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Unraveling the interplay of Business Intelligence, Business Analytics, and Big Data: A synergizing approach.

Démêler l'interaction entre la Business Intelligence, la Business Analytics et le Big Data : Une approche synergique.

AIT TOUIL Abdelhak
Professor of Higher Education
National School of Commerce and Management
Moulay Ismail University Meknès-Morocco
ReDeMO

JABRAOUI Siham
Professor of Higher Education
National School of Commerce and Management
Hassan II University Casablanca- Morocco
ISO

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Abstract

Organizations are increasingly relying on their ability to process data and extract knowledge that can be used to make decisions. In the literature, terms such as "business intelligence" (BI), "business analytics" (BA), and "big data" (BD) are sometimes used interchangeably and sometimes to refer to different concepts. Experts and scholars find this perplexing. By reviewing the literature and proposing an integrative approach to these concepts, this work hopes to shed light on the interactions and complementarities between BI, BA, and BD.

Keywords: Big Data; Business Analytics; Business Intelligence; Big Data Analytics Process.

Résumé

Les organisations s'appuient de plus en plus sur leur capacité à traiter les données et à en extraire des connaissances qui peuvent être utilisées pour prendre des décisions. Dans la littérature, des termes tels que "business intelligence" (BI), "business analytics" (BA) et "big data" (BD) sont parfois utilisés de manière interchangeable et parfois pour désigner des concepts différents. Cette situation laisse les experts et les chercheurs perplexes. En passant en revue la littérature et en proposant une vision intégrative de ces concepts, ce travail espère mettre en lumière les interactions et les complémentarités entre BI, BA et BD.

Mots clés: Big Data; Business Analytics; Business Intelligence; Processus analytique Big Data

Introduction

Companies are collecting more and more data thanks to new technologies. These technologies enable companies to collect and analyze massive amounts of digital information from a variety of sources in real-time (Aydiner et al., 2019). This data can be analyzed to identify trends and patterns and to predict future outcomes and events. Many researchers and practitioners believe that data analysis can be a source of competitive advantage. That's why a plethora of technologies and techniques have been developed to enable and support data analysis.

Several terms are used to designate these technologies and techniques. However, three terms are attracting growing interest: Business Intelligence (BI), Business Analytics (BA), and Big Data (BD). Despite increasing investment and research in the field, these concepts lack a consensus about their definition in academic or professional literature.

Any management researchers wishing to explore these information systems technologies will quickly find themselves bewildered by the arbitrary and nonchalant use of these concepts in the literature. This is likely to require a monumental effort on the part of management science researchers just to master the concepts and be able to differentiate them to delimit their field of research. Indeed, existing definitions create confusion as to what these terms mean. This confusion has led to uncertainty about how these concepts can be related (Mashingaidze and Backhouse, 2017).

For example, Chen et al (Chen et al., 2012)combined Business Analytics and BI into a single acronym "BI&A" and treated BA as a separate but related concept. Côrte-Real et al (Côrte-Real et al., 2014) used the same name as Chen et al (2012), treating BI, BA, and BI&A as interchangeable terms without reference to Big Data. Bayrak (Bayrak, 2015), meanwhile, treats BI, BA, and BD interchangeably, arguing that they all refer to the same concept, stating that "a new field called Business Analytics (BA), also known as Business Intelligence or Big Data, has emerged in recent years. ".

According to some authors, the terminology used to describe information systems with similar objectives varies over time. During each period and as these systems evolve, a distinct term seems to be used to describe an information system designed to support decision-making in organizations. For Davenport (Davenport, 2014), for example, this is simply a change in terminology for data use and analysis (decision support (1970-1985), top management support (1980-1990), OLAP (90-2000), Business Intelligence (1989-2005), Business Analytics (2005-2010) and Big Data (since 2010)). However, as we shall see in the rest of this article, it's not just a question of terminology.

These different approaches to considering the three concepts, all related to decision support, arouse curiosity and invite further exploration of the possible relationships between them. Do these concepts refer to different technologies and approaches? Or, on the contrary, are they merely a conceptual proliferation alluding to the same thing? Else what links might exist between these three concepts?

This leads us to pose the following research question: to what extent are the concepts of BI, BA, and Big Data interchangeable?

By reviewing the literature related to these three concepts, we propose to conduct a conceptual analysis leading to an attempt to unravel the entanglements between these three technologies, which are widely used in companies to support decision-making.

