Full Length Research Paper

Business Intelligence Against Big Data Approaches From Theory to Application

Adel A. Alyoubi, Ph.D

University of Jeddah, Jeddah, Saudi Arabia
E-mail: aaaalyoubi1@uj.edu.sa

Big data is not a new topic where the analysis of the data and extract the underlying knowledge become the main concern for every business. So, the main objective of this paper is to discuss and identify the variance between Business Intelligence (BI) and big data approaches as Business Intelligence has been one of the most important sources of knowledge in the business during the last two decades. The importance of this lies in considering BI contributed significantly to the decision-making and forecasting events as well as relying on the analysis of the processes that take place within the business of buying and selling and the like, and over a relatively long period of time. The way that decision-making of different kinds has been applied in any company mainly depends on the aggregate information is treated (processed) to get the result of a decision and that the lack of adequate information, accurate and correct may lead to decisions that were not a failure, it may be more like a non-random guaranteed results.

Keywords: XML, Hadoop, Big Data and Business Intelligence (BI), Decision Making, OLAP

INTRODUCTION

The term "Big Data" commonly used today for marketing services and technical products. This term has become an essential part of any speech in any technical conference or announcement of any company. Big data is a term used to pack a very large and complex data to the extent that it becomes difficult to treat using only one tool of database management tools or by using the traditional data processing applications. Which include the challenges associated with updates to come by, and duration, and storage operations, research, and participation, transportation, analysis and presentation (Chen et al., 2014). The term usually refers to the use of predictive analysis methods and the analysis of user behavior or any advanced data analysis that helps to extract value from the data will help to make more accurate decisions.

The Inflation of data has significantly during the past years led to the evolution of the data or the massive data-aware. Every move you make on the Internet is part of this data and all the information is added or video is submitted or its note is sent or the case be changed in the social media is ultimately serve the large number of data to be examined and analyzed to use them for marketing purposes or warehouse development or treatment of diseases or improve education or the provision of welfare and so on. Participate in the making of this huge data all communications, governments and social networking platforms and search engines and browsers and Internet applications and mobile e-commerce sites and providers of education and health services and providers of payment services in various forms companies warehouse (Chen et al., 2013). On

other hand, Business intelligence refers to computational techniques used in the discovery, drilling and analyzing business data, such as sales of products and revenue departments and the associated costs and income. It also represents the provision of points of the previous and current view technology, and predictive view of the business operations of commercial common task for IT business intelligence and reporting, online analytical processing and extracting information from the data, performance management, measurement, text mining and predictive analysis.

Business Intelligence is designed to support better business decision-making. Thus, we can call on intelligent technology business decision support system. Although the business intelligence technology as a synonym for competitive intelligence, because they both use the decision support technology, business intelligence technology uses the technology, processes, and applications for the analysis of most of the internal information, the vehicle and Alamagliat trade data, while competitive intelligence, analysis and dissemination of information gathered with a focus on competitors all information collected about them. Intelligent technological business system are generally understood and could include a subset of competitive intelligence.

Also, Business Intelligence is considered a set of techniques and processes and architectures, and technologies that transform raw data into expressive and useful information used to enable more strategic and tactical Effectiveness and Executive ideas and decision-making. When using this definition, we find that the Business Intelligence includes technologies such as data integration, data quality, data storage, data management, text, content analysis, and many others that the market sometimes enters into Mdilat information management sector (Chen et al., 2013).

BIG DATA ANALYSIS AND BUSINESS INTELLIGENCE ELEMENTS

Data is analyzed in industrial domain process through the use of existing systems for production processes for manufacturers and the resulting data for their systems such as inventory data, financial transactions and operating systems such as alarm and sensor systems, and manufacturing processes, and systems that record the quality of events and products that are exposed during the production phase of the product, these data are derived from different sources, either through internal systems and equipment for creating or external uncoordinated and different by customers, suppliers, the Internet. The work on the amount of data that was provided and the use of advanced tools for analyzing data on manufacturing processes to find a relationship between them (Assuncao et al., 2015).

