

Chapter 10

Amalgamation of Business Intelligence with Corporate Strategic Management



Adham Kahlawi

10.1 Introduction

In recent years, the volumes of data available to companies are growing, and new technologies in business analysis are developing; consequently, the use of business intelligence tools is increasing.

Business Intelligence (BI) [1] means all the processes and tools through which a company manages to collect data of different nature to analyse them and draw strategic decisions.

In fact, business intelligence tools become a daily habit for some people even without knowing that they use it [2]. For example, the person who manages his/her company's account in LinkedIn can apply different analyses using the data collected from the interaction between users and the company profile. At the same time, the person who has an admin role for a Facebook page has access to a number of analyses that enable him/her to know the geographical distribution of the users who liked this page; in addition, can study the diversity of their opinions based on the diversity of their interaction with the different posts on the page, and the person who manages a hotel has the information of his customers including the personal data, the historical record of services and products requested by customers, period time and duration of customer reservations, and much more. These data can help predict the new strategy used by the hotel management to prepare for the upcoming season, including activities such as advertising and logistical preparations.

One of the advantages of business intelligence tools is their simple design that allows being used even by non-specialist users and understood easily by decision makers [3]. This happens thanks to BI dashboards that make it easy to integrate

A. Kahlawi (✉)

Department of Statistics, Computer Science, Applications, University of Florence, Florence, Italy
e-mail: adham.kahlawi@unifi.it

different data sources, easy to understand performance indicators with diagrams and graphs. Consequently, the dashboards allow even those who non-specialist in data analysis to have an instant idea of each type of activity in a few seconds; furthermore, it helps to prepare the reports easily in the form of visual dashboards.

Therefore, we can say the advancement of BI tools such as business analytics [4] makes the companies able to use the data collected to make strategic decisions faster and more effectively.

Business intelligence shows the business context data to help decision makers decide better strategic management [5]. Performance benchmarking helps the decision makers to make the control of the company more efficient and more manageable. Moreover, it facilitates identifying market trends, aimed at increasing sales or revenues, and it can also prove useful in compliance procedures and hiring. With business intelligence, you can optimise any aspect of strategic management.

10.2 Strategic Management

Strategic management is the way of leading a company based on a strategy. The traditional strategic management model [6] implies the belief that it is possible to formulate and develop a successful strategy through a rational process.

Strategic management is an integrated system of operations and activities related to analysing the internal and external environment, formulating an appropriate strategy, applying it and evaluating it in light of analysing the impact of environmental variables on it to ensure achieving a competitive strategic advantage for the company.

Companies have four levels of strategy, which are:

First, the organisation's strategy [7]It focuses on describing the company's overall and overall direction in terms of growth trends and methods of managing multiple activities. This level's fundamental responsibility is thinking about take advantage of the company's strengths and mitigate the impact of weaknesses in making strategic management such as the activity's type that the company has to participate in, the integration of joint projects, change the type of activity, the liquidation of activity, the distribution of resources, the flow of financial and non-financial resources to and from departments, between the company and interest groups, the entry points that the company can benefit from it in order to enhance profits and other tasks. The upper management layer provides the occasion for strategic unit's heads and major activities heads to improve the company's strategic vision. Strategies at this level are long term and have a widespread impact on the company as a whole.

Second, business strategy [8]

The business strategy usually takes place at the departmental level and focuses on improving its products or services' competitive position. It is stipulated that these strategies are consistent with the overall strategy of the company. These strategies

attempt to give a high capacity for competition, innovation, market penetration, and opening new outlets for distribution. These strategies cover medium-term periods.

Third: the career strategy [9]

This strategy is drawn up planned by the business strategy and the overall strategy. This level identifies with the company's primary functions, such as production function, marketing strategy, finance plan, human resources manage, business administration function, and accounting departments. A manager responsible for one of these functional areas has to define the field's contribution to the implementation of the strategy. The strategies at this level are characterised by a short-term nature whose effect does not last for a long time.

