Introduction:

Imagine that you are the sales manager for a large retail organization and that you were able, within some probability, to predict how much money each of your customers was going to spend and which products each was going to purchase over the next six months. Or, as the productivity manager, imagine that you could figure out which production teams within your organization build the highest quality products. Or imagine that, as the broker negotiating electricity generation and delivery contracts for a region of the country, you were able to predict with relative accuracy what the demand for electricity would be for the next 90 days.

Or imagine that you are in charge of managing your company's supply chain and that you could determine which of your vendors provides the highest-quality products the quickest. Or let's say you are the customer retention manager for a credit card company and you can identify customers about to cut up their credit card a month before they do so. I am sure you would agree that each of these people is in an enviable position, because each has special knowledge about a business situation that conveys some business advantage. These are just a few examples of the kind of knowledge that can be exposed and exploited through the use of business intelligence (BI).

Why Business Intelligence?

Proper Business Intelligence can lead to:

- **Increased profitability**—For example, according to financial consultants, in a typical retail bank portfolio, 20% of the accounts contribute profits equaling 200% of the overall return, whereas more than half of the accounts generate losses. Business intelligence can help business clients to evaluate customer lifetime value and short-term profitability expectations and to use this knowledge to distinguish between profitable and nonprofitable customers.

- **Decreased costs**—Whether it is improved logistics management, lowered operational costs (such as decreased warehousing and delivery costs), or a decreasing of the investments required to make sales, BI can be used to help evaluate organizational costs.

Why Business Intelligence?

Proper Business Intelligence can lead to:

- **Improved customer relationship management (CRM)**—This is basically a BI application that applies the analysis of aggregated customer information to provide improved customer service responsiveness, to discover cross-sell and up-sell opportunities, and to increase overall customer loyalty.

- **Decreased risk**—Applying BI methods to credit data can improve credit risk analysis, whereas analyzing both supplier and consumer activity and reliability can provide insight into how to streamline the supply chain.

Why Business Intelligence?

In a company you can ask simple questions like

- How many customers do you have?

- For each product, how many were sold over the last 12 months?

- Who are your 20 best customers?

- What is the value of any particular customer?

- Who are your 20 best suppliers?

Why Business Intelligence?

here: Starting a well-conceived and comprehensive BI practice will not just provide the physical tools for answering these kinds of questions, but, more importantly, should be a catalyst for a change in the way we think about doing business and about how we can use information within that new way of thinking.

For example, before we can determine who the 20 best customers are, we must be able to articulate the difference between a "good" and a "bad" customer, as well as be able to identify a collection of metrics used to measure goodness, what data sets need to be collected for measurement, establish and integrate the methods for collecting and aggregating the data used for measuring, establish the processes required for conducting the measurement, ensure the quality of that data so as to not draw faulty conclusions, package the results into a reasonable report, and find a method to quickly and effectively disseminate the results of this process. Although a lot of this process may be automated using off-the-shelf technology, the most important part (i.e., asking the right question) needs input from individuals with expertise and a stake in the result.

The Information

Although a significant amount of money has been invested in attempts at building and launching BI frameworks and applications, most of that money has been spent in infrastructure, whereas very little has been invested in managing and exploiting a valuable corporate asset—a company's data. In fact, the concept of business intelligence is so poorly defined that a manager's expectations are set based on what that manager is told by the last software tool vendor. Because of lack of focus or the absence of clear success criteria, many data warehousing implementations have been delayed or scrapped altogether because the actual BI implementations deliver far short of their expectations.

On the other hand, there are a number of organizations that have started to view their data as a corporate asset and to realize that properly collecting, aggregating, and analyzing their data opens an opportunity to discover bits of knowledge that can both improve operational processing and provide better

Exploiting Information
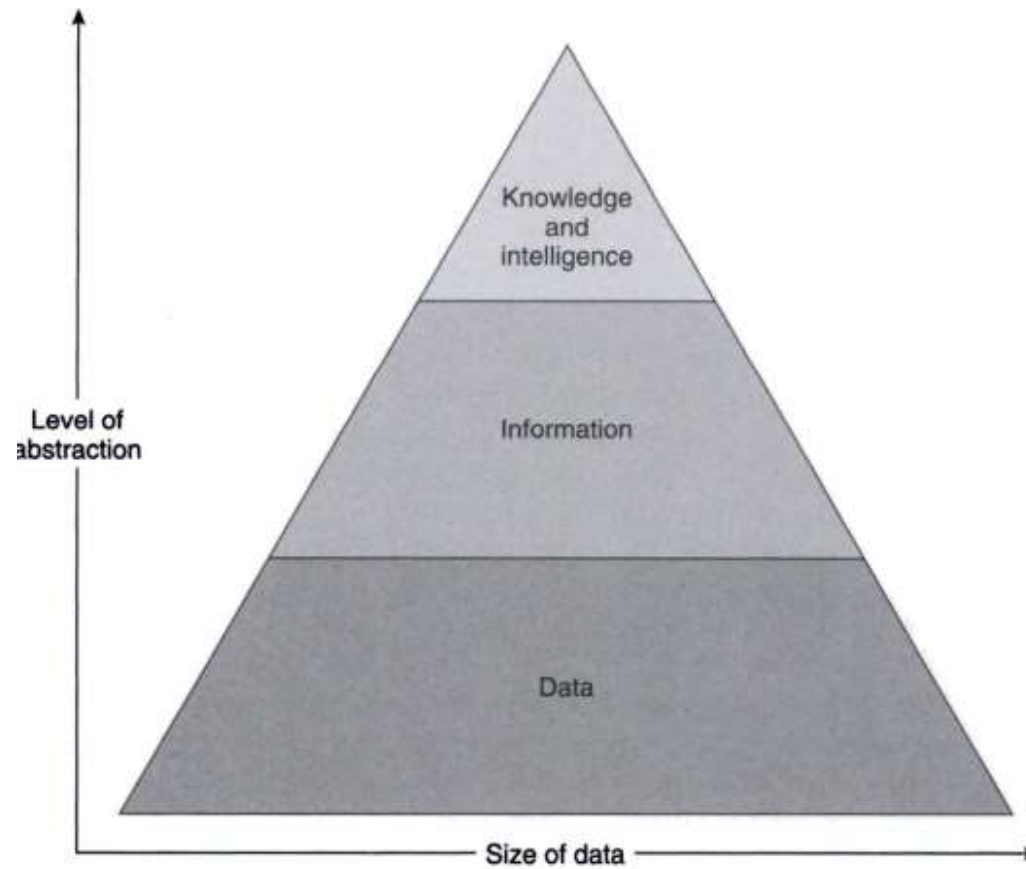
Pyramid of Abstraction

Business Intelligence and Program Success

Looking at companies that have started data warehousing projects or have purchased large-scale data mining software suites, we see high expectations and many disappointments related to the failure in the way that data warehouse projects are conceived, designed, architected, managed, and implemented, for any, if not all, of these reasons:

- The amorphous understanding of what BI methods and products could do resulted in an absence of a proper value proposition on behalf of the business sponsor.