The aim of this paper is first to distinguish between these three concepts and then to identify possible links and overlaps between them. It's worth noting that Through this work we are trying to fill a gap in the literature on decision-support information systems because, to the best of our knowledge, no study has attempted a conceptual clarification of these three technologies at the same time.

The remainder of this paper is organized as follows. We begin by presenting these three concepts separately, then attempt to distinguish the various links and interconnections revealed by the literature to arrive at a synthetic and integrative vision of the interrelations and connections between BI, BD, and BA.

1. Business Intelligence and its many interpretations: a literature review

There doesn't seem to be a single, all-embracing definition of Business Intelligence. The field of BI research is multi-dimensional and holistic, and no precise or universal understanding of BI exists today. There are many different points of view on BI, depending on how it is generally understood. The different points of view are often influenced by the context of the person giving the definition.

Several researchers, however, have detected the existence of two (Ahmad, 2015; Olszak, 2016) or even three (Rouhani et al., 2012) approaches to defining BI. Olszak points out that definitions of BI include both technical and organizational elements (Olszak, 2014). From a technical point of view, BI is an integrated set of tools, technologies, and software used to collect heterogeneous data from dispersed sources, and then integrate and analyze it to make it commonly available. From an organizational point of view, BI is a holistic and sophisticated approach to decision support across the organization (Moss and Atre, 2003).

For Rouhani et al (2012), we can distinguish three approaches in BI depending on the purpose of its use. These approaches are:

1. The managerial approach focuses on improving management decision-making.

2. The technical approach focuses on the tools supporting the processes associated with intelligence in the management approach.

3. The enabling approach, focuses on value-added capabilities to support information sharing.

The managerial approach sees BI as a process in which data collected from inside and outside the company is integrated to generate information relevant to the decision-making process. The role of BI here is to create an information environment in which operational data collected from transactional systems and external sources can be analyzed, to reveal the "strategic" aspects of the company's business. The technical approach presents BI as a set of tools that support the process described above. The focus is not on the process itself, but on the technologies that enable the capture, retrieval, manipulation, and analysis of information. Finally, the enabling approach focuses primarily on the value created by this process through the use of BI tools and technologies. Return on investment and the creation of competitive advantage through the enhancement of corporate information are the most important aspects of this approach.

It is fair to say that Business Intelligence (BI) can be interpreted in various ways. It can be viewed as a solution that combines various analytical technologies and techniques within a single information system. Alternatively, it can be perceived as a set of technologies and methods designed to aid decision-making activities.

In this article, we define BI as **"***an organizational capability to provide the right decision support to the right people at the right time to gain a competitive advantage***"**.

This definition has the advantage of encompassing the three approaches identified in the BI literature. The use of term "organizational capability" refers to the resource-based view (Barney, 1991; Wernerfelt, 1984), which sees capability as the ability to combine different resources to achieve a goal. In the case of BI, these resources are of different types: technical (data warehouse, software applications, etc.), human (individual skills), and organizational (processes, culture, governance, etc.). All these resources are brought together harmoniously so that decision-makers at all levels of the organization can make informed decisions, thanks to the availability of the necessary information and knowledge at the right time. A company that has succeeded in developing this kind of competence has a good chance of securing a competitive advantage over its rivals.

2. Business Analytics and Big Data: A BI evolution?

As technology evolves, organizations are collecting and storing more and more data. This data can be analyzed to identify trends and patterns and to predict future outcomes and events. Many researchers and practitioners believe that data analytics can be a source of competitive advantage. As a result, a plethora of technologies and techniques have been developed to enable and support data analysis.

In the late 2000s, Business Analytics (Davenport uses only the term analytics) was introduced to represent the key analytical component of BI (Davenport and Harris, 2006). More recently, the terms "big data" and "big data analytics" have been used to describe data sets and analytical techniques in applications that are so large (terabytes to exabytes) and complex (from sensors to social media data) that they require advanced and unique data storage, management, analysis, and visualization techniques (Chen et al., 2012).

Figure 1 illustrates the trend highlighted by Chen et al. (2012), which shows an overall increase over time in the number of articles published relating to BI, BA, or BD.