Fourth, operational strategies [10]

Operational strategies are strategies for implementing career strategies. The issues here are urgent, fast, and require a robust, fast, and phased decision. The need for such a strategy appears due to the presence of emergency problems or tourist opportunities and does not bear the delay. Examples include the marketing strategies for facing specific threats from entering a new competitor, facing a promotional campaign, a deterioration in the quality of a commodity, a decrease in sales in a particular market, or a reduction in production in one of the production halls. The strategies in this part are strategies for implementing the project activities, representing quotidian behaviour or may cover a longer period but not more than 1 month.

The importance of strategic management can be summarised in the following points [11]. It improves the company's ability to deal with problems, makes the right decisions, reduces resistance to change, clarifies of future vision, achieves environmental interaction in the long term, strengthens the competitive position of the company, effective allocation of resources and capabilities; finally, it enhances performance and achieving satisfactory financial results.

10.3 The Role of Business Intelligence on Strategic Management Choices

Strategic management involves the formulation and implementation of the main objectives and initiatives taken by a top company's government [12], based on consideration of the resources and assessing the internal and external environments in which the company operates.

Strategic management is not static in nature; the feedback loop helps monitor the company objectives' execution and inform the next goals. Indeed, strategic management's dynamic nature provides the policies and plans to achieve its objectives, therefore allocating resources to implement the plans.

Determining strategic management has an important role; for instance, it helps to give your company a precise direction. It enables you to focus on where the business

needs to grow, increase teamwork effectiveness, and collaborate within the team to measure business progress. It helps in a variety of other things.

To evaluate a company's current position before deciding on a new strategy, the decision makers can apply different analysis types as SWOT analysis [13]. Decision makers can use SWOT analysis to make the most of what you have for your company's benefit [14]. You can reduce your chances of failure by understanding what is missing and eliminating the dangers that would otherwise catch you off guard.

SWOT stands for Strengths, Weaknesses, Opportunities, and Threats, which means.

Strengths: Internal factors are indicators used by the company to apply immediate monitoring on the company activities; thus, it positively affects the company's business.

Weaknesses: All businesses, even the best ones, have some weaknesses. The absence of essential resources to contend in the market is weakness factors that lead to a disadvantage compared to the market. The essential resources can be in various fields, such as special skills, advanced technologies, lack of funding, creative marketing strategy and communication channels, and the absence of innovation.

Opportunities: Represent external factors that allow the company to benefit from an opportunity to achieve more economic profits, gain a better market position, or acquire a competitive advantage if adequately exploited.

Threats: Represent external risks factors that the company is exposed by the effect of the surrounding environment. In addition, the company cannot potentially exercise direct control over these factors; thus, it can only defend itself from prospective negative impacts.

The company's information collected and processed allows the evaluation and interpretation of the strengths and weaknesses of this company. Companies can influence strengths and weaknesses by monitoring, controlling, and analysing it through business intelligence software. The use of BI software for inventory management, accounting, customer intelligence and beyond, and others can increase the decision's quality, increase operational efficiency, and gain a competitive edge.

The company can improve its strengths and minimise as much as possible, its weaknesses by delivering the right information to the right people at the right time. In fact, that is what business intelligence is all about.

10.4 The Role of Data Quality in Strategic Management

Data quality [15] has always been an essential component for the company; indeed, it assumes a fundamental role for the company in an increasingly competitive market company and for its success in the businesses in which it operates.

The awareness of the data quality [16] has in supporting informed decisions and, conversely, of the disastrous consequences of inaccurate data. It has grown hand in

hand with the spread of information sources available to companies, creating more substantial the need for adequate management for the company's data ever.

The standard ISO 8402 has defined the data quality as "The totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs".

The previous definition tells the decision makers that the data quality does not depend only on the characteristics of the data itself but also on the business context in which it is used. Data quality is a critical component of the company [17]; for this reason, not implementing a strategy for evaluating and controlling the data quality is possessed can have disastrous effects. The presence of low data quality is not a theoretical problem but a real business problem [18]; consequently, it negatively affects the company's critical decisions.

The challenge of determining the company's competitive level in the market depends on strategic management; meanwhile, strategic management is affected by the quality of the data used from the decision makers at the time of its approving [19]. All in all, without data, strategic decisions are only hypotheses; on the other hand, the data and especially the high quality data makes every strategic decision, informed and targeted.