The majority of industrial sectors pointed to the importance of the results of the data analysis and achieved by highly effective for marketing operations for products, it is an opportunity for a new revenue, new solutions, increase market opportunities, and this is an opportunity to enter a new constituent, better customer service, improve efficiency in the operation, the advantages of a more competitive , clear decisions as a result of that data has become clear and there is no ambiguity and to increase the company's ability to predict.

The five major challenges that face Big data in this area are given as follows:-

• Understanding of data: data analysis process must be understandable and clear to the end user, where it should be data that has been processed and clear when viewed. To achieve this, the data must be clarified and expressed content, and determine the scope of the user in addition to providing data results.

• Address the quality of the data must be accurate and timely data. And ensure quality of data when dealing with large data, to achieve this you need to use the company's systems management process.

• Showing meaningful: after the results are presented from large data meaningful results using graphic representation of the analysis, was to be divided into smaller groups during the presentation and to a higher perception makes more effective level.

• Dealing with outliers: the retrieval of information from norma process data much faster than the retrieval of text or tables that contain numbers and texts. When you make a large amount of data it is not easy when you are presented data from 1% to 5%, to resolve this problem should be removing these extreme data from the data or create a separate layout of extreme values.

The challenges facing the manufacturers facilities when dealing with Big data are summerised with the following points (Survey of Big Data Architectures and Framework from the industry, 2014):-

• Lack of internal analysis skills for creating manufacturer.
• High recruit experienced professionals in the analysis costs.
The amount of information that is usually available is not easy to handle.
• Huge diversity of data, a non-formatted data.

- Data affecting the speed of decision-making in real time because of the time it takes to deal with them.
- Address the quality of the data must be accurate and timely data. We should ensure the quality of data when dealing with large data, and to do so you need to use the company's systems management process.
- Showing meaningful: after the results are presented from large data meaningful results using graphic representation of the analysis, it must be divided into smaller groups in the display to a higher perception makes more effective level.
- Dealing with outliers: retrieving useful information from norma process data much faster than the retrieval of text or tables that contain numbers and text, but when you make a significant amount of data, a process that is not easy when viewing data from 1% to 5%.
- Lack of internal analysis skills of the swatter manufacturer.
- High recruit experienced professionals in the analysis costs.
- The amount of information that is usually available and it is not easy to handle.
- Diversity in big data, a non-formatted data.
- Data affecting the speed of decision-making in real time.

Business intelligence as a process is an ongoing process where companies continually gather, record and analyze data according to specific objectives and use results in the decision-making process in a step to improve the performance of the company. Business intelligence as a technology is a set of technologies in information technology that gives business intelligence substance and form in institutions. In general, processes, strategies, culture, tools, structure, standards and ICT technologies result in a more intelligent performance for institutions and development. The Business intelligence elements are given as follows:-

Data warehouse or data source: Data warehouse is different from the operational database. The database is implemented after the techniques and rules of business intelligence. Or is a separate system compiled by merging different databases or as we discussed in the previous article "Data Merge Not Like Data Saving". It is a system with its own structure and technology.

Data Mining: For data warehouse analysis, you can use control panels and programs according to the data you want to analyze. If you want to analyze what wrote about you in social networks as a whole it is possible to use this Attentio or Radian6 and work around the results to improve your products or services eg improve customer relationship; = Data mining for large companies.

Data Minna is used to find hidden directions. It is possible to know the trends of using specialized programs or data collection and conducting correlation analysis, clustering, regression through the SPSS program. Or through neural networks and fuzzy logic, which are more difficult for specialists in this field of analysis of heavy data.

OLAP: While you want to analyze your pages only on social networks for example you can use an advanced version of Hootsuite or Crowdbooster and so, ... If we want to analyze the company's sales and purchases for this ERP solutions can be used; Personnel management solutions staff; ... = OLAP OLAP or online analytical processing or compiling data in a warehouse (the first point) and performing calculations on it. • Know the relationship (= information) between buying a lot of sweets and the family status of a "B" (many stores give cards where each person's purchases or "data" are recorded and at the same time During the card get opponents, ...)

