

## **THE IMPACT OF BIG DATA TECHNOLOGIES ON COMPETITIVE ADVANTAGE OF COMPANIES**

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**Abstract.** *The emergence of a large quantity of data, from various sources, available in real-time, known as Big Data, has stimulated development of new technologies, techniques, tools, knowledge and skills, which enable us to work with this data. Big Data represents not only a factor from the environment that confronts the companies with an avalanche of data, but also a very important resource which provides opportunities for companies to make value on the basis of collected data. Characteristics and possibilities which Big Data technologies offer have positioned them as a valuable factor for gaining and sustaining the competitive advantage of companies. The aim of this paper is to examine the impact of Big Data technologies on competitive advantage of the companies that use them.*

**Key words:** *Big Data, Big Data Analytics, competitive advantage, strategic activities, companies*

**JEL Classification:** 033, L21

### INTRODUCTION

The development and application of various social networks, smart phones, tablets and intelligent devices connected with sensors have led to an enormous increase of the volume and variety of data which have become available for processing and analysis in real-time (Heisterberg & Verma, 2014). All that data were named as „Big Data” and caused the development of new technologies, techniques and tools that have the possibility to acquire, process, analyze and store them. Through history companies have striven to get regular and reliable information, but today in a hyper-networked world, they have realized

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the importance of Big Data for their functioning and started to implement some of the Big Data solutions. The aim of this paper is to examine the impact of Big Data technologies on competitive advantage of the companies that use them.

The paper is organized as follows. The first two headings are focused on Big Data definitions, key characteristics, technologies and tools. The fourth and fifth headings are focused on the impact of Big Data technologies on functioning of companies and on key advantages that companies can gain by using those technologies.

## 1. BIG DATA DEFINITION

By reviewing the literature, numerous definitions regarding Big Data can be found (Lukić, 2015). One of the most accepted and cited is the McKinsey definition, according to which Big Data refers to datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze data (Manyika et al., 2011, p. 1). However, Big Data as a concept is not just a matter of size and challenges for working with these data cannot be overcome with larger storage space and processors (Lukić, 2015). The facts that data are largely semi-structured or unstructured and that these data represent 95% of all new data are often neglected (Berman, 2013, p. 2). Some authors pointed out that Big Data represents large quantities of structured, semi-structured and unstructured data that cannot be placed in relational databases (Rouse, 2014), while others stated that Big Data represents data sets whose size and complexity need innovative and special approaches for storing, managing, processing, analyzing and visualization of these data (Chen et al., 2012).

Some attributes that need to exist in order to name data as Big Data are determined over time. These attributes vary from author to author, but there is a consensus among all the authors around three attributes, popularly known as 3Vs: Volume, Variety and Velocity (McAfee & Brynjolfsson, 2012; Minelli et al., 2013). Volume is the huge amount of data that companies are trying to use in order to improve the decision making process across the enterprise. Nowadays, companies measure their collected data in terabytes, petabytes and zettabytes, and there are estimations that people create 2.5 quintillion bytes of data on a daily basis (Walker, 2015). Variety, as the second attribute of Big Data, refers to different types of data because data are available from numerous sources (social networks, digital TV, credit cards, medical devices, sensors, bar codes, smart phones, tablets, etc.) and can be structured, semi-structured and unstructured (Minelli et al., 2013; Kudyba & Kwatinetz, 2014). The third attribute of Big Data, Velocity, is the speed at which data are created, processed and analyzed and reflects the need for real-time decision making on the basis of collected data (McAfee & Brynjolfsson, 2012; Minelli et al., 2013). Beside these three attributes of Big Data, some authors propose Volume as the fourth „V“ in the sense that there can be revealed significant values for companies through analysis of data, while some other authors propose Veracity which refers to questions of consistency, relevance and quality of all available data (Schroek et al., 2012). It is important to acknowledge that Big Data is not just one of the newest trends in information and communication technologies, but a significant and valuable factor of competitiveness of any company which is surrounded by an avalanche of data (Nerney, 2013; Hagen et al., 2013). In practice, there are no industries or sectors that are immune