There are numerous traditional data sources such as relational databases, excel sheets, and social networks in each company. At this point, the problem becomes guaranteeing the quality of the data, primarily if used to support strategic management; in fact, guaranteeing the data quality is the critical factor of extreme importance in all business intelligence projects.

The main dimensions to measure the data quality in a given context are the following [20, 21]:

- **Accessibility:** it indicates the ease with which a user can identify, obtain, and use data. Business intelligence is interactive and approachable where users can customise dashboards and create reports on little notice.
- **Accuracy:** it refers to the difference between an estimate of how an attribute should be valued and the actual value reported by the data. Business intelligence tools can control this aspect of quality.
- **Trustworthiness:** It indicates the degree of credibility and reliability of the data, depending on the source of origin's reliability. Business intelligence platform appears data flaws very evidently once the company starts to use it.
- **Completeness:** it is a measure of correspondence between the real world and the specific dataset. Business intelligence tools indicate how much data is missing in the dataset to offer a 100% complete representation of the real context.
- **Consistency:** The degree of consistency of the data to obtain a consistent representation of the data. Business intelligence tools clean the data to ensure that the system's data is compatible to avoid garbage in/garbage out problems.
- **Interpretability:** it refers to the availability of clear and precise documentation of the database that indicates to decision makers which types of data are contained in the database and how to use and analyse it. Business intelligence methods use state of the art to create interactive dashboards that turn complex data into easily interpretable dashboards and graphs.

- **Punctuality:** it indicates how updated the data is concerning the real context. It is a measure of temporal alignment of the database with respect to the real world and constitutes an indicator of fundamental importance. Working on outdated data can lead to making bad critical decisions. Business intelligence uses analytics and other data processing tools to give companies access to the most recent data.
- **Quantity:** indicates how appropriate the volume of data held about a specific activity. Working with more or less data than necessary can be counterproductive and difficult to manage. Companies use business intelligence software to extract valuable insights from a specific quantity of data of their systems and operations.

10.5 The Business Intelligence for Development of Data Integration

Data integration is the process that defines the various steps: Data integration tools allow you to design these processes, one phase at a time and automate their execution. The most common data integration tools are known with ETL (extract, transform, load).

ETL (extract, transform, load) [22] is the acronym that refers to the process of extracting, transforming, and loading data from the most varied sources into a data warehouse or data mart for all business intelligence operations.

The role of an ETL process [23] is to feed a single, detailed, comprehensive, and high quality data source that can, in turn, provide a data warehouse. Very often the three operations of extraction, transformation, and loading are accompanied by a fourth cleaning operation, which is responsible for improving the quality of the data, avoiding the following situations: duplicate data, missing data, incorrect values, and values inconsistent.

The phases of the process are divided as follows:

Extract, the data is extracted from various sources, such as databases, activity logs, anomaly reports, security events, and other transactional activities;

Transform, the data then undergoes a transformation process that consists of selecting only those consistent with the system, eliminating duplicates, making connections between data from different sources, and aggregating them. Consequently, this transformation phase consolidated the data; in other words, this phase makes data coming from various sources homogeneous and making sure that the data adhere to the business logic of the analysis system for which it is developed;

Load, the last act of the entire data preparation process involves loading the data that extracted and transformed into a new destination. There are two distinct data replication models in the upload phase. In “push” replication, the application pushes the transformed data into the target database. In “pull” replication, the contrary, the target application or database requests the data, following the moment’s specific needs.

Through the ETL process, the data acquire a high level of quality, so that it can be used for various operations:

- Data migration from one application to another;
- Replication of data for backup or redundancy analysis;
- Data entry into a data warehouse for assimilation, sorting, and transformation into business intelligence;
- Synchronisation of key systems.

In fact, ETL systems are business intelligence systems that considered as the key infrastructure for strategic management. This software allows you to transform unorganised data and content into strategically useful information to make critical decisions and operate effectively.

10.6 The Business Intelligence for the Development of a Reporting System

The report is presented as a combination of tables and graphs representing the relevant measures for the various phenomena analysed and disaggregated according to needs.

The reporting systems [24] are of strategic importance in keeping the company system in full efficiency and disseminating information to the various levels concerned. The reporting system is part of the programming and control systems. In fact, planning cannot be carried out if there is no information and data relating to the activities, resources used, and results obtained previously.