- The scope of the project was not fully understood, causing delays in delivering to the business sponsor.

- Insufficient technical training prevented developers from getting software products to do what the vendors said they do.

- Poor understanding of technology infrastructure led to poor planning and scheduling.

- Business users were unable to trust results due to poor data quality.

- The lack of a clear statement of success criteria, along with a lack of ways to measure program success, led to a perception of failure.

Effective and timely decisions

- In complex organizations, public or private, **decisions are made on a continual basis**.

- The ability of these *knowledge workers* to make decisions, both as individuals and as a community, is one of the primary factors that influence the **performance and competitive strength** of a given organization.

- require a more rigorous **attitude based on analytical methodologies and mathematical models**

- **Retention in the mobile phone industry** o **low customer loyalty**, also known as customer *attrition* or *churn* o **rely on a budget adequate** to pursue a customer retention

  o **choosing those customers** to be contacted so as **to optimize** the **effectiveness** of the campaign

  o **target the best group of customers** and thus reduce churning and maximize customer retention

- The main purpose of business intelligence systems is to provide knowledge workers with tools and methodologies that allow them to make *effective* and *timely* decisions.

Effective and timely decisions

- decisions may be more or less critical, have long- or short-term effects and involve people and roles at various hierarchical levels.
- The ability of these knowledge workers to make decisions, both as individuals and as a community, is one of the primary factors that influence the performance and competitive strength of a given organization.
- his approach leads to a stagnant decision-making style which is inappropriate for the unstable conditions determined by frequent and rapid changes in the economic environment.

Effective and timely decisions

- Example 1.1 – Retention in the mobile phone industry. The marketing manager of a mobile phone company realizes that a large number of customers are discontinuing their service, leaving her company in favor of some competing provider. As can be imagined, low customer loyalty, also known as customer attrition or churn, is a critical factor for many companies operating in service industries. Suppose that the marketing manager can rely on a budget adequate to pursue a customer retention campaign aimed at 2000 individuals out of a total customer base of 2 million people. Hence, the question naturally arises of how she should go about choosing those customers to be contacted so as to optimize the effectiveness of the campaign. In other words, how can the probability that each single customer will discontinue the service be estimated so as to target the best group of customers and thus reduce churning and maximize customer retention? By knowing these probabilities, the target group can be chosen as the 2000 people having the highest churn likelihood among the customers of high business value.

Effective and timely decisions

- **Example 1.2 – Logistics planning. The logistics manager of a manufacturing company wishes to develop a medium-term logistic-production plan. This is a decision-making process of high complexity which includes, among other choices, the allocation of the demand originating from different market areas to the production sites, the procurement of raw materials and purchased parts from suppliers, the production planning of the plants and the distribution of end products to market areas. In a typical manufacturing company this could well entail tens of facilities, hundreds of suppliers, and thousands of finished goods and components, over a time span of one year divided into weeks. The magnitude and complexity of the problem suggest that advanced optimization models are required to devise the best logistic plan. As we will see in Chapter 14, optimization models allow highly complex and large-scale problems to be tackled Successfully within a business intelligence framework.**

Effective and timely decisions

Effective decisions.

- The application of rigorous analytical methods allows decision makers to rely on information and knowledge which are more dependable.
- As a result, they are able to make better decisions and devise action plans that allow their objectives to be reached in a more effective way. Indeed, turning to formal analytical methods forces decision makers to explicitly describe both the criteria for evaluating alternative choices and the mechanisms regulating the problem under investigation.
- Furthermore, the ensuing in-depth examination and thought lead to a deeper awareness and comprehension of the underlying logic of the decision-making process.

Effective and timely decisions

Timely decisions:

- **Enterprises operate in economic environments characterized by growing levels of competition and high dynamism. As a consequence, the ability to rapidly react to the actions of competitors and to new market conditions is a critical factor in the success or even the survival of a company.**

Effective and timely decisions

Data, information and knowledge:

As observed above, a vast amount of data has been accumulated within the information systems of public and private organizations. These data originate partly from internal transactions of an administrative, logistical and commercial nature and partly from external sources. However, even if they have been gathered and stored in a systematic and structured way, these data cannot be used directly for decision-making purposes. They need to be processed by means of appropriate extraction tools and analytical methods capable of transforming them into information and knowledge that can be subsequently used by decision makers. The difference between data, information and knowledge can be better understood through the following remarks

Effective and timely decisions

Data:

Generally, data represent a structured codification of single primary entities, as well as of transactions involving two or more primary entities. For example, for a retailer data refer to primary entities such as customers, points of sale and items, while sales receipts represent the commercial transactions.

Effective and timely decisions

Information:

Information is the outcome of extraction and processing activities carried out on data, and it appears meaningful for those who receive it in a specific domain. For example, to the sales manager of a retail company, the proportion of sales receipts in the amount of over ¤100 per week, or the number of customers holding a loyalty card who have reduced by more than 50% the monthly amount spent in the last three months, represent meaningful pieces of information that can be extracted from raw stored data

Effective and timely decisions

Knowledge.:

Information is transformed into knowledge when it is used to make decisions and develop the corresponding actions. Therefore, we can think of knowledge as consisting of information put to work into a specific domain, enhanced by the experience and competence of decision makers in tackling and solving complex problems. For a retail company, a sales analysis may detect that a group of customers, living in an area where a competitor has recently opened a new point of sale, have reduced their usual amount of business.