BIG DATA WITH ITS APPLICATIONS IN VARIOUS ENTERPRISES

Big data source is a result of individuals who communicate with IT different together instruments in ways that processes a various resources such as user records from Web sites and the Internet, social networking sites, electronic mail, web servers, web content and means of social communications and data on manufacturing equipment and achieved data report about, and research operation in all fields. Big data has become a grappling with its volume and growth significantly in recent times and the difficulty of dealing with it for several reasons (Aggarwal and Zhai, 2012). As a result, big data is becoming the next generation of computing and the use of information technology tools to create value through the analysis and get result. Examples include IBM's produce 2.5 quintillion bytes of data every day, the extracted data from different sources, such as information on climate and comments posted on social networking sites, digital pictures and videos and transactions buying and selling. Today the uses of big data can not be limited where everyone is able to take advantage of them one way or another, whether companies or individuals, governmental bodies and organizations or quasi-governmental organizations. Today, everyone is able to read and study and analyze data, albeit simplified so that according to them to make different decisions as needed. Google analyst can analyzes data that come from communicating a clear example platforms, so they are tools available to everyone and therefore the process is no longer restricted to one.

It has become enterprises, institutions and organizations can now different types analyze customer

Figure 1. Business process support using BI (Grünwald and Taubner, 2009)

movements of buying and selling and so more accurately so that they can accordingly know Hot or those stagnant goods and propose to their customers certain items according to purchases made. Also now they have the ability to understand customer behavior more precisely and identify discerning them and they need help or to determine their attitudes or monitor their performance. This is not only the traditional sales centers, but also now includes electronic stores on the Internet and on a larger scale. It is also not limited to the upcoming data from the company's customers only, but companies can today rely on data coming from the Internet to study the behavior of consumers in general and the evaluation of their products and services accordingly. This huge data warehouse has become available for all to benefit from it in the development of products and services best suited to real consumer behavior after the development operations previously carried only a sample of consumers. I've become a task of the works in marketing today Aa read that data and study to reach the consumer better and more appropriate (Jardak et al., 2014).

It does not stop at the business, but that these data are also available in the field of education, assuming that students are the customers and that the curriculum is the product. It had been using massive data for the study of students in schools and universities behavior techniques we were able to develop a learning system and methods suited to these students. This can be done on the next level of data from all schools on the national level or the level of a particular geographic area and even at the level of a school or university, or even a course or a traditional letter. You can also use big data to evaluate students in a real and according to their movements and activities that they do, instead of using conventional testing techniques. In education environment, the online course could have become easily get the data analysis of the students and their movements, enabling it to change and development any scheduled to come to him, according to the information without having to wait until the holding of the calendar and get feedback from him feed (Jardak et al., 2014).

In Figure 1, the combination of BI, business process, and the technical toolset could be understood as the elements that define a DSS, because they represent

information transformations followed by their application in decision-making and the provision of feedback to initiate a new cycle of information transformation (Grünwald and Taubner, 2009).

Also, in the health field has become hospitals, medical centers and even doctors can benefit from the huge data in the study of the behavior of patients through their medical files and their visits for treatment, which may help them to provide better medical service analysis. It has become possible today to research centers and medical centers analyze the data coming from mobile devices and software health that have sprung up recently and assistance prediction of diseases and the development of good or bad health behaviors in a society in such a way that I am without having to wait for the informed consent of research results.

Now we can benefit from the big data to communicate with others better if we scrutinize the analytical data provided by us to the social networking platforms with each publication that we send. Knowing the percentage of interaction with our publication of the total of the saw, for example, will give us an indication of the extent of our ability to deliver our message to the others to the evolution in our style accordingly. We just have to pay attention to tack data and be alert them and this is what many people do not do (Chen and Zhang CY).