Reporting is fundamental and indispensable. No team will operate for long if operators have no information to provide feedback on their activities. With modern and efficient systems, they have to make people understand in time if the planned activities they are meeting expectations and if the set goals are achieved.

The different macroeconomic contexts of the company's activity create particular development environments; accordingly, a process of developing a reporting system is a dynamic process where its phases can be extended or reduced as a consequence of the particular development environments. Generally, composed of the following steps. First of all, its identification of information needs; then, its identification of the information context; after that, its identification of the information sources; next, its integration phase of information resources; then, its preparation of the report; after that, its identification of report visualisation needs; last of all, its validation of the report.

The decision maker of a company has to have a set of tools and techniques capable of providing functional mechanism strategic management. These tools represent a reporting system and the mensuration system of specific indicators. Consequently, all the information deems useful to understand better the business trend and support decision makers in making faster and more rational decisions.

Report generation is a standard application of business intelligence software. BI products can seamlessly generate reports for internal stakeholders and automate critical tasks for analysts. Thus, company managers can identify and modify corporate strategies and processes, supported by indicators provided in real time, which help guide choices, based on particular and measured elements.

On-Line Analytical Processing “OLAP” [25] indicates a set of BI techniques for the interactive analysis of large amounts of data, even in rather complex ways. The principle behind this technology is to search for data much more efficiently to allow analysts to make more complex queries aiming to develop the reporting system.

10.7 The Business Intelligence for Developing Future Scenarios

Scenario analysis is an essential tool in developing new strategies within the company [26]. This type of analysis explores firstly various paths that the company can follow then implement the one that best matches the company’s objectives.

Future analysis is a crucial tool for strategic management, as it creates future predictions and situations, analyses the environment, and prepares the company for possible scenarios.

Scenario planning is a model that can be used in strategic management to explore and learn the future of business strategy formation [27]. It works by describing a small number of scenarios, creating stories about how the future will evolve, and how this will affect specific issues affecting the market. The scenario planning method works by understanding the nature and effect of the most important forces affecting the future.

Predictive analysis systems are based on data collection and on the projection of reliable scenarios in the medium and long term, in order to provide indications and guidelines for strategic management. What-if analysis [28] is the necessary predictive analysis level based on data that can significantly contribute to making strategic management more effective, safe, and informed. What-if analysis in business intelligence scenarios indicates forecasting analysis techniques that allow evaluating a real system’s behaviour assuming a particular set of initial conditions. This type of analysis overcomes one of the fundamental limitations of reporting and OLAP, namely that of recording only the past and not allowing to analyse future scenarios.

10.8 The Business Intelligence for Optimising Processes

A company’s ability to face market needs competitively is closely linked to its ability to optimise its processes. The optimisation of processes and services in

a company ensures this organisational efficiency and this ability to adapt; thus, continuously verifying the validity of the business processes implemented and the quality of the services provided [29].

Monitoring the processes helps identify the core business's critical points, improves its operations, and improves overall economic results. The optimisation of processes has become necessary for companies that identify cost reduction as the basis for maintaining their competitive capacity.

An optimal process can be defined as a set of activities that satisfy the client's expectations and all the company's technological and organisational constraints; besides, maintaining the primary goal of maximises profits and/or minimises costs.

The sequence of the main steps to be optimised can be summarised as follows:

- Identification and representation of existing processes
- Identification of the needs of the company
- Identification of critical processes
- Identification the roles and responsibilities of the organisational figures involved in the processes
- Identification of the systems of supporting the processes
- Identification and representation of the possible optimisation of processes
- Identification of any new roles and responsibilities of the organisational figures involved in the processes
- Identification of any changes to the information systems

BI tools are used to optimise a company's processes making a decisive contribution to reducing costs and increasing revenues.

In a fluctuating and articulated economic scenario like today, the need arises to interpret the market through an increasingly sophisticated analysis of the data in one's possession. BI is the primary tool for reading such information, which often lies unused in databases. Therefore, these data constitute a fundamental resource to photograph the business's health and define any corrective measures.

10.9 The Role of Business Intelligence on Obtaining a Competitive Advantage

Contemporary companies work in an external environment on a high degree of complexity and change; consequently, companies have to have methods and technical tools to study and analyse the market to prepare and implement the strategic management plan [23].

