

Preliminary communication

**THE NEW JOB POSITIONS FOR WORKING WITH BIG DATA
TECHNOLOGIES AND THEIR PLACEMENT IN COMPANIES
WORLDWIDE: EVIDENCE FROM EMPIRICAL RESEARCH**

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Abstract. *The question regarding the impact of modern technologies on organizational design has become an important and attractive issue in the theory and practice of management and organization again with the development of Big Data technologies. Those technologies represent new technologies, techniques, tools, knowledge, skills and methods for collecting, processing and analyzing data with new attributes (quantity, structure, speed). On the one hand, Big Data technologies are the factor from environment that confronts the companies with large quantities of data from 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. One of the first changes that comes with the implementation of Big Data technologies in company is establishment of new job positions because companies must have employees with new knowledge and skills. The aim of this paper is to identify, through empirical research, the new job positions for working with Big Data technologies, required knowledge and skills of those employees and how they are placed in the company.*

Key words: *Big Data, organizational design, T shaped professionals, hard and soft knowledge and skills*

INTRODUCTION

The quantity of data which are generated with modern technologies is constantly growing. Everyday, people create about 2.5 quintillion bytes of data while estimation is that by 2020 the amount of data will reach 45 zettabytes (Philips, 2013; Heisterberg & Verma, 2014). Those large quantities of data from variety of sources available in real time are named as Big Data and they stimulated development of new technologies and techniques

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which can handle them. Big Data, as currently the most attractive development form of information and communication technologies, represents new technologies, techniques and tools for working with data which have new attributes (quantity, structure, speed) (Berman, 2013), but also and even more importantly, new knowledge, skills and methods for collecting, processing, analyzing and transforming raw data into valuable information and decisions (El-Darwiche et al., 2014).

Many theorists and practitioners point out that large quantities of data, variety of data sources and possibilities for their collection and processing in real time represent new development phase in digital era so-called Big Data era (Brown, Chui & Manyika, 2011; Kudyba & Kwatinetz, 2014; Berner, Graupner & Maedche, 2014), while Big Data technologies are named to be disruptive technologies that lead to fundamental transformation of how companies gain and sustain competitive advantage (Nerney, 2013). On the one hand, Big Data technologies are the factor from environment that confronts the companies with large quantities of data from 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. Observed through history, managers have been finding the greatest support for changing organizational design in technology (Huber, 1990). Even in the context of contingency approach it was point out that besides the size and environment of organization, technology is very important determinant of organizational structure (Woodward, 1965; Thompson, 1967; Perrow, 1967). Information and communication technology (ICT) and its impact on organizations have been the subject of many researches and their findings show that ICT has impact on each parameter of organizational structure (specialization of work, formalization, coordination, grouping of units, chain of command, decentralization) (Daft & Lengel, 1986; DeSanctis & Jackson 1994; Dewett & Jones, 2001; Daft, 2009). Furthermore, ICT is named to be the major catalyst for creation of novel organizational forms (meta-organization, network, virtual, cellular, innovative form organization, ambidextrous, hypertext, inverted organization) whose main characteristics are speed and flexibility (Petković & Lukić, 2014).

The question regarding the impact of modern technologies on organizational design is raised one more time with the development of Big Data technologies. Jay Galbraith believed that those technologies will be a „*capability that is designed into all of our organizations*” (Galbraith, 2014, p. 2). The key question is not whether companies need to implement Big Data technologies, but rather what is the right way to implement them, which consequently opens numerous questions regarding organizational design. One of the first changes that comes with the implementation of new technologies in company is change in job positions because companies must have the employees with new knowledge and skills (Clegg, 2003). Each company which implements new technologies must have employees who are competent for their use (Harreld, 1998). For that reason, the aim of this paper is to answer on the following questions: (1) What are the new job positions in companies that use Big Data technologies? (2) What knowledge and skills must employees who work with Big Data technologies have? and (3) In which way are those employees placed in a company?