Figure N°1: Trends in BI, BA, and Big Data publications

Keyword	All Years	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Business Intelligence	3,146	113	104	146	159	229	330	346	394	352	201	334	338
Business Analytics	213	0	5	43	4	5	2	9	6	19	16	17	126
Big Data	243	0	1	0	0	7	4	3	26	11	41	44	95
Total	3,602	113	110	149	163	241	336	358	426	382	358	356	560

Source: Chen et al, 2012

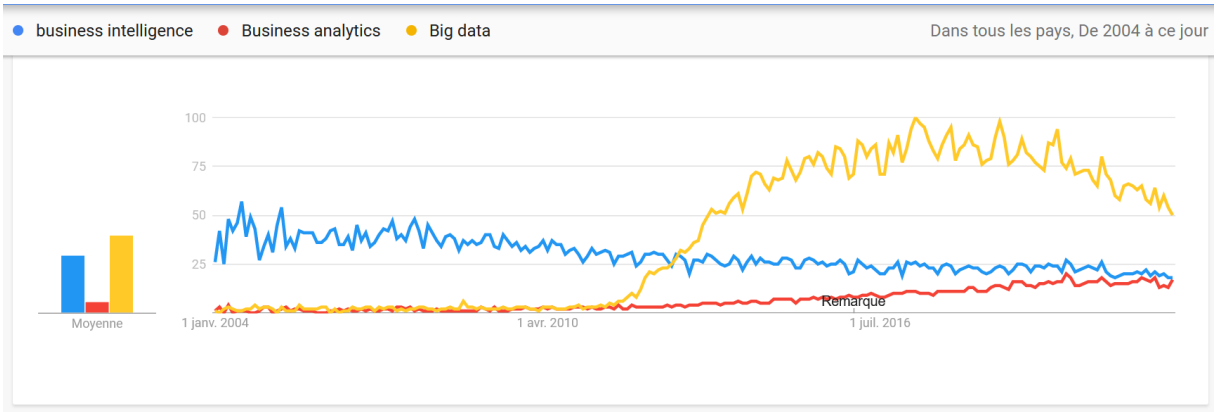
Overall, Business Intelligence publications have the largest coverage over the period. This corresponds to the evolution of BI and BA since the term BI first appeared in the early 1990s. BA and Big Data began to appear in the literature in 2001 but didn't attract attention until around 2007. While the overall trend in BI publications remains stable, publications on BA and BD have grown more rapidly since 2010. This is supported by search trends on Google Trends. **Figure 2** shows keyword search trends from 2004 to 2021 for the three terms: BI, BA, and Big Data.

BI was dominant until 2012, as reported by Chen et al. (2012). Since 2012, there has been remarkable growth, especially in searches using the term Big Data. We also note that from this year on, after a downward trend, searches related to BI have stabilized, while those related to Business Analytics grow slowly (far from that of BD), but continue to almost equal BI around March 2020.

To understand the interrelationships between these terms, it is therefore important to first look at what business analytics and big data mean, and then try to identify the links with business intelligence.

Vast amounts of data are now readily available, thanks to the exponential growth in storage capacity and the development of data collection techniques (Elgendy and Elragal, 2016). More and more data are being created every second from a variety of sources. Today, companies and individuals own more technologies and devices that create and collect more data in different categories. These types of data are now referred to as big data or data whose volume, variety, and velocity are such that it is becoming difficult to manage with traditional tools (Russom, 2011).

Figure N°2:Search trends for the terms BI, BA, and Big Data



Source: Google Trends

The amount of digital data generated worldwide in 2018 reached 33 zettabytes (one billion terabytes), equivalent to the storage capacity of 33 million human brains. International Data Corporation predicts that by 2025, the amount of data generated will be 175 Zb, rising to 612 Zb by 2030.

By surfing the web, accessing social networks, playing sports, and even sleeping, people generate data (Ait Touil and Jabraoui, 2020). As McAfee & Brynjolfsson noted in 2012, "Each of us is now a walking data generator" (McAfee and Brynjolfsson, 2012).

The concept of big data is often defined by its characteristics. It seems that the earliest reference to the characteristics of Big Data dates back to 2001 when Doug Laney identified three data

management challenges: volume, velocity, and variety (or the three Vs) (Laney, 2001). Subsequently, the three Vs emerged as a common framework for describing big data (Chen et al., 2012; Elgendy and Elragal, 2016; Hilmi, 2024; Gandomi and Haider, 2015). We describe their three characteristics below:

