



Big data technologies: An empirical investigation on their adoption, benefits and risks for companies



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ABSTRACT

Companies currently have to deal with profound changes in the way they manage their business, their customers and their business models, since they are overrun by a data-driven revolution in management. This revolution is due to the wide availability of big data and the fast evolution of big data technologies. Big data is recognized as one of the most important areas of future technology, and is fast gaining the attention of many industries, since it can provide high value to companies. This article investigates the adoption levels of big data technologies in companies, and the big data sources used by them. This article also points out the most frequently recognized strategic, transactional, transformational and informational benefits and risks related to the usage of big data technologies by companies. In order to achieve these aims, the paper looks at the differences that exist among companies of different sizes, by comparing medium-sized and large companies, and the differences among companies of different industrial sectors. It provides evidence that only in a few cases these differences are significant. This study could serve as a reference for managers who wish to initiate an evaluation cycle on the adoption and usage of big data technologies.

1. Introduction

Companies have to deal with profound changes in the way they manage their business, their customers and their business models, since they are overrun by a data-driven revolution in management (Tambe, 2014). This is taking place because new opportunities are emerging thanks to the fast evolution of big data technologies and to the enormous availability of data that firms can capture from many sources, such as social media activities, Radio Frequency Identification (RFID) tags, web information, mobile phone usage and consumer preferences expressed on the web (Davenport, 2014).

In view of the increasing importance of big data, companies can leverage on these data to exploit new opportunities and gain an in-depth understanding of the hidden values. Companies in many industries are increasingly interested in their potentialities, since they can generate high revenues. As stated by the International Data Corporation (IDC, 2016) “Big data and business analytics worldwide revenues will grow from nearly \$122 B in 2015 to more than \$187 B in 2019, an increase of more than 50% over the five-year forecast period”.

Big data can be obtained from within and outside companies, in the form of structured and unstructured data, and it can generate difficulties for companies in capturing, aggregating, analysing and extracting value from them (Gandomi & Haider, 2015). As stated by McAfee, Brynjolfsson, Davenport, Patil and Barton (2012) “businesses

are collecting more data than they know what to do with”. However, they need to develop new skills and a new management style to turn all this information into a competitive advantage. In order to achieve this goal, and considering the managerial complexity involved in dealing with such an enormous quantity of data, as well as the difficulties that companies may have in managing them, managers should not underestimate the positive and negative issues that need to be taken into account in the exploitation of big data. For this reason, managers need to be aware not only of its positive effects, but also of its negative ones in order to avoid being unprepared when they decide to invest and to derive value from big data. In this direction, there is scant empirical evidence about the benefits and risks associated with the exploitation of big data for business goals.

Till now, literature has provided very little empirical evidence on these issues, and the key contribution of this paper is therefore to enrich the studies that investigate the issues related to big data by empirically studying, through a survey analysis on a sample of 200 companies, the benefits and risks of big data at a company level. This topic is acquiring importance in literature, since the benefits and risks need to be identified, managed and controlled if managers want to derive value from their investments in big data technologies. This paper also provides statistics about the type of big data sources used by companies, and the big data technologies that are adopted. In order to achieve these aims, the differences that emerge according to the size and to a company

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industrial sector have also been investigated.

Based on the increasing academic and managerial interest in big data, this paper first explains what big data is, and then discusses the main issues that need to be considered when managing big data. After this discussion, the research methodology is presented, and this is followed by the results of the study. Finally, the discussion and the conclusion sections are given. The paper concludes by highlighting the big data technologies that are adopted the most frequently by companies, the big data sources that are used the most by companies, and the benefits and risks of big data technologies that are recognised the most by companies, in an aggregated way, and by showing results according to the company size and industrial sector.

2. What big data is

How organizations capture, create and use data is changing the way these organizations work. Executives, academics and business analysts need to be aware of this change, which will transform how organizations are managed, and will also alter the economies and societies in which they operate. This revolution has introduced several changes in companies. For example, they now have more data to use than ever before. This data may be internal or external, structured or unstructured. By using internal and external data, companies are beginning to understand patterns of consumer activity that had once been impossible to perceive or act upon. Companies are also using new technological solutions to understand their own operations and behaviour at a much finer level of detail.