Effective and timely decisions

Benefits of Business Intelligence Systems:
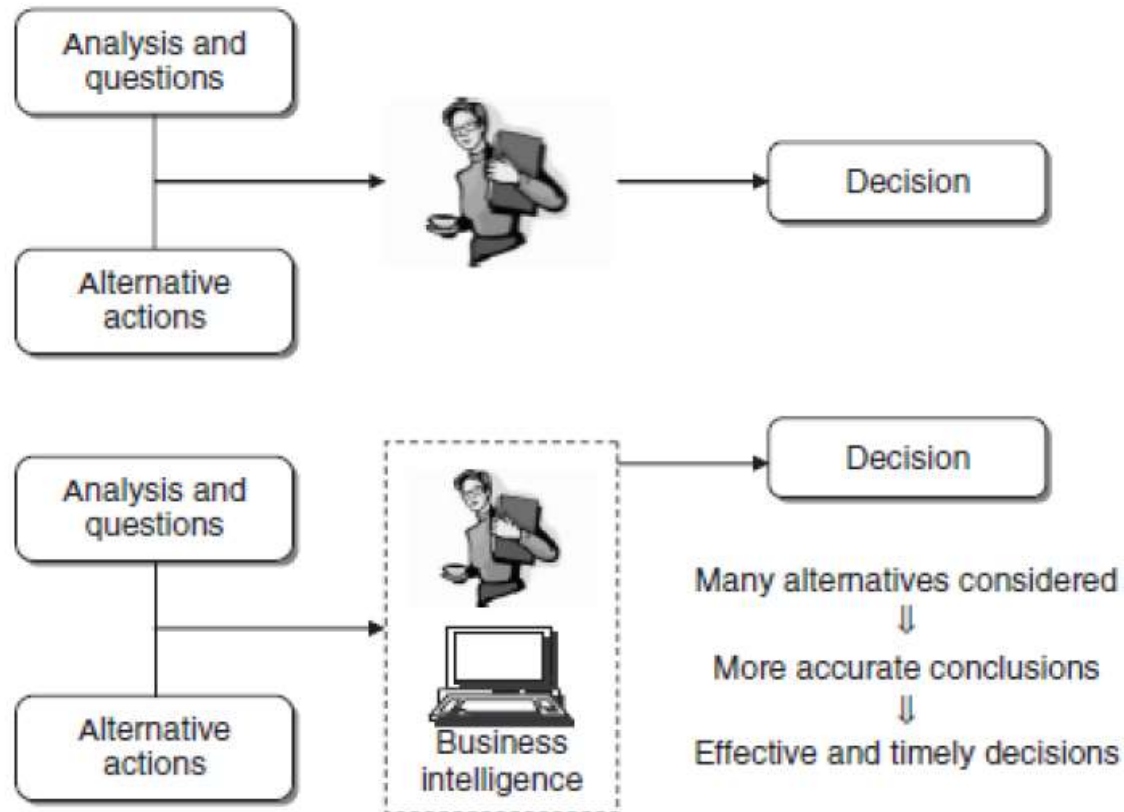
Figure 1.1 Benefits of a business intelligence system

Effective and timely decisions

Role of Mathematical Model in Business Intelligence:

The rational approach typical of a business intelligence analysis can be summarized schematically in the following main characteristics.

• First, the objectives of the analysis are identified and the performance indicators that will be used to evaluate alternative options are defined.

• Mathematical models are then developed by exploiting the relationships among system control variables, parameters and evaluation metrics.

• Finally, *what-if* analyses are carried out to evaluate the effects on the performance determined by variations in the control variables and changes in the parameters.

Effective and timely decisions

Role of Mathematical Model in Business Intelligence:

- Although their primary objective is to enhance the effectiveness of the decision making process, the adoption of mathematical models also affords other advantages, which can be appreciated particularly in the long term.

- First, the development of an abstract model forces decision makers to focus on the main features of the analyzed domain, thus inducing a deeper understanding of the phenomenon under investigation.

- Furthermore, the knowledge about the domain acquired when building a mathematical model can be more easily transferred in the long run to other individuals within the same organization, thus allowing a sharper preservation of knowledge in comparison to empirical decision-making processes.

- Finally, a mathematical model developed for a specific decision-making task is so general and flexible that in most cases it can be applied to other ensuing situations to solve problems of similar type

Effective and timely decisions

Business Intelligence Architecture: Includes three major components.

Data Sources: In a first stage, it is necessary to gather and integrate the data stored in the various primary and secondary sources, which are heterogeneous in origin and type. The sources consist for the most part of data belonging to operational systems, but may also include unstructured documents, such as emails and data received from external providers. Generally speaking, a major effort is required to unify and integrate the different data sources

Business Intelligence (Prof. Neil Joshi)

Effective and timely decisions

Business Intelligence Architecture: Includes three major components.

Data Warehouses and Data Marts: Using extraction and transformation tools known as extract, transform, load (ETL), the data originating from the different sources are stored in databases intended to support business intelligence analyses. These databases are usually referred to as data warehouses and data marts,

Effective and timely decisions

Business Intelligence Architecture: Includes three major components.

Business Intelligence Methodologies: Data are finally extracted and used to feed mathematical models and analysis methodologies intended to support decision makers. In a business intelligence system, several decision support applications may be implemented, most of which will be described in the following chapters:

- multidimensional cube analysis;
- exploratory data analysis;
- time series analysis;
- inductive learning models for data mining;
- optimization models.

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Effective and timely decisions