DESIGNED FRAMEWORK TO DEAL WITH BIG DATA

The most impactful Big Data Applications will be industry- or even organization-specific, leveraging the data that the organization consumes and generates in the course of doing business. There is no single set formula for extracting value from this data; it will depend on the application (Diebold, 2000). There are many applications where simply being able to comb through large volumes of complex data from multiple sources via interactive queries can give organizations new insights about their products, customers, services, etc. Being able to combine these interactive data explorations with some analytics and visualization can produce new insights that would otherwise be hidden. The"Big Data Search" implies the following:-
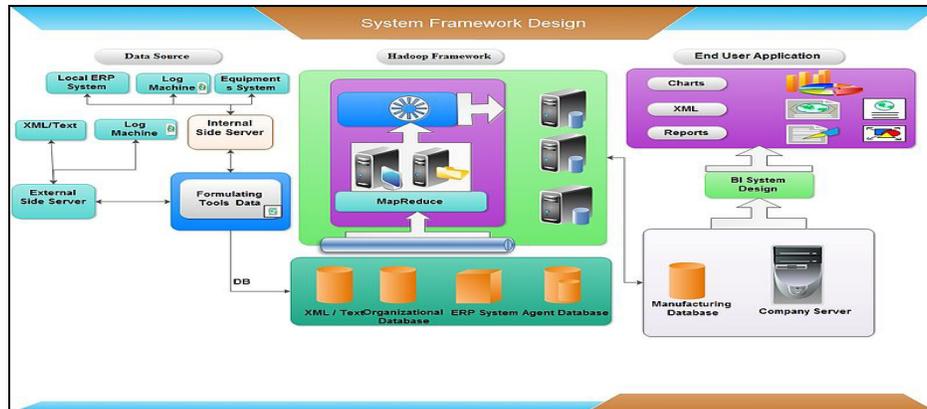
Figure 2. IT and Analytics (Big Data) in Manufacturing (Kaisler et al., 2013)

• There is no single set formula for extracting value from Big Data; it will depend on the application.

• There are many applications where simply being able to comb through large volumes of complex data from multiple sources via interactive queries can give organizations new insights about their products, customers, services, etc.

• Being able to combine these interactive data explorations with some analytics and visualization can produce new insights that would otherwise be hidden.

Through our study of the systems that have been in the field of Big and manufacturing data has been inferred components can be summed up in the framework of the new system, which consists of three main sections (Laney, 2001):-

a.   Data Source: through which data can be determined, which in turn are large data such as establishing internal or external data sources facilities which are in different formats (XML, TXT) and is split this data to:-

• Machines records in the factory : are records containing product data and the functioning of the production process in the production chain and that are used to determine the failure or error of these machines for the product in the production process.

• Machinery and equipment systems: systems which contain data related to raw materials and the quality of each product.

• Internal ERP system: is the system that has a public cost data and all suppliers including materials costs.

• Various files: Bearing components and costs of each product and information about the product and the type of customer with little information about purchasing products request and demand.

• Realigned and formulation data: the use of information technology tools to coordinate all data inputs and reduce input errors to fit the structure of the database based on predetermined criteria for these tools.

b.   Using Hadoop Technology with multiple databases and servers to provide information to the BI system to be used for the purpose of subsequent analysis (see Figure 2) (Letouz, 2011; Manyika et al., 2011):

• MapReducing be received data bases specific data in a coordinated manner of the previous stage, and carried to a single database by setting standards for the analysis of each source and improve the data using these parameters to save all the data results in a database management server that holds data types.

• Remember as a result of data from MapReducing stage in different server system for Business Intelligence system database.

c.   Application Business Intelligence System: Application steps multiple processes using a single database and contain a setup consists of:

• Manufacturing data that was provided by the results of previous Hadoop process when retrieving database.

• Company's server: the system is set and the analysis of BI tools even on this server. It is to create a connection with the system to define the variables to analyze the data and system design ties for Business Intelligence system to be displayed to the end user.

The expected results of the design of this framework through the process of handling and analysis of data in the large manufacturing system are:-

1- Reduce data processing time because the data becomes organized and coordinated. And reduce the time to detect errors and speed up the decision-making and enhance the quality of products.

2- Choose the best suppliers and materials for each product in addition to providing for an increase or decrease production lines solutions.

3- The identification of products that give greater competitive results and achieve the goal of production.