to Big Data, because everything we do now leaves a digital trace – data that can be used (Marr, 2015). A few events gave legitimacy and significance to Big Data. McKinsey Institute published a report „*Big Data: The Next Frontier for Innovation, Competition and Productivity*“ in 2011, The World Economic Forum held a conference „*Big Data, Big Impact: New Possibilities for International Development*“ in 2012, while in the last couple of years a large number of books regarding Big Data impact on productivity and competitiveness of companies has been published (Mayer-Schönberger & Cukier, 2013; Van Rijmenam, 2014; Wasterman et al., 2014; Marr, 2016). Simultaneously, Big Data has become the subject of numerous media (The Economist, New York Times, National Public Radio), leading publishers have introduced new journals regarding Big Data topics [Journal of Big Data (*Springer*), Big Data Research (*Elsevier*), Big Data and Society (*Sage*), International Journal of Big Data Intelligence (*InterScience Publishers*)], while existing journals frequently publish calls for papers regarding Big Data technologies (Journal of Organization Design, Journal of Information Systems and e-Business Management, Journal of Biomedical and Health Informatics, etc.). Meanwhile, conferences on Big Data started to be organized worldwide, but also in our region.<sup>2</sup> In just a few years, Big Data as a concept has entered the scene and become the subject of interest of countries, academics, communities, individuals. The number of faculties, educational institutions and consulting companies which offer different educational programs and trainings in the field of Big Data is also increasing. Because of all of this, Big Data technologies have found their place not just in theory, but also in practice.

## 2. BIG DATA TECHNOLOGIES AND TECHNIQUES

There are a number of technologies that are developed to work with Big Data. It is believed that at the beginning of the 2000s Google developed tools for Big Data and encouraged the emergence of other technologies and tools that enable collection, processing, analysis and storage of large quantities of different types of data in real-time in a more economical way (Heisterberg & Verma, 2014). Some of these technologies are new, while some of them already existed but were upgraded in order to be able to work with Big Data. Different authors classify Big Data technologies in different ways. There is no single list of all available technologies for working with Big Data because their number is constantly changing - there are new technologies almost every day. Also, a lot of these technologies overlap or are interdependent. Without intending to cover all existing technologies for working with Big Data, in Table 1 are presented some of them, according to Joshi who classified those technologies into several segments – Big Data platforms, databases, business intelligence, data mining, file systems, programming languages, search, aggregation and transfer of data.

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<sup>2</sup> Significant conferences and forums devoted to Big Data were organized in Belgrade: Conference „Big Data Analytics for Decision-Making“ in May 2015 at the Faculty of Organizational Sciences, forum „South-East European Forum on Data Science“ in June 2016 at the Faculty of Organizational Sciences, and Data Science Conferences (organized by Institute of Modern Sciences) were held in October 2015 and 2016.

**Table 1** The review of available Big Data technologies

Segment	Technologies
Big Data platforms and tools	Hadoop, MapReduce, GridGain, HPCC, Storm
Databases/ warehouses	Cassandra, Hbase (Hadoop tools), MongoDB, Neo4j, CouchDB, OrientDB, Terrastore, FlockDB, Hibari, Riak, Hypertable, BigData, Hive (Hadoop tools), InfoBright Community Edition, Infinispan, Redis
Business Intelligence	Talendchn, Jaspersoft, Palo BI Suite/Jedox, Pentaho, SpagoBI, KNIME, BIRT/Actuate
Data Mining	RapidMiner/, Rapid Analytics, Mahout (Hadoop tools), Orange, Weka, jHepWork, KEEL, SPMF, Rattle
File Systems	HDFS (Hadoop Distributed File System)
Programming Languages	Pig/Pig Latin, R, ECL
Big Data Search	Lucene, Solr
Data Aggregation and Transfer	Sqoop (Hadoop tools), Flume (Hadoop tools), Chukwa
Various Big Data tools	Terracotta, Avro, Oozie, Zookeeper

*Source: Adapted according to Joshi, P. (2015). Analyzing Big Data Tools and Deployment Platforms. International Journal of Multidisciplinary Approach and Studies, 2(2), 45-56.*

The most frequently used technologies for working with Big Data are Hadoop, Map Reduce and Big Table which provide opportunities for prompt and effective processing of large amounts of data in real-time or near real-time (Khan et al., 2014).