- **Volume**: Most intuitive definitions of big data focus on the volume of data produced. While volume is certainly an aspect of big data, it's probably the least problematic. As technology evolves, what was big in the past will be normal tomorrow and will probably be considered quite small in the future (Kimble and Milolidakis, 2015).
- **Velocity**: While volume refers to what might be considered a "stock" of data, velocity refers to the rate at which that stock is changing. For example, the speed at which data is generated, the frequency with which it is updated, or the speed at which it is delivered. Examples of high-speed data include financial data from stock markets, real-time data from sensors and video cameras, and clickstream data generated by visitors to online stores.
- **Variety**: Although perhaps not as obvious as volume or velocity, variety is often the biggest problem for big data analytics (Kimble and Milolidakis, 2015). Variety refers to the number of different sources from which data can come and the formats, structures, and semantics associated with them. Problems can arise because each different data source needs to be handled differently;

In addition to these three Vs, other dimensions of big data have been mentioned. These include veracity, variability, and value. Authors diverge by adopting either the 3V, 4V, 5V or 6V model. However, it seems insufficient to define a phenomenon like big data by several V's. Gartner's definition seems to be more consistent: "**Big Data is high-volume, fast-moving, and diverse information that requires cost-effective and innovative forms of information processing to improve understanding and decision making.**"

This definition, as Gartner consultant Sicular (2013) so aptly noted, includes three parts or dimensions of big data (Sicular, 2013). The first, where most readers of the definition stop, is the 3V model. The second is the cost of supporting big data. Indeed, to have the technological capabilities to store and process unstructured Big Data and perform comprehensive analytics, organizations should not expect low-cost solutions, but cost-effective and appropriate answers to their problems. Finally, the definition emphasizes a third dimension that is the ultimate goal of big data: the value created. The value lies in knowledge (insight) that was previously unavailable (without big data). It is imperative to act on this knowledge. "Missing the third part

is the most arduous and painful path to the bottom of the trough of disillusionment" (Sicular, 2013). Hence the importance of big data analytics.

Big data is worthless in a vacuum. Its potential value is only unlocked when it is used to facilitate decision making. To enable such evidence-based decisions, organizations need effective processes for transforming large volumes of diverse, fast-changing data into meaningful information. This is known as business analytics (BA).

Sharda et al. (2015) describe BA as "the process of developing actionable decisions or recommendations for action based on information generated from historical data." (SHARDA et al., 2015). For the Institute for Operations Research and Management Sciences (INFORMS), "analytics is considered both (i) a comprehensive problem-solving and decision-making process and (ii) a broad set of analytical methods that enable value creation." [1].

For Power (2015), "Analytics refers to the quantitative analysis of data. It is the process of data-driven decision making. " (Power and Sharda, 2015). In their seminal article on Analytics, "Competing on Analytics," Davenport and Harris (2006) define analytics as "the extensive use of data, statistical and quantitative analysis, exploratory and predictive models, and evidence-based management to drive decisions and actions". Analytics can serve as input to human decisions or drive fully automated decisions. (Davenport and Harris, 2006).

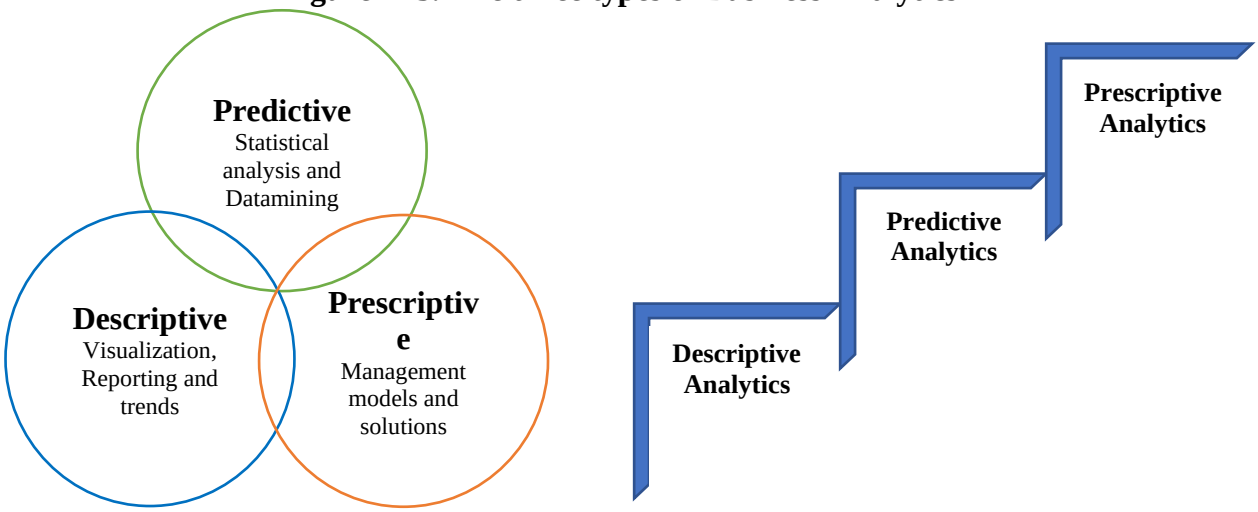
INFORMS has adopted a classification of Business Analytics into three components: Descriptive Analytics, Predictive Analytics, and Prescriptive Analytics. **Figure 3** presents two graphical views of these three types of BA. One view suggests that these three types of analytics are independent rungs on a ladder and that one type of analytic application leads to another. The interconnected circles' view suggests that there is some overlap between these three types of analysis. In either case, the interconnected nature of the different types of analytical applications is evident.