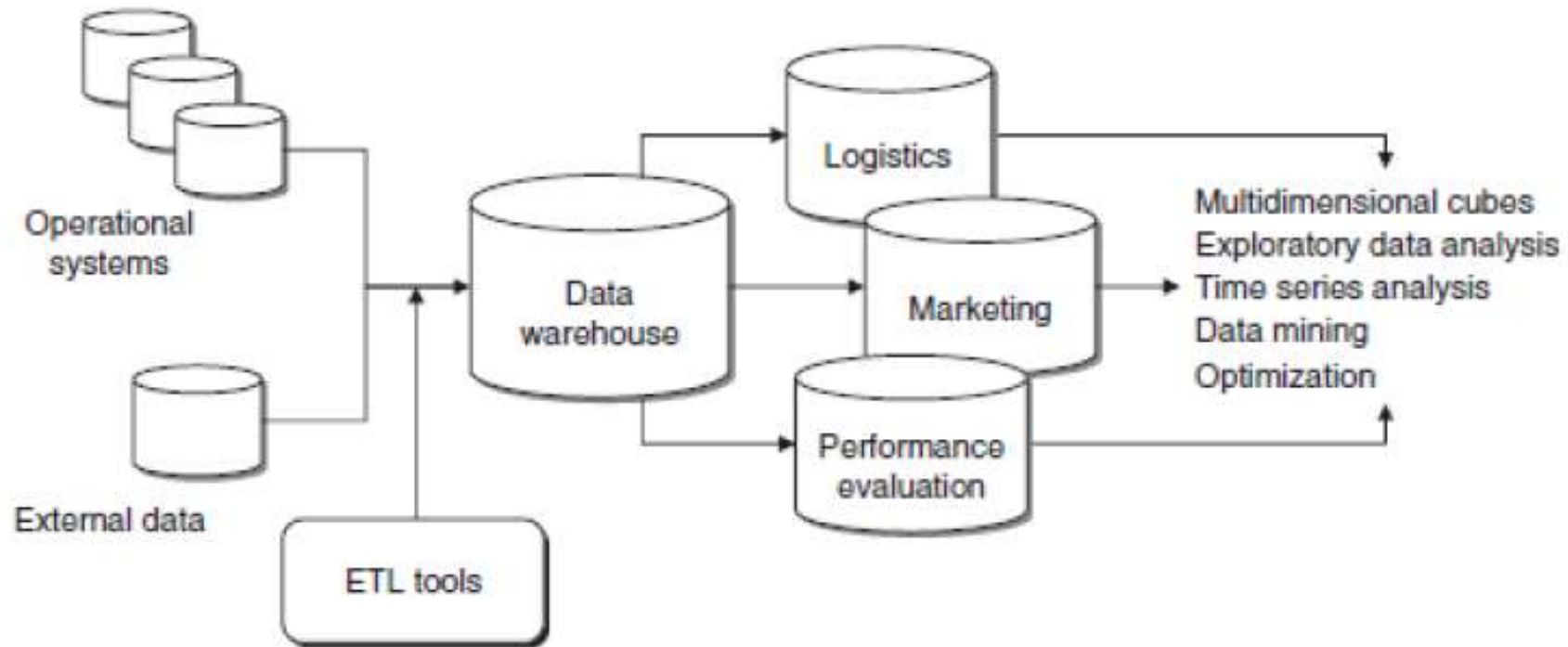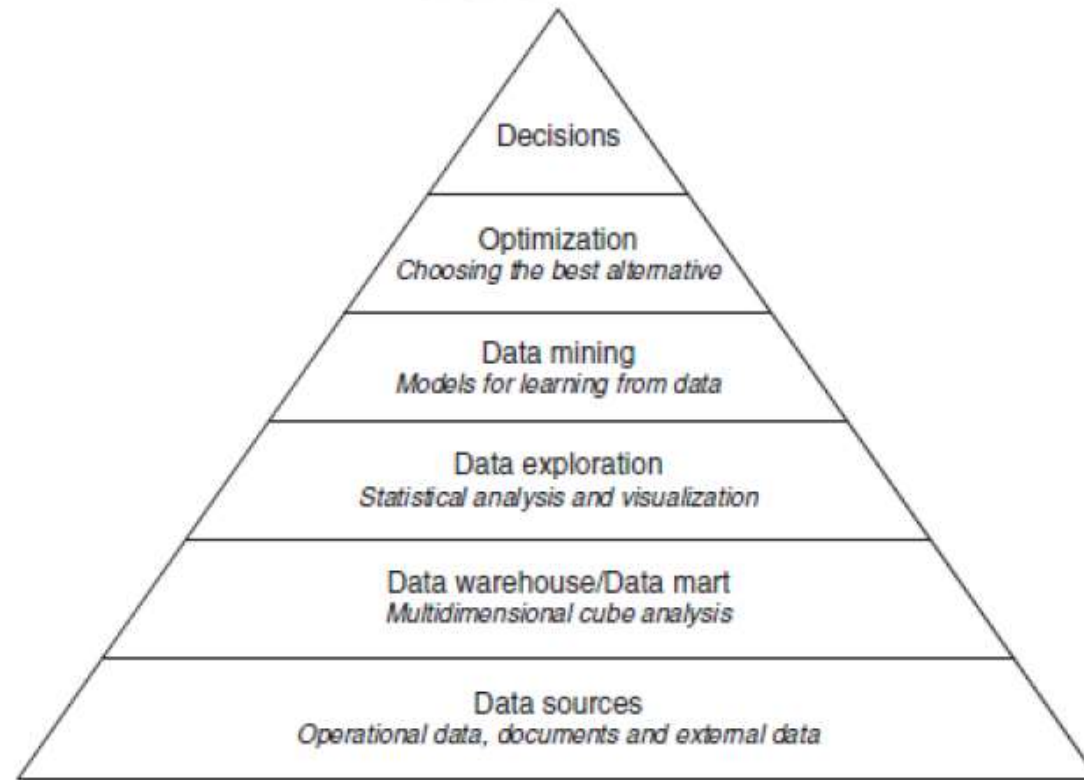**Business Intelligence Architecture:** Includes three major components.

Figure 1.2   A typical business intelligence architecture

Effective and timely decisions

Business Intelligence Architecture: Includes three major components.

Decisions

Optimization
Choosing the best alternative

Data mining
Models for learning from data

Data exploration
Statistical analysis and visualization

Data warehouse/Data mart
Multidimensional cube analysis

Data sources
Operational data, documents and external data

Figure 1.3   The main components of a business intelligence system

Effective and timely decisions

Business Intelligence Architecture:

Data Exploration: At the third level of the pyramid we find the tools for performing a *passive* business intelligence analysis, which consist of query and reporting systems, as well as statistical methods. These are referred to as passive methodologies because decision makers are requested to generate prior hypotheses or define data extraction criteria, and then use the analysis tools to find answers and confirm their original insight. For instance, consider the sales manager of a company who notices that revenues in a given geographic area have dropped for a specific group of customers. Hence, she might want to bear out her hypothesis by using extraction and visualization tools, and then apply a statistical test to verify that her conclusions are adequately supported by data.

Effective and timely decisions

Business Intelligence Architecture:

Data Mining:

- The fourth level includes *active* business intelligence methodologies, whose purpose is the extraction of information and knowledge from data.
- These include mathematical models for pattern recognition, machine learning and data mining techniques, which will be dealt with in Part II of this book.
- Unlike the tools described at the previous level of the pyramid, the models of an active kind do not require decision makers to formulate any prior hypothesis to be later verified.
- Their purpose is instead to expand the decision makers' knowledge.

Effective and timely decisions

Business Intelligence Architecture:

Optimization.

By moving up one level in the pyramid we find optimization models that allow us to determine the best solution out of a set of alternative actions, which is usually fairly extensive and sometimes even infinite.

