 5	155	2410	2900	2250	700	700
<b>TOTAL</b>	<b>660</b>	<b>10860</b>	<b>14652</b>	<b>7980</b>	<b>4680</b>	<b>4884</b>
<b>TOTAL/12</b>	<b>55</b>	<b>905</b>	<b>1221</b>	<b>665</b>	<b>390</b>	<b>407</b>

Budget 2016	July	August	September	October	November	December
Automatic steel	55	55	55	55	55	55
Wire C4D/C9D Bright	905	905	905	905	905	905
Wire KGK	1221	1221	1221	1221	1221	1221
Wire GK	665	665	665	665	665	665
Wire K	390	390	390	390	390	390
Subcontracting	407	407	407	407	407	407

Source: Personal elaboration

**Picture 25**

The simplified procedure of budgeting the quantities of wire sold by the company described in Picture 25, leads us to the next picture which represents the budget of quantities for September, October, November and December 2016. As mentioned above, since we assume a linear sale for each month the budget is constant, therefore it is equal also for the other months of 2016. If we take the data of the table on the bottom of Picture 25 and insert those data in our standard layout of the report we obtain Picture 26.

TON	September 2016	October 2016	November 2016	December 2016
<b>Product</b>	<b>BUDGET</b>			
<b>Automatic Steel</b>	<b>55</b>	<b>55</b>	<b>55</b>	<b>55</b>
Automatic steel	55	55	55	55
<b>Bright Wire</b>	<b>905</b>	<b>905</b>	<b>905</b>	<b>905</b>
Wire C4D/C9D Bright	905	905	905	905
<b>Cold Headed Wire</b>	<b>2.276</b>	<b>2.276</b>	<b>2.276</b>	<b>2.276</b>
Wire KGK	1.221	1.221	1.221	1.221
Wire GK	665	665	665	665
Wire K	390	390	390	390
<b>Subcontracting</b>	<b>407</b>	<b>407</b>	<b>407</b>	<b>407</b>
Subcontracting	407	407	407	407
<b>Wire Rod</b>	<b>878</b>	<b>878</b>	<b>878</b>	<b>878</b>
Wire rod untreated	10	10	10	10
Wire rod pickled	336	336	336	336
Wire rod pickled annealed	532	532	532	532
<b>Coated Wire</b>	<b>522</b>	<b>522</b>	<b>522</b>	<b>522</b>
Copper	196	196	196	196
Nichel	277	277	277	277
Zinc	49	49	49	49
<b>Profile</b>	<b>61</b>	<b>61</b>	<b>61</b>	<b>61</b>
Profile	61	61	61	61
<b>Others</b>	<b>180</b>	<b>180</b>	<b>180</b>	<b>180</b>
Scrap	180	180	180	180
2nd Choice	0	0	0	0
<b>Total</b>	<b>5.284</b>	<b>5.284</b>	<b>5.284</b>	<b>5.284</b>

Source: Personal elaboration

**Picture 26**

Now that the budget of the quantities sold has been made, we can make comments and evaluate the actual quantities that the company estimates to sell or sells each month. This can be done by comparing the actual quantities sold with our expectations i.e. the budget. Picture 27 on the next page gives us a better idea of this.

	Projection for the end of the month			Actual quantities sold		
TON	November 2016			November 2016		
Product	PROJECTION	BUD	%	ACT	BUD	%
Automatic Steel	63	55	13%	57	55	4%
Automatic steel	63	55	13%	57	55	4%
Bright Wire	960	905	6%	978	905	8%
Wire C4D/C9D Bright	960	905	6%	978	905	8%
Cold Headed Wire	2.132	2.276	-7%	2.275	2.276	0%
Wire KGK	1.203	1.221	-1%	1.236	1.221	1%
Wire GK	525	665	-27%	658	665	-1%
Wire K	403	390	3%	381	390	-2%
Subcontracting	506	407	20%	405	407	0%
Subcontracting	506	407	20%	405	407	0%
Wire Rod	1.103	878	20%	915	878	4%
Wire rod untreated	13	10	21%	30	10	200%
Wire rod pickled	323	336	-4%	344	336	2%
Wire rod pickled annealed	767	532	31%	541	532	2%
Coated Wire	647	522	19%	656	522	26%
Copper	200	196	2%	244	196	24%
Nichel	370	277	25%	357	277	29%
Zinc	78	49	37%	55	49	12%
Profile	88	61	31%	59	61	-3%
Profile	88	61	31%	59	61	-3%
Others	200	180	10%	238	180	32%
Scrap	168	180	-7%	197	180	9%
2nd Choice	32	0	100%	41	0	100%
Total	5.697	5.284	7%	5.583	5.284	5%

Source: Personal elaboration

Picture 27

If we take Picture 22, which describes how to compute the projection of quantities sold at the end of the month, and add the column of the budget, we get the table on the left which is represented in Picture 27. The table on the right instead, is generated by adding the budget column to the Picture 23.

To compare the actual values with our expectations, we have a third column which represents the difference in percentage between actual quantities sold and the budget. Excel cells are coloured using conditional formatting. Green were used when the difference was positive, i.e. actual quantity exceeded budget quantity. Yellow, instead represented the situation where both budget and actual values were equal. Finally, the red colour represented a negative situation where we sold less than we expected.

$(ACT-BUD)/ACT$	1%	ACT > BUD (POSITIVE)
$(ACT-BUD)/ACT$	0%	ACT = BUD (NULL)
$(ACT-BUD)/ACT$	-1%	ACT < BUD (NEGATIVE)

Thanks to the colours, the user is able to detect whether the difference between actual and budget is positive, null or negative, simply by giving a short look to the report.

If we analyse the last row of the Picture 27, which summarize all the results, we can say that the projections made in the middle of November, on the left side, have been optimistic because they have predicted an increase of 7% of actual quantities with the respect to the budget. Indeed, at the end of November actual data revealed a positive difference of 5%, instead of 7%.

In this case the difference was acceptable, however in some cases, the difference between the projection made in the middle of the month and the actual values at the end of the same month, were quite large. For example, there was a case where the projections resulted in a negative difference of -2% with the respect to the budget, whereas at the end, using actual data the difference was -25%. This was a big problem because it made the report unreliable and the executive manager wasn't happy. Indeed, in a meeting he said that if we don't solve this problem, the holding company in Linz will lose the trust and credibility not only on the report but also on the people.

The problem was caused by the production process which was not linear, while our forecast model (see p.55) assumed that it actually was. For example, we might have produced five tonnes of wire in one day and we allocate those five tonnes to 10 working days instead of allocating to one working day. To solve this problem, we thought that in the future it would be better to record the production quantity day by day.

Next pages will show a more complete picture of the report with actual tonnes produced and sold at the end of each month.

TON	September 2016			October 2016			November 2016			December 2016		
Product	ACT	BUD	%	ACT	BUD	%	ACT	BUD	%	ACT	BUD	%
Automatic Steel	54	55	-2%	83	55	51%	57	55	4%	75	55	27%
Automatic steel	54	55	-2%	83	55	51%	57	55	4%	75	55	27%
Bright Wire	772	905	-15%	598	905	-34%	978	905	8%	855	905	-6%
Wire C4D/C9D Bright	772	905	-15%	598	905	-34%	978	905	8%	855	905	-6%
Cold Headed Wire	2.308	2.276	1%	2.137	2.276	-6%	2.275	2.276	0%	2.450	2.276	7%
Wire KGK	1.166	1.221	-5%	1.112	1.221	-9%	1.236	1.221	1%	1.367	1.221	11%
Wire GK	769	665	16%	703	665	6%	658	665	-1%	689	665	3%
Wire K	373	390	-4%	322	390	-17%	381	390	-2%	394	390	1%
Subcontracting	155	407	-62%	276	407	-32%	405	407	0%	455	407	11%
Subcontracting	155	407	-62%	276	407	-32%	405	407	0%	455	407	11%
Wire Rod	848	878	-3%	902	878	3%	915	878	4%	807	878	-9%
Wire rod untreated	28	10	180%	25	10	150%	30	10	200%	8	10	-25%
Wire rod pickled	287	336	-15%	322	336	-4%	344	336	2%	321	336	-5%
Wire rod pickled annealed	533	532	0%	555	532	4%	541	532	2%	478	532	-11%
Coated Wire	744	522	43%	587	522	12%	656	522	26%	521	522	0%
Copper	217	196	11%	212	196	8%	244	196	24%	167	196	-17%
Nichel	443	277	60%	297	277	7%	357	277	29%	296	277	6%
Zinc	84	49	71%	78	49	59%	55	49	12%	58	49	16%
Profile	68	61	11%	48	61	-21%	59	61	-3%	60	61	-2%
Profile	68	61	11%	48	61	-21%	59	61	-3%	60	61	-2%
Others	120	180	-33%	130	180	-28%	238	180	32%	175	180	-3%
Scrap	81	180	-55%	102	180	-43%	197	180	9%	150	180	-20%
2nd Choice	39	0	100%	28	0	100%	41	0	100%	25	0	100%
Total	5.069	5.284	-4%	4.761	5.284	-11%	5.583	5.284	5%	5.398	5.284	2%

Source: Personal elaboration

Picture 28

Picture 28 shows the report of quantities containing actual data (not predictions) of September, October, November and December. Only this four months are included for simplistic reasons but the procedure was the same for all the remaining months.

As depicted in Picture 28, September and October have been disappointing in terms of quantities with the respect to the expectations, while November and December have been quite satisfying.

Picture 28 is quite intuitive with the different colours emphasizing different situations in the column of percentages. However, we need something even more intuitive that takes only few seconds to understand the situation. To do so, we used a line chart. Before we used the line chart, we needed to purify the data by subtracting from the total tonnes sold, the 2<sup>nd</sup> choice and the scrap. In this way, we considered only core activities in our line chart.

Then, starting from the bottom of Picture 28, we subtracted Others from the Total (see blue line in Picture 29), after that we divided the actual by the budget and in this way we got what we call Monthly Result. To obtain the Annual Trend we summed actuals of each month and divide them by budgets of the same months. Picture 29 illustrates better the whole process and the final result obtained.

TON	September 2016			October 2016			November 2016			December 2016		
Product	ACT	BUD	%	ACT	BUD	%	ACT	BUD	%	ACT	BUD	%
Profile	68	61	11%	48	61	-21%	59	61	-3%	60	61	-2%
Profile	68	61	11%	48	61	-21%	59	61	-3%	60	61	-2%
Others	120	180	-33%	130	180	-28%	238	180	32%	175	180	-3%
Scrap	81	180	-55%	102	180	-43%	197	180	9%	150	180	-20%
2nd Choice	39	0	100%	28	0	100%	41	0	100%	25	0	100%
Total	5.069	5.284	-4%	4.761	5.284	-11%	5.583	5.284	5%	5.398	5.284	2%

	September		October		November		December	
	ACT	BUD	ACT	BUD	ACT	BUD	ACT	BUD
ACT	4.949	5.104	4.631	5.104	5.345	5.104	5.223	5.104
BUD	97%		91%		105%		102%	

	September	October	November	December
Monthly Results	97%	91%	105%	102%
Annual Trend	97%	94%	97%	99%
Low	90%	90%	90%	90%
Lower Middle	6%	6%	6%	6%
Middle	4%	4%	4%	4%
Higher Middle	3%	3%	3%	3%
High	7%	7%	7%	7%

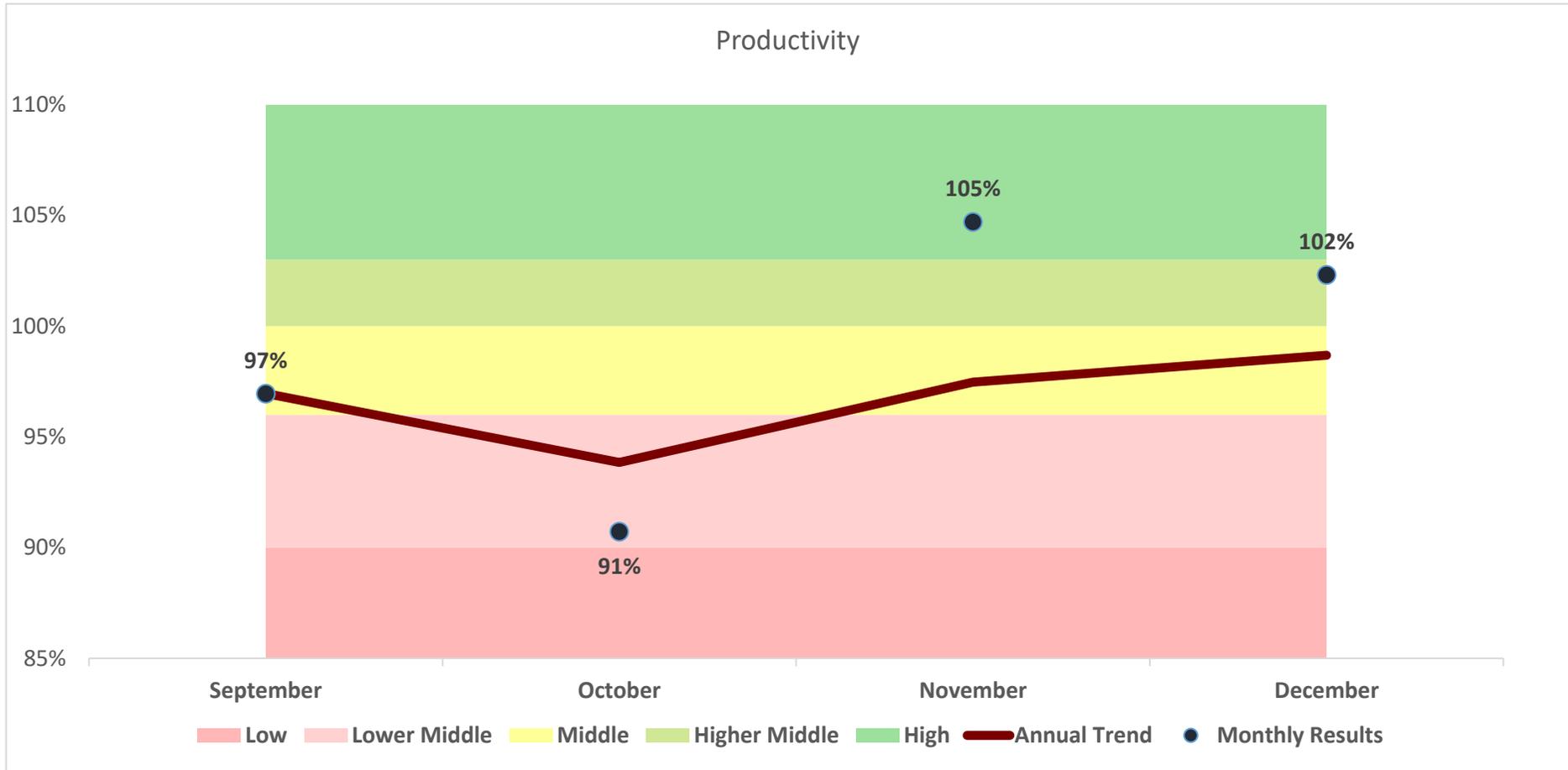
ACT  
BUD

$[ACT (SEP)+ACT (OCT)+ACT (NOV)+ACT (DEC)]$   
 $[BUD (SEP)+BUD (OCT)+BUD (NOV)+BUD (DEC)]$

$[ACT (SEP)+ACT (OCT)+ACT (NOV)]$   
 $[BUD (SEP)+BUD (OCT)+BUD (NOV)]$

Source: Personal elaboration

Picture 29



Source: Personal elaboration

Picture 30

To get to the line chart showed in Picture 30, the table situated on the bottom of Picture 29 were used. Thanks to the line chart senior executives need to give a look of only few seconds to understand the whole situation therefore, they save their valuable time when they look the tonnes of wire sold and produced. As showed here, October has been less productive, whereas November has been more productive.

### 6.3.Sales Report

Until now, the previous pages have described how to predict the quantities sold at the end of the month, how to compute the budget and showed the actual tonnes sold at the end of the month in a fancy looking report. However, all this would have been uncompleted if the other side of the same coin, namely the turnover, wasn't showed. Picture 31 shows the turnover related to the quantities sold until the 15/11/2016. The data has been extracted from SAP and do not include discounts. Now, as for the quantities, the turnover at the end of November 2016 has to be predicted.

	<b>till today</b>	
<b>Sales</b>	<b>November 2016</b>	
<b>Product</b>	<b>ACT</b>	
<b>Automatic Steel</b>	€	<b>29.107</b>
Automatic steel	€	29.107
<b>Bright Wire</b>	€	<b>250.235</b>
Wire C4D/C9D Bright	€	250.235
<b>Cold Headed Wire</b>	€	<b>852.557</b>
Wire KGK	€	527.343
Wire GK	€	160.958
Wire K	€	164.256
<b>Subcontracting</b>	€	<b>53.162</b>
Subcontracting	€	53.162
<b>Wire Rod</b>	€	<b>445.927</b>
Wire rod untreated	€	1.730
Wire rod pickled	€	160.950
Wire rod pickled annealed	€	283.247
<b>Coated Wire</b>	€	<b>200.929</b>
Copper	€	88.374
Nichel	€	90.709
Zinc	€	21.847
<b>Profile</b>	€	<b>39.405</b>
Profile	€	39.405
<b>Others</b>	€	<b>13.648</b>
Scrap	€	9.216
2nd Choice	€	4.432
<b>Total</b>	€	<b>1.884.971</b>
Today	15/11/2016	
Working days	10	
Remaining days	11	

Source: Personal elaboration

**Picture 31**

First of all, the price of each product has to be computed, this was obtained by dividing actual sales by actual quantities until 15/11/2016, depicted respectively in Picture 31 and Picture 20.

$$\left( \frac{\text{Sales}}{\text{Quantity}} \right) = \text{Price}$$

$$\left( \frac{29'107}{30} \right) = 970$$

	till today
Price	November 2016
Product	ACT
<b>Automatic Steel</b>	<b>970</b>
Automatic steel	970
<b>Bright Wire</b>	<b>548</b>
Wire C4D/C9D Bright	548
<b>Cold Headed Wire</b>	<b>840</b>
Wire KGK	920
Wire GK	644
Wire K	856
<b>Subcontracting</b>	<b>221</b>
Subcontracting	221
<b>Wire Rod</b>	<b>849</b>
Wire rod untreated	288
Wire rod pickled	1.045
Wire rod pickled annealed	776
<b>Coated Wire</b>	<b>652</b>
Copper	930
Nichel	515
Zinc	590
<b>Profile</b>	<b>938</b>
Profile	938
<b>Others</b>	<b>144</b>
Scrap	115
2nd Choice	295

Source: Personal elaboration

**Picture 32**

Picture 32 represents the price of one tonne of product, to convert them in kg it is enough to divide them by 1'000.

Now that the price has been calculated, we had to forecast the sales at the end of the month. To do so the following formula was used:

$$\text{Sales} + \left\{ \text{Price} \times \left( \frac{\text{Quantity}}{\text{Working Days}} \right) \times \text{Remaining Days} \right\}$$



Sales, Price, Quantity and Working Days refers to the actual data until 15/11/2016

$$29'106.9 + \left\{ 970.23 \times \left( \frac{30}{10} \right) \times 11 \right\} = \text{€ } 61'124.49$$

Projection for the end of the month	
Sales	November 2016
<b>Product</b>	<b>PROJECTION</b>
<b>Automatic Steel</b>	€ 61.124
Automatic steel	€ 61.124
<b>Bright Wire</b>	€ 525.493
Wire C4D/C9D Bright	€ 525.493
<b>Cold Headed Wire</b>	€ 1.790.369
Wire KGK	€ 1.107.421
Wire GK	€ 338.011
Wire K	€ 344.938
<b>Subcontracting</b>	€ 111.641
Subcontracting	€ 111.641
<b>Wire Rod</b>	€ 936.447
Wire rod untreated	€ 3.632
Wire rod pickled	€ 337.995
Wire rod pickled annealed	€ 594.819
<b>Coated Wire</b>	€ 421.952
Copper	€ 185.585
Nichel	€ 190.488
Zinc	€ 45.879
<b>Profile</b>	€ 82.751
Profile	€ 82.751
<b>Others</b>	€ 28.662
Scrapt	€ 19.354
2nd Choice	€ 9.308
<b>Total</b>	€ 3.958.439

Source: Personal elaboration

Picture 33

When the next month came, i.e. 15/12/2016, the same forecast was done also for December, while the fact that we have already finished November allowed us to refresh the report and replace the forecast of November with the actual data.

	<b>Actual sales</b>
<b>Sales</b>	<b>November 2016</b>
<b>Product</b>	<b>ACT</b>
<b>Automatic Steel</b>	<b>55.689 €</b>
Automatic steel	55.689 €
<b>Bright Wire</b>	<b>525.674 €</b>
Wire C4D/C9D Bright	525.674 €
<b>Cold Headed Wire</b>	<b>1.902.634 €</b>
Wire KGK	1.135.677 €
Wire GK	438.312 €
Wire K	328.645 €
<b>Subcontracting</b>	<b>88.678 €</b>
Subcontracting	88.678 €
<b>Wire Rod</b>	<b>783.464 €</b>
Wire rod untreated	8.966 €
Wire rod pickled	361.865 €
Wire rod pickled annealed	412.633 €
<b>Coated Wire</b>	<b>439.043 €</b>
Copper	225.966 €
Nichel	180.422 €
Zinc	32.655 €
<b>Profile</b>	<b>55.988 €</b>
Profile	55.988 €
<b>Others</b>	<b>34.514 €</b>
Scrap	22.432 €
2nd Choice	12.082 €
<b>Total</b>	<b>3.885.684 €</b>

Source: Personal elaboration

**Picture 34**

Picture 34 represents the actual sales at the end of November 2016. If we compare the actual sales showed in Picture 34 with the forecasts represented in Picture 33, we can notice that there are some differences. The differences derive from the fact that, even though our forecast model is good enough, we can't predict the future. To have a better idea of these differences between forecast and actual sales see Picture 35 on the next page.

Sales	November 2016			
	Product	Till 15th	PROJECTION	ACT
<b>Automatic Steel</b>	€ 29.107	€ 61.124	€ 55.689	-€ 5.435
Automatic steel	€ 29.107	€ 61.124	€ 55.689	-€ 5.435
<b>Bright Wire</b>	€ 250.235	€ 525.493	€ 525.674	€ 181
Wire C4D/C9D Bright	€ 250.235	€ 525.493	€ 525.674	€ 181
<b>Cold Headed Wire</b>	€ 852.557	€ 1.790.369	€ 1.902.634	€ 112.265
Wire KGK	€ 527.343	€ 1.107.421	€ 1.135.677	€ 28.256
Wire GK	€ 160.958	€ 338.011	€ 438.312	€ 100.301
Wire K	€ 164.256	€ 344.938	€ 328.645	-€ 16.293
<b>Subcontracting</b>	€ 53.162	€ 111.641	€ 88.678	-€ 22.963
Subcontracting	€ 53.162	€ 111.641	€ 88.678	-€ 22.963
<b>Wire Rod</b>	€ 445.927	€ 936.447	€ 783.464	-€ 152.983
Wire rod untreated	€ 1.730	€ 3.632	€ 8.966	€ 5.334
Wire rod pickled	€ 160.950	€ 337.995	€ 361.865	€ 23.870
Wire rod pickled annealed	€ 283.247	€ 594.819	€ 412.633	-€ 182.186
<b>Coated Wire</b>	€ 200.929	€ 421.952	€ 439.043	€ 17.091
Copper	€ 88.374	€ 185.585	€ 225.966	€ 40.381
Nichel	€ 90.709	€ 190.488	€ 180.422	-€ 10.066
Zinc	€ 21.847	€ 45.879	€ 32.655	-€ 13.224
<b>Profile</b>	€ 39.405	€ 82.751	€ 55.988	-€ 26.763
Profile	€ 39.405	€ 82.751	€ 55.988	-€ 26.763
<b>Others</b>	€ 13.648	€ 28.662	€ 34.514	€ 5.852
Script	€ 9.216	€ 19.354	€ 22.432	€ 3.078
2nd Choice	€ 4.432	€ 9.308	€ 12.082	€ 2.774
				€ -
<b>Total</b>	€ 1.884.971	€ 3.958.439	€ 3.885.684	-€ 72.755
Today	15/11/2016			
Working days	10			
Remaining days	11			

Source: Personal elaboration

**Picture 35**

The actual turnover is lower than the projected one in some cases, as represented in Picture 35. This result derives from the difference between actual and projected quantities represented in Picture 24.

Now that the forecasted and actual turnover have been calculated, the budget is needed to evaluate whether the sales have been positive or negative.

The starting point of the sales budget were the prices. To create the sales budget, we took the prices of the last year and made some assumptions. The assumptions consisted mainly in an increase of price of raw materials, electricity, methane gas and so on, which consequently increased the price of the products. But, to make it more simply, the assumptions were skipped in the description of the sales budget.