BUSINESS INTELLIGENCE FROM THEORY TO APPLICATION

Business intelligence has become a key element in the IT sector. The term business intelligence is an old one, but it was general or ambiguous. It was used as a synonym for decision support, analysis, and data stores. Now business intelligence has become more clearly defined and has better understood applications. If we interpret this term linguistically, it simply means intelligence in understanding your business, you can understand your work by analyzing your business processes. We can accomplish business analysis by aggregating information about our operations such as marketing, sales, service activities, customer behavior in response to these activities, the behavior of your internal systems, and supplier systems in response to your customers' behavior. After you collect this information (this compilation must be done continuously, not just once), this information is organized and stored in a way that is easy to access, process, and display using various techniques such as reports, queries, analytics, OLAP, And data mining tools. In the end, the results of applying these techniques can be used to improve processes within your business and start a new analysis cycle again (Figure 3).

In order to bring business intelligence to the widest possible audience, and to take full advantage of the benefits of using related technologies, it must be deployed with an appropriate infrastructure capable of achieving the business intelligence procedures we mentioned earlier, and supporting the appropriate application area for each user in each pattern. We have poisoned this infrastructure with business intelligence platforms. Business Intelligence platforms should include the following technologies:

Data Warehouse Databases: Business intelligence should support typical relational and multidimensional relational database repositories. In addition, storage models must support transparent access to data or near-transparent wherever they are stored.

OLAP: OLAP is a core component of the Business Intelligence platform. It is the most commonly used technique for analysis. The Business Intelligence platform
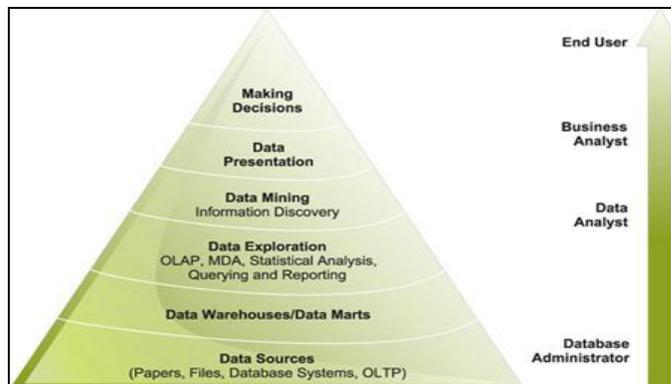

Figure 3. Business Intelligence Platforms (Survey of Big Data Architectures and Framework from the industry, 2014)

should provide OLAP support within its databases, as well as OLAP functions and interfaces, with the possibility of building and managing them.

Data Mining: Business intelligence platforms should include support for data mining technologies, especially those that provide us with a wide range of algorithms that can work with data in data stores.

Interfaces: Business intelligence platforms should provide open interfaces for data warehouse databases, OLAP, and data mining. These interfaces must comply with global standards to make it easier to purchase and build applications that use business intelligence platforms.

Build and Manage Capabilities: Work platforms must support the ability to build and manage data stores. Building capabilities should include the ability to implement data warehouse models, collect, transfer, and clean up existing data in operational sources, with the possibility of performing initial loading and updating of data warehouses based on their models. A wide range of data sources, including databases, files, and data in known software packages, should also be supported. Conversion capabilities must be strong and flexible. Pre-defined conversions must be packaged. It must also be scalable through programming languages. Management capabilities should cover all sources, users, data, and procedures across all platforms.

Business Intelligence is used as a generic term that indicates all procedures, techniques, and tools that support IT-based decision-making systems. The following pyramid illustrates the logical positioning of different business intelligence techniques according to their inherent value as the basis for strategic and tactical business decisions.

In general, the value of information that will support decision-making from the bottom of the pyramid to the above is increasing. Decisions based on data in the lower

layers, where millions of data records are usually present, will affect the conversion of only one client. Decisions based on highly aggregated data in the upper layers of the pyramid will affect the company's divisions, even the entire company. So we usually find different types of users according to the different layers on the pyramid. The database manager works primarily on the data source database and the data warehouse, and the executives and business analysts work at the top levels of the pyramid. Here are some of the business applications that can be explored in addition to real value:

- Default payment of loans.
- Purchase a product or respond to product downloads.
- Cancellation of a policy.
- Fraud detection.