The study's importance and continuous environmental diagnosis of markets and competitors' position increase because of the expansion of markets, the multiplicity of competitors, the diversity of customer categories, the difference in their needs and desires, and their expectations. The importance of having clear developed tools and policies for conducting this study and that diagnosis is evident to monitor and

analyse the opportunities, restrictions, or threats emerging from markets, customers, and competitors.

The term competitiveness [30] is extremely important in a world characterised by the speed of changes and their complexity in various fields as a result of the technological revolution. Companies cannot remain isolated from the static and non-static changes arising from multiple factors such as the communications revolution and global trade organisations' liberalisation. Companies have to pursue competitive paths and achieve Competitive advantages that guarantee its growth, survival, and continuity thanks to its competencies compared to its competitors.

Competitive advantage is anything that positively distinguishes a company or its products in a positive way from its competitors in the eyes of its customers or the end-users of its products. Furthermore, the competitive advantage arises from the value that the company is able to achieve for its customers and can be retained for a relatively long period due to the difficulty of imitation, as it can take in the form of low price or provide distinct benefits in the product compared to competitors.

Competitive advantage can be described as follows:

- it is relative
- it originates from within the company
- it reflects the efficiency of the company
- it affects the customer
- it works for the long term and does not go away quickly

The application of BI is considered a means to provide the organisation with the strategic information it needs to build competitive advantages that achieve a competitive advantage over competing organisations.

BI Analysis offers a company a competitive advantage in five aspects:

- Make faster decisions

A regular and daily data collection activity allows management to examine the processes from a new perspective. Indeed, it will enable greater clarity on what is being done correctly. Meanwhile, the more advanced data analysis is the greater will be the competitive advantage over competitors in undertaking innovative business choices; especially, in those market sectors that are constantly evolving.

- Knowing the market

Knowing the market is essential for making more efficient business decisions, and many BI tools can allow you to obtain in-depth information about your customers.

- Identify new market opportunities

A company can obtain a competitive advantage with the help of data analysis. It can identify market opportunities not covered by other competitors and consistently assess the risks associated with pursuing them. In other words, a company will be able to develop new products of interest to the market before its competitors, thanks to knowing the trends and needs of customers by using BI tools that able to do so by relying on real data, not on assumptions of its management.

- Increase efficiency
For BI to be useful, a company has to use it correctly, which is to understand how to simplify its processes and reduce costs.
- Take advantage of the benefits of being a small or medium company
Data analysis can offer real-time indications on the need to change production or commercial processes, but it is difficult for large companies to reorient processes that have already started. On the other hand, a small or medium company can exploit their size to the advantage of greater flexibility and therefore change their strategies more quickly, according to the needs of the market.

10.10 Case Study

The year 2020 witnessed significant changes in consumer behaviour, especially after governments applying the lockdown. Indeed, many consumers started to count on buying their supplies through websites. Accordingly, the companies working in the field of E-Commerce found an excellent opportunity to increase their sales; however, this matter was not easy because the market witnessed the entry of many new competitors. Consequently, existing companies turn threatened to lose part of their market share. Therefore, these companies had to implement a particular strategy to increase their benefit from the external factors surrounding them and reduce the economic damage that could be inflicted on companies.

To implement this strategy, the Business Intelligence Department had to provide the company's management with information that enables it to understand its customers' nature based on the company's sales data. The historical data includes the following details, InvoiceNo, StockCode, Quantity, InvoiceDate, UnitPrice, CustomerID, and CustomerCountry.

The Business Intelligence Department falsified the company's management with the following information:

1. Geographical distribution of customers

Figure 10.1 shows that more than 80% of the customers live in England. In other words, the company's economic activity focuses almost entirely on customers residing in England, which indicates that it can expand the company into the markets of neighbouring countries to increase its market share.

2. Time distribution of purchases

Figure 10.2 indicates that the purchases are at a similar rate during the first 9 months of the year, while this percentage increases in the last 3 months of the year.