Descriptive or reporting analytics is about knowing what's going on in the organization and understanding some of the underlying trends and causes of those events. It involves consolidating data sources and making all relevant data available in a form that enables appropriate reporting and analysis. Descriptive analysis provides meaningful insights into business performance and enables users to better monitor and manage their operational processes (Bayrak, 2015). Predictive analytics, on the other hand, uses a variety of models and techniques to predict future outcomes based on historical and current data. This analytics relies

[1] https://connect.informs.org/analytics/home

on statistical techniques as well as other newer techniques that fall under the general category of data mining (Sharda et al., 2015). The third category of analytics is called Prescriptive Analytics, which aims to identify what is happening as well as likely predictions and make decisions to achieve the best possible performance. The goal is to provide a decision or recommendation for a specific action. Therefore, this type of Analytics can also be referred to as Decision Analytics (Sharda et al., 2015).

Figure N°3: The three types of Business Analytics

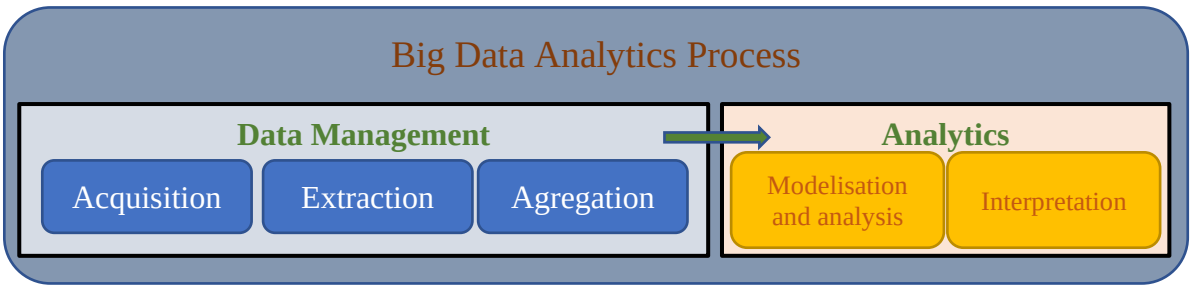


Source: adapted from Sharda et al (2015)

From the above, we can see that Predictive Analytics builds on both Descriptive Analytics and Prescriptive Analytics, which explains the interference of the circles shown in Figure 3. What's more, the techniques of Prescriptive Analytics are more advanced than those of Predictive Analytics, and Predictive Analytics also has more advanced techniques than Descriptive Analytics. This justifies the hierarchical representation of the three analytics by level in the figure above.

The overall process of extracting information from Big Data can be divided into five stages (Labrinidis and Jagadish, 2012), as shown in **Figure 4**. These five stages form the two main sub-processes: Data Management and Analytics. Data Management includes processes and supporting technologies for collecting and storing data, as well as preparing and retrieving it for analysis. Analytics, on the other hand, refers to the techniques used to analyze and derive insights from big data. As such, BDA can be seen as a sub-process of the overall process of "knowledge extraction" from Big Data.

Figure N°4: The process of extracting meaningful information from Big Data



Source: adapted from Labrinidis & Jagadish (2012) and Gandomi and Haider (2015)

Two technical entities come together here. First, there's Big Data, for massive amounts of detailed information. Then there's advanced analytics, which is a collection of different types of tools, including those based on predictive analytics, data mining, statistics, artificial intelligence, natural language processing, and so on. Combined, they make up BDA, the hottest new practice in BI today. BDA is the application of advanced analytical techniques to large data sets (Russom, 2011).