Effective and timely decisions

Business Intelligence Architecture:

Optimization.

Finally, the top of the pyramid corresponds to the choice and the actual adoption of a specific decision, and in some way represents the natural conclusion of the decision-making process. Even when business intelligence methodologies are available and successfully adopted, the choice of a decision pertains to the decision makers, who may also take advantage of informal and unstructured information available to adapt and modify the recommendations
and the conclusions achieved through the use of mathematical models.

As we progress from the bottom to the top of the pyramid, business intelligence systems offer increasingly more advanced support tools of an active type. Even roles and competencies change. At the bottom, the required competencies are provided for the most part by the information systems specialists within the organization, usually referred to as *database administrators*. Analysts and experts in mathematical and statistical models are responsible for the intermediate phases. Finally, the activities of decision makers responsible for the application domain appear dominant at the top.

Effective and timely decisions

Business Intelligence Architecture:

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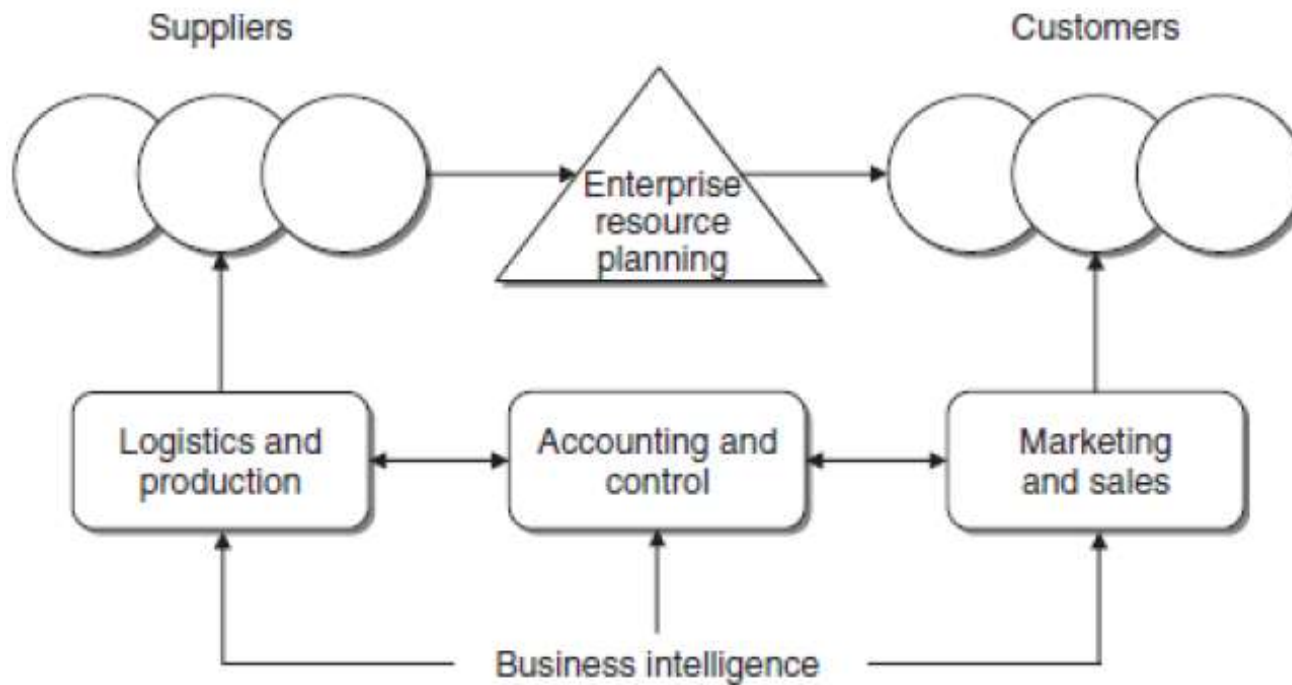# Effective and timely decisions

Cycles of Business Intelligence :

- Each business intelligence analysis follows its own path according to the application domain, the personal attitude of the decision makers and the available analytical methodologies.
- However, it is possible to identify an ideal cyclical path characterizing the evolution of a typical business intelligence analysis.

Effective and timely decisions

Cycles of Business Intelligence :

Departments of an enterprise concerned with business intelligence

Effective and timely decisions
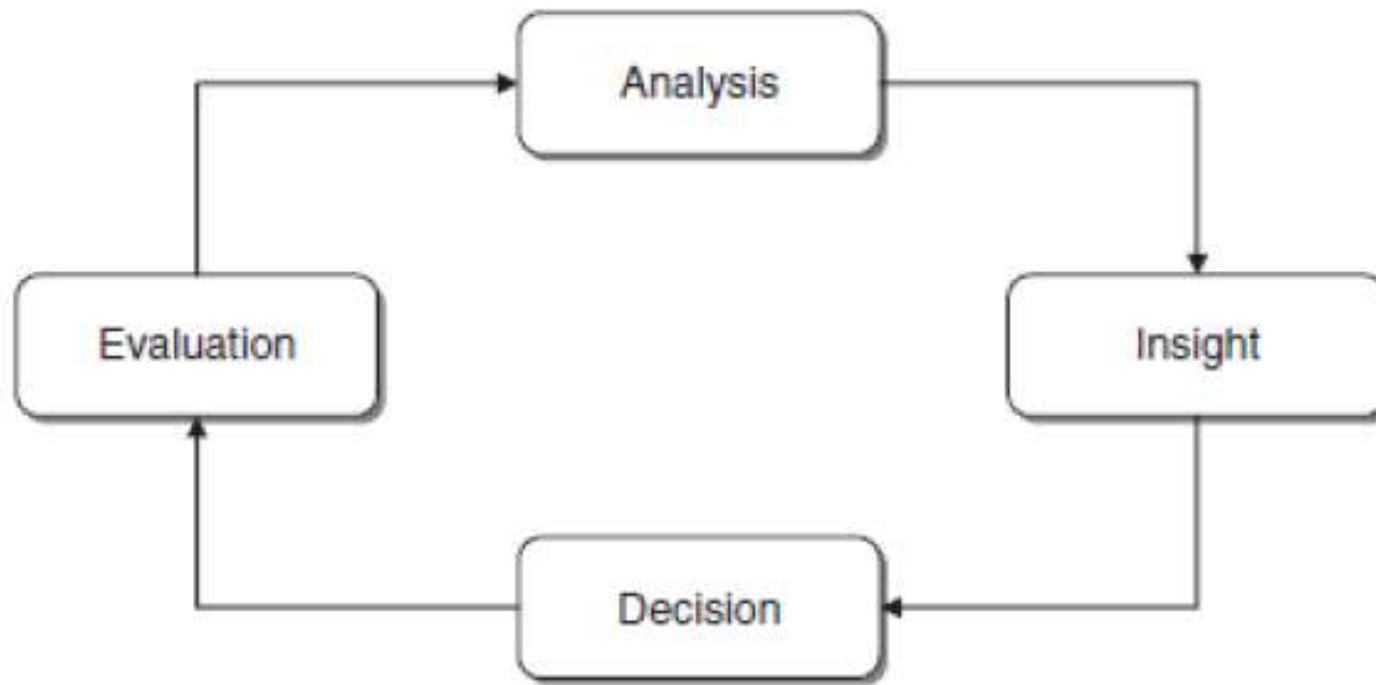
Cycles of Business Intelligence :