3. Customer Segmentation

It is not possible to deal with customers in the same manner; therefore, it is necessary to divide them into groups similar to their purchasing behaviour. To achieve this goal, we will apply the K-means algorithm depending on three variables that have been extracted from historical data, namely:



Fig. 10.1 Geographical distribution of customers

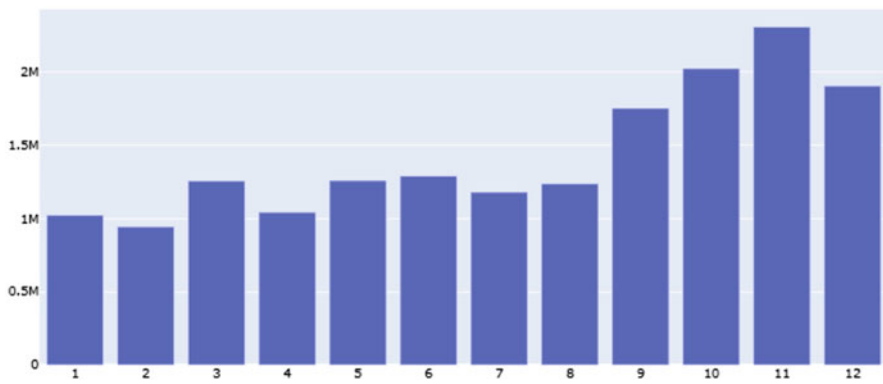


Fig. 10.2 Time distribution of purchases

Recency: represent the time since the last order.

Frequency: represent an average time between transactions.

Monetary: average transactions value.

Figure 10.3 shows that the customers can be divided into three groups. These three groups are characterised as the following:

Group 1: represent 48.9% of customers. Customers belonging to this group are distinguished by the fact that they make purchases frequently, but their orders range between a medium and a low value;

Group 2: represent 23.3% of customers. Customers belonging to this group are distinguished by the fact that they make purchases frequently; however, they do not make a new order for a long time, and their orders range between a medium and a low value.

Group 3: represent 27.7% of customers. Customers belonging to this group are distinguished by the fact that they make purchases infrequently, but their orders range between a medium and a high value.