Data mining can also play a prominent role in performance-related processes such as:

- Determine the effectiveness of advertising, marketing and advertising campaigns.
- Pricing of products.
- Determining the effectiveness of a call center.
- Evaluation of employees' performance.
- Evaluate the performance of suppliers and vendors.
- Evaluation of manufacturing and production activities.

THE VARIANCE BETWEEN BIG DATA AND BUSINESS INTELLIGENCE

Big data techniques differ from business intelligence as Bid data deals with various sources and the size of the largest of structured and unstructured data and distributed to many devices over the Internet and are not limited to a specific number of systems and databases in one place as in businesses. But at the same time using the same analytical methods known in the field of business intelligence and data warehouses, and data mining operations neurological Kalshbkat and algorithms, artificial intelligence and logic mysterious Fuzzy Logic and inductive reasoning Clustering and assembly methods and other methods (Kaisler et al., 2013).

- The tools that deal with Big data are classified into three parts:-
Data mining exploration data tools are usually running on the discovery of evidence, both structured (as users movement) or unstructured (as text and images), which are distributed to various devices via the Web. Where software tools working to extract the data and put it properly to be handled later.

- Data Analysis tools that operate on the data that have been discovered through the use of comparison and classification approach, connectivity and other analytical and organizational tools and analysis in order to get out the required results and that already have been identified objectives.
- Results Dashboard tools that offering visually and graphical and have the final results of the analysis, according to what has been determined as the goal of the analysis in advance.

In the current times, where increasingly rely on digital technology, day after day, the institutions that instilled a strong culture centered around information and have the ability to identify and manage its assets and take advantage of them is that eventually overtake their rivals. To achieve this, it is necessary to enable individuals to draw analyzes that they need to improve their field. Business Intelligence solutions from the company serves a diverse offering packages designed specifically for data analysis and representation in front of you on the screen. This platform provides a unique and uniform experience dealing with various data sources and devices, which allows you the luxury and speed in performance for data extraction, search, analysis and representation. The business intelligence tools from the center is available for all devices to ensure we have access to it and take advantage of them with ease (Inmon, 2005). The user can single click of conduct searches in the data using the control panel, by means of an easy to use and ensures smooth data discovery and take business decisions well-thought-interactive. The various tools of BI tarjet to achieve the following benefits:-

- Live data and reports real-time analysis tools, which displays the current status of the institution.
- Assist users in interpreting data for key performance indicators they have, and help them make better decisions.
- Represent a customizable on-demand for control panels and data.
- Ease of integration of different data sources.
- Analysis of complex business models and processes.
- Smoother design and ease of user experience, without the need to rely on specialists.
- Needed to reduce system response times.

Usually characterized by traditional reporting the existence of specific and prefigured boxes, resulting in institutions for answers to the questions asked only. The company serves a diverse solution for Business Intelligence, offers inquire possibilities depending on the purpose. That would be the solution users from receiving

answers to any question that might be put forward, which in turn leads to a deeper understanding of the causal patterns that affect the dynamics of institutions (Aggarwal, 2013). Business Intelligence can be applied for the purposes of the following acts in order to drive business value:-

• *Measurement:* a program that creates a hierarchy of performance metrics and measurement of business leaders on the progress made towards achieving the goals of the work (also known as business process management).
• *Analyses:* program that builds quantitative processes to work to reach optimal decisions and business performance knowledge discovery. Often involve: data mining, statistical analysis, predictive analytics, predictive modeling, business process modeling.
• *Reporting / institution amount:* a program that builds strategic infrastructure to serve the reporting to the strategic management of businesses, the reports do not work. Often involve: data visualization, Executive Information System, olap.
• *Cooperation / collaboration platform:* a program that gets different areas (inside and outside of work) to work together through the exchange of data and electronic data interchange.
• *Knowledge management:* a program to make the company data driven by strategies and practices to identify, create, represent, distribute and enable adoption of ideas and experiences that are real business knowledge. Knowledge management leads to the Department of Education and regulatory compliance / compliance.
• *Collection requirements:* according to the tendencies of business users and their requirements impact almost every decision made throughout the design and implementation of the BI system. Business requirements sits in the heart of the business center, and linked to all aspects of daily business operations. Therefore it is very important to the success of data storage.