The term “big” began to be diffused in 2011 (Gandomi & Haider, 2015). Leading companies, such as IBM, have made huge investments in building a powerful platform for big data analytics in order to deliver new business insights with the goal, for example, of reducing storage and maintenance costs. Gartner provided the following definition for big data: “Big data is high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making”. In this definition, volume refers to the generation and collection of a huge amount of data where the data scale becomes increasingly high; velocity refers to the timeliness by which big data is produced, collected and analysed; variety indicates the different types of data that can be produced in a structured and unstructured way as audios, videos, webpages and texts. As mentioned by Davenport (2014), big data can be also classified as machine-generated, which refers to data that is created by a machine without human intervention, or as human-generated, which refers to data that humans, in interaction with computers, supply. The former refers to audio, music, image, speech and video data, to sensor data, such as RFID tags used to track locations, to Intelligent Lighting Control (ILC) sensors used to identify the location and conditions of goods on the supply chain for example, and to smart meter, medical device or Global Positioning System (GPS) data. The latter instead refers to Twitter tweets, social media posts, clickstream data or web contents.

The importance of big data is demonstrated by the fact that data are produced extensively every day in many forms and from many different sources. For example, more than 98,000 tweets are written every sixty seconds, 695,000 status updates are posted on Facebook, 11 million instant messages are written, 685,445 Google searches are launched, more than 169 million emails are sent, more than 1820 TB of data are created, and there are 217 new mobile web users. Furthermore, as shown by Google trends (2016), interest in big data has also increased over time (Fig. 1).

3. Managing big data technologies in companies

Davenport (2014) highlighted the importance of big data technologies, such as Hadoop or Natural Languages Processes, to analyse a huge amount of data for cost reduction purposes, to take faster and

better decisions and to improve the products and services offered. For example, Wal-Mart’s semantic analysis search engine, Polaris, a platform that was in-house designed, relies on text analysis and machine learning to produce relevant search results. Adding a semantic search has improved the possibility of online shoppers completing a purchase in Wal-Mart by 10% to 15%.

When new technological solutions are adopted by companies, as big data technologies are, these companies can exploit the benefits, but they also need to be aware of the existence of the possible risks they can incur. On the one hand, investments in new technologies necessitate changes over time in organizations, in order to reap the full benefits. In fact, companies need to sustain a range of management activities in order to ensure that they obtain benefits from a technological investment (Farbey, Land, & Targett, 1999). According to Gregor, Martin, Fernandez, Stern, & Vitale (2006), the benefits associated with technological investments can be classified in four typologies: strategic, informational, transactional and transformational. The strategic benefits are those that can alter the way companies compete or the nature of their products. The informational benefits are those that provide information and communication that can be used to improve decision making in a company. The transactional benefits refer to investments that support operational management and which are able to cut the costs sustained by companies. Finally, transformational benefits refer to the results of changes that a firm has to make to the structure and to the capacity of implementing a technological investment.

Organizations, on the other hand, need to enhance their ability to manage the risks associated with a new technological investment, if they want to have successful implementations (Willcocks & Graeser, 2001). Managers feel the need to minimize the systemic risks that arise from the use of Information Technology (IT). Accordingly, the assessment of the risks that managers might incur is very important, and it allows managers to identify any outcomes that could mine the achievement of the expected benefits. For example, there may be risks related to a security breach of information systems or risks related to the costs of the breakdown of systems for the company (Dhillon & Backhouse, 1996).

Considering all these reasons, the following sections show the research methodology that has been used to investigate the specific benefits and risks of big data technologies and their adoption in companies.

4. Research methodology

4.1. Data collection

A questionnaire was distributed to medium and large-sized French companies in order to evaluate the benefits and risks that these companies have to face when adopting and implementing big data solutions. In order to decide whether a company belonged to the medium or large sized categories, we adopted the European definition that considers the number of employees. A medium-sized firm is a company with a number of employees of between 50 and 249, while a large company has more than 249 employees.

As our study has been conducted at the firm level, we followed the lines of previous studies (Ji-fan Ren, Fosso Wamba, Akter, Dubey, & Childe, 2016) and targeted the Chief Information Officer (CIO). We implemented a random sampling method to select 1,962 medium and large French companies to interview from a population of 19,875 companies registered in the Bureau Van Dijk database. The questionnaire was divided into two sections. In the first section, questions were included about the big data sources used by the companies and the big data technologies. In the second part, questions were asked about the benefits and risks of the usage of big data.

First, a pilot study was conducted on a subsample of companies in order to test the comprehensibility of the questions included in the questionnaire, as well as to identify any possible criticalities and to

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