Price 2015	September	October	November	December
Automatic steel	1018	918	956	976
Wire C4D/C9D Bright	539	486	491	508
Wire KGK	1016	916	918	1000
Wire GK	936	844	864	894
Wire K	710	641	638	658
Subcontracting	190	172	176	181
Wire rod untreated	639	576	533	625
Wire rod pickled	685	618	639	758
Wire rod pickled annealed	806	726	756	745
Copper	565	509	529	496
Nichel	841	759	743	810
Zinc	650	586	544	625
Profile	1301	1173	1229	1158
Scrap	258	233	245	232
Budget of Quantities 2016	September	October	November	December
Automatic steel	55	55	55	55
Wire C4D/C9D Bright	905	905	905	905
Wire KGK	1221	1221	1221	1221
Wire GK	665	665	665	665
Wire K	390	390	390	390
Subcontracting	407	407	407	407
Wire rod untreated	10	10	10	10
Wire rod pickled	336	336	336	336
Wire rod pickled annealed	532	532	532	532
Copper	196	196	196	196
Nichel	277	277	277	277
Zinc	49	49	49	49
Profile	42	42	42	42
Scrap	80	80	80	80
Budget of Sales 2016	September	October	November	December
Automatic steel	€ 55.966	€ 50.467	€ 52.589	€ 53.679
Wire C4D/C9D Bright	€ 487.364	€ 439.482	€ 444.392	€ 459.432
Wire KGK	€ 1.240.268	€ 1.118.416	€ 1.120.326	€ 1.220.688
Wire GK	€ 622.166	€ 561.040	€ 574.651	€ 594.612
Wire K	€ 277.093	€ 249.869	€ 248.791	€ 256.523
Subcontracting	€ 77.506	€ 69.891	€ 71.456	€ 73.666
Wire rod untreated	€ 6.392	€ 5.764	€ 5.325	€ 6.245
Wire rod pickled	€ 230.184	€ 207.569	€ 214.623	€ 254.831
Wire rod pickled annealed	€ 428.529	€ 386.428	€ 401.966	€ 396.533
Copper	€ 110.661	€ 99.789	€ 103.655	€ 97.276
Nichel	€ 233.074	€ 210.175	€ 205.675	€ 224.358
Zinc	€ 31.827	€ 28.700	€ 26.659	€ 30.645
Profile	€ 54.628	€ 49.261	€ 51.622	€ 48.633
Scrap	€ 20.656	€ 18.627	€ 19.633	€ 18.523

Source: Personal elaboration

Picture 36

The budget of sales was created by the multiplication of the price of the last year with the budget of the quantities of the current year, as described by the blue line in Picture 36.

Price of 2015 X Budget of quantities 2016 = Budget of Sales 2016

$$1017.56 \times 55 = \text{€ } 55'965.8 \sim 55'966$$

Now that we have the budget of sales we can evaluate our sales comparing them with the budget.

	Projection for the end of the month			Actual Sales		
Sales	November 2016			November 2016		
Product	PROJECTION	BUD	%	ACT	BUD	%
<b>Automatic Steel</b>	€ 61.124	€ 52.589	16%	€ 55.689	€ 52.589	6%
Automatic steel	€ 61.124	€ 52.589	16%	€ 55.689	€ 52.589	6%
<b>Bright Wire</b>	€ 525.493	€ 444.392	18%	€ 525.674	€ 444.392	18%
Wire C4D/C9D Bright	€ 525.493	€ 444.392	18%	€ 525.674	€ 444.392	18%
<b>Cold Headed Wire</b>	€ 1.790.369	€ 1.943.768	-8%	€ 1.902.634	€ 1.943.768	-2%
Wire KGK	€ 1.107.421	€ 1.120.326	-1%	€ 1.135.677	€ 1.120.326	1%
Wire GK	€ 338.011	€ 574.651	-41%	€ 438.312	€ 574.651	-24%
Wire K	€ 344.938	€ 248.791	39%	€ 328.645	€ 248.791	32%
<b>Subcontracting</b>	€ 111.641	€ 71.456	56%	€ 88.678	€ 71.456	24%
Subcontracting	€ 111.641	€ 71.456	56%	€ 88.678	€ 71.456	24%
<b>Wire Rod</b>	€ 936.447	€ 621.914	51%	€ 783.464	€ 621.914	26%
Wire rod untreated	€ 3.632	€ 5.325	-32%	€ 8.966	€ 5.325	68%
Wire rod pickled	€ 337.995	€ 214.623	57%	€ 361.865	€ 214.623	69%
Wire rod pickled annealed	€ 594.819	€ 401.966	48%	€ 412.633	€ 401.966	3%
<b>Coated Wire</b>	€ 421.952	€ 335.989	26%	€ 439.043	€ 335.989	31%
Copper	€ 185.585	€ 103.655	79%	€ 225.966	€ 103.655	118%
Nichel	€ 190.488	€ 205.675	-7%	€ 180.422	€ 205.675	-12%
Zinc	€ 45.879	€ 26.659	72%	€ 32.655	€ 26.659	22%
<b>Profile</b>	€ 82.751	€ 51.622	60%	€ 55.988	€ 51.622	8%
Profile	€ 82.751	€ 51.622	60%	€ 55.988	€ 51.622	8%
<b>Others</b>	€ 28.662	€ 19.633	46%	€ 34.514	€ 19.633	76%
Scrap	€ 19.354	€ 19.633	-1%	€ 22.432	€ 19.633	14%
2nd Choice	€ 9.308		100%	€ 12.082		100%
<b>Total</b>	€ 3.958.439	€ 3.541.363	11%	€ 3.885.684	€ 3.541.363	9%

Source: Personal elaboration

Picture 37

If we compare the totals in percentage of the last row, we can say that our projections have been a little bit optimistic because we have forecasted an increase of sales of +11% with the respect to the budget, whereas actual sales have actually increase of only +9%. Indeed, we have forecasted to have € 3'958'439 of sales but we got only € 3'885'684.

If products are evaluated comparing actual sales with the budget in relative terms, we can say that Wire GK has experienced the biggest increase and Cooper the biggest decrease. Picture 38 gives us a greater view of actual sales of the last four months of 2016. As we can see, in September the company has had the biggest turnover in absolute terms and the lowest one in October. Instead if we evaluate the turnover in relative terms we can say that November has had the biggest positive variation with +9%, October instead has had biggest negative variation with -1%.

Sales	September 2016			October 2016			November 2016			December 2016		
Product	ACT	BUD	%	ACT	BUD	%	ACT	BUD	%	ACT	BUD	%
<b>Automatic Steel</b>	€ 51.643	€ 55.966	-8%	€ 84.547	€ 50.467	68%	€ 55.689	€ 52.589	6%	€ 73.354	€ 53.679	37%
Automatic steel	€ 51.643	€ 55.966	-8%	€ 84.547	€ 50.467	68%	€ 55.689	€ 52.589	6%	€ 73.354	€ 53.679	37%
<b>Bright Wire</b>	€ 473.505	€ 487.364	-3%	€ 344.186	€ 439.482	-22%	€ 525.674	€ 444.392	18%	€ 454.782	€ 459.432	-1%
Wire C4D/C9D Bright	€ 473.505	€ 487.364	-3%	€ 344.186	€ 439.482	-22%	€ 525.674	€ 444.392	18%	€ 454.782	€ 459.432	-1%
<b>Cold Headed Wire</b>	€ 2.231.782	€ 2.139.527	4%	€ 1.714.681	€ 1.929.325	-11%	€ 1.902.634	€ 1.943.768	-2%	€ 2.082.951	€ 2.071.823	1%
Wire KGK	€ 1.198.235	€ 1.240.268	-3%	€ 925.148	€ 1.118.416	-17%	€ 1.135.677	€ 1.120.326	1%	€ 1.230.622	€ 1.220.688	1%
Wire GK	€ 759.121	€ 622.166	22%	€ 510.588	€ 561.040	-9%	€ 438.312	€ 574.651	-24%	€ 585.355	€ 594.612	-2%
Wire K	€ 274.426	€ 277.093	-1%	€ 278.945	€ 249.869	12%	€ 328.645	€ 248.791	32%	€ 266.974	€ 256.523	4%
<b>Subcontracting</b>	€ 39.377	€ 77.506	-49%	€ 55.100	€ 69.891	-21%	€ 88.678	€ 71.456	24%	€ 69.124	€ 73.666	-6%
Subcontracting	€ 39.377	€ 77.506	-49%	€ 55.100	€ 69.891	-21%	€ 88.678	€ 71.456	24%	€ 69.124	€ 73.666	-6%
<b>Wire Rod</b>	€ 645.730	€ 665.105	-3%	€ 786.455	€ 599.761	31%	€ 783.464	€ 621.914	26%	€ 723.491	€ 657.609	10%
Wire rod untreated	€ 14.363	€ 6.392	125%	€ -	€ 5.764	-100%	€ 8.966	€ 5.325	68%	€ 6.222	€ 6.245	0%
Wire rod pickled	€ 200.914	€ 230.184	-13%	€ 356.962	€ 207.569	72%	€ 361.865	€ 214.623	69%	€ 288.691	€ 254.831	13%
Wire rod pickled annealed	€ 430.453	€ 428.529	0%	€ 429.493	€ 386.428	11%	€ 412.633	€ 401.966	3%	€ 428.578	€ 396.533	8%
<b>Coated Wire</b>	€ 590.888	€ 375.562	57%	€ 419.462	€ 338.664	24%	€ 439.043	€ 335.989	31%	€ 386.662	€ 352.279	10%
Copper	€ 130.167	€ 110.661	18%	€ 107.598	€ 99.789	8%	€ 225.966	€ 103.655	118%	€ 105.346	€ 97.276	8%
Nichel	€ 399.397	€ 233.074	71%	€ 283.601	€ 210.175	35%	€ 180.422	€ 205.675	-12%	€ 225.632	€ 224.358	1%
Zinc	€ 61.324	€ 31.827	93%	€ 28.263	€ 28.700	-2%	€ 32.655	€ 26.659	22%	€ 55.684	€ 30.645	82%
<b>Profile</b>	€ 63.105	€ 54.628	16%	€ 40.401	€ 49.261	-18%	€ 55.988	€ 51.622	8%	€ 51.871	€ 48.633	7%
Profile	€ 63.105	€ 54.628	16%	€ 40.401	€ 49.261	-18%	€ 55.988	€ 51.622	8%	€ 51.871	€ 48.633	7%
<b>Others</b>	€ 28.075	€ 20.656	36%	€ 25.753	€ 18.627	38%	€ 34.514	€ 19.633	76%	€ 35.969	€ 18.523	94%
Scrap	€ 13.027	€ 20.656	-37%	€ 8.754	€ 18.627	-53%	€ 22.432	€ 19.633	14%	€ 21.643	€ 18.523	17%
2nd Choice	€ 15.048	€ -	100%	€ 16.999	€ -	100%	€ 12.082	€ -	100%	€ 14.326	€ -	100%
<b>Total</b>	€ 4.124.105	€ 3.876.314	6%	€ 3.470.585	€ 3.495.478	-1%	€ 3.885.684	€ 3.541.363	9%	€ 3.878.204	€ 3.735.644	4%

Source: Personal elaboration

Picture 38

## 6.4. Price and Other Reports

Now that we have actual sales and actual quantities depicted respectively in Picture 38 and Picture 28, it is possible to calculate also actual prices which will be used in the next year for the budget of sales as showed before. To calculate the price, we used the following formula:

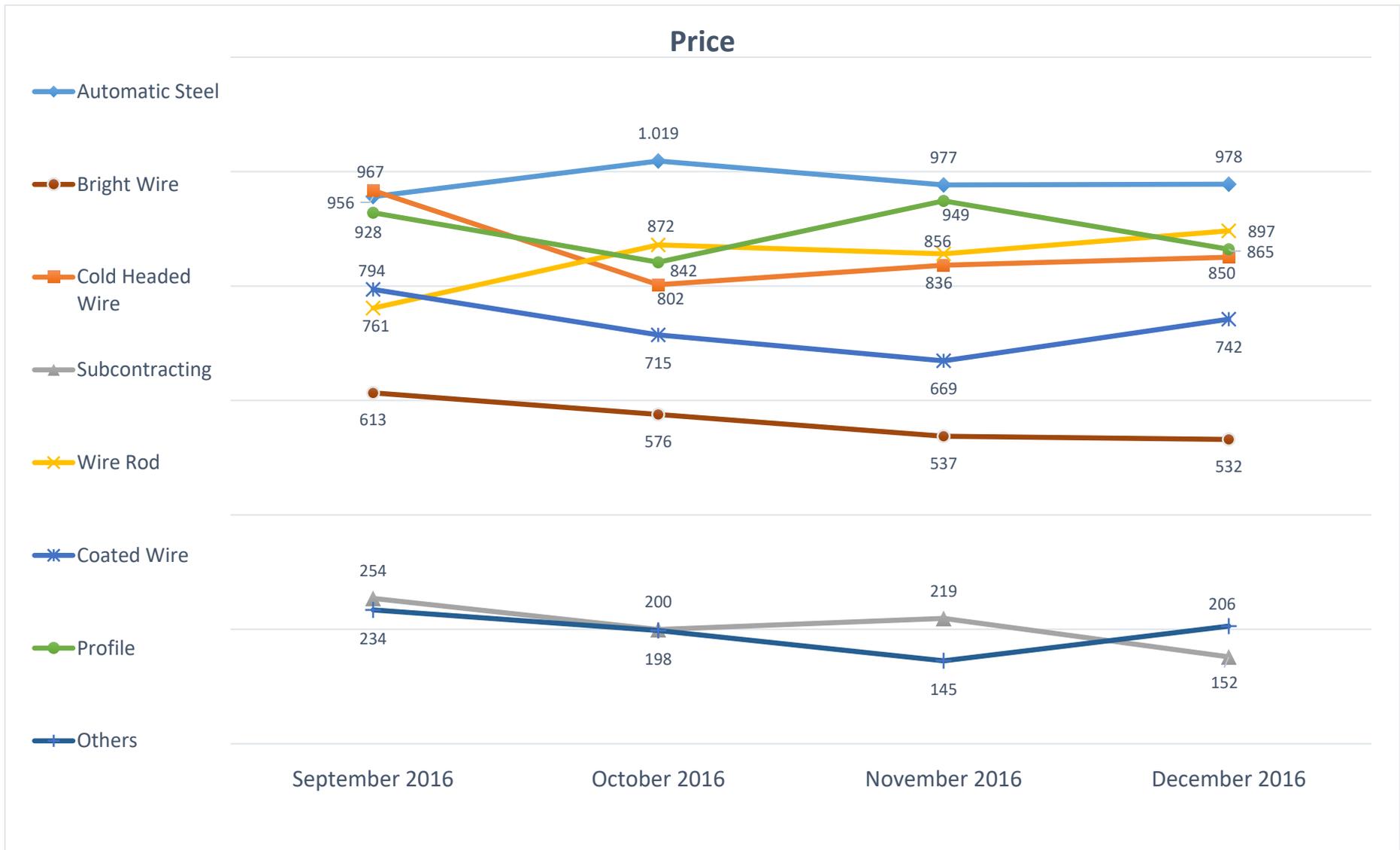
$$\text{Price} = \left( \frac{\text{Sales}}{\text{Quantity}} \right)$$

PRICE	September 2016	October 2016	November 2016	December 2016
Product				
<b>Automatic Steel</b>	<b>956</b>	<b>1.019</b>	<b>977</b>	<b>978</b>
Automatic steel	956	1.019	977	978
<b>Bright Wire</b>	<b>613</b>	<b>576</b>	<b>537</b>	<b>532</b>
Wire C4D/C9D Bright	613	576	537	532
<b>Cold Headed Wire</b>	<b>967</b>	<b>802</b>	<b>836</b>	<b>850</b>
Wire KGK	1.028	832	919	900
Wire GK	987	726	666	850
Wire K	736	866	863	678
<b>Subcontracting</b>	<b>254</b>	<b>200</b>	<b>219</b>	<b>152</b>
Subcontracting	254	200	219	152
<b>Wire Rod</b>	<b>761</b>	<b>872</b>	<b>856</b>	<b>897</b>
Wire rod untreated	513	0	299	778
Wire rod pickled	700	1.109	1.052	899
Wire rod pickled annealed	808	774	763	897
<b>Coated Wire</b>	<b>794</b>	<b>715</b>	<b>669</b>	<b>742</b>
Copper	600	508	926	631
Nichel	902	955	505	762
Zinc	730	362	594	960
<b>Profile</b>	<b>928</b>	<b>842</b>	<b>949</b>	<b>865</b>
Profile	928	842	949	865
<b>Others</b>	<b>234</b>	<b>198</b>	<b>145</b>	<b>206</b>
Scrap	161	86	114	144
2nd Choice	386	607	295	573

Source: Personal elaboration

Picture 39

Picture 40 on the next page is a graphical representation of prices contained in Picture 39. The graph is useful because it is more intuitive and easier to understand and evaluate the price and the trend over the last months. Indeed, if we look at the Picture 39, it is really difficult and it takes time to see and evaluate the price of each product, whereas if we take a look at the Picture 40, in few seconds we can understand which product prices are falling and which are growing. The price of Automatic steel and Bright wire are quite stable whereas the other prices are relatively volatile. Automatic steel is the most expensive product whereas Others which includes 2<sup>nd</sup> Choice and Scrap, is the cheapest one.

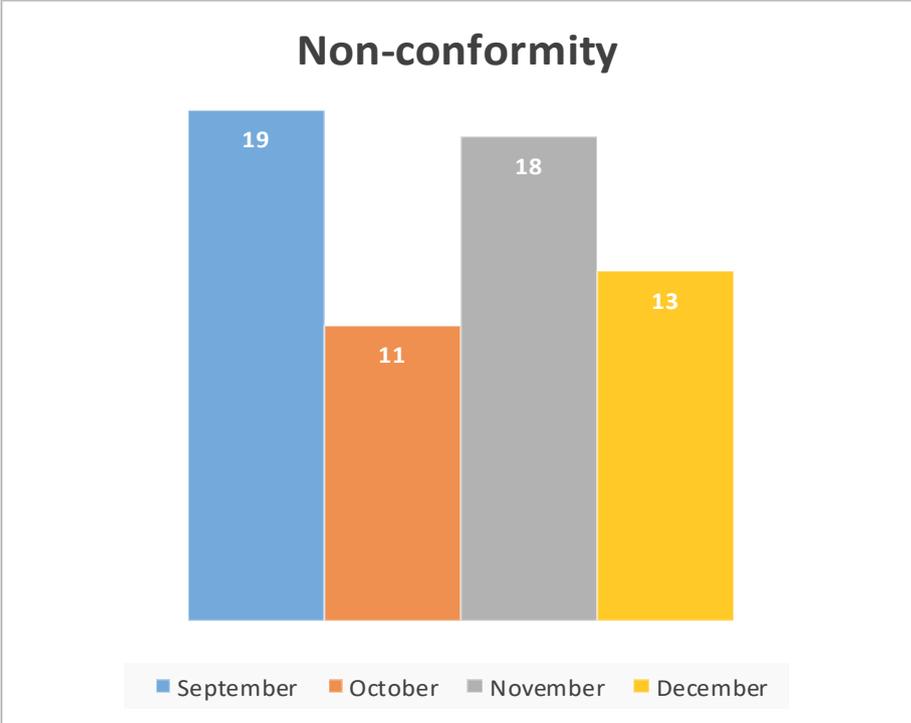


Source: Personal elaboration

Picture 40

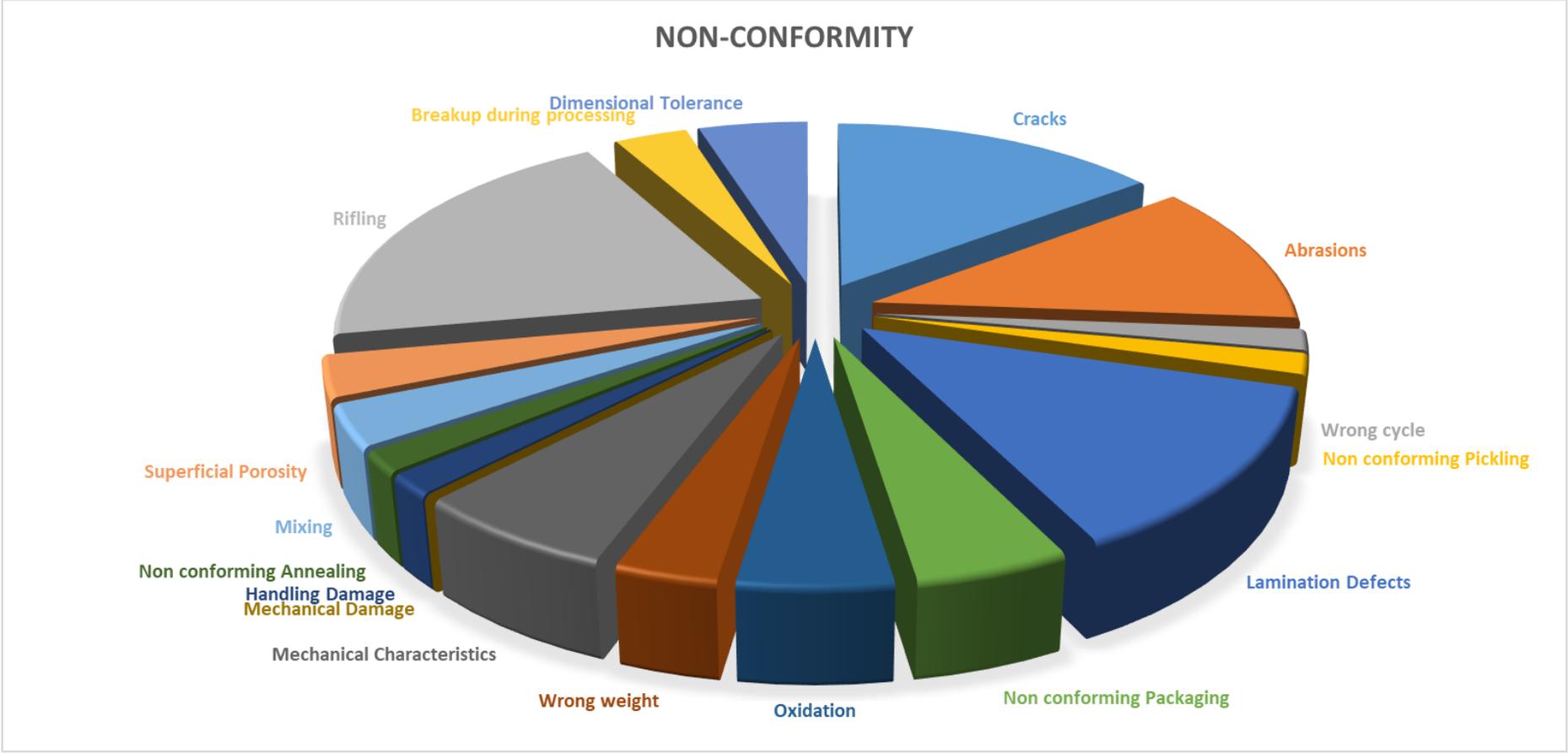
Picture 41 represents another report related to the non-conformities of the production process. As usually, the data has been extracted from SAP and then elaborated in an excel sheet.

Non-conformity	September	October	November	December	Total
Cracks	2	2	5		9
Abrasions	5			2	7
Wrong cycle			1		1
Non conforming Pickling			1		1
Lamination Defects	4	2	1	1	8
Non conforming Packaging			2	1	3
Oxidation			3		3
Wrong weight			2		2
Mechanical Characteristics		2		2	4
Mechanical Damage					0
Handling Damage			1		1
Non conforming Annealing			1		1
Mixing	1	1			2
Superficial Porosity	1			1	2
Rifling	5	4		3	12
Breakup during processing				2	2
Dimensional Tolerance	1		1	1	3
<b>Total</b>	<b>19</b>	<b>11</b>	<b>18</b>	<b>13</b>	



Source: Personal elaboration

Picture 41



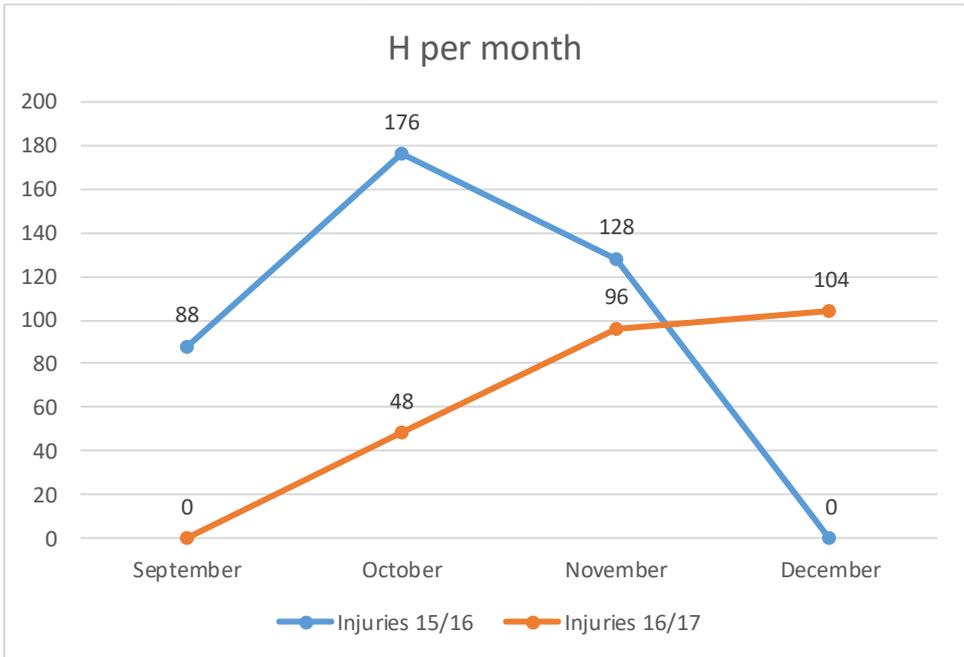
Source: Personal elaboration

Picture 42

While the chart in Picture 41 represents the non-conformities in relation with different month, Picture 42 represent the same non-conformities but in relation with the non-conformity type.