Cycle of a business intelligence analysis

Effective and timely decisions

Cycles of Business Intelligence :

Analysis:

- During the analysis phase, it is necessary to recognize and accurately spell out the problem at hand.
- Decision makers must then create a mental representation of the phenomenon being analyzed, by identifying the critical factors that are perceived as the most relevant.
- The availability of business intelligence methodologies may help already in this stage, by permitting decision makers to rapidly develop various paths of investigation.
- For instance, the exploration of data cubes in a multidimensional analysis, according to different logical views, allows decision makers to modify their hypotheses flexibly and rapidly, until they reach an interpretation scheme that they deem satisfactory.
- Thus, the first phase in the business intelligence cycle leads decision makers to ask several questions and to obtain quick responses in an interactive way.

Effective and timely decisions

Cycles of Business Intelligence :

Insight:

- The second phase allows decision makers to better and more deeply understand the problem at hand, often at a causal level.
- For instance, if the analysis carried out in the first phase shows that a large number of customers are discontinuing an insurance policy upon yearly expiration, in the second phase it will be necessary to identify the profile and characteristics shared by such customers.
- The information obtained through the analysis phase is then transformed into knowledge during the insight phase.
- On the one hand, the extraction of knowledge may occur due to the intuition of the decision makers and therefore be based on their experience and possibly on unstructured information available to them.
- On the other hand, inductive learning models may also prove very useful during this stage of analysis, particularly when applied to structured data.

Effective and timely decisions

Cycles of Business Intelligence :

Decision:

- During the third phase, knowledge obtained as a result of the insight phase is converted into decisions and subsequently into actions.

- The availability of business intelligence methodologies allows the analysis and insight phases to be executed more rapidly so that more effective and timely decisions can be made that better suit the strategic priorities of a given organization.

- This leads to an overall reduction in the execution time of the *analysis–decision–action–revision* cycle, and thus to a decision-making process of better quality.

Effective and timely decisions

Cycles of Business Intelligence :

Evaluation:

- Finally, the fourth phase of the business intelligence cycle involves performance measurement and evaluation.
- Extensive metrics should then be devised that are not exclusively limited to the financial aspects but also take into account the major performance indicators defined for the different company departments.

Effective and timely decisions

Enabling Factors in Business Intelligence Project :

Technology:

- Hardware and software technologies are significant enabling factors that have facilitated the development of business intelligence systems within enterprises and complex organizations.
- On the one hand, the computing capabilities of microprocessors have increased on average by 100% every 18 months during the last two decades, and prices have fallen.
- This trend has enabled the use of advanced algorithms which are required to employ inductive learning methods and optimization models, keeping the processing times within a reasonable range.

Effective and timely decisions

Enabling Factors in Business Intelligence Project :

Technology:

- Moreover, it permits the adoption of state-of-the-art graphical visualization techniques, featuring real-time animations.

- A further relevant enabling factor derives from the exponential increase in the capacity of mass storage devices, again at decreasing costs, enabling any organization to store terabytes of data for business intelligence systems. And network connectivity, in the form of *Extranets* or *Intranets*, has played a primary role in the diffusion within organizations of information and knowledge extracted from business intelligence systems.

Effective and timely decisions

Enabling Factors in Business Intelligence Project :

Analytics:

- mathematical models and analytical methodologies play a key role in information enhancement and knowledge extraction from the data available inside most organizations.
- The mere visualization of the data according to timely and flexible logical views,, plays a relevant role in facilitating the decision-making process, but still represents a passive form of support.
- Therefore, it is necessary to apply more advanced models of inductive learning and optimization in order to achieve active forms of support for the decision-making process.

Business Intelligence (Prof. Neil Joshi)

Effective and timely decisions

Enabling Factors in Business Intelligence Project :

Human Resource:

- The human assets of an organization are built up by the competencies of those who operate within its boundaries, whether as individuals or collectively.
- The overall knowledge possessed and shared by these individuals constitutes the *organizational culture*.
- The ability of knowledge workers to acquire information and then translate it into practical actions is one of the major assets of any organization, and has a major impact on the quality of the decision-making process.
- If a given enterprise has implemented an advanced business intelligence system, there still remains much scope to emphasize the personal skills of its knowledge workers, who are required to perform the analyses and to interpret the results, to work out creative solutions and to devise effective action plans.