The analysis of business requirements is happening on two different levels:

1- *Macro level:* Understand the business needs and priorities relative to the perspective of the program
2- *Micro level:* understanding users' needs and desires in the context of the project, one relatively narrow.

CONCLUSION

After reviewing the previous studies and the study of the importance of Big Data in the manufacturing and tools used operations to provide useful information, and attention to the importance of research and development to find new solutions to the challenges in this area, it has been established many companies to offer the best solutions to problems through the process of dealing with the analysis of large data in the field Manufacturing To achieve the objectives constructors manufactured as described previously.

A design that has been described in this study, offers several practical steps ranging from data sources even extract reports to the end user through this data which will give further details of the data and information about the products and the cost of errors after analyzing data in the Business Intelligence system and helps in decision making best of production processes. More importantly, it analyzes the error logs to determine which process should be changed or keeping it unchanged in the production chain. Finally, we concluded that the integration of the advantages of information technology with statistical methods and algorithms has provided the potential to predict future behavior and thus develop appropriate solutions to problems before they occur in the event they can occur, or to predict the goal of development and modernization in all areas, The data, which constitute a stage of a more comprehensive process, is the exploration of knowledge in databases, which has become a major concern for all countries in all its institutions in general.

REFERENCES

Aggarwal CC (2013). editor. Managing and Mining Sensor Data. Advances in Database Systems. Springer.
Aggarwal CC, Zhai C (2012). Probabilistic Models for Text Mining:in Mining Text Data, Kluwer Academic Publishers, Netherlands. pp.257-294
Assuncao MD, Calheiros RN, Bianchi S, Netto M, Buyya R (2015). Big Data Computing and Clouds: Trends and Future Directions, Journal of Parallel and Distributed Computing (JPDC). 79(5): 3-15
Chen CLP, Zhang CY. Data-intensive applications, challenges, techniques and technologies: A survey on Big Data, Inform.Sci
Chen J, Chen Y, Du X, Li C, Lu J, Zhao S, Zhou X (2013). Big Data challenge: a data management perspective, Frontiers of Computer Science. 7(2): 157-164.
Chen M, Mao S, Liu Y (2014). Big Data Survey, Mobile Networks and Applications 19(2): 171-209
Diebold F (2000). "Big Data" Dynamic Factor Models for Macroeconomic Measurement and Forecasting.Discussion Read to the Eighth World Congress of the Econo-metric Society,
Grünwald M, Taubner D (2009). Business intelligence. Informatik-Spektrum 32: 398–403.
Inmon WH (2005). Building the Data Warehouse, John Wiley & Sons,
James Manyika, Michael Chui, Brad Brown, Jacques Bughin, Richard Dobbs, Charles Roxburgh, Angela Hung Byers (2011). Big data: The next frontier for innovation, competition, and productivity.. McKinsey Global Institute.

Jardak C, Mahonen P, Riihiajariv J (2014). Spatial Big Data and Wireless Networks: Experiences, applications, and Research Challenges, IEEE Network 28(4): 26-31

Kaisler S, Armour F, Espinosa JA, Money W (2013). Big Data: issues and challenges moving forward, in: Proceedings of the 46th IEEE Annual Hawaii international Conference on System Sciences (HICC 2013), Grand Wailea, Maui, Hawaii. pp.995-1004

Laney D (2001). 3-D Data Management: Controlling Data Volume, Velocity and Variety.META Group Research Note.

Letouz E (2011). Big Data for Development: Opportunities & Challenges. May.

Survey of Big Data Architectures and Framework from the industry, NIST Big Data Public Working Group, 2014