Injuries report is showed in Picture 43 here below, and also in this case as before, the data were extracted from SAP and then elaborated in the excel sheet.

Injuries	Injuries 15/16	Injuries 16/17
September	88	0
October	176	48
November	128	96
December	0	104

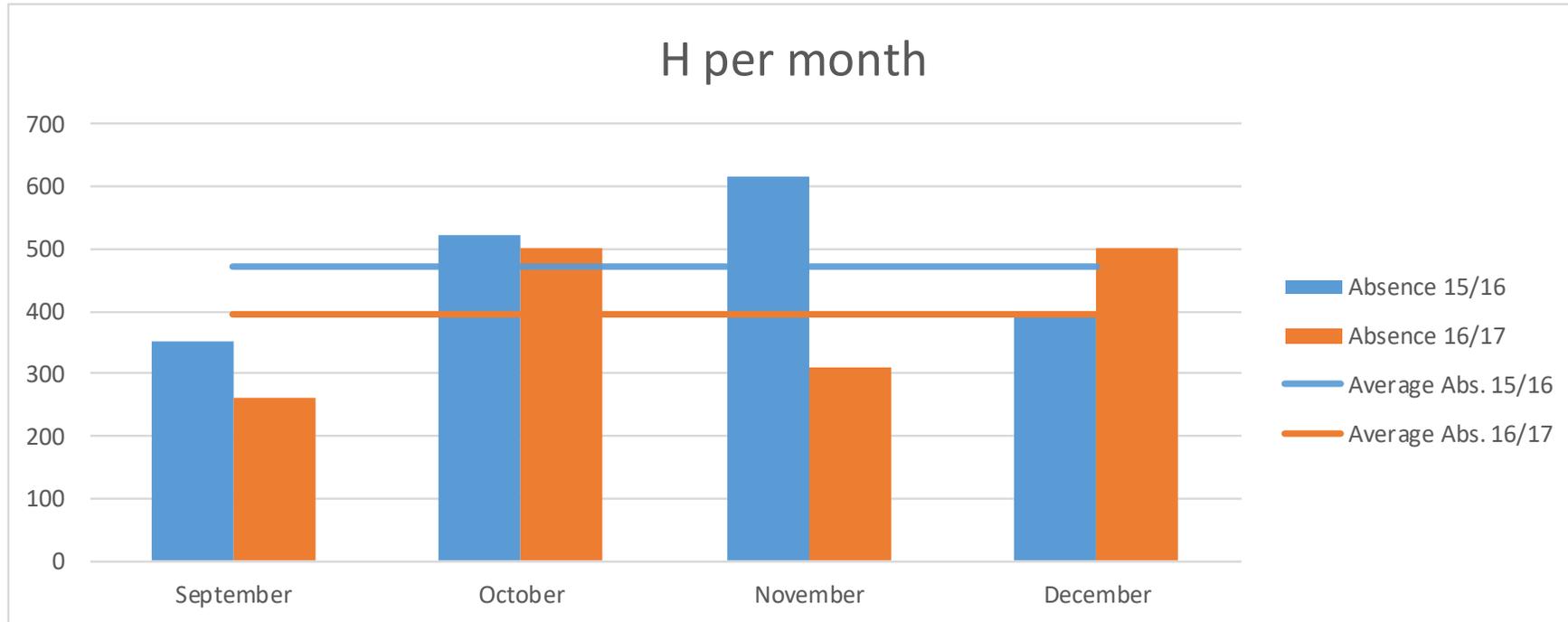


Source: Personal elaboration

Picture 43

Absence and Credit Limit reports are depicted respectively in Picture 44 and Picture 45 following the same procedure as before.

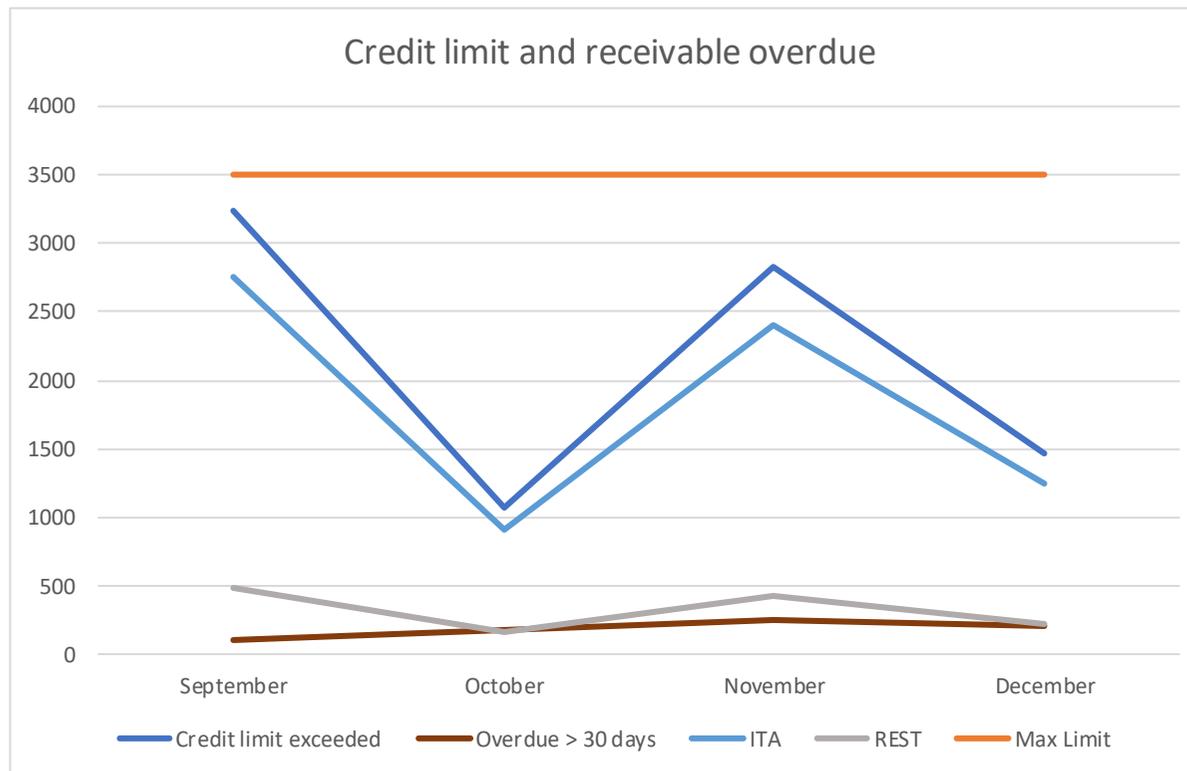
Absence	Absence 15/16	Average Abs. 15/16	Absence 16/17	Average Abs. 16/17
September	352	471,5	261	393,75
October	523	471,5	503	393,75
November	615	471,5	311	393,75
December	396	471,5	500	393,75



Source: Personal elaboration

Picture 44

Credit Limit	Credit limit exceeded	Overdue > 30 days	ITA	REST	Max Limit
September	3242	100	2756	486	3500
October	1067	175	907	160	3500
November	2822	255	2399	423	3500
December	1462	212	1243	219	3500



Source: Personal elaboration

Picture 45



## CHAPTER 7. PERFORMANCE DASHBOARD IMPLEMENTATION

This chapter will describe how to implement and use a Performance Dashboard in the case study described in the previous chapter. The main aim is to create the same reports of the previous chapter with a software, instead of creating them manually in an excel sheet.

In this case a software called Pentaho<sup>32</sup> will be used. Thanks to Pentaho, the report will be refreshed automatically, avoiding human errors and saving a lot of time.

Pentaho will be overviewed on the next page, and then a description will follow, showing how to create a dashboard using Pentaho.

At the end of the chapter the final result will be showed, i.e. a screenshot of the Performance Dashboard created using Pentaho.

For more details, the Appendix provides a step by step guide on how to create a dashboard with Penatho.

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<sup>32</sup> <http://www.pentaho.com/>

## 7.1. BI Software: Pentaho

Pentaho is a Hitachi Group company and offers different functionalities such as data preparation, self-service and advanced analytics, with a focus on big data access and integration. Pentaho can be used for a broad range of user needs.

According to Gartner's Magic Quadrant, depicted in Picture 7, Pentaho is a niche player. Indeed, it is positioned in the left lower quadrant, near other software solutions like Pyramid Analytics and Datameer. This position is associated with a lack of completeness of vision and a weak ability to execute. "Its relative lack of vision around cloud BI and a range of next-generation machine-learning automation capabilities for smart data discovery including autoinsight generation and natural-language query and generation, as well as weaker customer and analyst views of the ease of use of the platform, have affected its evaluation in the heavily weighted product strategy and market understanding categories and have therefore influenced its position on the Completeness of Vision axis. The position on the Ability to Execute axis reflects its current product capabilities, market responsiveness and track record, and vendor viability which are slightly below average; it also gained weaker scores for sales experience, customer experience and operations — derived from both customer reference survey data and Gartner inquiries."<sup>33</sup>

According to Gartner Pentaho's strengths are:

- Scope for complexity and scale: If we evaluate the complexity of analysis undertaken, Pentaho is one of the top three vendors represented in the Magic Quadrant. This is coherent with the company focus i.e. big data.  
Pentaho is one of the top four vendors of the Magic Quadrant when user deployments is taken into consideration. Indeed, Pentaho provides broad BI solutions for different users.
- Data reach beyond traditional sources: Pentaho has the ability to integrate and analyse traditional SQL databases, ad hoc files, NoSQL databases and unstructured data (such as social media feeds). Data access and integration and low licence cost (thanks to open source BI platform) are the two main reasons why customers select Pentaho.

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<sup>33</sup> <https://www.gartner.com/doc/reprints?id=1-3TYE0CD&ct=170221&st=sb>

- Core data-centric functional capabilities: Pentaho has excellent capabilities in areas of administration, security and architecture, self-contained ETL and data storage, embedded advanced analytics, embedded analytic content, data source connectivity and metadata management. Capabilities in self-service data preparation, interactive visual exploration, analytic dashboards, and mobile exploration are not excellent but still good.

According to Gartner Pentaho's weaknesses are:

- Customer experience: User enablement such as conferences, user community and availability of skills, have achieved low ratings. Also, business benefits achieved are weaker compared to other vendors in the Magic Quadrant. Pentaho should invest more to improve this area.
- Market awareness in a crowded market: The awareness of Pentaho is lower compared to other vendors in the Magic Quadrant, this has been revealed by different researches and inquiries made by Gartner. Although its focus is on big data deployment, the use of BI and analytics platforms in big data is not yet mature.
- Ease of use: The ease of use is a top buying criterion in BI market. Customers report that the ease of use is a concern in the case of Pentaho. The difficulties are in both implementation and usage. This is due in part to the complexities that Pentaho addresses.
- Functional gaps: Pentaho has lower scores in the areas of cloud BI and in the business user centric categories which includes support for publishing, sharing and collaborating, smart data discovery and general functionalities.

## 7.2. Steel Italy S.p.A.: Performance Dashboard

To create the Performance Dashboard, which will be presented at the end of this paragraph, the following steps were taken into consideration:

- Define core objectives and select the appropriate KPI (keeping in mind core objectives): The first step was already done by the company before I started the internship. The same core objectives and the related KPI represented in the previous chapter, will be used to create the Performance Dashboard of this chapter.
- Collect the needed data for the KPI, selected previously, from reliable sources: To do so, the data were extracted from the database using SQL queries.
- Reach a final conclusion, generate a Performance Dashboard: The Performance Dashboard we are going to generate, won't represent the final decision but it will support the decision-making system.

On the following pages we will refer to the Pentaho Guide represented on the Appendix to describe the process which leads to the creation of the Performance Dashboard.

First of all, the software needs to be downloaded using the following link:

<http://www.pentaho.com/download>

Once that is done, the database driver needs to be downloaded as well, and placed in the following destination:

C:\Pentaho\server\pentaho-server\tomcat\lib

The database driver is needed to connect the software to the database, in this way using a simple SQL query the user can extract and analyse the data directly from the database. Once we have installed Pentaho and database drivers, we can proceed with the creation of the connection between the database, which in this case is MySQL, and Pentaho. This process is described in the first 7 steps of the Appendix.

Now that we have the connection, we can start to create our dashboard using a Pentaho tool called CDE Dashboard, described in the step 8 and 9 of Appendix.

When a CDE Dashboard is created, first of all a template should be chosen and the dashboard needs to be saved. These two processes are described respectively in the steps 10-12 and 13-17 of the Appendix.

At this point we are able to start and create the charts of the dashboard. To do so, we need to create a data source for each chart. A data source is a query that extracts the data from the database and feeds the chart. The data source creation for the Dial Component is described in the steps 18-28 of the Appendix.

Once we have the data source, we need to create a chart, in the case of Dial Component some additional parameters are needed, as described in the steps 29-40 of the Appendix. The last steps concern the template configuration, i.e. panel configuration of the Dashboard as described in the steps 41-59 of the Appendix. At this point we have created the Dial Component, as showed in the step 59 of the Appendix.

To create the Bar chart the procedure is almost the same. In the Appendix the steps 60-64 are related to the data source, the steps 65-67 are related to the chart and the steps 68-84 are related to the template configuration.

To summarize, the process needed to create a chart in the CDE Dashboard is composed of three steps (see Appendix for more details):

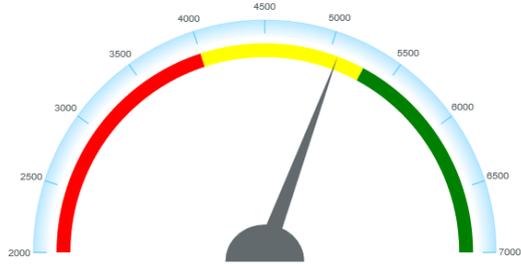
- 1) Creation of Data Source;
- 2) Creation of Charts and Components;
- 3) Template Configuration.

The Final result of the CDE Dashboard created with Pentaho is showed in the Picture on the next page.

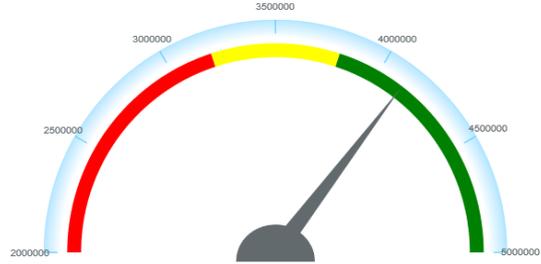
The Pictures on the following pages derive from personal elaboration.

September 2016

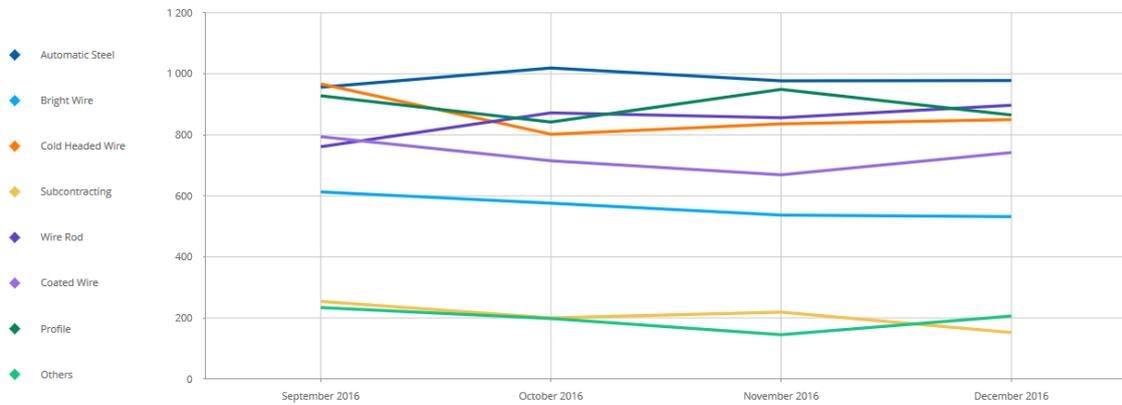
Quantity (Ton)



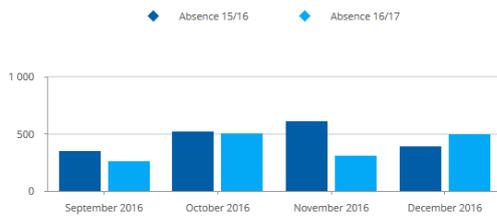
Turnover (€)



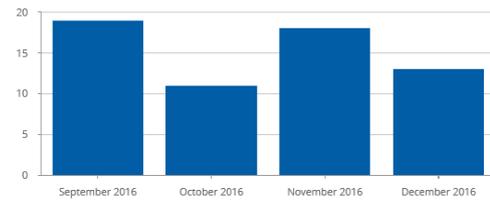
Price (€/Ton)



Absence (H)



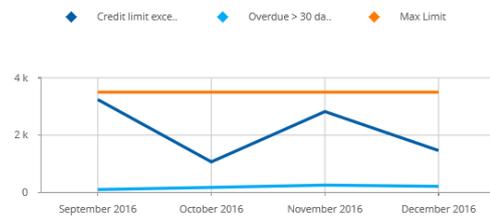
Non-Conformity



Injuries (H)



Credit Limit (€)



TON Product	September 2016			October 2016			November 2016		
	ACT	BUD	%	ACT	BUD	%	ACT	BUD	%
Automatic Steel	54	55	-2%	83	55	51%	57	55	4%
Bright Wire	772	905	-15%	598	905	-34%	978	905	8%
Cold Headed Wire	2.308	2.276	1%	2.137	2.276	-6%	2.275	2.276	0%
Subcontracting	155	407	-62%	276	407	-32%	405	407	0%
Wire Rod	848	878	-3%	902	878	3%	915	878	4%
Coated Wire	744	522	43%	587	522	12%	656	522	26%
Profile	68	61	11%	48	61	-21%	59	61	-3%
Others	120	180	-33%	130	180	-28%	238	180	32%
<b>Total</b>	<b>5.069</b>	<b>5.284</b>	<b>-4%</b>	<b>4.761</b>	<b>5.284</b>	<b>-11%</b>	<b>5.583</b>	<b>5.284</b>	<b>5%</b>

Sales Product	September 2016			October 2016			November 2016		
	ACT	BUD	%	ACT	BUD	%	ACT	BUD	%
Automatic Steel	51.643	55.966	-8%	84.547	50.467	68%	55.689	52.589	6%
Bright Wire	473.505	487.364	-3%	344.186	439.482	-22%	525.674	444.392	18%
Cold Headed Wire	2.231.782	2.139.527	4%	1.714.681	1.929.325	-11%	1.902.634	1.943.768	-2%
Subcontracting	39.377	77.506	-49%	55.100	69.891	-21%	88.678	71.456	24%
Wire Rod	645.730	665.105	-3%	786.455	599.761	31%	783.464	621.914	26%
Coated Wire	590.888	375.562	57%	419.462	338.664	24%	439.043	335.989	31%
Profile	63.105	54.628	16%	40.401	49.261	-18%	55.988	51.622	8%
Others	28.075	20.656	36%	25.753	18.627	38%	34.514	19.633	76%
<b>Total</b>	<b>4.124.105</b>	<b>3.876.314</b>	<b>6%</b>	<b>3.470.585</b>	<b>3.495.478</b>	<b>-1%</b>	<b>3.885.684</b>	<b>3.541.363</b>	<b>9%</b>



## Steel Italy S.P.A.

September 2016 ▾

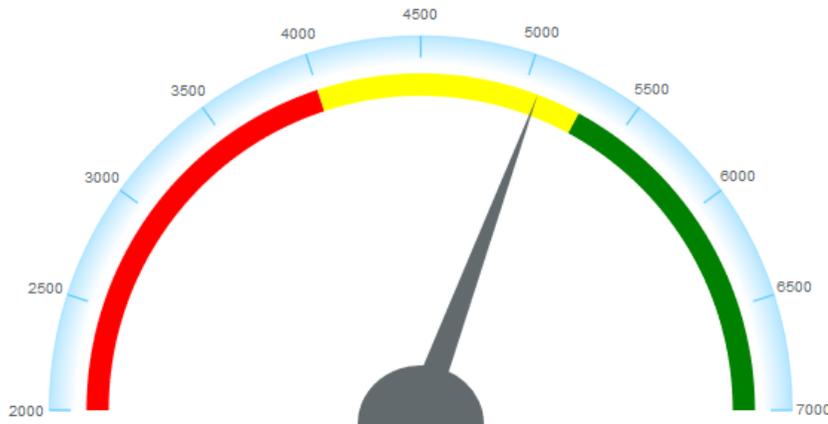
September 2016

October 2016

November 2016

December 2016

Quantity (Ton)

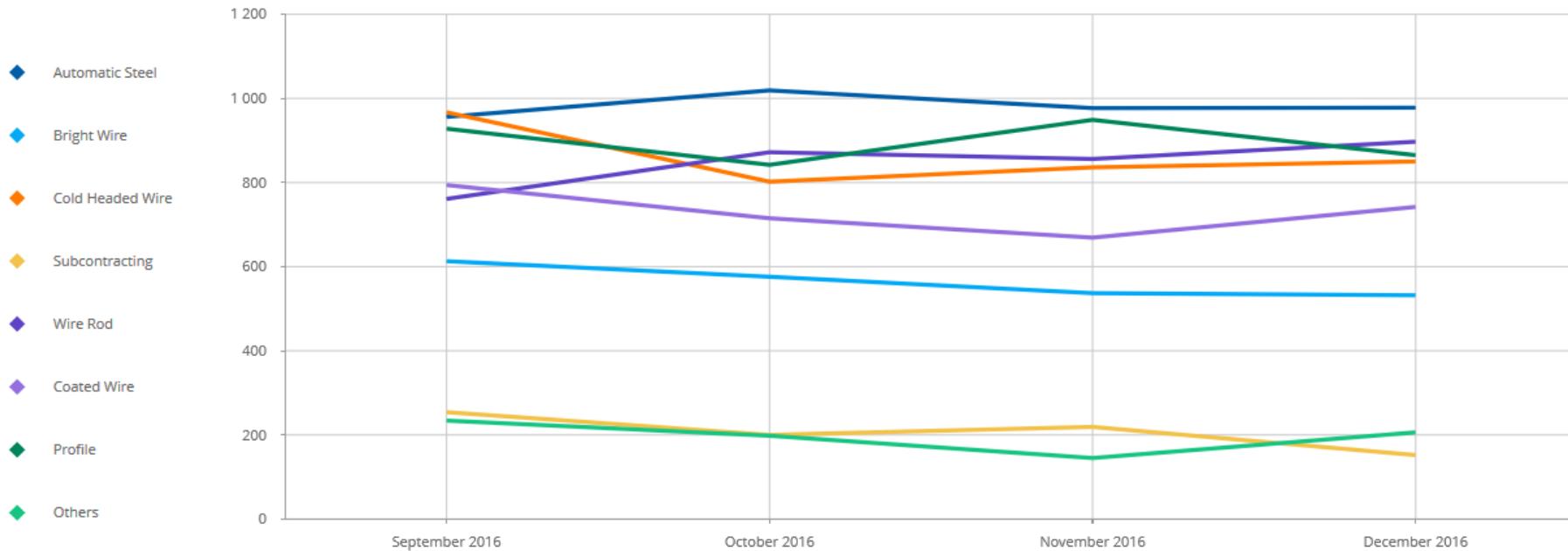


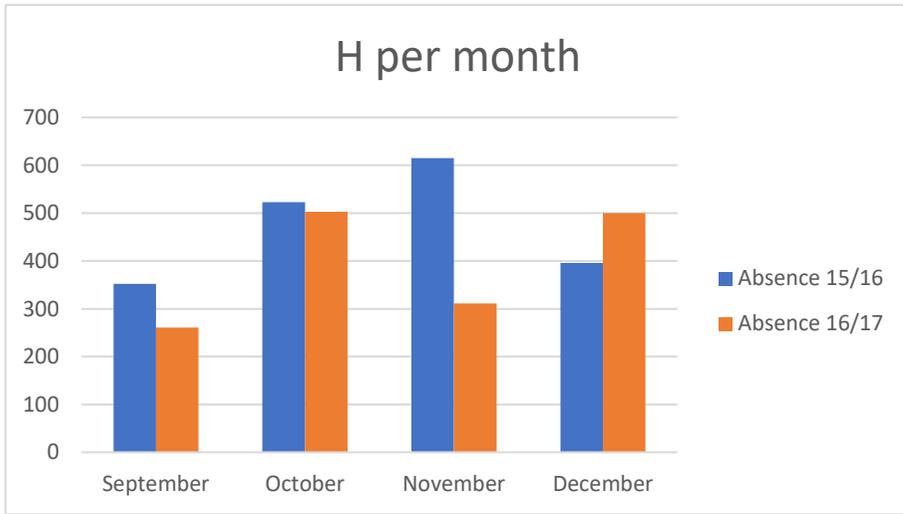
Turnover (€)