Effective and timely decisions

Enabling Factors in Business Intelligence Project :
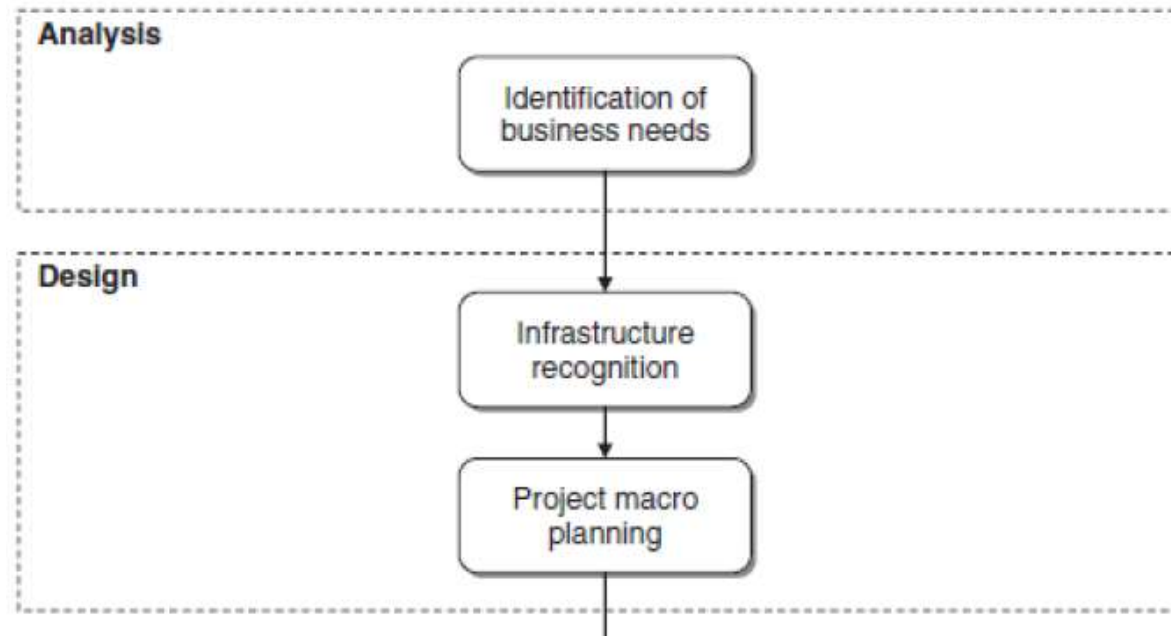
Human Resource:

- All the available analytical tools being equal, a company employing human resources endowed with a greater mental agility and willing to accept changes in the decision-making style will be at an advantage over its competitors.
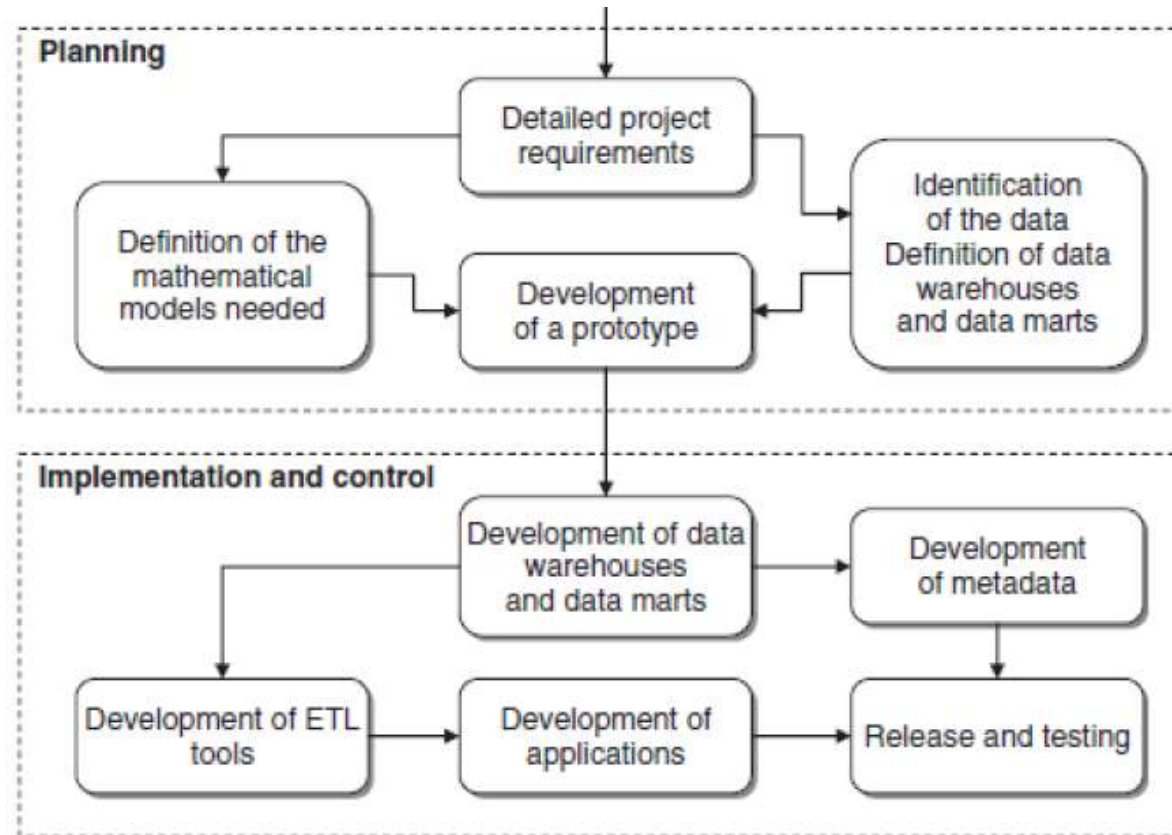
Development of a Business Intelligence System:

Development of a Business Intelligence System:

Phases in the development of a business intelligence system

Development of a Business Intelligence System:

Analysis:

- During the first phase, the needs of the organization relative to the development of a business intelligence system should be carefully identified.

- This preliminary phase is generally conducted through a series of interviews of knowledge workers performing different roles and activities within the organization.

- It is necessary to clearly describe the general objectives and priorities of the project, as well as to set out the costs and benefits deriving from the development of the business intelligence system.

Development of a Business Intelligence System:

Design:

- The second phase includes two sub-phases and is aimed at deriving a provisional plan of the overall architecture, taking into account any development in the near future and the evolution of the system in the mid term.
- First, it is necessary to make an assessment of the existing information infrastructures.
- Moreover, the main decision-making processes that are to be supported by the business intelligence system should be examined, in order to adequately determine the information requirements.
- Later on, using classical project management methodologies, the project plan will be laid down, identifying development phases, priorities, expected execution times and costs, together with the required roles and resources.

Development of a Business Intelligence System:

Planning:

- The planning stage includes a sub-phase where the functions of the business intelligence system are defined and described in greater detail.
- Subsequently, existing data as well as other data that might be retrieved externally are assessed.
- This allows the information structures of the business intelligence architecture, which consist of a central data warehouse and possibly some satellite data marts, to be designed.
- Simultaneously with the recognition of the available data, the mathematical models to be adopted should be defined, ensuring the availability of the data required to feed each model and verifying that the efficiency of the algorithms to be utilized will be adequate for the magnitude of the resulting problems.
- Finally, it is appropriate to create a system prototype, at low cost and with limited capabilities, in order to uncover beforehand any discrepancy between actual needs and project specifications.

Development of a Business Intelligence System:

## Implementation and control:

The last phase consists of five main sub-phases.