3. Synergizing Business Intelligence, Business Analytics and Big Data

BI became a popular term in the business and IT communities in the 1990s. In the late 2000s, "Analytics" or "Business Analytics" was introduced to describe the analytical component of BI (Davenport and Harris, 2006). More recently, the terms "big data" and "big data analytics" have been used to describe data sets and analytical techniques in applications that are so large and complex that they require advanced and unique data storage, management, analysis, and visualization technologies.

Chen et al. (2012) described BA as a subset of BI. They used the two terms synonymously and even created a new term, BI&A, which combines the two concepts and has subsequently been used by several authors (Chen et al., 2012). For Yin and Fernandez (2020), the term BI&A was unnecessary because it was only introduced to bridge the gap between business intelligence and BA and to serve as a transition in time (Yin and Fernandez, 2020). Torres et al. (2018) do not agree with this view, as for them the term BI&A reflects both the growing importance of analytical components in BI systems and the shift from reporting-centric to analysis-centric capabilities in BI applications. Furthermore, in practice, BI and BA are considered so closely related that trying to distinguish between the two terms may cause more confusion than it alleviates (Torres et al., 2018).

According to Mashingaidze and Backhouse (2017), two other references argue that BA and BI can be used interchangeably. These are Marjanovic (2013) and Sircar (2009), who argue that BI and BA are identical (Mashingaidze and Backhouse, 2017). Both terms are described as a set of applications, technologies, architectures, processes, and methodologies used to collect, store, retrieve, and analyze data. Both terms are also used to support decision-making. However, the definition of BA is more specific than that of BI in that the BA definition specifies mathematical and statistical techniques and distinguishes between descriptive, predictive, and prescriptive analysis. Since the main difference between BI and BA is that the latter is more specific, these two authors can argue that Business Analytics is a subset of BI. This description is consistent with the relationship between the two terms described by Chen et al. (2012).

According to Sharda et al. (2015), BI relies heavily on descriptive analysis, and the leading BI technology is data visualization. While business intelligence is useful for reporting data, the capacity of BI systems is limited by the lack of predictive modeling and algorithmically generated recommendations for decision-making. Thus, for Sharda et al. (2015), from a managerial perspective, BA is an extension of what is known as business intelligence (Sharda et al., 2015).

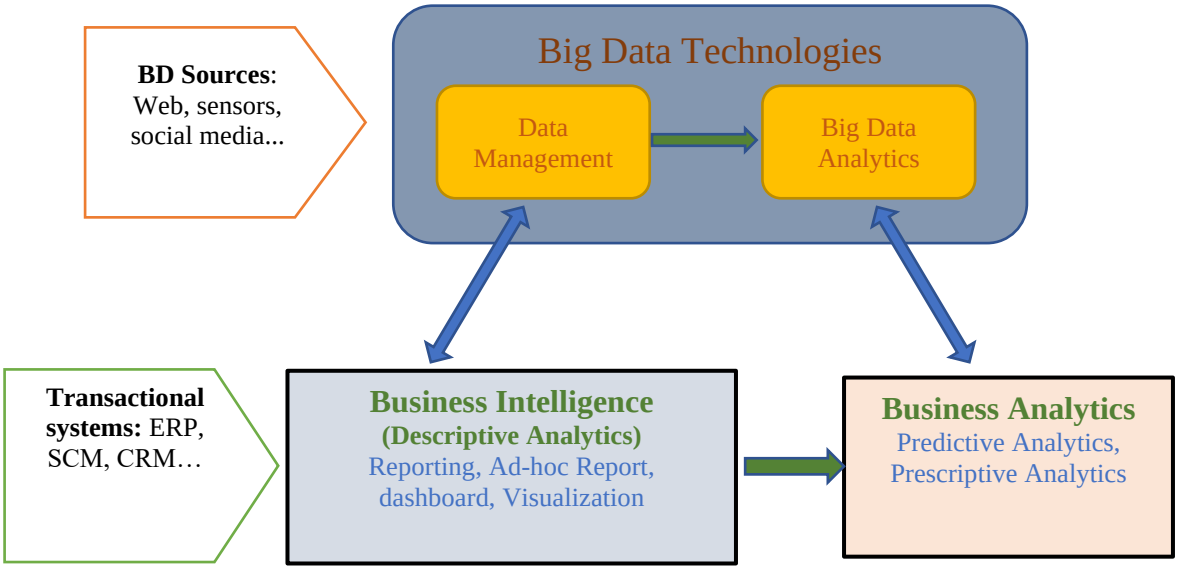
Kowalczyk and Buxmann (2014) described BD as the data used by BI and BA (Kowalczyk and Buxmann, 2014). Kowalczyk and Buxmann's (2014) definition of BD indicates that advanced technologies and techniques are required to store and analyze BD. However, these techniques and technologies are applied to achieve the same goal as BI and BA, which is to store and analyze data. Therefore, advanced technologies and techniques applied to DB can still be classified as BI or BA. Therefore, BD can be considered a new type of data that is different from conventional data and requires special technologies that can be used in BI and BA (Kowalczyk and Buxmann, 2014).