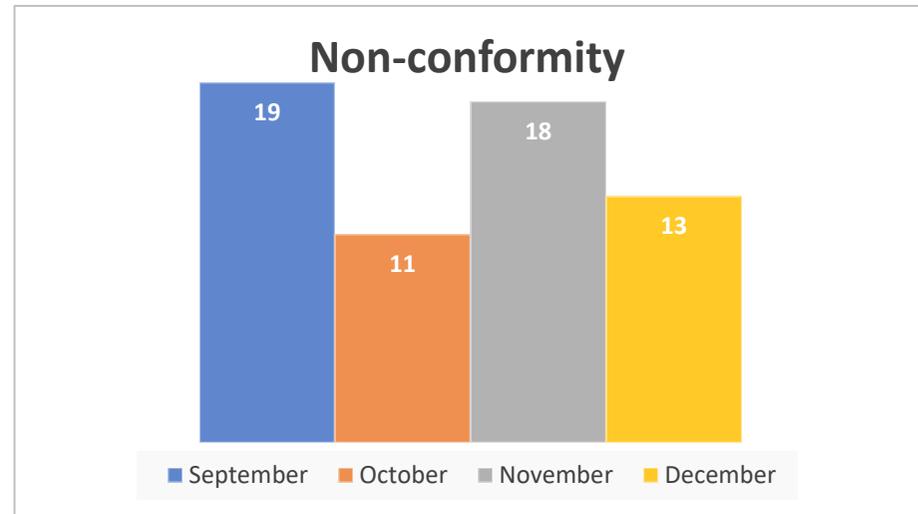
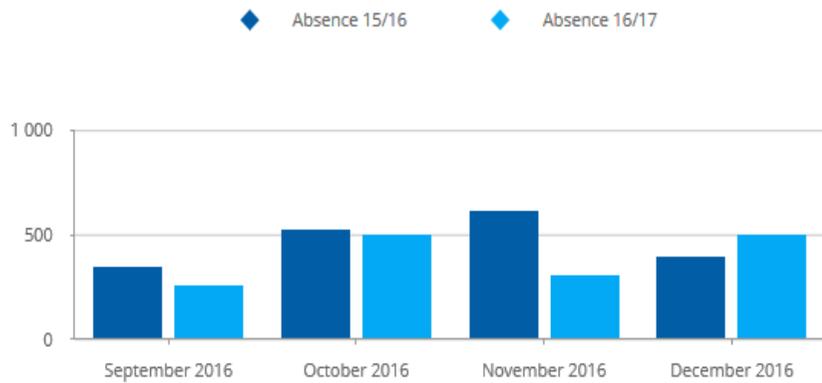


Price (€/Ton)

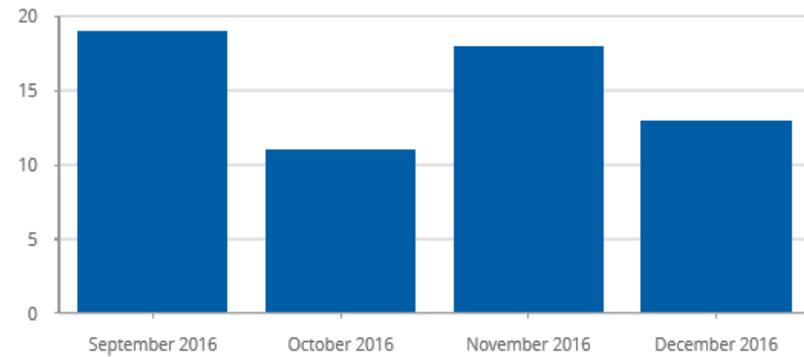


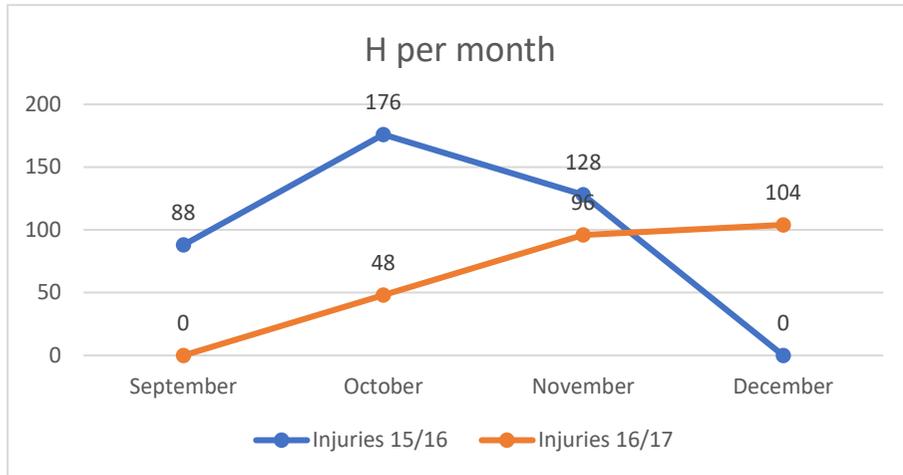


### Absence (H)



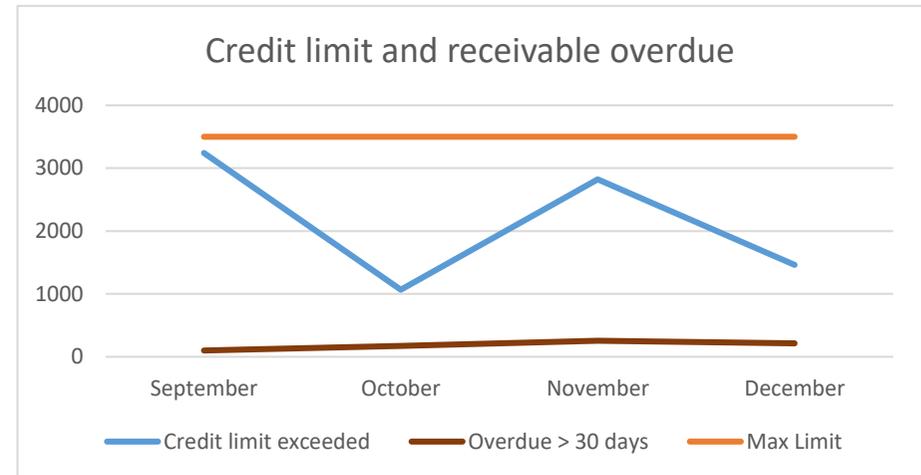
### Non-Conformity





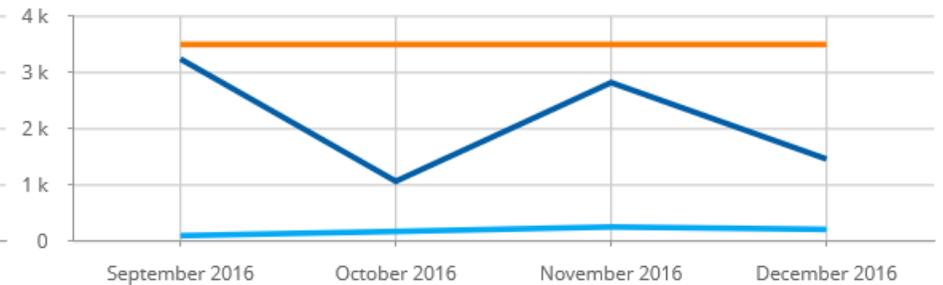
## Injuries (H)

◆ Injuries 15/16    ◆ Injuries 16/17



## Credit Limit (€)

◆ Credit limit exceeded    ◆ Overdue > 30 days    ◆ Max Limit



The charts generated by Excel, on the top of the previous four pages, and the charts generated by Pentaho, on the bottom of the same page, they all look the same, apart from the dial chart, placed on page 114 which is totally different compared to Excel.

Even if they have the same aspect, in fact they are totally different.

First of all, generating charts with a BI software like Pentaho is far more complicated because you need to use SQL queries instead of just selecting data from some simple Excel tables.

But the positive side of the charts generated by queries derives from the fact that they are refreshed automatically. Excel charts instead, needs to be refreshed manually and refreshing manually Excel charts takes a lot of time and human errors are not excluded.

It is true that it is more complicated at the beginning to set a Performance Dashboard like the one created by a BI software, in this case Pentaho. But once the Performance Dashboard is in place, everything you need is to monitor the performance. The more this type of software are used, the greater is the benefit the organizations will have, because the greater is the time that the organization will save. This means that the sooner the management uses these tools, the better it will be for the organization.

By using these tools, users save a lot of time dedicated on refreshing reports, in this way, they can dedicate their time to those activities which have higher value for the organization.

This chapter was dedicated to the introduction of Pentaho software and to the implementation of the Performance Dashboard in the case study introduced in the previous chapter.

The next chapter will summarize the most important topics discussed in the previous pages and will be dedicated to the final conclusions

At the end, there is the Appendix, which provides a guide on how to use Pentaho to create a Dashboard.

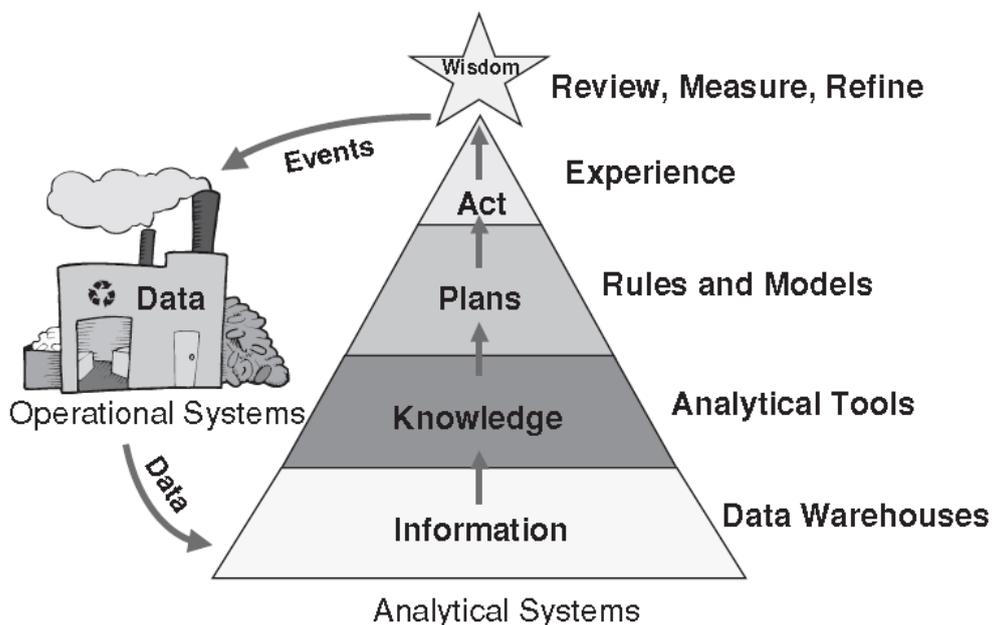


## CHAPTER 8. CONSIDERATIONS

Carlo VerCELLIS claims that our economy and society is based on information. Peter Drucker<sup>34</sup>, a worldwide known management thinker, has argued that the world is moving from an “economy of goods” to an economy of “knowledge”. Since the economy is based on knowledge, the amount of information held by organizations makes the difference between winners and losers. Indeed, the quantity of information is growing in our society. According to Bernard Marr, it is estimated that by 2020 there could be four times more digital data than all the grains of sand on Earth.

Not just the quantity of information held is important but also the ability to manage data, i.e. transform raw data into knowledge, is crucial for the success of an organization. In fact, managers and organizations have to manage big quantities of data. But how to manage a lot of data?

The main tool used by managers to manage big quantities of data is Business Intelligence. According to Wayne W. Eckerson, Business Intelligence is a data refinery which transforms raw data into information and information into knowledge.



Source: Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2006, p.49

Picture 46

<sup>34</sup> <http://www.economist.com/node/5165460>

BI (Business Intelligence) may represent the source of competitive advantage for an organization for several reasons. First of all, according to Carlo Vercellis, BI through the DSS (decision support system) supports decision makers by providing them with appropriate, reliable and timely information, allowing them in this way, to make the right decision. Secondly, BI save executives time dedicated in gathering data and creating reports, knowing that executives time is expensive, it represents also a save in terms of money. And thirdly, according to Eckerson, it is crucial to detect potential problems or opportunities that may arise, before it is too late.

## 8.1. Findings

According to Howard Dresner, one of the most important tools of BI is the Dashboard. This is supported by Dresner Advisory Services market research depicted here below.



Source: Howard Dresner, *Wisdom of Crowds® Business Intelligence Market Study*, Dresner Advisory Services, LLC, 2017 Edition, p.61

Picture 47

To understand the role a Dashboard can play within an organization, we need to see the relationship between BPM (Business Performance Management) and the Dashboard.

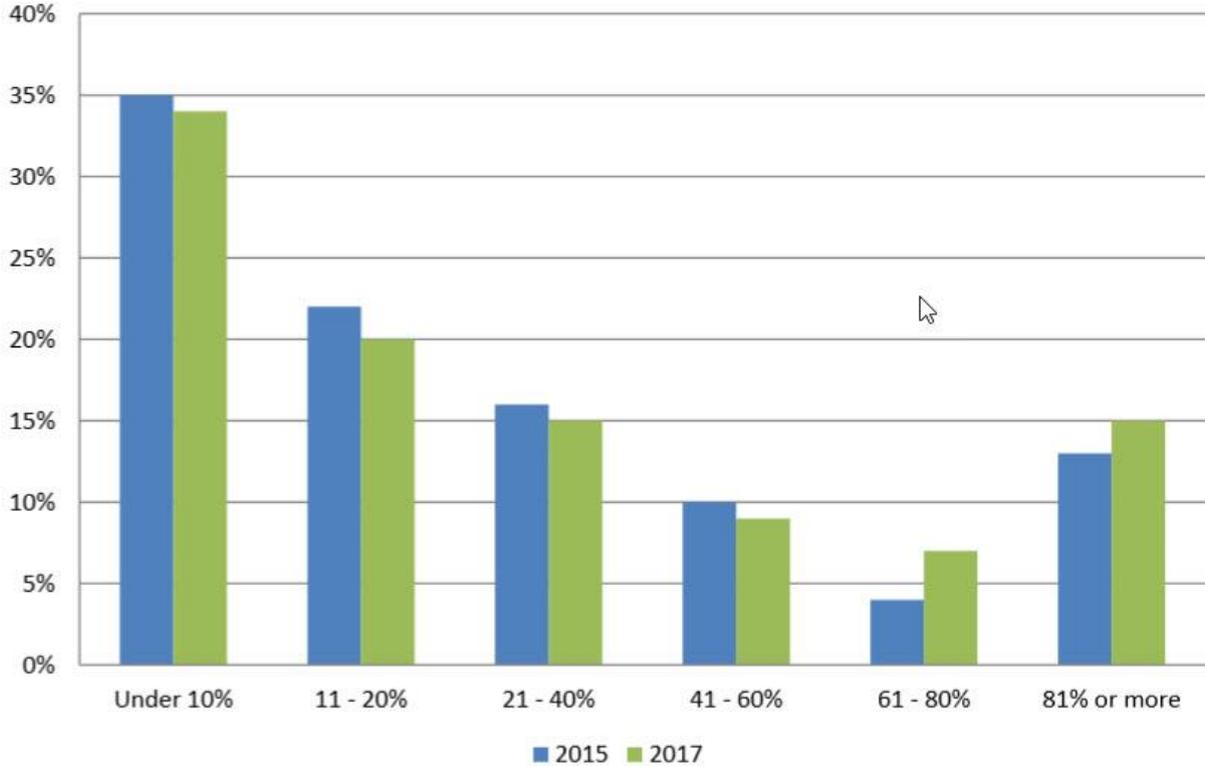
If we assume that the organization is a car, we can say that BPM is the steeringwheel used to direct the car towards the right direction<sup>35</sup>, while the dashboard with gauges

<sup>35</sup> Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2nd edition 2011, p. 29

represents the situation or the condition such as oil pressure, speed, temperature, etc., under which the car operates<sup>36</sup>.

Managers and executives are using always more dashboards to conduct their organizations. As depicted in the picture here below, high percentage of employees using BI is increasing while low percentage are decreasing.

### Penetration of Business Intelligence Solutions 2015-2017



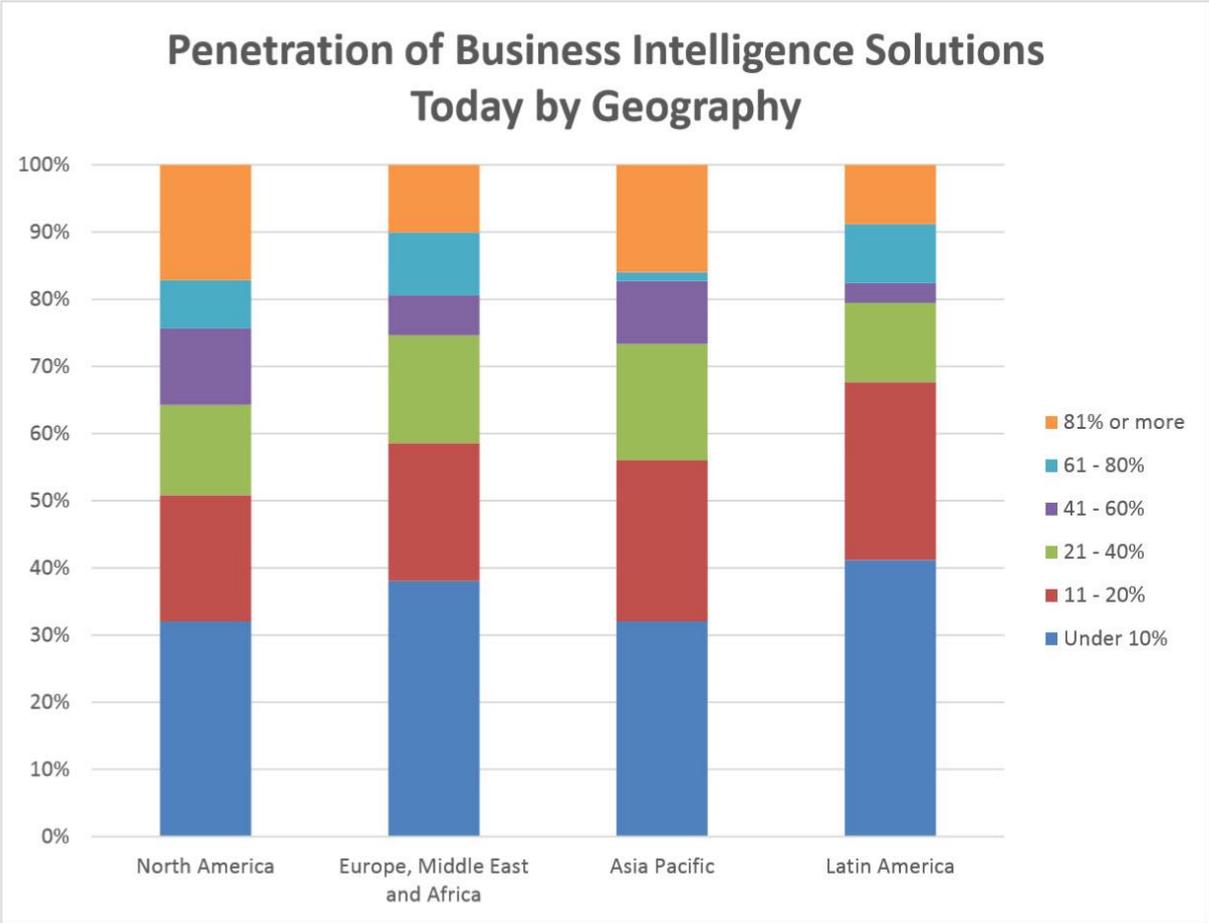
Source: Howard Dresner, *Wisdom of Crowds® Business Intelligence Market Study*, Dresner Advisory Services, LLC, 2017 Edition, p.38

Picture 48

The positive trend on BI adoption is due to the democratization of software systems, which means that BI software systems are getting cheaper and also small and medium organizations can afford them.

<sup>36</sup> Nils Rasmussen, Claire Y. Chen, Manish Bansal, *Business Dashboards: A Visual Catalog for Design and Deployment*, John Wiley & Sons, 2009, p.3

BI adoption is considered to be yet too low in 2017, especially in Europe if we look at the picture here below.



Source: Howard Dresner, *Wisdom of Crowds® Business Intelligence Market Study*, Dresner Advisory Services, LLC, 2017 Edition, p.40

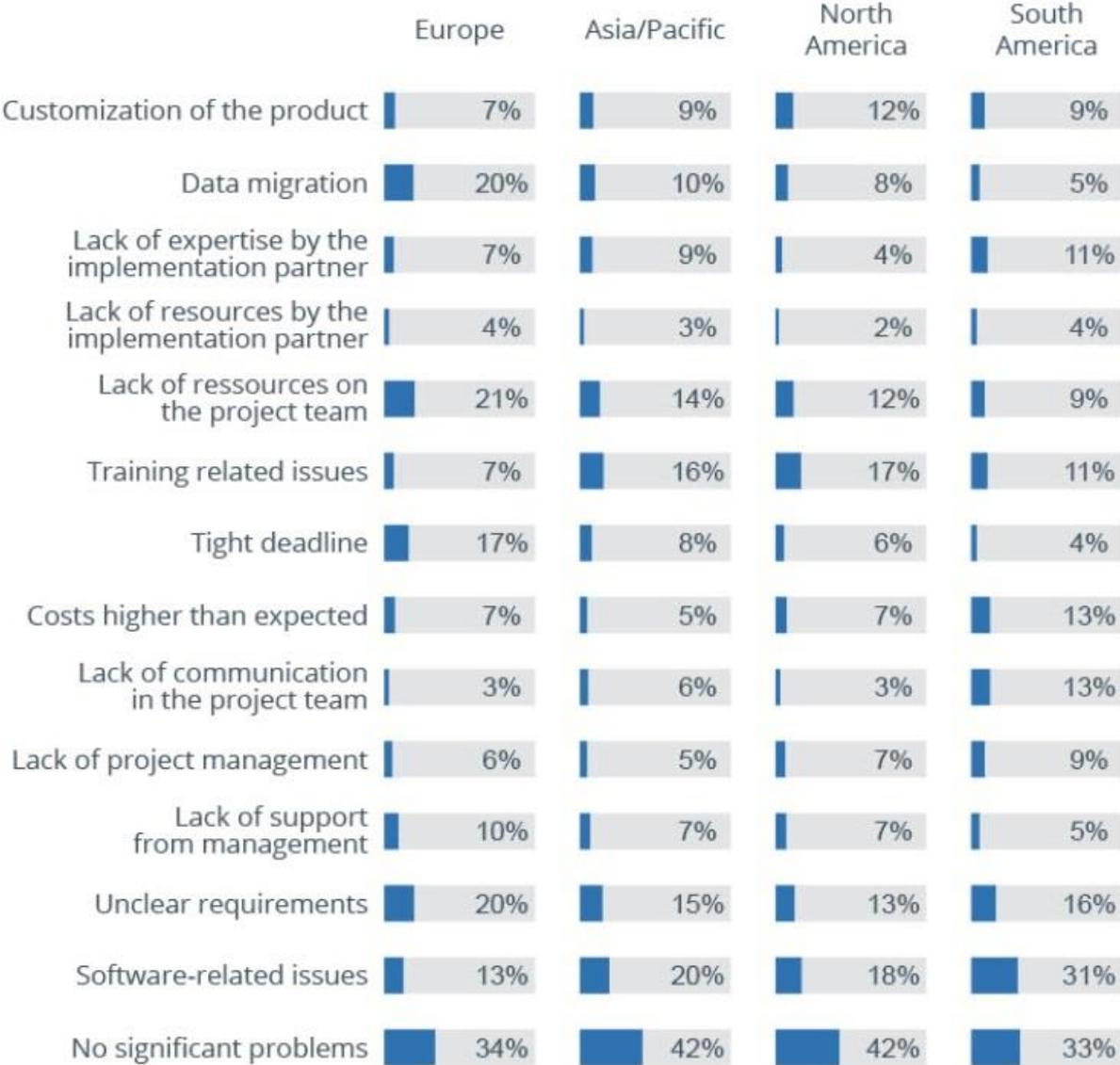
**Picture 49**

Low BI adoption is not natural, knowing that the market of BI Analytics is going to increase by 25% in the next three years passing from \$18.3 billion in 2017 to \$22.8 billion by the end of 2020<sup>37</sup>.

<sup>37</sup> <https://www.gartner.com/newsroom/id/3612617>

Low BI adoption is due to several reasons. According to BARC<sup>38</sup>, implementation problems arise mainly because of training, requirement and software problems. In Europe, the lack of resources and data migration problems are emphasized.

In the last row of the picture below, the term “no significant problems” is 34% in Europe, meaning that the issue of BI is undervalued.