- First, the data warehouse and each specific data mart are developed. These represent the information infrastructures that will feed the business intelligence system. In order to explain the meaning of the data contained in the data warehouse and the transformations applied in advance to the primary data, a *metadata* archive should be created.

- Moreover, ETL procedures are set out to extract and transform the data existing in the primary sources, loading them into the data warehouse and the data marts.

- The next step is aimed at developing the core business intelligence applications that allow the planned analyses to be carried out.

- Finally, the system is released for test and usage.

Development of a Business Intelligence System:
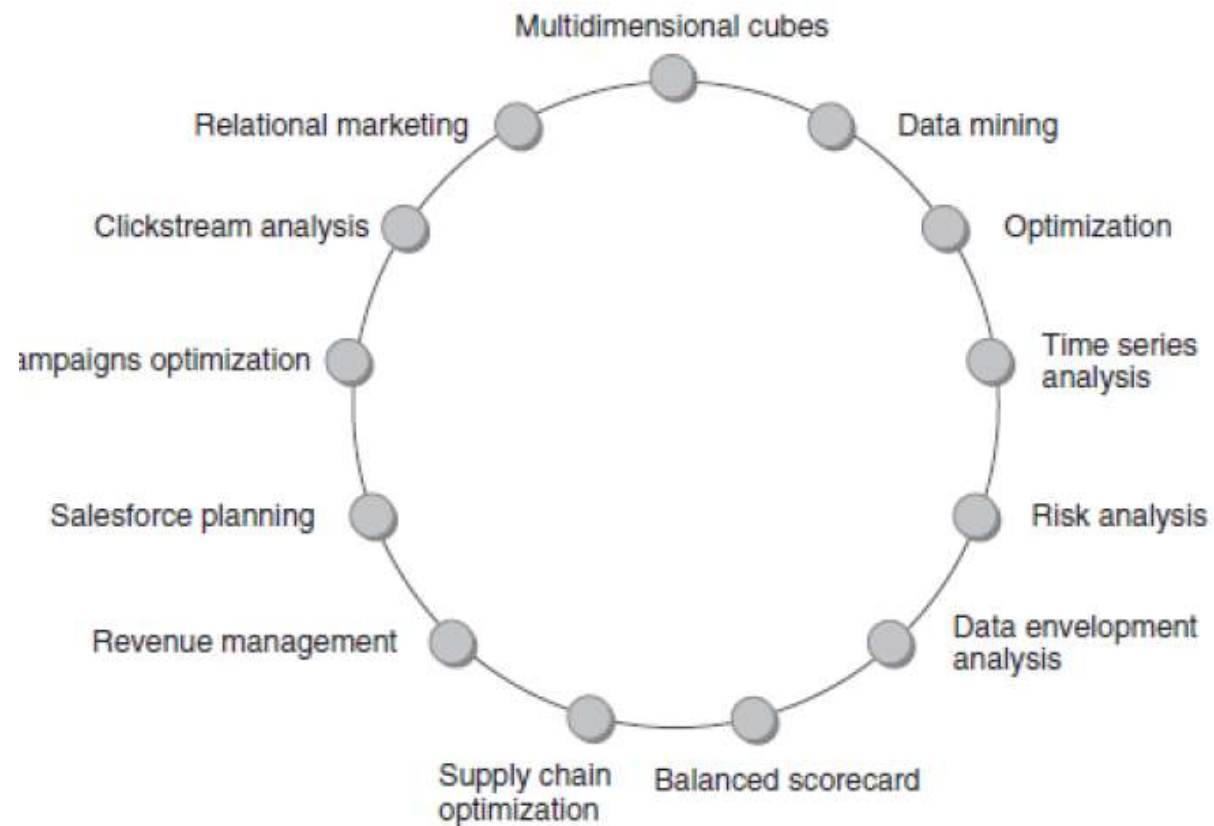
Portfolio of available methodologies in a business intelligence sys-

Ethics in Business Development System:

- The adoption of business intelligence methodologies, data mining methods and decision support systems raises some ethical problems that should not be overlooked.
- Indeed, the progress toward the information and knowledge society opens up countless opportunities, but may also generate distortions and risks which should be prevented and avoided by using adequate control rules and mechanisms. Usage of data by public and private organizations that is improper and does not respect the individuals' right to privacy should not be tolerated.
- More generally, we must guard against the excessive growth of the political and economic power of enterprises allowing the transformation processes outlined above to exclusively and unilaterally benefit such enterprises themselves, at the expense of consumers, workers and inhabitants of the Earth ecosystem.

Business Intelligence (Prof. Neil Joshi)

Ethics in Business Development System:

- However, even failing specific regulations that would prevent the abuse of data gathering and invasive investigations, it is essential that business intelligence analysts and decision makers abide by the ethical principle of respect for the personal rights of the individuals. For example, even if disguised under apparently inoffensive names such as 'data enrichment', private information on individuals and households does circulate, but that does not mean that it is ethical for decision makers and enterprises to use it.

Ethics in Business Development System:

Respect for the right to privacy is not the only ethical issue concerning the use of business intelligence systems. There has been much discussion in recent years of the social responsibilities of enterprises, leading to the introduction of the new concept of *stakeholders*. This term refers to anyone with any interest in the activities of a given enterprise, such as investors, employees, labor unions and civil society as a whole. There is a diversity of opinion on whether a company should pursue the short-term maximization of profits, acting exclusively in the interest of shareholders, or should instead adopt an approach that takes into account the social consequences of its decisions.

Ethics in Business Development System:

As this is not the right place to discuss a problem of such magnitude, we will confine ourselves to pointing out that analyses based on business intelligence systems are affected by this issue and therefore run the risk of being used to maximize profits even when different considerations should prevail related to the social consequences of the decisions made, according to a logic that we believe should be rejected. For example, is it right to develop an optimization model with the purpose of distributing costs on an international scale in order to circumvent the tax systems of certain countries? Is it legitimate to make a decision on the optimal position of the tank in a vehicle in order to minimize production costs, even if this may cause serious harm to the passengers in the event of a collision? As proven by these examples, analysts developing a mathematical model and those who make the decisions cannot remain neutral, but have the moral obligation to take an ethical stance.

Measurement of Central Tendency:

Central tendency is defined as "the statistical measure that identifies a single value as representative of an entire distribution."[2] It aims to provide an accurate description of the entire data. It is the single value that is most typical/representative of the collected data. The term "number crunching" is used to illustrate this aspect of data description. The mean, median and mode are the three commonly used measures of central tendency.

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