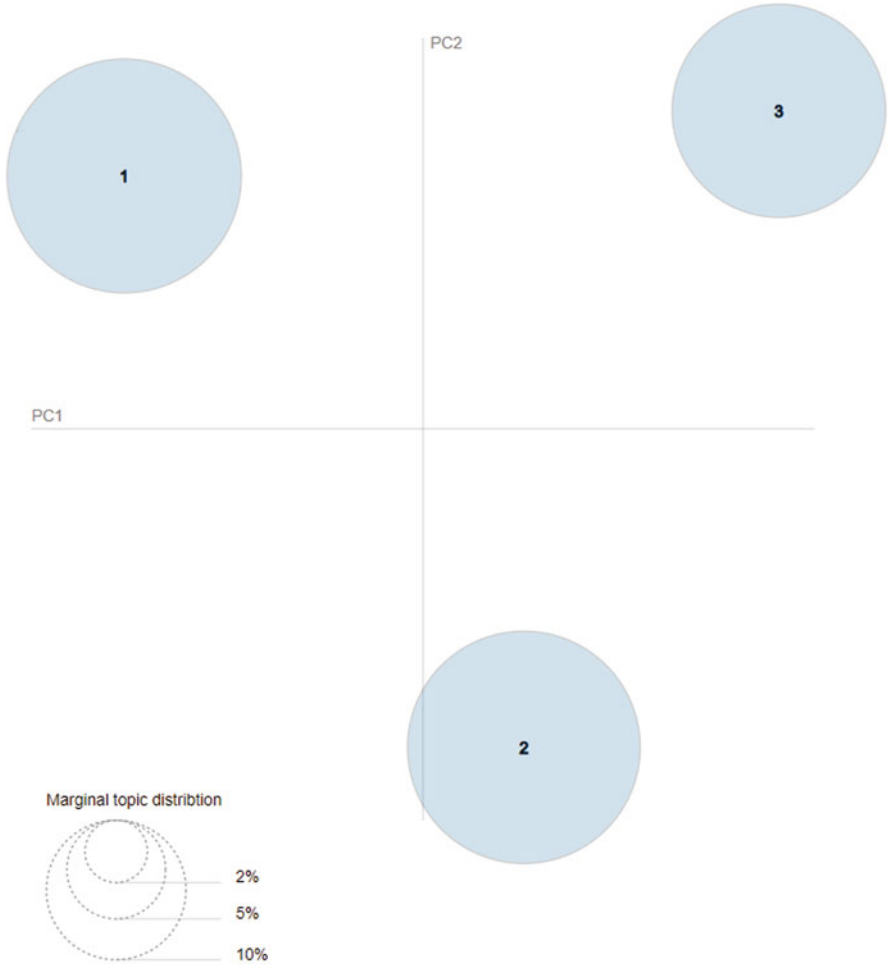


Fig. 10.3 K-means algorithm results

In conclusion, this report submitted by business intelligence will be the basis for the company’s management, and in particular, the marketing department, to decide its future strategies.

10.11 Conclusion

To conclude this chapter, we can say, the future of Business Intelligence will be strongly governed by the technological advancement of Industry 4.0 and the

growing availability and interconnection of data within companies. For this reason, BI will become an increasingly and evolved service.

On the one hand, it will be possible to take advantage of more data and more sophisticated techniques to extract data from previously inaccessible sources, for example, through natural language processing (Natural Language Processing) and on the other hand, it will be possible to create increasingly advanced information reports, thanks to the use of artificial intelligence models and techniques for the processing of insights starting from company databases.

References

1. X. Belle, Peng, Review of business intelligence through data analysis. *BIJ* **21**(2), 300–311 (2014). <https://doi.org/10.1108/BIJ-08-2012-0050>
2. R. Heath, Prediction machines: The simple economics of artificial intelligence. *J. Inform. Technol. Case Appl. Res.* **21**(3–4), 163–166 (2019). <https://doi.org/10.1080/15228053.2019.1673511>
3. Larson, Chang, A review and future direction of agile, business intelligence, analytics and data science. *Int. J. Inform. Manage.* **36**(5), 700–710 (2016). <https://doi.org/10.1016/j.ijinfomgt.2016.04.013>
4. Vercellis, *Business intelligence: data mining and optimization for decision making* (Wiley, London, 2009)
5. L. Arnott, Song, Patterns of business intelligence systems use in organizations. *Decis. Support Syst.* **97**, 58–68 (2017)
6. D. Wiltbank, Read, D. Sarasvathy, What to do next? The case for non-predictive strategy. *Strat. Manage. J.* **27**(10), 981–998 (2006). <https://doi.org/10.1002/smj.555>
7. Thevenet, Salinesi, Aligning IS to organization's strategy: The InStAl method BT, in *Advanced Information Systems Engineering*, (Springer, Berlin, 2007), pp. 203–217
8. M.-R. Bragge, Nurmi, Tanner, A repeatable e-collaboration process based on thinklets for multi-organization strategy development. *Group Decis. Negot.* **16**(4), 363–379 (2007). <https://doi.org/10.1007/s10726-006-9055-5>
9. F. Yean, K. Yahya, The influence of human resource management practices and career strategy on career satisfaction of insurance agents. *Int. J. Business Soc.* **14**(2), 193 (2013)
10. Tomlin, Wang, Operational strategies for managing supply chain disruption risk, in *The Handbook of Integrated Risk Management in Global Supply Chains*, (Wiley, Oxford, 2011), pp. 79–101. <https://doi.org/10.1002/9781118115800>
11. J. Teece, A capability theory of the firm: An economics and (strategic) management perspective. *N. Z. Econ. Pap.* **53**(1), 1–43 (2019). <https://doi.org/10.1080/00779954.2017.1371208>
12. P. Rony, Florinda, Knowledge management as a factor for the formulation and implementation of organization strategy. *J. Knowl. Manage.* **21**(2), 308–329 (2017). <https://doi.org/10.1108/JKM-02-2016-0068>
13. Gurel, Tat, SWOT analysis: A theoretical review. *J. Int. Soc. Res.* **10**(51), 51–66 (2017). <https://doi.org/10.17719/jisr.2017.1832>