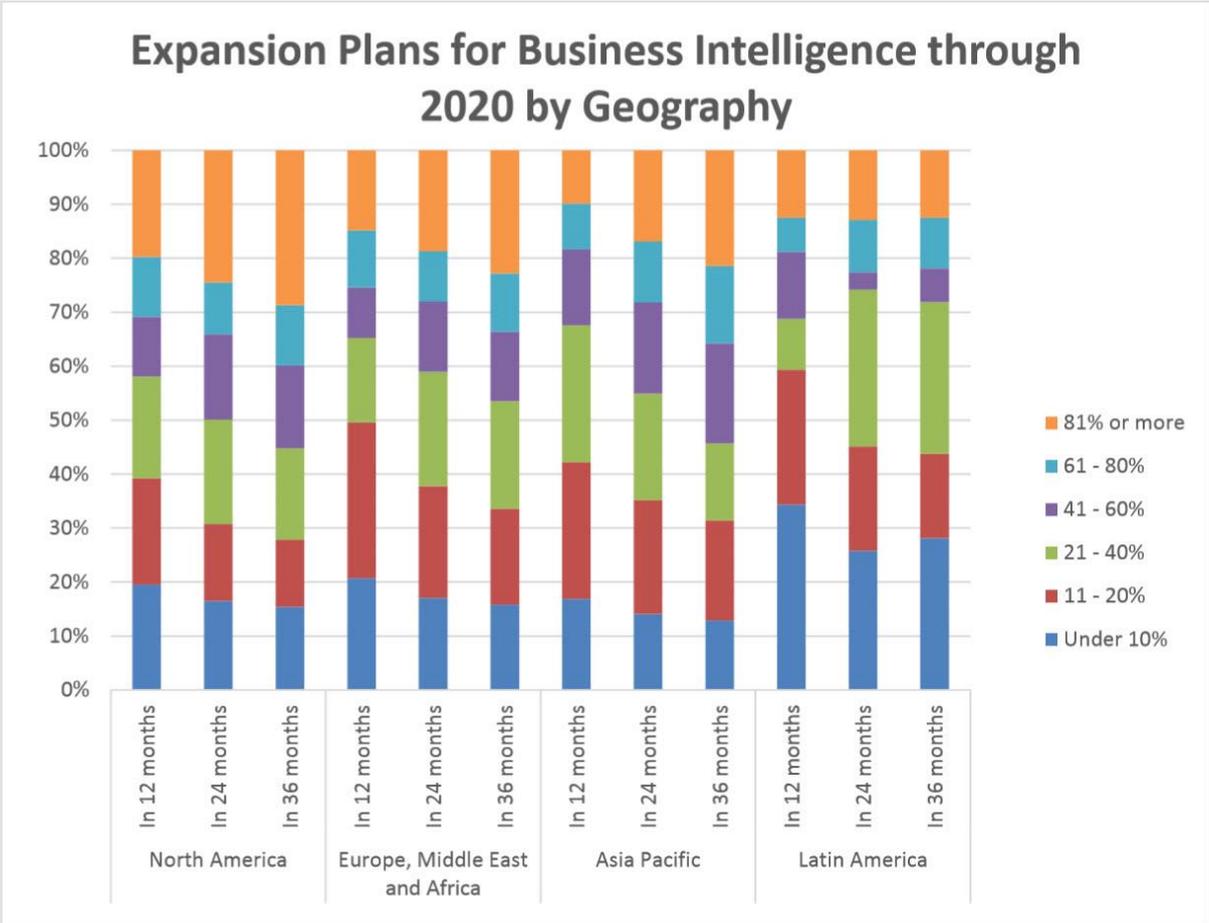
*Most serious implementation problems (n=2,542)*

Source: BARC; <https://bi-survey.com/business-intelligence-problems>

**Picture 50**

<sup>38</sup> BARC is a European research and consulting firm for business software, It service and digital transformation: <https://bi-survey.com/business-intelligence-problems>

However, BI adoption is expected to grow almost everywhere. According to Dresner research, North America will experience the highest growth followed by EMEA and Asia Pacific. Latin America, instead is not expected to grow in terms of BI adoption within the next 36 months.



Source: Howard Dresner, *Wisdom of Crowds® Business Intelligence Market Study*, Dresner Advisory Services, LLC, 2017 Edition, p.41

Picture 51

## 8.2. Conclusions

Because of the complexities of the organizations and the highly dynamic environments, intuition in the decision making process doesn't work anymore. Organizations need to have BI tools, like Performance Dashboard, to support and give to the decision making process a fair degree of rationality. "Performance dashboard deliver the right information to the right users at the right time to optimize decisions, enhance efficiency, and accelerate bottom-line results"<sup>39</sup>.

Even though, a Performance Dashboard as a BI tool brings a lot of benefits to organizations, the adoption rate is still too low, especially in Europe, according to Howard Dresner. Low adoption rates, according to BARC, are due to lack of resources, data migration problems and undervaluation.

Another reason that might explain low adoption rates, comes from the overvaluation of the difficulties that an organization has to face to implement a BI system and undervaluation of benefits. For instance, in the company where I have experienced the internship, I noticed that it wasn't quite clear to the people with high decision making power, the benefits they could get from the implementation of a BI system. This is due to the fact that, usually when they were involved in the evaluation of the trade-off between the investment and the benefit, they were prone to overestimate costs and underestimate benefits. Wayne W. Eckerson would have defined them as traditional executives, this means that they endorse projects only when they see tangible benefits and a favourable ROI. It is quite difficult to convince traditional executives to invest in intangible assets, such as that of BI.

But the Performance Dashboard Implementation in the real case study, described in the previous chapter (Chapter 7), is a demonstration that using a BI software to create a dashboard is not impossible. If a student, which is my case, without any experience in the field of BI, database and IT but with a little bit of curiosity in BI, was able to create a dashboard starting from scratch, then any company with an IT department can do it without any problem.

There is also evidence<sup>40</sup> to suggest that executives with relatively high decision-making power are not taking an active role in BI implementation, mainly because of the lack of

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<sup>39</sup> Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2nd edition, 2010

<sup>40</sup> <http://digitalevolution.eiu.com/the-digital-transformation-agenda-2016>

confidence in these systems. For example, the project of BI wasn't a priority at all for the CEO of the company under analysis, i.e. Steel Italy S.P.A. The executives were prioritizing the final result of the data, rather than the process used to reach that result. There was, moreover, a lack of willingness, determination from the executives of the company to endorse an important project like BI.

Not just managers or executives should take an active role in favour of a digital transformation, but also governments can foster investments in intangible goods. For example, if we take into consideration Italy, we can say that thanks to the "National Industry 4.0 Plan", BI implementation is expected to grow. The "Industria 4.0" is the Italian national plan for industry, promoted by the Italian Minister of Economic Development, Carlo Calenda.

According to Carlo Calenda, "the "Industria 4.0", supports and offers incentives to companies that invest in new capital goods, tangible assets and intangible assets (software and IT systems) for the technological and digital transformation of their production processes.

The support includes hyper and superdepreciation from 140% up to 250%, support in bank loans request, tax credit for R&D, incentives for investment in innovative start-ups and SMEs etc."<sup>41</sup>.

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<sup>41</sup> [http://www.mise.gov.it/images/stories/documenti/INDUSTRIA-40-NATIONAL%20PLAN\\_EN-def.pdf](http://www.mise.gov.it/images/stories/documenti/INDUSTRIA-40-NATIONAL%20PLAN_EN-def.pdf)

### 8.3.Suggestion for Further Research: Artificial intelligence

According to Gartner's report "Top 10 Strategic Technology Trends for 2018"<sup>42</sup>, Artificial Intelligence (AI) is the trend number one which will have significant potential of impact and disruption in businesses over the next few years. Gartner views the new trend of artificial intelligence as a disruptive technology that can shape the business model of different organizations.

The interest for the AI issue is growing as organizations and business experts recognize its potential. Therefore, it is important to understand what is the relationship between BI and AI. But, first of all, we have to define artificial intelligence.

"Artificial intelligence (AI) simulates human thinking and behaviour, such as the ability to reason and learn. Its ultimate goal is to build a system that can mimic human intelligence"<sup>43</sup>.

According to Gartner, thanks to this technology deployed in BI, user interface will change radically within the next few years, applications by themselves will be able to run intelligent action automatically and data analytics will be enhanced.

AI capabilities makes easier than ever before to process inconsistent data and provide users with the needed information when they need them, but also before they need them in a proactive manner.

AI will allow next generation BI and analytic tools to find, visualize and narrate findings automatically. This will reduce the time and the cost of adoption of these tools, expanding in this way BI adoptions.

Gartner claims that AI deployed in BI might change the way we create Performance Dashboards and KPIs. Instead of being defined by data analysts, KPIs will be created by AI algorithms. In this way, it is possible to discover new insights and findings that were unknown before, instead of just monitoring what we already know is important. Thanks to AI, we will pass from a manual process of defining KPIs to an automated process where sophisticated AI algorithms will define KPIs. Instead of working for KPIs, KPIs will work for us and tell what is important and what not for our organization.

However, to work properly AI needs data and the quality should be good, otherwise the decisions won't be reliable. In addition, AI needs humans help in monitoring and

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<sup>42</sup> <https://www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2018/>

<sup>43</sup> Paige Baltzan, *Business Driven Technology*, seventh edition, McGraw Hill, 2017, p.172

maintenance. Indeed, AI is viewed as a way to support human activity rather than replace people.

The Issue of AI integrated in BI is not new, Gartner has already talked about smart data discovery in 2015, but just recently the attention has grown.

AI will shape the whole data analytics industry and when integrated into the BI it becomes an interesting field of research for the future.

Regardless of what we might think about the AI, we are in front of an important change which may shape the way organizations work. There are a lot of articles published in different important magazines that recognize the importance and the potential of AI. To cite one example, Bernard Marr has published an article in Forbes<sup>44</sup> where he claims that new technology will make accountants job obsolete. AI has great potential also in the big data and analytics industry. Indeed, according to Gartner, it is the trend number one with a high potential of disruption in the data and analytics industry.

AI is a phenomenon which, at least can't be ignored, organizations should understand and manage it, instead of ignoring and being managed by AI. That's why AI is worthy of an in-depth investigation in the future.

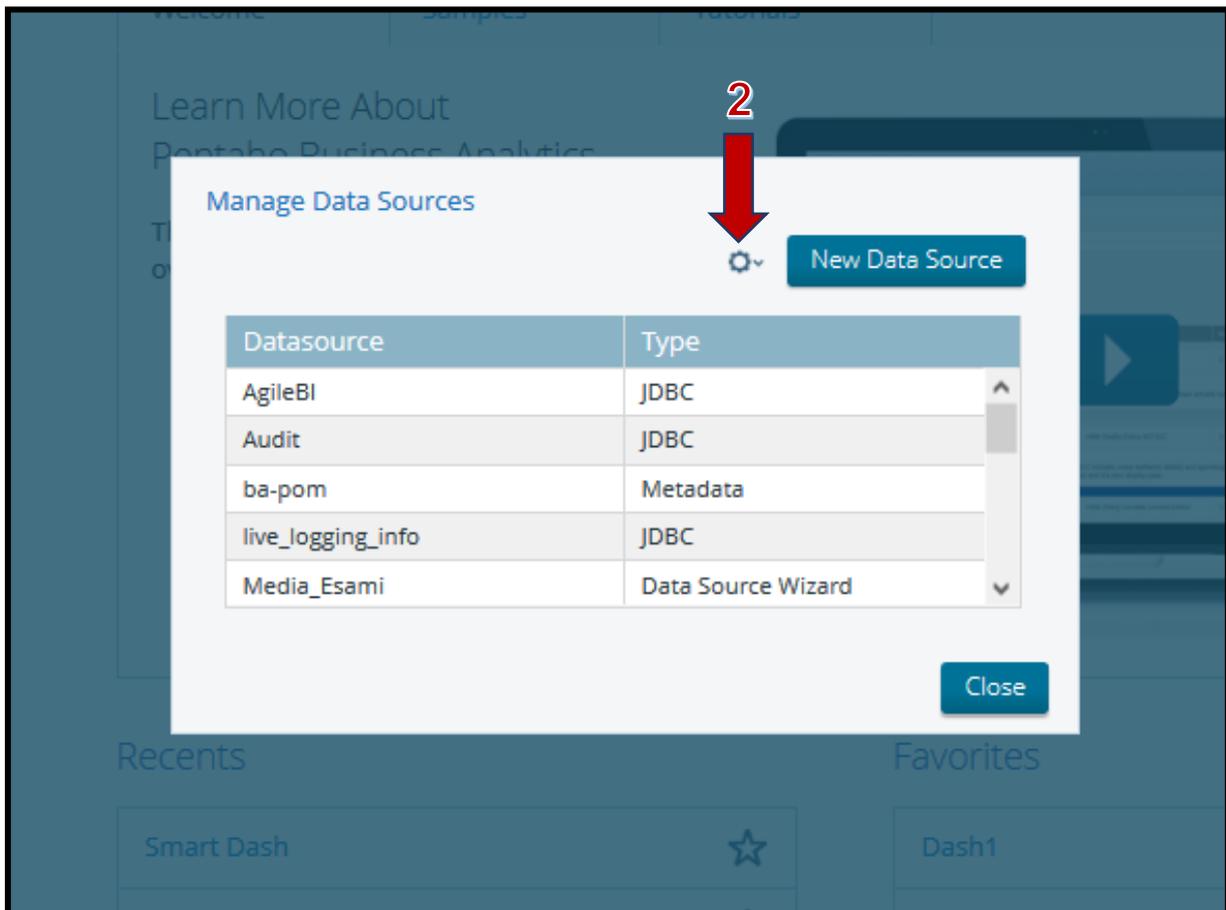
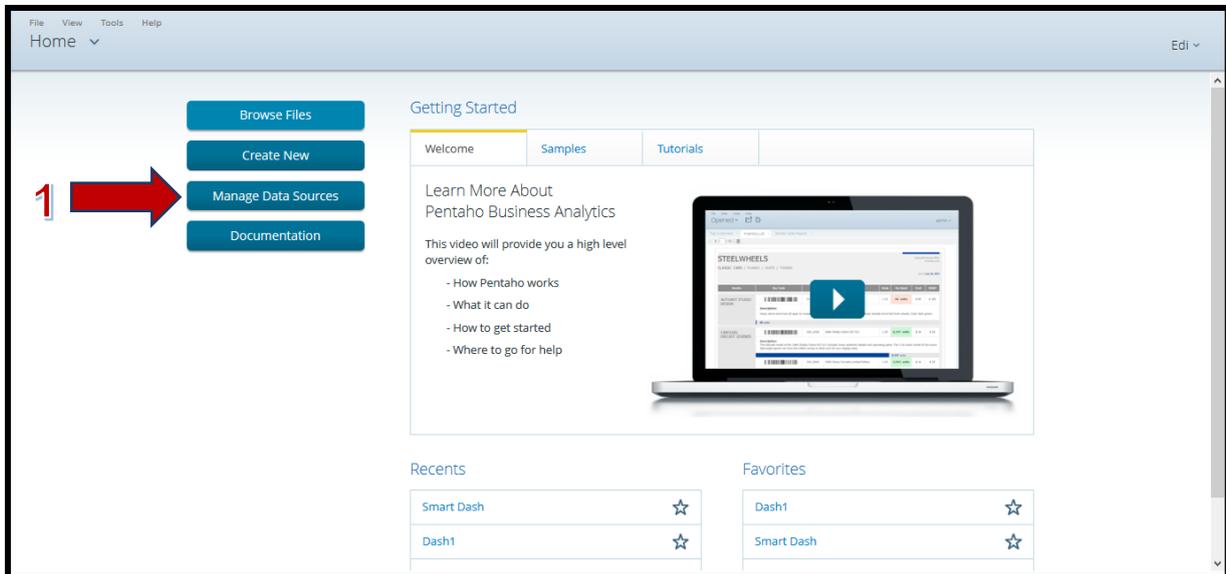
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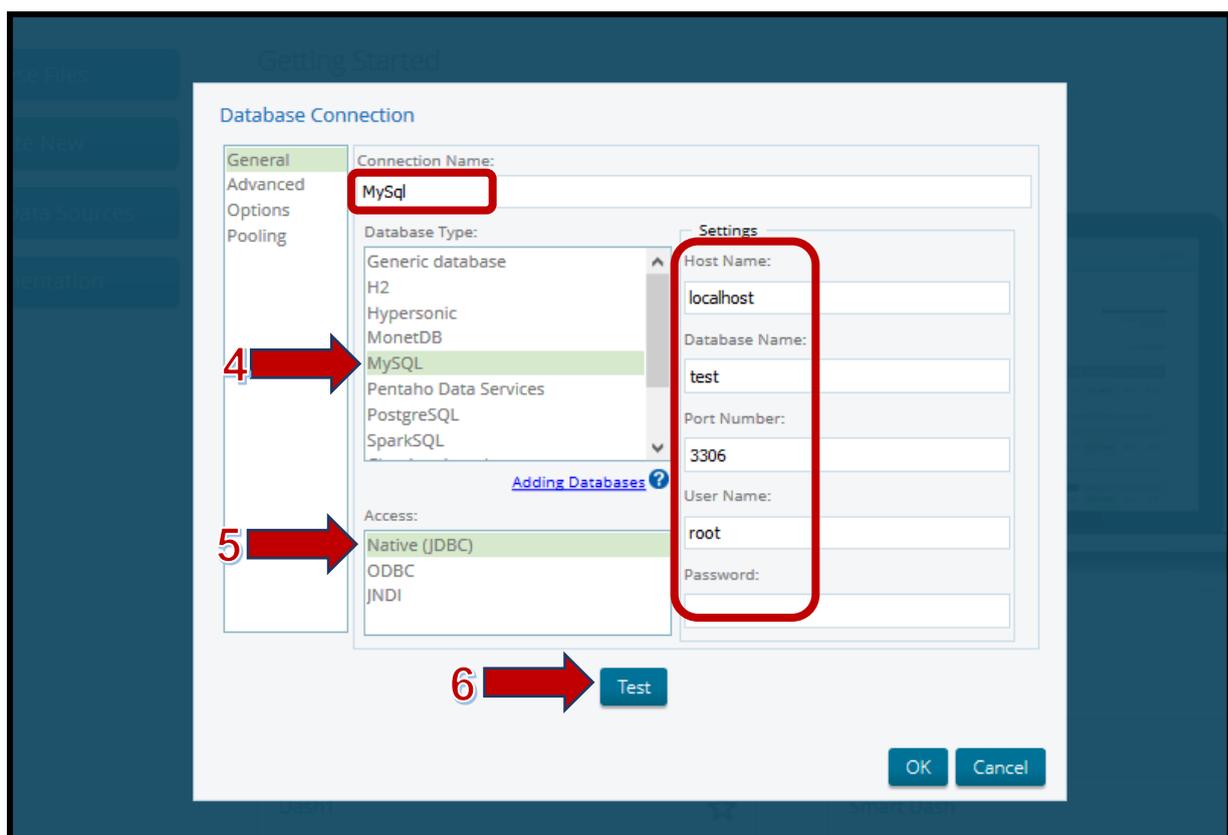
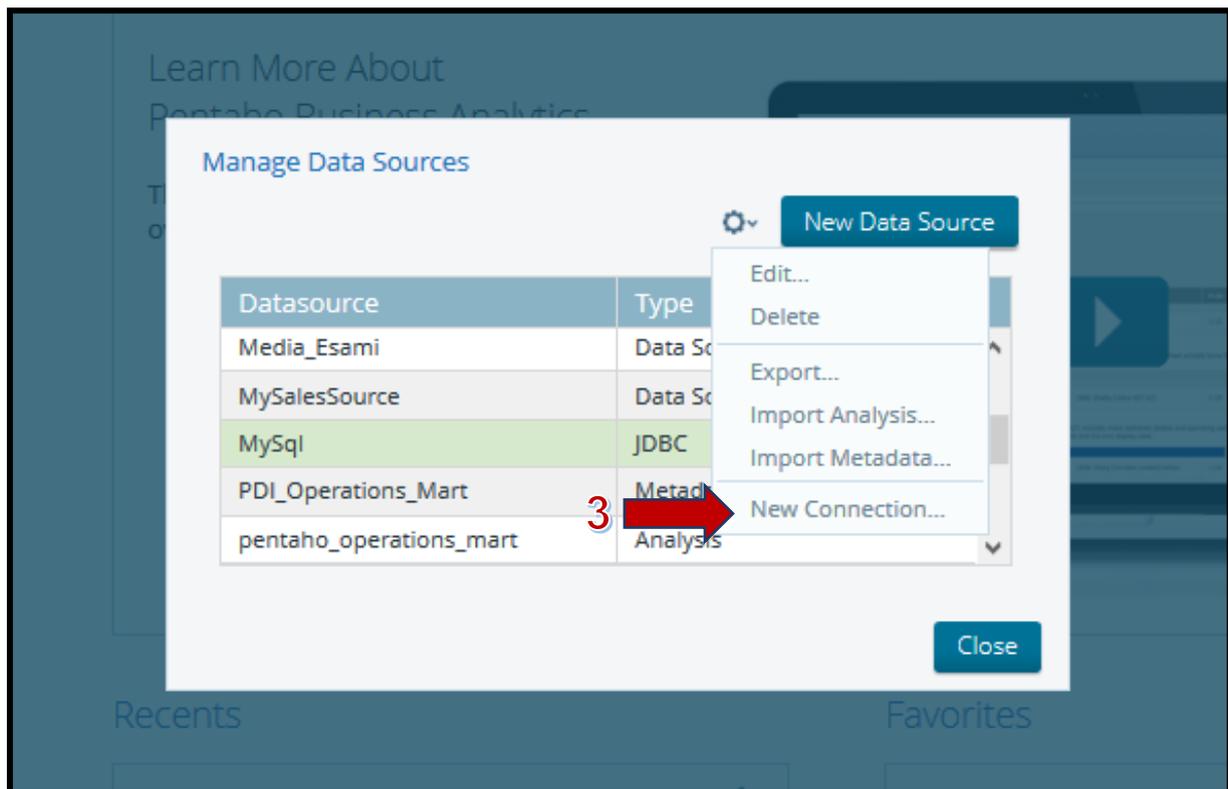
<sup>44</sup> <https://www.forbes.com/sites/bernardmarr/2017/07/07/machine-learning-artificial-intelligence-and-the-future-of-accounting/#772f48ea2dd1>



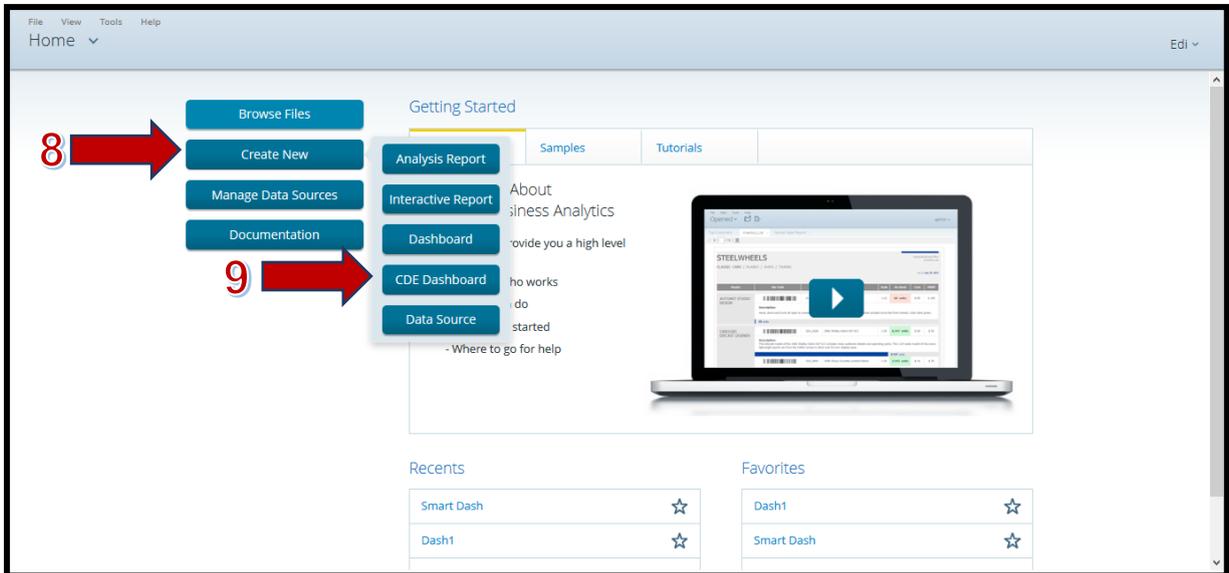
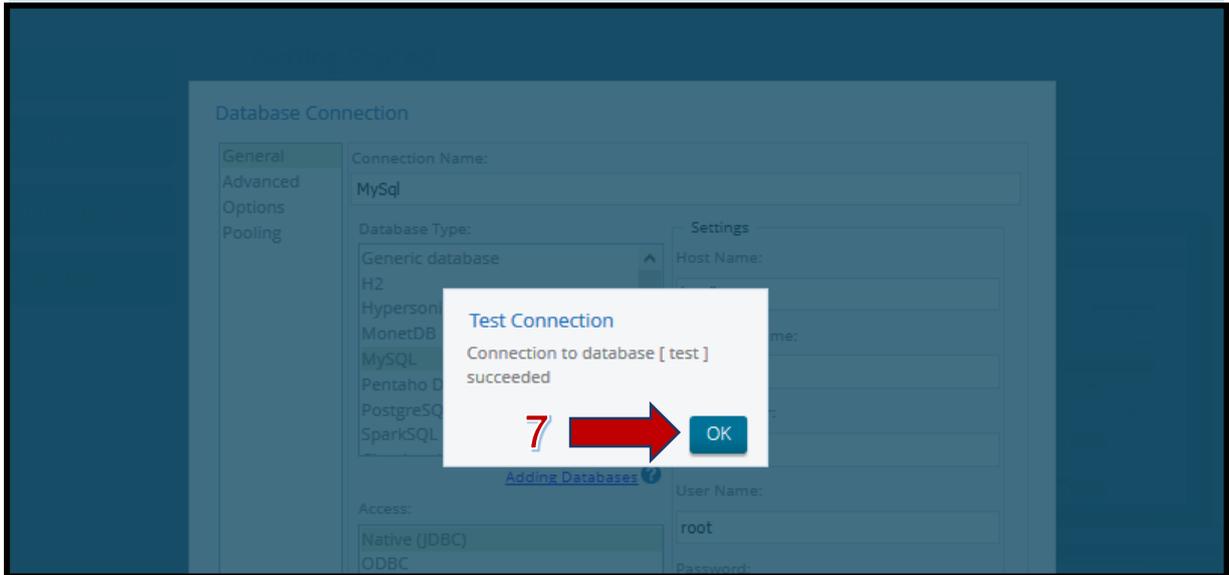
## APPENDIX. Pentaho Guide