In the last couple of years, there is a rise of interest on the impact of Big Data analytics which represents the usage of various analytical techniques on large amounts of data from different sources in order to discover hidden patterns, regularities and other useful information (Daft, 2015). There are some important differences between traditional analytics and Big Data analytics. Those differences are presented in Table 2.

**Table 2** The key differences between traditional and Big Data analytics

Characteristics	Traditional Analytics	Big Data Analytics
Key data characteristics	Structured data Typical data volume is measured with megabytes and gigabytes	Any type of data: structured, semi-structured and unstructured Typical data volume is measured with terabytes and petabytes
The object of analysis	The sample from known population	Entire population
Facts and findings Necessary knowledge	Answers on already defined questions Knowledge of analytical techniques and tools, basic knowledge of reporting	New and unsuspected findings and facts Advanced analytical, mathematical, statistical and computer knowledge

*Source: Adapted according to Yan, J. (2013). Big Data, Bigger Opportunities, Retrieved from: <http://www.meritalk.com/pdfs/bdx/bdx-whitepaper-090413.pdf>, Accessed on: 05 November 2014.*

As presented in Table 2, the key characteristics of data are significantly changed, data are largely unstructured, present in large quantities and available in real-time. The subject of analysis is extended from the sample to the entire population, while answers are provided to questions that companies were not able to recognize as meaningful for their

functioning. Due to this fact, there is a need for new and different types of thinking on how to gain value on the basis of available data (Taylor et al., 2014). The solution has been found in numerous techniques for analytical processing of data that derive more disciplines including computing, mathematics, statistics and economics. Some of the most frequently used techniques originate from machine learning, neural networks, social networks analysis, optimization methods and similar (Chen & Zhang, 2014). Manyika et al. (2011) made a list of Big Data analytics techniques in which they classified: A/B testing, association rules, classification, clustering, genetic algorithms, machine learning, neural networks, predictive modeling, regression, signal processing, spatial analysis, simulation, time series analysis. Some of the most frequently used algorithms are (Erl et al., 2016):

- Association rule learning presents an algorithm for identifying the connections and relationships among variables. One common application is in retail when this technique detects which products are frequently bought together.
- Classification presents an algorithm that identifies to which category of data belongs some generated information. With this techniques, companies are able to make special customer segments and monitor their behavior.
- Clustering has the goal to classify various objects into groups/clusters based on some common characteristics, for example, classification of customers into groups based on their behavior and adjustment of marketing activities.

In the past few years various software solutions have been developed for visualization of results, because the manner in which results are presented is very important for their analysis and interpretation. It is easier to examine given results and to make conclusions using different tables, graphs and figures. Some of the most popular visualization techniques are (Olshannikova et al., 2015):

- Tag cloud which is used during the analysis of text and refers to the frequency of the usage of certain words or phrases.
- Clustergram is used in cluster analysis and displays the connections and relationships among individual elements in the data depending on the cluster to which they belong.
- Motion charts represent a large number of different data on two-dimensional graphs.

Very frequently used in practice are Heat Maps which present desired results according to provided categories – for example location, brand, market, sales manager and similar. Also, Dashboards are very popular because they provide results of all analyses that users want in one place.

### 3. THE IMPACT OF BIG DATA TECHNOLOGIES ON FUNCTIONING OF COMPANIES

The potential for strategic value creation based on data has always existed, but today this potential is much larger due to all available data and new technological opportunities for handling them. According to Porter and Millar, information can affect competition by changing industry structure and rules of competition, by giving companies new ways to be better than rivals, and by opportunities to introduce new business models (Porter & Millar, 1985). In the last couple of years, data have been named as the new frontier for innovation, competitiveness and productivity (Manyika et al., 2011), the resource responsible for management revolution (McAfee & Brynjolfsson, 2012), the resource equal to oil and gold (Bilbao-Osorio et al., 2014), and the key determinant for innovation