For Kimble (2015), although BA and BI are linked, extracting strategic intelligence from BD is not as straightforward as it may seem. The knowledge generated from big data could be of immense value (Kimble, 2015). Sirin and Karacan (2017) argue that the emergence of big data does not mean that the use of BI will disappear and that big data technology will replace it. On the contrary, the new big data technology seems to complement the existing BI systems. Big Data has expanded the capabilities of BI by enabling the use of new data sources, new technologies, and unusual skills. In other words, by using big data, BI gets many opportunities to perform better and meet the expectations placed on it. Big data seems to be complementary

to BI systems. The fusion of big data and advanced analytics is the most profound trend in BI (Sirin and Karacan, 2017).

We synthesize this comparative analysis of the concepts of business intelligence, business analytics, and big data in an integrating model shown in **Figure 5** below.

Figure N°5: The relationship between Big Data, BI, and BA



Source: The authors

While BI is the ability to collect and analyze data from internal and external sources to derive knowledge, it is limited to the descriptive aspect through reporting, dashboards, and visualization. Only advanced statistical techniques in Business Analytics (data mining, machine learning, etc.) may offer more meaningful insights. Big Data, through its two main processes (Data Management, and BD Analytics), intervenes both on BI, by feeding it with data and information that cannot be exploited by conventional BI techniques (SQL, DW...etc.), and on BA through techniques and processes specific to unstructured data analysis (NoSQL, Hadoop...etc.).

Conclusion

Our starting point was the lack of a clear distinction between the three decision-support technologies. The ambiguity between the three concepts is perplexing for both academics and practitioners. Our comparative analysis of the three concepts revealed that business intelligence, business analytics, and big data are not synonymous concepts, as Bayrak (2015) suggests, or terms of changing trends, as Davenport (2014) argues, but rather distinct and interrelated concepts.

It is difficult to draw a clear line between Big Data analytics and business intelligence. It's difficult to tell where the former begins and the latter stops. Analytics appears to be an intersection of BI and Big Data. The scope of BI extends beyond that of big data (Sirin and Karacan, 2017). In a business environment, one distinguishing feature between big data and BI is that big data focuses on processing huge data, whereas BI works with the flow and exchange of information.

Finally, as illustrated in Figure 5, we may summarize the relationship between BD, BI, and BA as follows: Big data is a kind of data utilized in advanced business intelligence (BI). Its nature differs significantly from that of historical data, which is generated by transactional systems, processed and stored in data warehouses, and utilized by traditional database technologies employing SQL language. Big Data necessitates modern technologies based on specialized software platforms such as Hadoop, which enable quick batch processing of data on parallel servers and employ a new class of databases known as NoSQL (Davenport, 2013). Finally, Business analytics is a subset of BI that represents the more advanced component of BI which is the analytical one.

Thus, while traditional BI focuses on the descriptive aspect of BA, the latter broadens the scope of BI by leveraging Big Data to move toward predictive and prescriptive analysis utilizing techniques such as data mining and machine learning (Côrte-Real et al., 2019). We therefore agree, regarding the description we have given of BI, that BI capabilities are continually growing, and Big Data is one of the most recent developments in BI (Alpar and Schulz, 2016).

At the end of this work, it is worth noting that the synergistic approach proposed between these three decision support systems remains in the realm of theoretical conceptualization. Its implementation by organizations would have to face a set of technical and organizational challenges. A possible future avenue of research would be to explore the various challenges and obstacles faced by organizations in orchestrating the harmonious operation of these three decision support systems and propose possible solutions. This could increase the chances of organizations getting a return on the colossal investments they have made in these three technologies.

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