Next pages illustrate a step by step guide on how to create a Dashboard using Pentaho. The following pictures derive from personal elaboration:

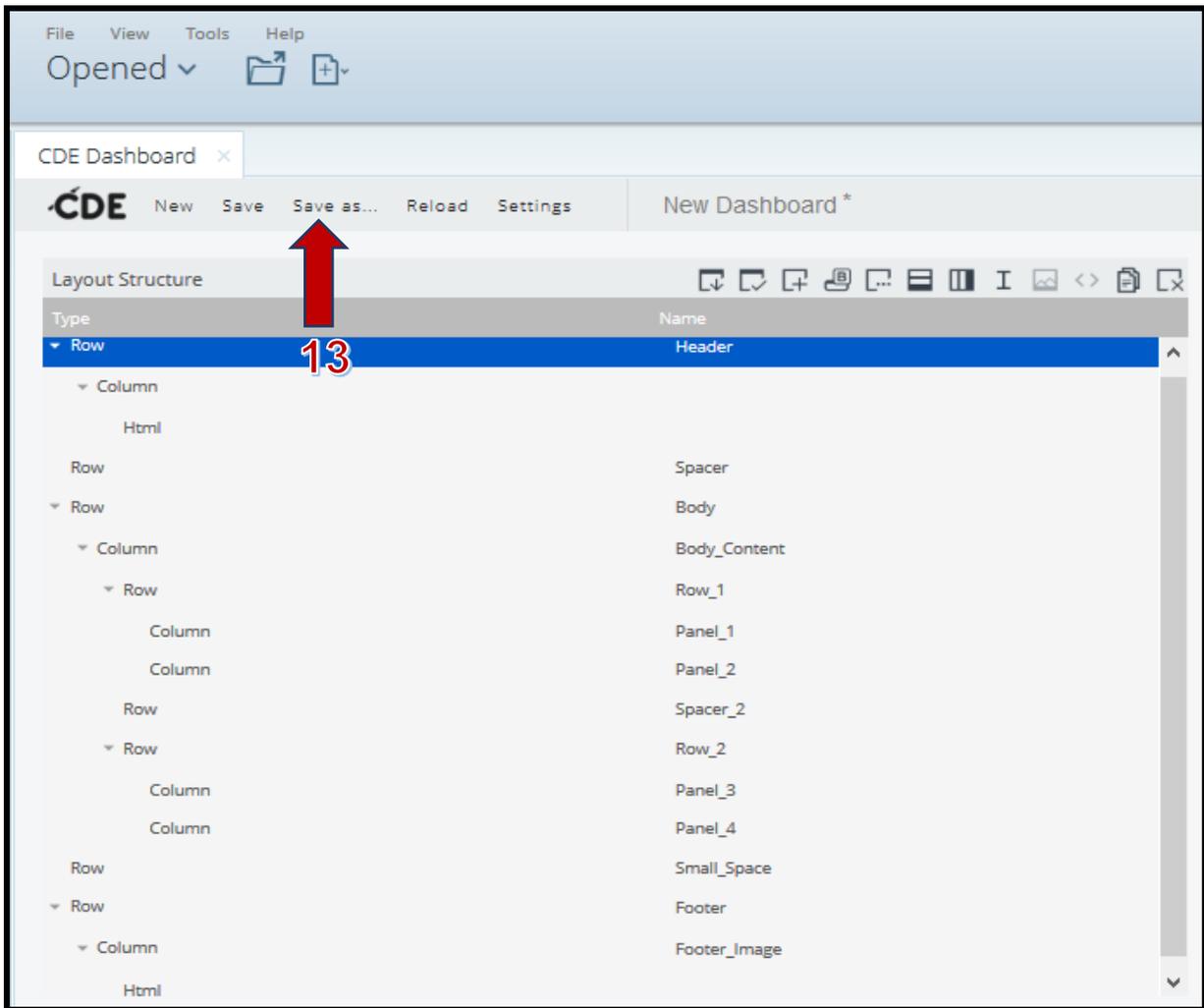
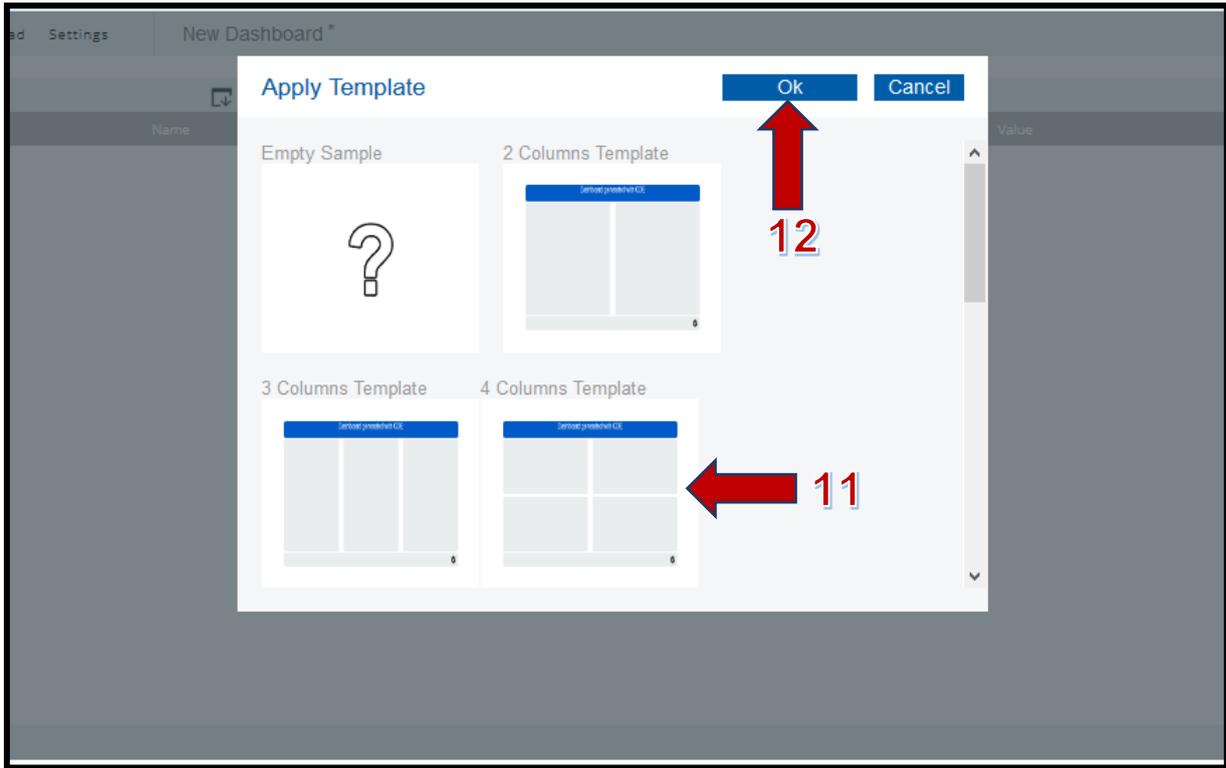


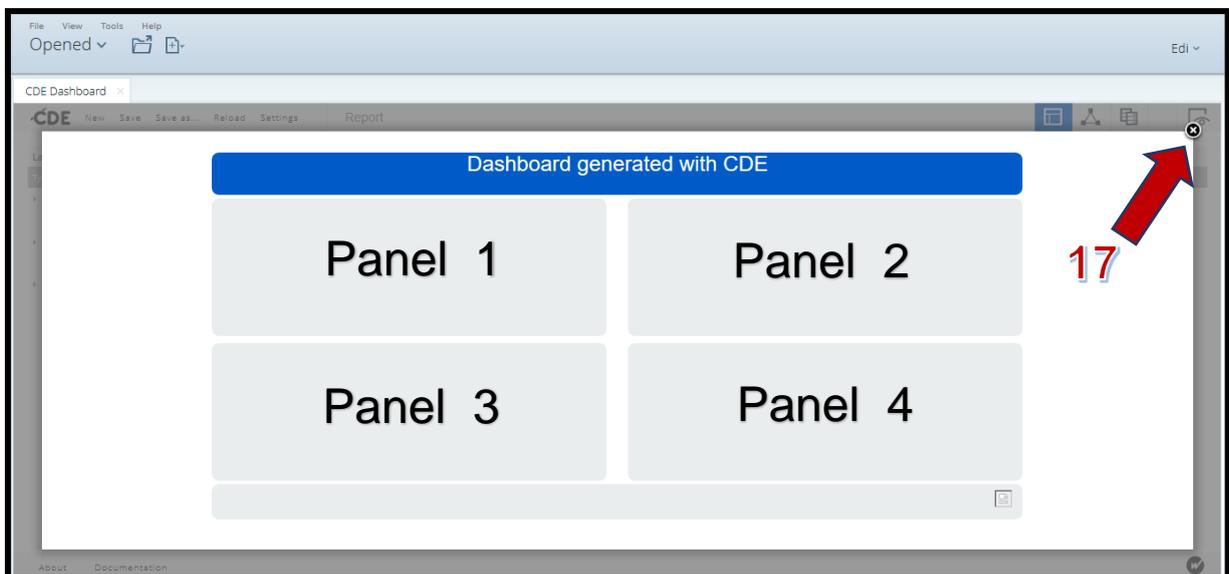
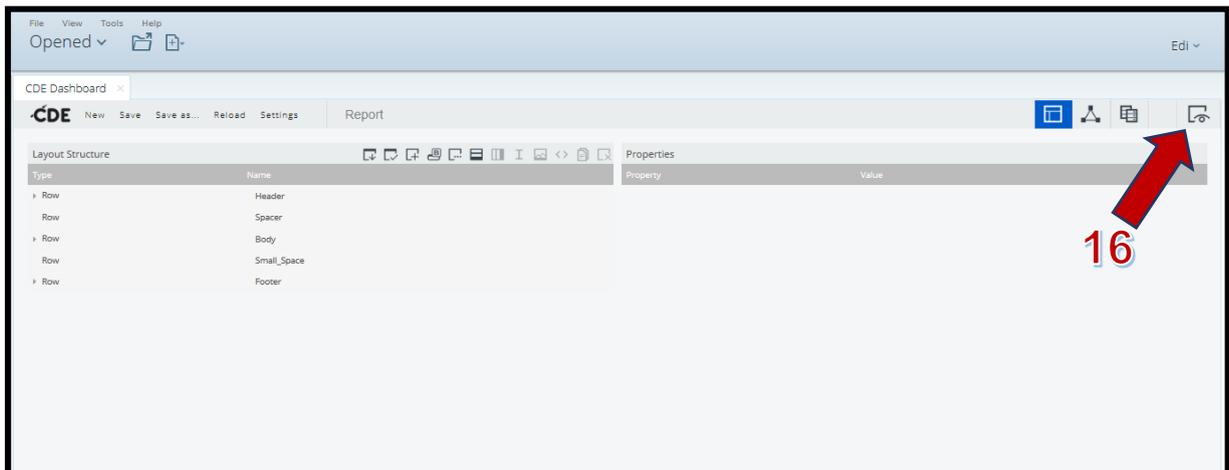
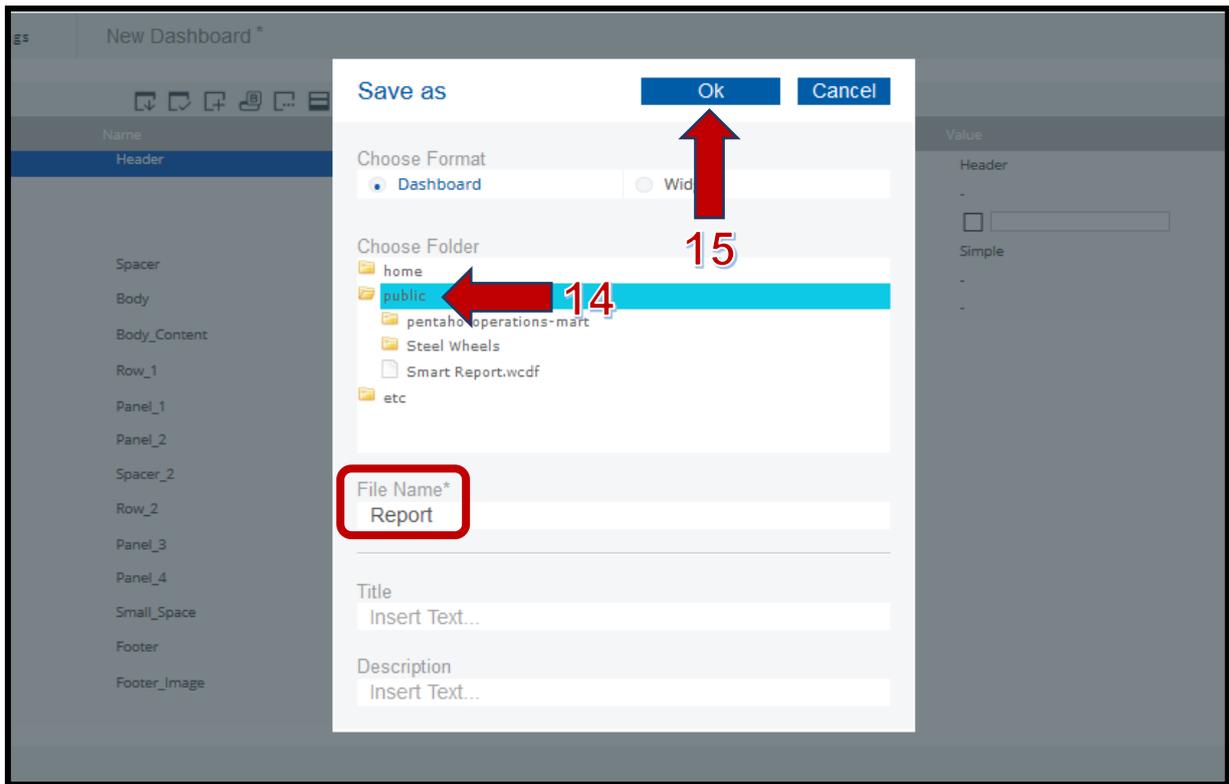


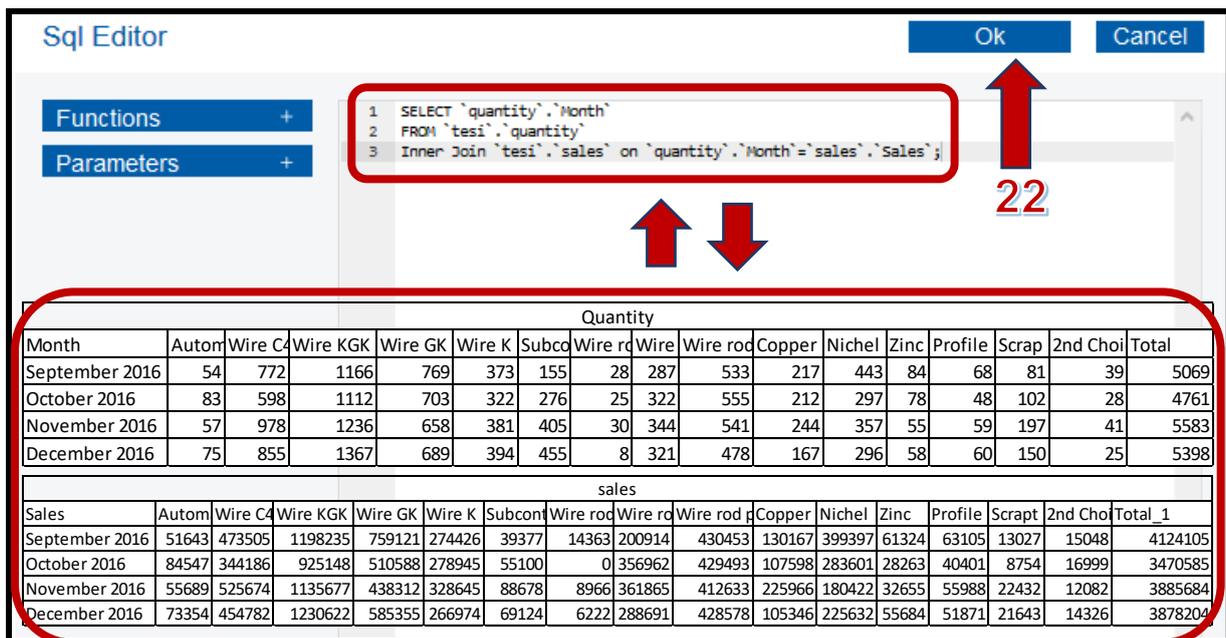
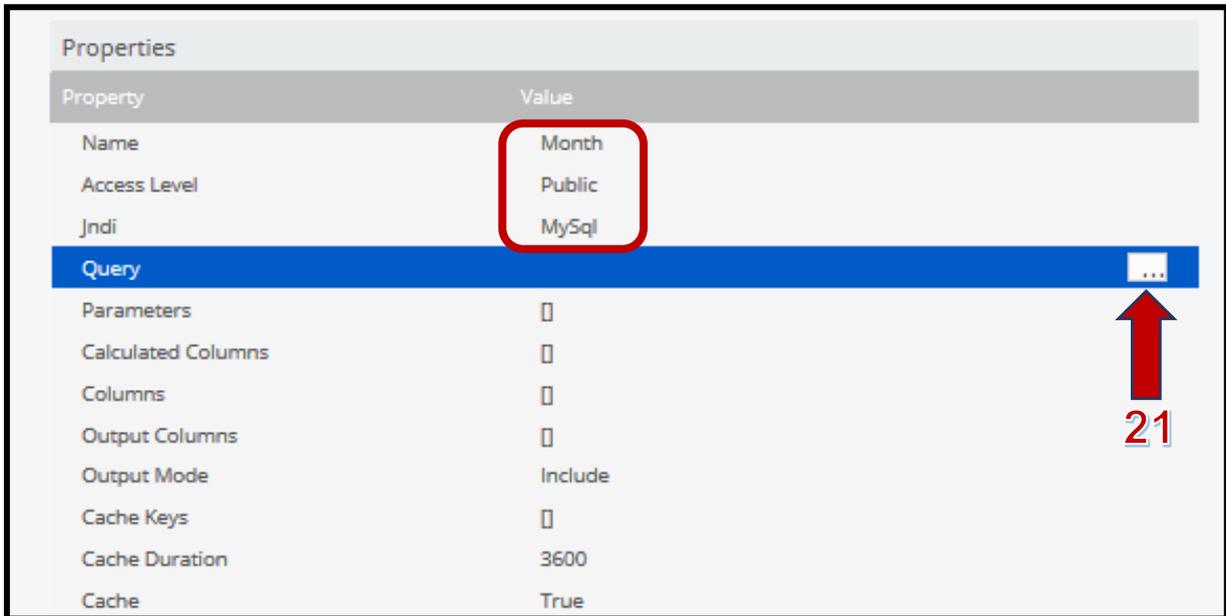
First of all, we need to create a connection between the database, which in this case is MySQL, and Pentaho. This process is described in the first 7 steps.



Once we have the connection, we need to create a new CDE Dashboard.







Editing Report

CDE New Save Save as... Reload Settings Report

Wizards

- Community Data Access
- Legacy Datasources
- FUSION\_PLUGIN Endpoints
- MDX Queries
- OLAP4j Queries
- Compound Queries
- SCRIPTING Queries
- KETTLE Queries
- MQL Queries
- SQL Queries**
- XPATCH Queries

Datasources

Type	Name
Group	SQL Queries
	sql over sqjndi
	Month

Properties

Property	Value
Name	Month
Access Level	Public
Jndi	MySql
Query	SELECT `quantity`.`M (...)
Parameters	
Calculated Columns	
Columns	
Output Columns	
Output Mode	Include
Cache Keys	
Cache Duration	3600
Cache	True

23

24

About Documentation

Properties

Property	Value
Name	Consult
Access Level	Public
Jndi	MySql
Query	
Parameters	
Calculated Columns	
Columns	
Output Columns	
Output Mode	Include
Cache Keys	
Cache Duration	3600
Cache	True

25

Sql Editor

Ok Cancel

Functions +

Parameters +

```

1 SELECT `quantity`.`Total`
2 FROM `tesi`.`quantity`
3 Inner Join `tesi`.`sales` on `quantity`.`Month`=`sales`.`Sales`
4 WHERE Month=${Month};

```

26

**Properties**

Property	Value
Name	Consult
Access Level	Public
Jndi	MySql
Query	SELECT `quantity` . `T` (...)
<b>Parameters</b>	<b>☐</b> ← <b>27</b>
Calculated Columns	☐
Columns	☐
Output Columns	☐
Output Mode	Include
Cache Keys	☐
Cache Duration	3600
Cache	True

**Parameters** Ok Cancel

Add

Name	Value	Type	Pattern	Private
× Month	Month	String		Private

↑ **28**

**CDE** New Save Save as... Reload Settings Report

- ▶ Fusion Charts XT
- ▶ Widgets
- ▶ **Parameters** ← **30**
  - Simple Parameter
  - Custom Parameter
  - Date Parameter
- ▶ Selects
- ▶ Standard
- ▶ Charts
- ▶ Others
- ▶ Legacy
- ▶ Scripts
- ▶ Community Contributions

Components

Type	Name

Properties / Advanced Properties

Property	Value

↑ **29**

About Documentation

Properties / Advanced Properties

Property	Value
Name	Month
Property value	-
Bookmarkable	False
Public	False

File View Tools Help  
Opened ▾

Editing:Report ×

**CDE** New Save Save as... Reload Settings Report\*

- ▶ Fusion Charts XT
- ▶ Widgets
- ▼ Parameters
  - Simple Parameter ← **31**
  - Custom Parameter
  - Date Parameter
- ▶ Selects
- ▶ Standard
- ▶ Charts
- ▶ Others
- ▶ Legacy
- ▶ Scripts
- ▶ Community Contributions

Components

Type	Name
▼ Group	Parameters
Simple Parameter	Month

Properties / Advanced Properties

Property	Value
Name	Value
Property value	-
Bookmarkable	False
Public	False

CDE New Save Save as... Reload Settings Report \*

▸ Fusion Charts XT  
 ▸ Widgets  
 ▸ Parameters  
**▾ Selects** 32

- Filter Component
- Date Range Input Component
- Date Input Component
- Autocomplete Component
- Radiobutton Component
- Check Component
- Select Component** 33
- Multiple Select Component
- Simple Autocomplete Component

▸ Standard  
 ▸ Charts  
 ▸ Others  
 ▸ Legacy

About Documentation

**Components**

Type	Name
Group	Parameters
Simple Parameter	Month
Simple Parameter	Value

Report \*

**Components**

Type	Name
Group	Parameters
Simple Parameter	Month
Simple Parameter	Value
Group	Selects
<b>Select Component</b>	<b>SelectMonth</b>

**Properties / Advanced Properties**

Property	Value
Name	SelectMonth
Parameter	Month
Listeners	["Month", "Value"]
Parameters	{}
jQuery Plugin	-
Value as id	True
Datasource	Month
Values array	{}
HtmlObject	Spacer