and creative destruction (Pepper & Garrity, 2014). These attitudes regarding the importance of data are very frequently expressed, because modern companies have become overwhelmed with data, the amount of which is increasing each year by 35% to 50% (Beath et al., 2012). Also, unlike the time when it was possible for information technologies to work only with quantitative data while all other information was not possible to use (Drucker, 2002), in the last few years, due to Big Data technologies, it becomes possible to interpret even data in the qualitative form. Mayer-Schönberger and Cukier introduced the term „datafication“ in 2013 with the aim to describe the process of collecting all available data and their transformation into valuable business decisions (Mayer-Schönberger & Cukier, 2013).

On the one hand, Big Data technologies are the factor from environment that confronts the companies with large quantities of data from a variety of sources, while on the other hand those technologies represent the resource of organization which allows the companies that use them to make value on the basis of collected data (Lukić, 2016). Companies which operate in a highly competitive environment must be able to cope with the constantly changing conditions (Janačković, Milovanović & Milovanović, 2016). The key question which needs to be examined through implementation of Big Data technologies is whether these technologies fundamentally change the business model of a company by creating new business opportunities or if they improve the existing business model (Morabito, 2015; Stackowiak et al., 2015). The managements of organizations need to answer the following questions (Kiron et al., 2014):

- Is the company ready for new ideas?
- Is the company ready to change the way in which it functions?
- Does the company consider data as a valuable resource for its functioning?
- In which way do the employees need to be encouraged to be led by data in the decision making process?

## 5. THE KEY ADVANTAGES OF USING BIG DATA TECHNOLOGIES

Big Data technologies offer new opportunities for growth and development, but also for the creation of new companies whose business model is based on data (McGuire et al., 2012). Having in mind that customer perspective has become integrated in all processes and activities in a company (Dehghan et al., 2015), and that strategies related to creation of new products or services are based on analysis of information related to customer needs (Stefanovska & Soluncevski, 2015), the application of Big Data can be of tremendous value not only for retaining the existing customers, but for identifying and attracting new ones. The companies that use Big Data technologies can better understand their customers, employees, business processes, partners and identify all those activities in which improvements are needed (Adduci et al., 2011; Wamba et al., 2015).

There are few characteristics of Big Data technologies that can be very useful to companies that use them (Manyika et al., 2011, pp. 4-6):

- Transparency. All data that exist inside and outside the company become available in one place, so the company can establish „one version of the truth“. Employees can easily find data which they need in one location, which consequently leads to savings in time and effort.

- Experimentation in order to identify different needs of customers and to create more custom products and services. Companies can collect more detailed data about customers, their opinions and attitudes about products and services. Thanks to different analytical techniques, companies can examine the effects of certain improvements in products and services.
- Identification of different customer segments in order to adjust products and services according to their needs and requirements. By creating different customer segments, companies gain a clearer picture of how they can meet customer needs better, and thus have a basis not only for improvement of existing products and services, but for the creation of new ones. Segmentation may be based on the large number of different criteria – income, age, location, buying habits, etc. (Kiron et al., 2011).
- Support for decision making process with automated algorithms. Sophisticated software has the possibility to improve the decision making process with automated algorithms which automatically analyze collected data and initiate corrective actions. The application of controlled experiments to test hypotheses and analyze the results of the decisions made, can significantly improve the decision making process (McGuire et al., 2012). Many authors pointed out that one of the significant changes is a shift from intuitive decision making to data driven decision making (Provost & Fawcett, 2013; Minelli et al., 2014).
- Improvement of existing products and services and the introduction of new ones. By identifying certain relationships in data, companies can realize important facts about products and services. The results of the analysis can be a new product, service, improvement of existing product or service, a new approach to pricing, etc. (Davenport, 2014).