14. M. Abdel-Basset, Smarandache, An extension of neutrosophic AHP–SWOT analysis for strategic planning and decision-making. *Symmetry* **10**, 4 (2018). <https://doi.org/10.3390/sym10040116>
15. C. Merino, S. Rivas, Piattini, A data quality in use model for big data. *Futur. Gener. Comput. Syst.* **63**, 123–130 (2016). <https://doi.org/10.1016/j.future.2015.11.024>
16. Kahlawi, An ontology driven ESCO LOD quality enhancement. *Int. J. Adv. Comp. Sci. Appl.* **11**, 60 (2020). <https://doi.org/10.14569/IJACSA.2020.0110308>
17. M. Smith, A. Roster, L. Golden, S. Albaum, A multi-group analysis of online survey respondent data quality: Comparing a regular USA consumer panel to MTurk samples. *J. Bus. Res.* **69**(8), 3139–3148 (2016). <https://doi.org/10.1016/j.jbusres.2015.12.002>
18. Choi, Luo, Data quality challenges for sustainable fashion supply chain operations in emerging markets: Roles of blockchain, government sponsors and environment taxes. *Transp. Res.* **131**, 139–152 (2019). <https://doi.org/10.1016/j.tre.2019.09.019>
19. R. Côte-Real, Oliveira, Leveraging internet of things and big data analytics initiatives in European and American firms: Is data quality a way to extract business value? *Inf. Manag.* **57**(1), 103141 (2020). <https://doi.org/10.1016/j.im.2019.01.003>
20. G. Juddoo, Duquenoy, Windridge, Data governance in the health industry: investigating data quality dimensions within a big data context. *Appl. Syst. Innov.* **1**, 4 (2018). <https://doi.org/10.3390/asi1040043>
21. T. Taleb. A. El Kassabi. Serhani, Dssouli, and Bouhaddioui, Big data quality: A quality dimensions evaluation, in 2016 Intl IEEE Conferences on Ubiquitous Intelligence & Computing, Advanced and Trusted Computing, Scalable Computing and Communications, Cloud and Big Data Computing, Internet of People, and Smart World Congress (UIC/ATC/ScalCom/CBDCCom/IoP/SmartWorld), 2016, pp. 759–765
22. Z. Fang, J. Elmore, A. Chien, UDP: A programmable accelerator for extract-transform-load workloads and more, in Proceedings of the 50th Annual IEEE/ACM International Symposium on Microarchitecture, 2017, pp. 55–68
23. A. Yulianto, Extract transform load (ETL) process in distributed database academic data warehouse. *J. Comp. Sci. Inform. Technol.* **4**(2), 61–68 (2019). <https://doi.org/10.11591/aptikom.j.csit.36>
24. E. Pearlson, S. Saunders, F. Galletta, *Managing and Using Information Systems: A Strategic Approach* (Wiley, New York, 2019)
25. S. Tohir, Kusriani, Sudarmawan, On-Line Analytic Processing (OLAP) modeling for graduation data presentation, in 2017 2nd International conferences on Information Technology, Information Systems and Electrical Engineering (ICITISEE), 2017, pp. 132–135
26. Quiceno et al., Scenario analysis for strategy design: A case study of the Colombian electricity industry. *Energ. Strat. Rev.* **23**, 57–68 (2019). <https://doi.org/10.1016/j.esr.2018.12.009>
27. Cairns, Wright, in *Evaluating the Effectiveness of Scenario Interventions Within Organizations BT-Scenario Thinking: Preparing Your Organization for the Future in an Unpredictable World*, ed. by G. Cairns, G. Wright, (Springer, Cham, 2018), pp. 247–255. https://doi.org/10.1007/978-3-319-49067-0_11
28. F. Hartmann, R. Moawad, L. Traon, GreyCat: Efficient what-if analytics for data in motion at scale. *Inf. Syst.* **83**, 101–117 (2019). <https://doi.org/10.1016/j.is.2019.03.004>
29. C. Carvalho, Cazarini, Gerolamo, Manufacturing in the fourth industrial revolution: A positive prospect in sustainable manufacturing. *Proc. Manuf.* **21**, 671–678 (2018). <https://doi.org/10.1016/j.promfg.2018.02.170>
30. Malik, Creating competitive advantage through source basic capital strategic humanity in the industrial age 4.0. *Int. Res. J. Adv. Eng. Sci.* **4**(1), 209–215 (2019)