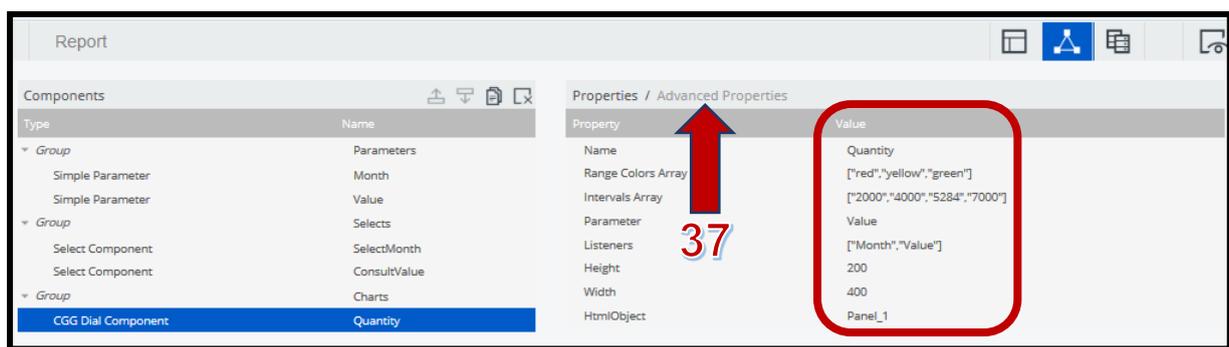
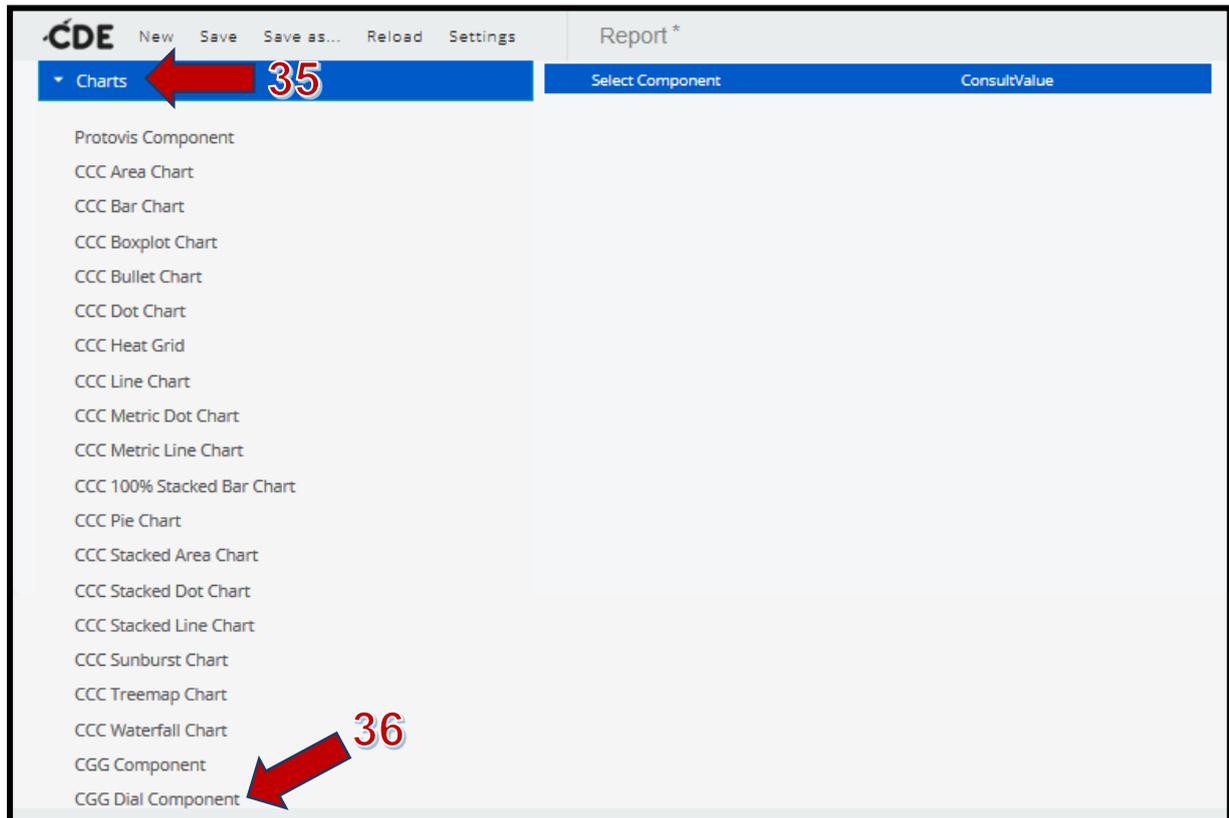
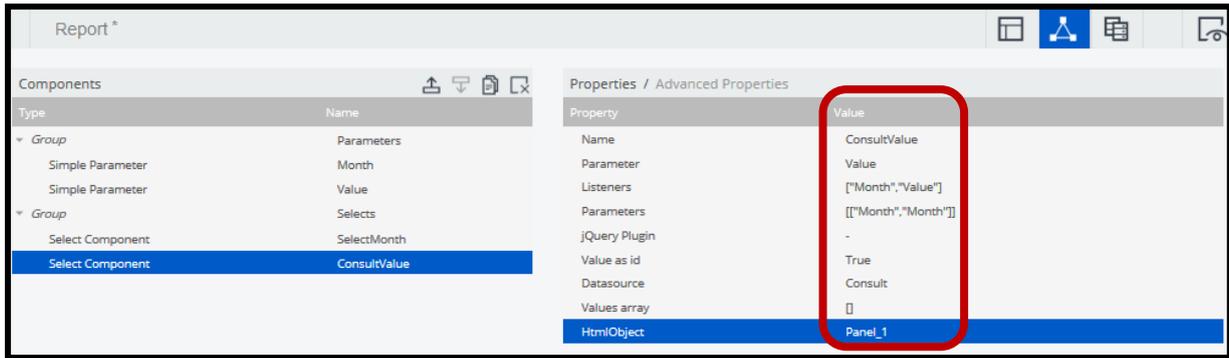
CDE New Save Save as... Reload Settings Report \*

▸ Fusion Charts XT  
 ▸ Widgets  
 ▸ Parameters  
**▾ Selects**

- Filter Component
- Date Range Input Component
- Date Input Component
- Autocomplete Component
- Radiobutton Component
- Check Component
- Select Component** 34
- Multiple Select Component
- Simple Autocomplete Component

**Components**

Type	Name
Group	Parameters
Simple Parameter	Month
Simple Parameter	Value
Group	Selects
<b>Select Component</b>	<b>SelectMonth</b>



Once the CDE Dashboard has been created, it is filled with different elements such as template (steps 10-17), data source or SQL queries (steps 18-28), components like parameters and charts (steps 29-40). Data source and components of this first part are related to the Dial Component.

Properties / Advanced Properties

Property	Value
Name	Quantity
Range Colors Array	["red","yellow","green"]
Intervals Array	["2000","4000","5284","7000"]
Parameter	Value
Listeners	["Month","Value"]
Height	200
<b>Priority</b>	<b>3</b>
Width	400
HtmlObject	Panel_1
Execute at start	True
Pre Execution	...
Post Execution	...

Report\*

Components

Type	Name
Group	Parameters
Simple Parameter	Month
Simple Parameter	Value
Group	Selects
Select Component	SelectMonth
<b>Select Component</b>	<b>ConsultValue</b>
Group	Charts
CGG Dial Component	Quantity

Properties / Advanced Properties

Property	Value
Name	ConsultValue
Parameter	Value
Listeners	["Month","Value"]
Parameters	[["Month","Month"]]
jQuery Plugin	-
Value as id	True
Datasource	Consult
Values array	["Month","Month"]
Priority	<b>4</b>
Refresh Period	-
HtmlObject	Panel_1
Execute at start	True
Pre Execution	...
Post Execution	...
Post Fetch	...
Pre Change	...
Post Change	...
Extra Options	["Month","Month"]
Tooltip	...

CDE New Save Save as... Reload Settings Report\*

Layout Structure

Type	Name
Row	Header
<b>Row</b>	<b>Spacer</b>
Row	Body
Column	Body_Content
Row	Row_1
Column	Panel_1
Column	Panel_2
Row	Spacer_2
Row	Row_2
Row	Small_Space
Row	Footer
Column	Footer_Image
Html	

Properties

Property	Value
Name	Spacer
Height	30
BackgroundColor	...
Corners	...
Text Align	Simple
Css Class	Center

Layout Structure

Type	Name
Row	Header
Column	Html
Row	Spacer
Body	Body_Content
Row	Row_1
Column	Panel_1
Column	Panel_2
Row	Spacer_2
Row	Row_2
Row	Small_Space
Row	Footer
Column	Footer_Image

Properties

Property	Value
Name	Panel_1
Extra Small Devices	6
Small Devices	-
Medium Devices	-
Large Devices	-
Bootstrap Css Class	-
Height	195
BackgroundColor	<input type="text"/>
Corners	Round
Text Align	Center
Css Class	-

Layout Structure

Type	Name
Row	Header
Column	Html
Row	Spacer
Body	Body_Content
Row	Row_1
Column	Panel_1
Column	Panel_2
Row	Spacer_2
Row	Row_2
Column	Panel_3
Column	Panel_4
Row	Small_Space
Row	Footer

Properties

Property	Value
Name	-
HTML	<h2 style="color:#FF...";>
Font Size	-
Color	<input type="text"/>
Css Class	-

Edit

1 <h2 style="color:#FFFFFF;";>Steel Italy S.P.A.</h2>

Ok Cancel

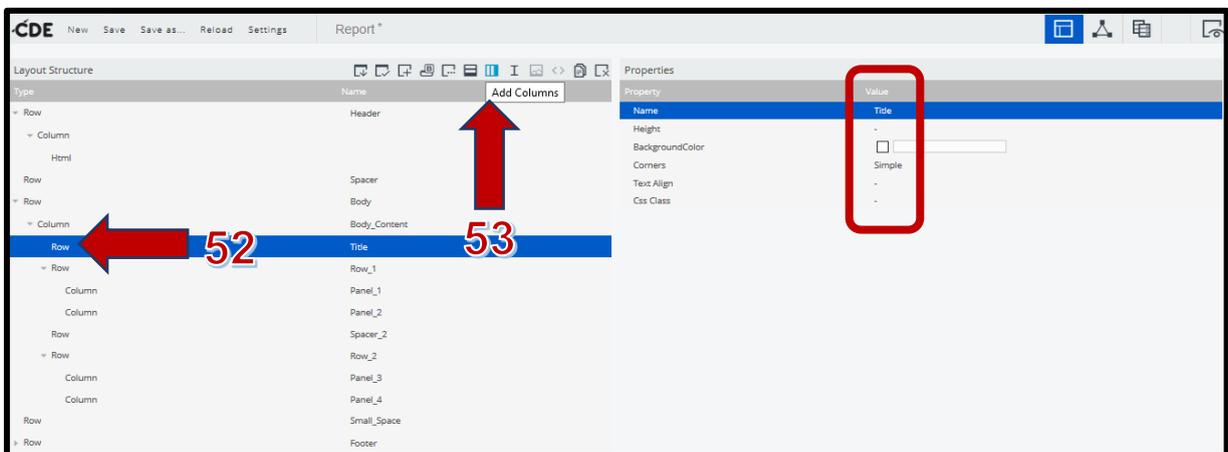
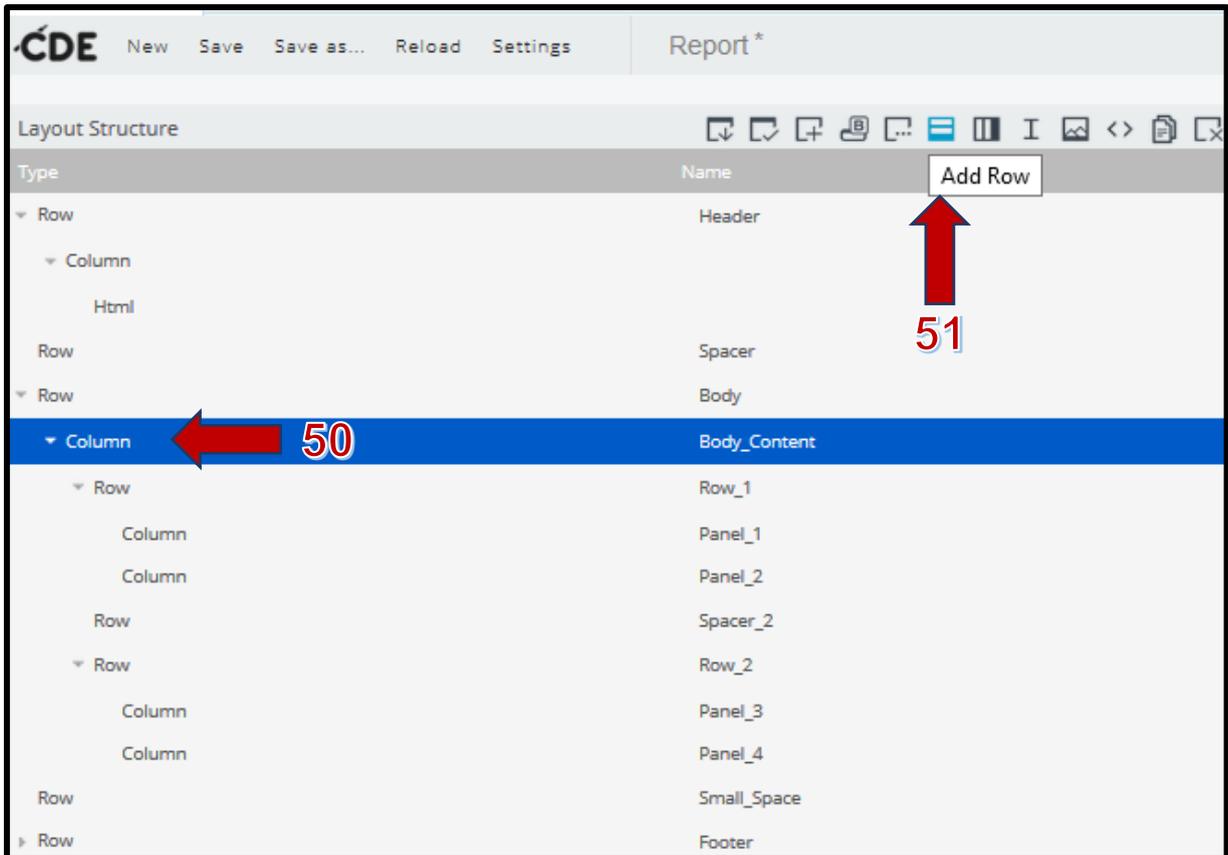
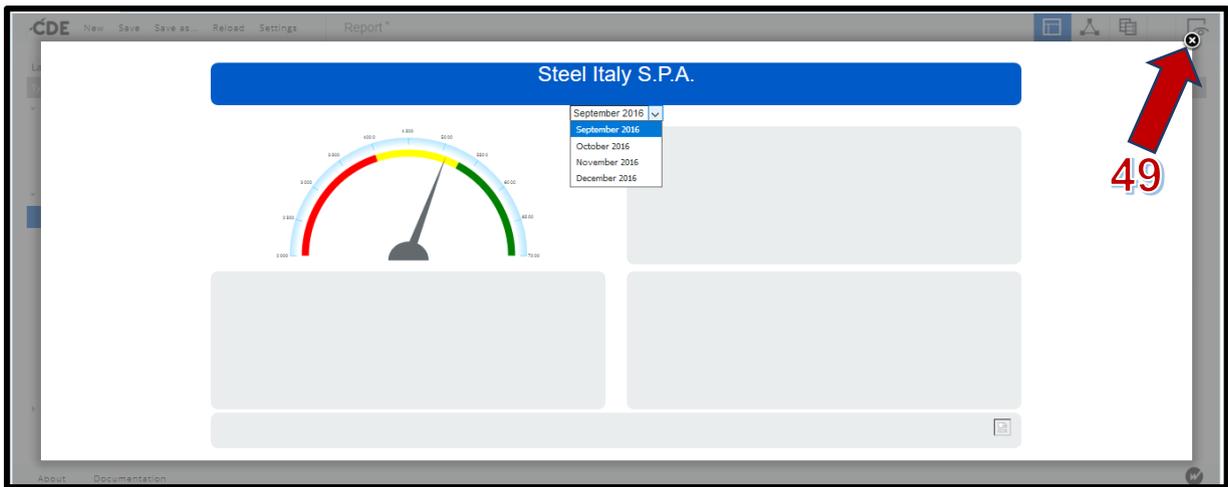
CDE New Save Save as... Reload Settings Report

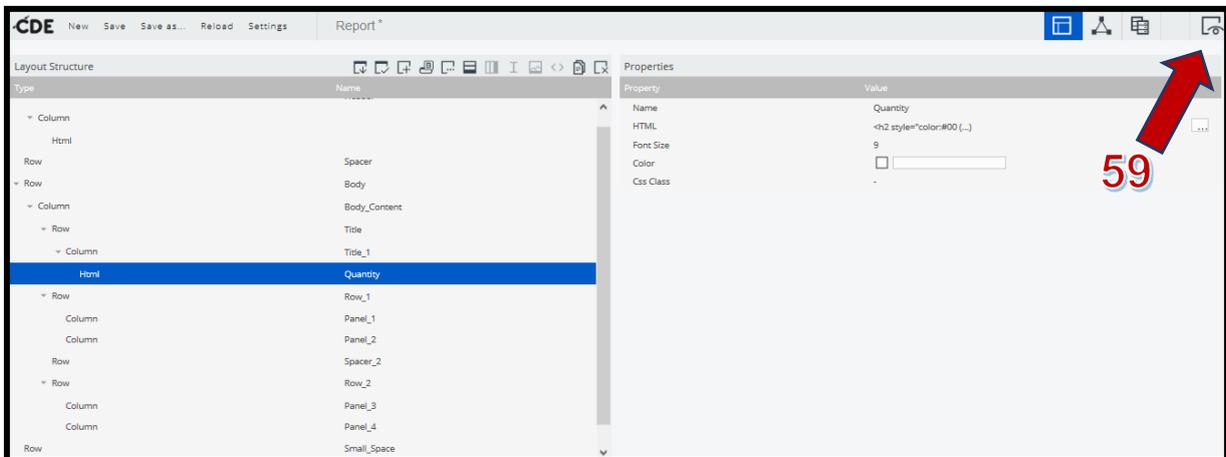
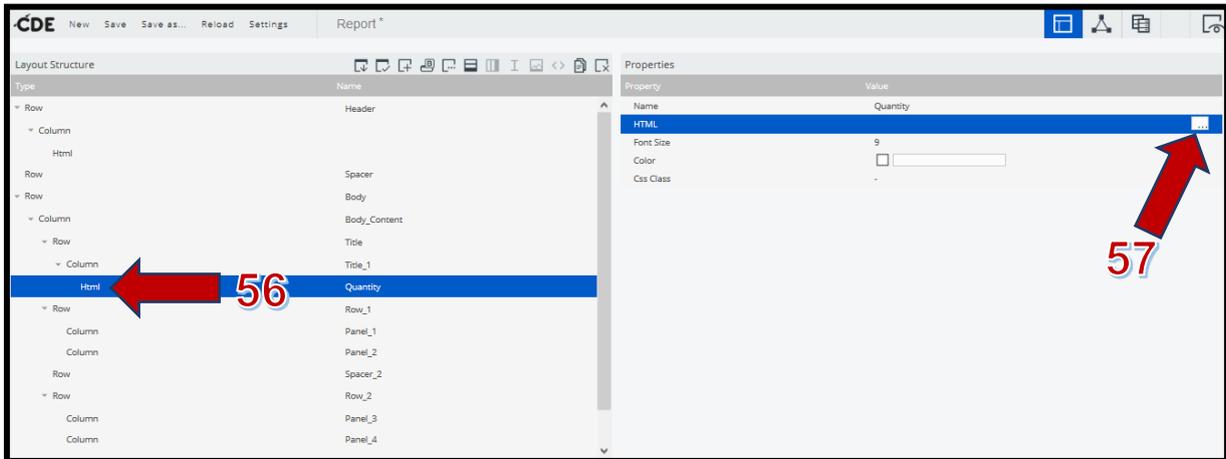
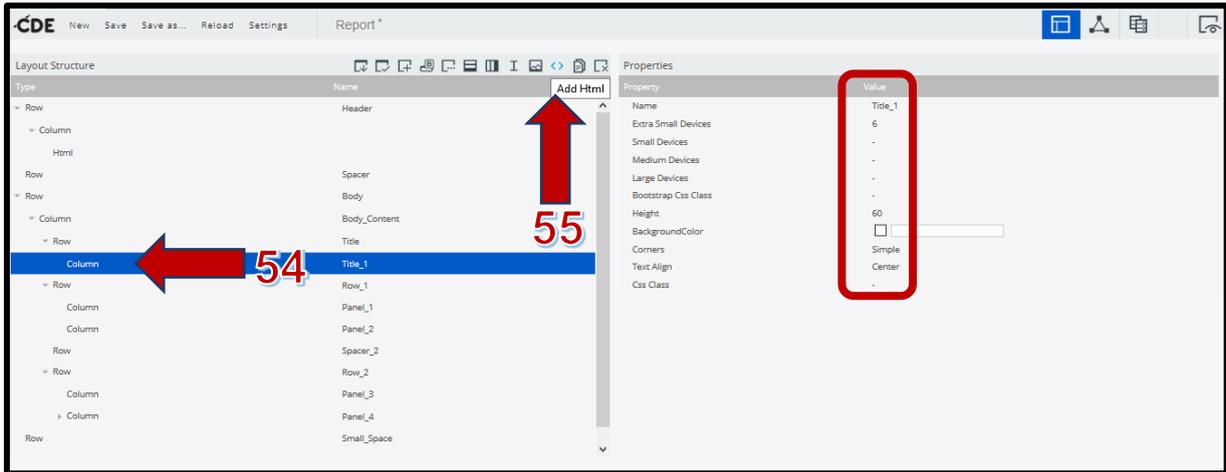
Layout Structure

Type	Name
Row	Header
Column	Html
Row	Spacer
Body	Body_Content
Row	Row_1
Column	Panel_1
Column	Panel_2
Row	Spacer_2
Row	Row_2
Column	Panel_3
Column	Panel_4
Row	Small_Space
Row	Footer

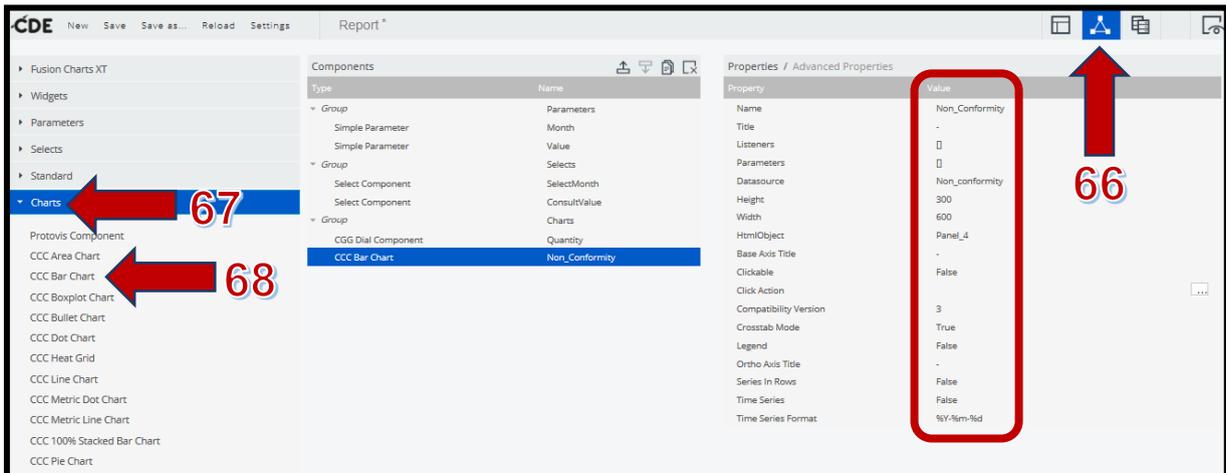
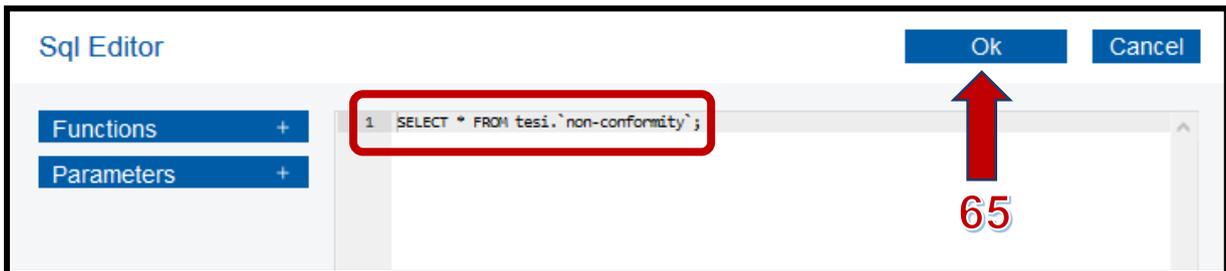
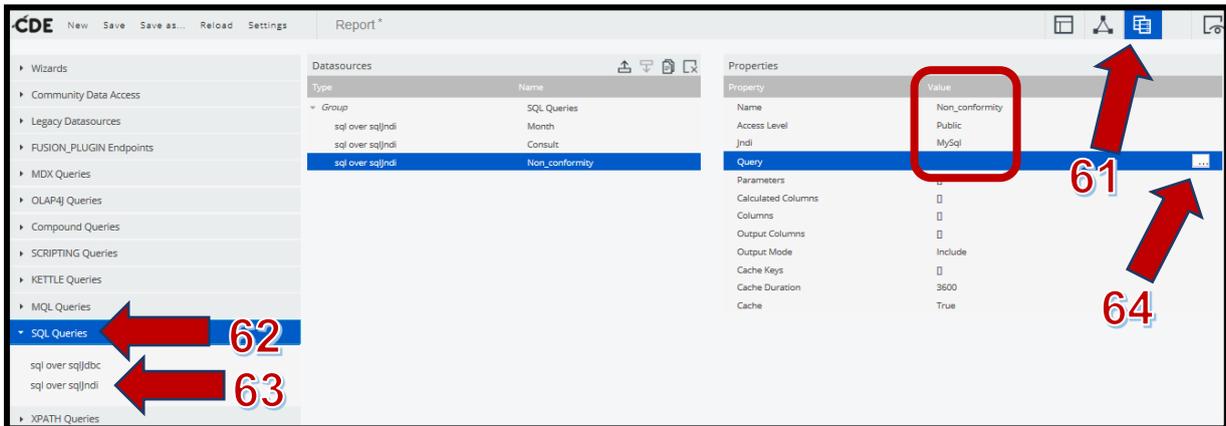
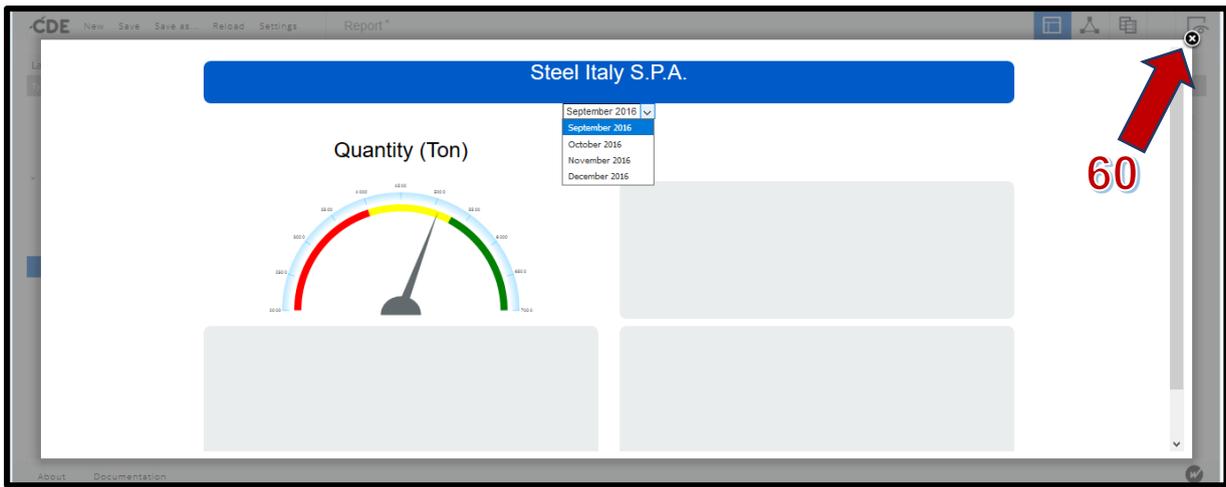
Properties

Property	Value
Name	-
HTML	<h2 style="color:#FF...";>
Font Size	-
Color	<input type="text"/>
Css Class	-





The Steps 41-59 describe the template configuration with details for each panel.