The application of Big Data technologies requires from company's management to be focused on activities related to customers, products, processes in order to optimize the key activities and identify new opportunities for further growth and development. The key objectives that companies want to achieve by using Big Data technologies are: identifying new sources of revenue, cost reduction, better sales, distribution, marketing activities (Schmarzo, 2013). Besides that, Big Data technologies have a great impact on the decision making process. Decision makers want to have the right data at the right time and in the right format (Power, 2015), so the decisions can be based on data, leaving intuition and gut feeling aside (Provost & Fawcett, 2013). Morabito emphasized that due to the application of Big Data technologies it is possible to: (1) improve the decision making process; (2) improve business performance in the entire company; (3) develop integrated access to key information and data (Morabito, 2015). Furthermore, Big Data technologies create opportunities for more precise adjustment of products and services because companies can monitor data for each customer individually and consider their buying habits, location, response to incentives, demographic characteristics such as business, memberships in various organizations, opinions and attitudes on social networks, blogs and forums (Morabito, 2015). Consequently, Big Data technologies have an impact on strategic and operational activities of companies (Table 3).

**Table 3** Key impacts of Big Data technologies on strategic and operational activities

Impacts	Benefits	Examples
Strategic Activities	Faster decisions	Faster strategic decisions Advanced and precise data analysis
	Better decisions	Assessment of the effects of made decisions Quantified impact of decisions which are made
	Proactive decisions	Application of predictive analytics to identify potential customers
Operational Activities	The improvement of organizational capabilities	Finding the causes of problems and making proposals for their overcoming The release of employees from the activities that have small value
	Increased Automation	Reduction of effort needed for reporting The release of management from activities that have small value
	Elimination of redundant tools	Elimination of all redundant tools for data collection, processing, reporting and analysis
	Speeding up the processes	Transparency of all information and data regarding processes

*Source: Adapted according to Hagen, C., Ciobo, M., Wall, D., Yadav, A., Khan, K., Miller J., Evans, H. et al. (2013). Big Data and the Creative Destructions of Today's Business Models, A.T. Kearney Inc.*

Regarding strategic activities of companies, Big Data technologies have a large impact on the decision making process, because due to their application decisions are faster, better and proactive. Beside strategic, operational activities are also under the impact of Big Data technologies, firstly through automation and improvement of business processes, but also through development of organizational capabilities for solving problems and elimination of activities with small added value.

#### CONCLUSION

Technology progress caused generation of data with high volume, velocity, and variety, known as Big Data, which are available in each industry and company. These data have stimulated the development of new technologies, techniques and tools that are able to collect, process, analyze and store them. Companies that realized the potential for value creation on the basis of collected data, started to implement some of the Big Data solutions. In this paper are examined the key impacts of Big Data technologies on competitive advantage of the companies that use them. Transparency, identification of new customer segments, support for the decision making process with automated algorithms, improvement of the existing products and services, and introduction of new ones are among the key advantages that companies can gain. Consequently, Big Data technologies have lead to better strategic and operational activities in companies and become an important factor of their competitiveness. Any aspect of further investigation of the impact of Big Data technologies on competitive advantage of companies may be of great benefit not only for managers, but also for all employees who work with those technologies. One of the important questions that requires further investigation is to identify which factors are necessary for successful use of Big Data technologies in companies, because technology on its own, without broader purview about other factors will not have great benefits.



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## UTICAJ TEHNOLOGIJA ZA RAD SA VELIKIM OBIMOM PODATAKA NA KONKURENTSKU PREDNOST KOMPANIJA

*Pojava velikih količina podataka koji potiču iz različitih izvora i koji su dostupni u realnom vremenu, stimulisala je razvoj novih tehnologija, tehnika, alata, znanja i veština koje omogućavaju rad sa njima. Velike količine podataka i tehnologije za rad sa njima predstavljaju značajan resurs koji kompanijama koje ih primenjuju omogućava da na osnovu raspoloživih podataka kreiraju vrednost. Karakteristike i mogućnosti koje tehnologije za rad sa velikim obimom podataka pružaju pozicionirale su ih na mesto važnog faktora za sticanje i održavanje konkurentske prednosti kompanija. Cilj ovog rada jeste da ukaže na koji način primena tehnologija za rad sa velikim obimom podataka utiče na konkurentsku prednost kompanija.*

**Ključne reči:** *veliki podaci, analitika velikih podataka, konkurentska prednost, stratejske aktivnosti, kompanije*