Next steps will describe the creation of Bar Chart elements, such as data source (steps 60-64), components (steps 65-67), template configuration (steps 68-84).

CDE New Save Save as... Reload Settings Report\*

Layout Structure

Type	Name
Row	Header
Row	Spacer
Row	Body
Column	Body_Content
Row	Title
Row	Row_1
Column	Panel_1
Column	Panel_2
Row	Spacer_2
Row	Row_2
Column	Panel_3
Column	Panel_4
Row	Small_Space
Row	Footer
Column	Footer_Image

Properties

Property	Value
Name	Panel_4
Extra Small Devices	6
Small Devices	-
Medium Devices	-
Large Devices	-
Bootstrap Cxs Class	-
Height	300
BackgroundColor	<input type="checkbox"/>
Corners	Round
Text Align	Center
Css Class	-

69

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CDE New Save Save as... Reload Settings Report\*

Layout Structure

Type	Name
Row	Header
Row	Spacer
Row	Body
Column	Body_Content
Row	Title
Column	Title_1
Html	Quantity
Row	Row_1
Column	Panel_1
Column	Panel_2
Row	Spacer_2
Row	Row_2
Column	Panel_3
Column	Panel_4
Row	Small_Space
Row	Footer
Column	Footer_Image

Properties

Property	Value
Name	Spacer_2
Height	10
BackgroundColor	<input type="checkbox"/>
Corners	Simple
Text Align	-
Css Class	-

71

72

Add Row

CDE New Save Save as... Reload Settings Report\*

Layout Structure

Type	Name
Row	Header
Row	Spacer
Row	Body
Column	Body_Content
Row	Title
Column	Title_1
Html	Quantity
Row	Row_1
Column	Panel_1
Column	Panel_2
Row	Spacer_2
Row	Title_2
Row	Row_2
Column	Panel_3
Column	Panel_4
Row	Small_Space
Row	Footer
Column	Footer_Image

Properties

Property	Value
Name	Title_2
Height	-
BackgroundColor	<input type="checkbox"/>
Corners	Simple
Text Align	-
Css Class	-

73

Add Columns

CDE New Save Save as... Reload Settings Report\*

Layout Structure

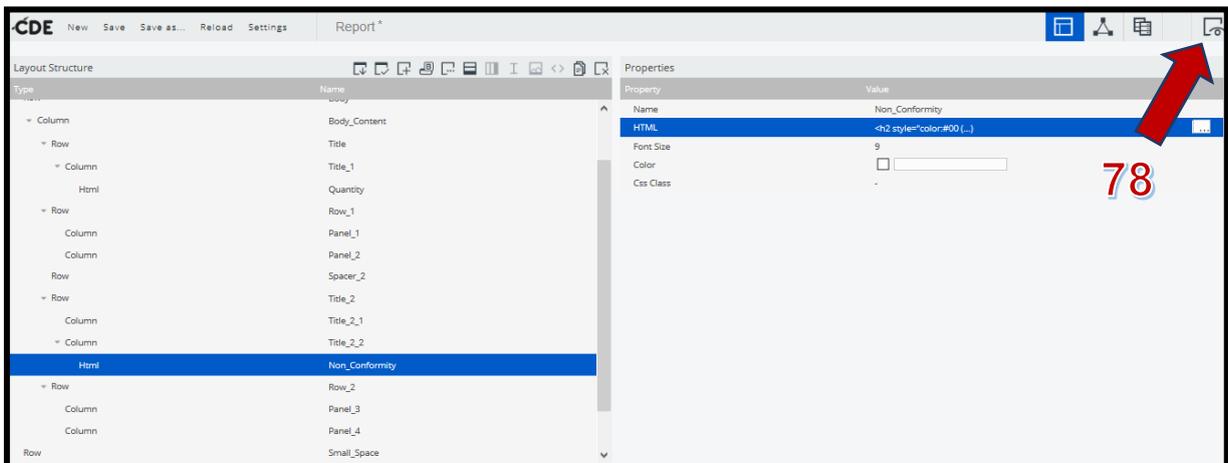
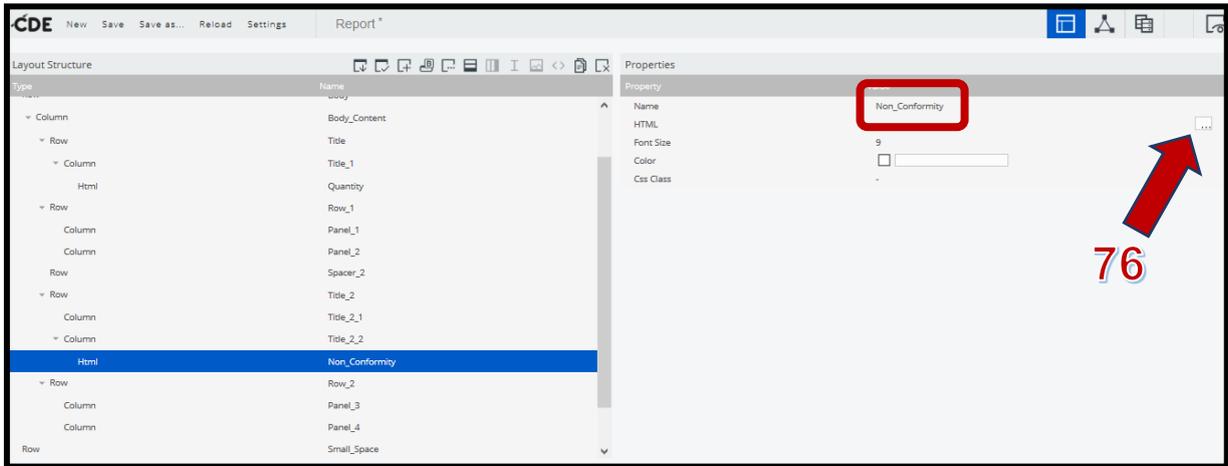
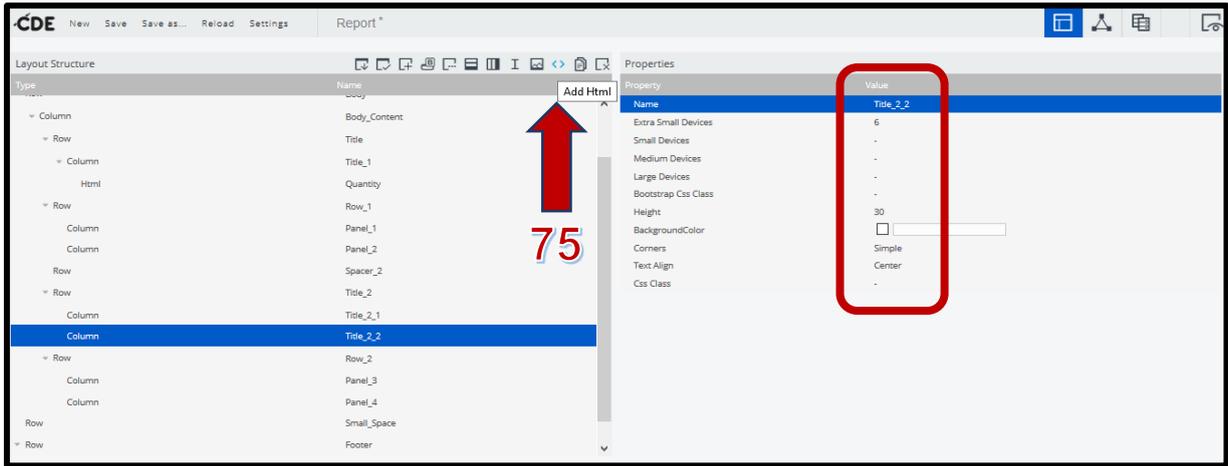
Type	Name
Row	Header
Row	Spacer
Row	Body
Column	Body_Content
Row	Title
Column	Title_1
Html	Quantity
Row	Row_1
Column	Panel_1
Column	Panel_2
Row	Spacer_2
Row	Title_2
Column	Title_2_1
Row	Row_2
Column	Panel_3
Column	Panel_4
Row	Small_Space
Row	Footer
Column	Footer_Image

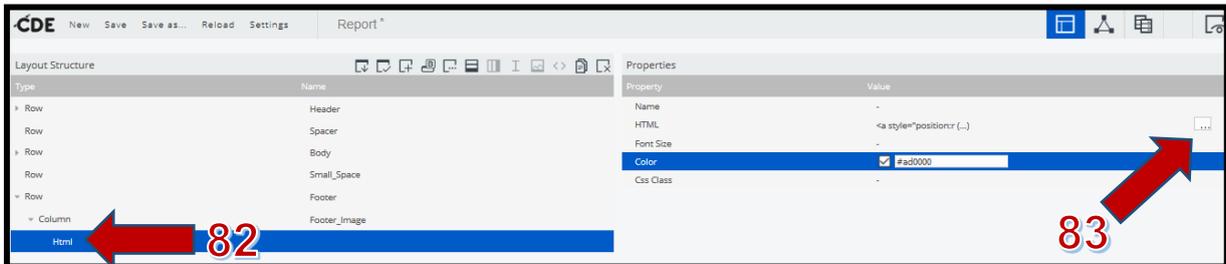
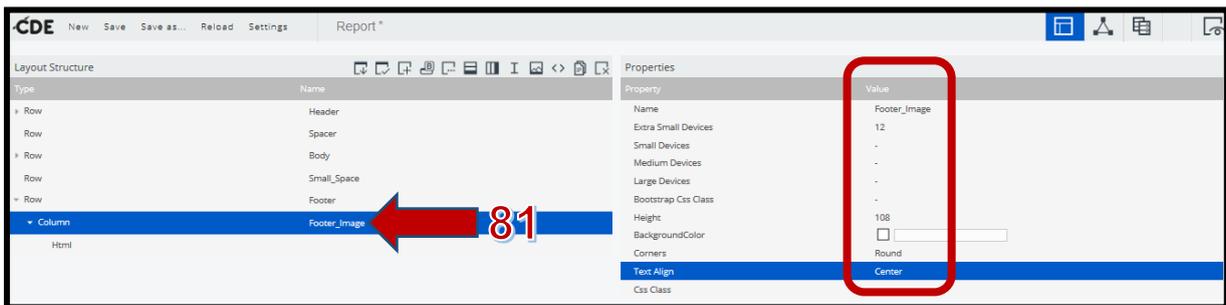
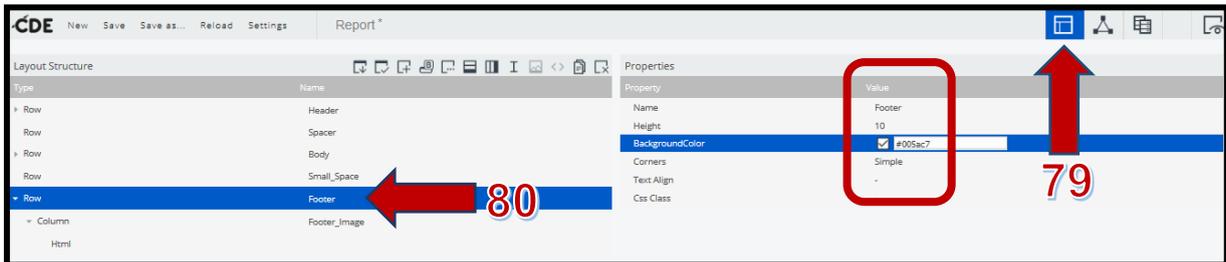
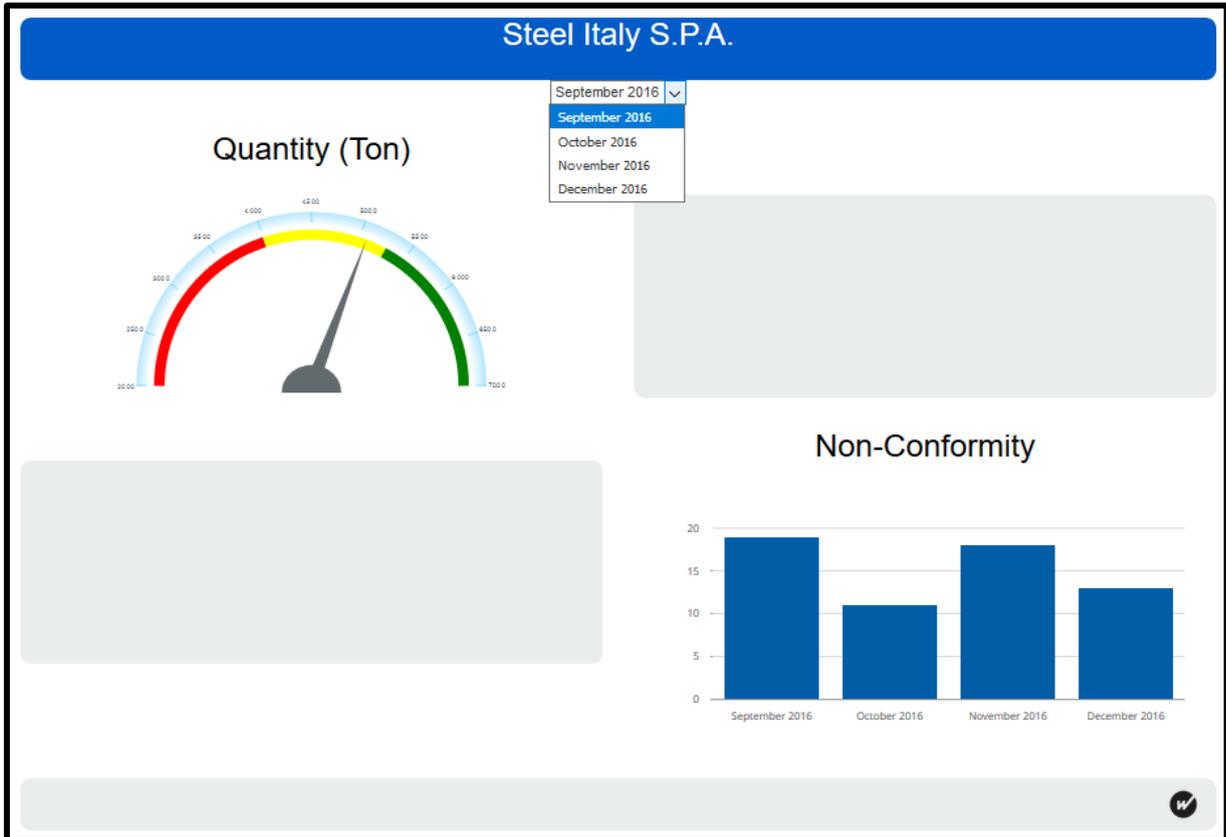
Properties

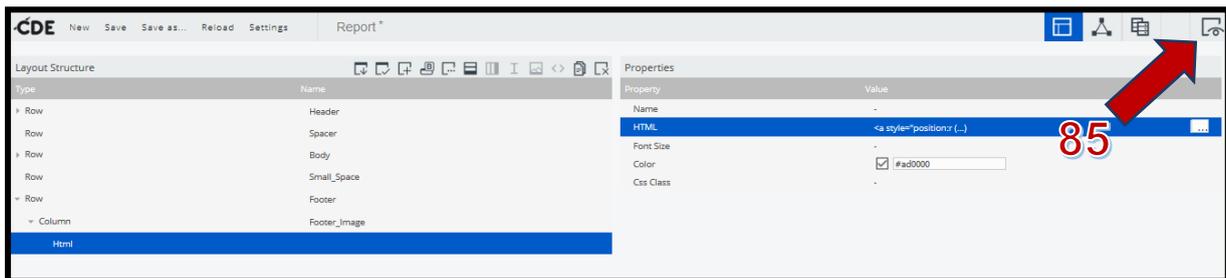
Property	Value
Name	Title_2_1
Extra Small Devices	6
Small Devices	-
Medium Devices	-
Large Devices	-
Bootstrap Cxs Class	-
Height	30
BackgroundColor	<input type="checkbox"/>
Corners	Simple
Text Align	Center
Css Class	-

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Add Columns



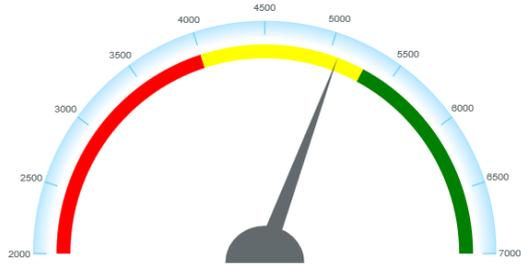




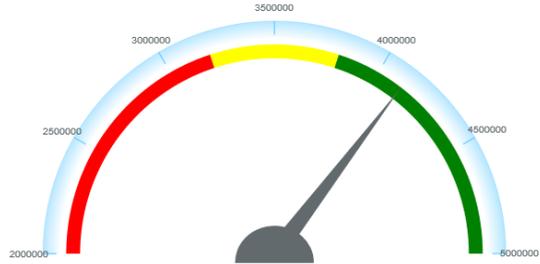
Some charts have been skipped in the guide because the procedure needed to create them is the same as that described in the previous pages. The final result of the Performance Dashboard will be depicted in the picture of the next page.

September 2016

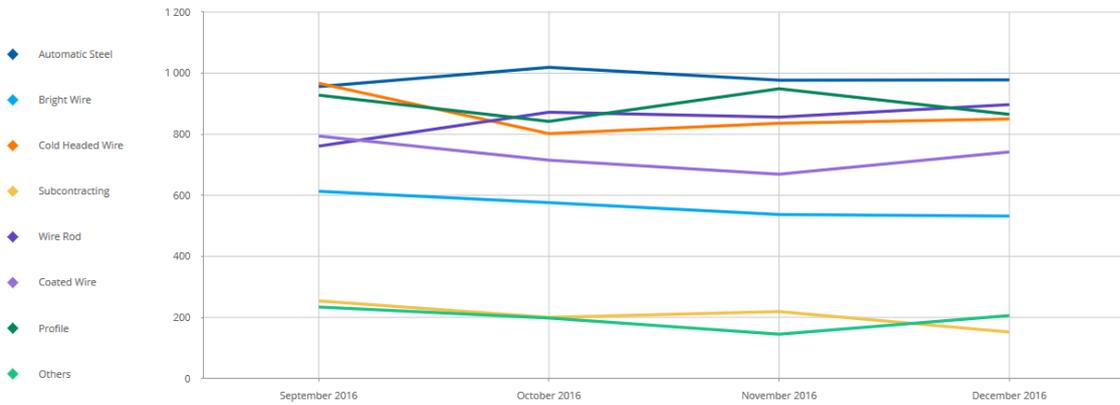
Quantity (Ton)



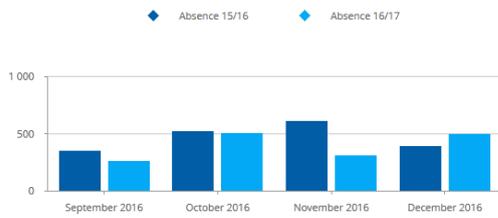
Turnover (€)



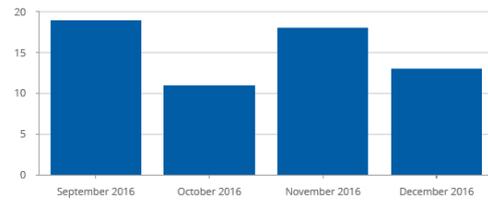
Price (€/Ton)



Absence (H)



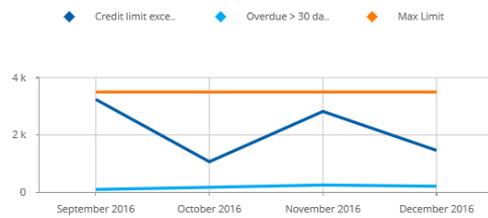
Non-Conformity



Injuries (H)



Credit Limit (€)



The process used to create the other type of charts is almost the same. The main differences are two, i.e. the type of chart selected in components and the SQL queries.

For the Dial Component chart, named Turnover (€) the following query was used:

```
SELECT `sales`.`Total_1`  
FROM `tesi`.`quantity`  
Inner Join `tesi`.`sales` on `quantity`.`Month`=`sales`.`Sales`  
WHERE Month=${Month};
```

For the Line chart, named Price (€/Ton) the following query was used:

```
SELECT `price`.`Product`,  
`price`.`Automatic Steel`,  
`price`.`Bright Wire`,  
`price`.`Cold Headed Wire`,  
`price`.`Subcontracting`,  
`price`.`Wire Rod`,  
`price`.`Coated Wire`,  
`price`.`Profile`,  
`price`.`Others`  
FROM `tesi`.`price`;
```

For the Bar chart, named Absence (H) the following query was used:

```
SELECT * FROM tesi.absence;
```

For the Line chart, named Injuries (H) the following query was used:

```
SELECT * FROM tesi.injuries;
```

For the Line chart, named Credit Limit (€) the following query was used

```
SELECT * FROM tesi.creditlimit;
```

## REFERENCES

- Carlo Vercellis, Business Intelligence: Data Mining and Optimization for Decision Making, Wiley, 2009,
- Charnes A., Cooper W., Rhodes E., *Measuring the efficiency of decision making units*, European Journal of Operational Research, 1978
- Cherkassky V., Mulier F., *Learning from data, concepts, theory and methods*, Wiley, 1998
- Cindi Howson, Alan D. Duncan, *ITScore Overview for BI and Analytics*, Gartner, 2015
- Clemen R., *Making Hard Decisions: An Introduction to Decision Analysis*, Duxbury Press, 1997
- Davenport T., Harris J., *Competing on Analytics: The New Science of Winning*, Harvard Business School Press, 2007.
- David Parmenter, Key performance indicators: developing, implementing, and using winning KPIs, Published by John Wiley & Sons, third edition, 2015
- Hans Peter Luhn, *A Business Intelligence System*, IBM Journal of Research and Development, 1958
- Howard Dresner, *Wisdom of Crowds® Business Intelligence Market Study*, Dresner Advisory Services, LLC, 2017 Edition
- Keen P., Scott Morton M., *Decision support systems: an organizational perspective*, Addison-Wesley, 1978
- Kohavi R., John G., *Artificial Intelligence*. Wrappers for feature subset selection, 1997
- Kudyba S., Hoptroff R., *Data Mining and Business Intelligence: A Guide to Productivity*, Idea Group, 2001.
- Markus and Tanis, *The Enterprise System Experience From Adoption to Success*, 2000

Marshall B., McDonald D., Chen H., Chung W., *Ebizport: collecting and analysing business intelligence information*, Journal of the American Society for information Science and Technology, 2004

Nils Rasmussen, Claire Y. Chen, Manish Bansal, *Business Dashboards: A Visual Catalog for Design and Deployment*, John Wiley & Sons, 2009

Paige Baltzan, *Business Driven Technology*, McGraw Hill, seventh edition 2017

Roland Hoelscher, *Business intelligence platforms boost ERP*, Financial Executive, Vol 18 Issue 2, March/April 2002

Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, second edition, 2010

Wayne W. Eckerson, *Performance Dashboards: Measuring, Monitoring and Managing Your Business*, John Wiley and Sons, 2006

## WEBSITES

<http://digitalevolution.eiu.com/the-digital-transformation-agenda-2016>

<http://www.techeconomy.it>

<https://www.gartner.com/doc/3136418/itscore-overview-bi-analytics>

<https://www.gartner.com/newsroom/id/3612617>

<https://www.gartner.com/doc/reprints?id=1-3TYE0CD&ct=170221&st=sb>

<https://www.gartner.com/doc/3136418/itscore-overview-bi-analytics#a-1122147190>

<https://www.businessintelligencesoftware.co/bi-tools-market-share-2017.html>

<https://www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2018/>

<http://static.klipfolio.com/dresner-reports/dresner-wisdom-of-crowds-2017.pdf>

[http://www.mise.gov.it/images/stories/documenti/INDUSTRIA-40-NATIONAL%20PLAN\\_EN-def.pdf](http://www.mise.gov.it/images/stories/documenti/INDUSTRIA-40-NATIONAL%20PLAN_EN-def.pdf)

<https://bi-survey.com/business-intelligence-problems>

<http://barc-research.com/about-us/>

<https://www.forbes.com/sites/bernardmarr/2017/07/07/machine-learning-artificial-intelligence-and-the-future-of-accounting/#772f48ea2dd1>