1. IMPLICATIONS OF BIG DATA TECHNOLOGIES ON EMPLOYEES

Organizations are open social systems that process information in order to interpret the external environment and accomplish internal tasks (Daft & Lengel, 1986). Ever since

the appearance of organization, decision makers have striven to get regular and reliable information for variety of purposes – control and coordination of activities, planning future moves, innovating (Khandwalla, 1977). At the beginning of the 21st century, technology progress leads to possibilities to collect and analyze large quantities of data from variety of sources in real time. Those data stimulated development of new technologies and techniques which can handle them, so-called Big Data. As companies are operating in a highly competitive environment and must be able to quickly adapt to the constantly changing conditions (Janačković, Milovanović & Milovanović, 2016), Big Data technologies can be of great importance to them. Those technologies enable companies to uncover new insights about customers, products, operations and to improve their overall activities. But, organizations must prepare themselves for using Big Data technologies in the right way. Many definitions about Big Data are focused only on new technologies and tools for working with data with new attributes, leaving organizational components in shadow (Lukić, 2015). Implementation of Big Data technologies is just one, the first step which is needed in order to make value on the basis of the collected data. There is a need for much broader purview about other components which are necessary for effective use of Big Data. Having in mind that technology encompasses the combination of skills, knowledge, abilities, techniques, computers, tools, and other equipment that employees use to convert or change raw materials into valuable goods and services (Jones, 2012), the aim of this paper is to point out to the employees which are needed for the effective use of Big Data technologies. Employees must be competent to use Big Data technologies in a way that will create value for the company on the basis of collected data. They must know what questions to ask, how to handle collected data, how to analyze them and how to use them as a basis for decision making (Lukić, 2015). The article „Data Scientist: The Sexiest Job of the 21st Century” pointed out to the need for professionals who will have a high level of knowledge and skills about how to create value of all available data (Davenport & Patil, 2012). Certain authors stress that technology was never a scarce resource but rather employees who will create value by applying that technology (Gurbaxani, 2003). A recent study of McKinsey Global Institute forecasts a significant shortfall in the big data skills in the United States: of 140.000 to 190.000 people with deep analytical skills and about 1,5 million of managers and analyst for Big Data (Manyika et al., 2011).

2. RESEARCH DESIGN AND SAMPLE DESCRIPTION

The the aim of this research was to identify the new job positions for working with Big Data technologies which are established in companies, required knowledge and skills of those employees and how those employees are placed in the company. In that sense, three hypotheses should be tested:

- Hypothesis 1:** Companies that use Big Data technologies have established new job positions.
- Hypothesis 2:** Employees who work with Big Data technologies have multidisciplinary knowledge and skills.
- Hypothesis 3:** There are changes in organizational structure in companies that use Big Data technologies.

The empirical research was conducted by using specially designed online questionnaire which consists of questions about:

- general information about companies (size, age, industry, location) and respondents (age, gender, education, experience with Big Data, managerial level);
- the new job positions which are established in companies for working with Big Data technologies;
- necessary knowledge and skills of employees who work with Big Data technologies;
- how those employees are placed in company.

The companies that use Big Data technologies in their work were the target population for empirical research, while the target respondents were employees who work with Big Data technologies and are in some of the managerial positions (top, middle or operational level). Accompanying letter and link to the questionnaire were sent to the e-mail addresses of the companies for which there exist public available information that they use Big Data technologies. Beside that, kind request was sent to companies which are engaged in the implementation of Big Data technology to forward the questionnaire to their clients (companies in which they implemented Big Data technologies). Also, the sample was formed by using the Snowball technique whose key characteristic is that the process of

Table 1 General information about companies: age, size, industry and location

Variable	Answer	Frequency	Percentage
Age of the companies	To 5 years	41	19,2
	From 6 to 15 years	43	20,1
	Above 15 years	126	58,9
	Total valid responses	210	98,1
	Missing responses	4	1,9
	Total	214	100,0
Size (regarding the number of employees)	Micro and small companies	41	19,2
	Middle companies	43	20,1
	Large companies	126	58,9
	Total valid responses	210	98,1
	Missing responses	4	1,9
	Total	214	100,0
Industry	Banking and Finance; Insurance	59	27,6
	Production; Transport and Logistics;	39	18,2
	Wholesale and Retail	80	37,4
	ICT; Telecommunications	35	16,4
	Consulting	213	99,5
	Total valid responses	1	0,5
	Missing responses	214	100,0
Location	Europe	74	34,6
	Asia	24	11,2
	North and South America	33	15,4
	Australia and Oceania	7	3,3
	Africa	3	1,4
	More continents	69	32,2
	Total valid responses	210	98,1
	Missing responses	4	1,9
Total	214	100,0	

collecting answers begins with a pre-defined list of subjects that meet the necessary criteria, and then each of the participants gave the proposal of other subjects which also meet the required criteria (Black, 1999).

The process of collecting answers from the questionnaire lasted from the 3rd of March until the 03rd of May 2016. After two months, the relevant answers were collected from 214 companies. General information about companies that participated in research is presented in Table 1.

The largest number of companies exist for more than 15 years (126), while among them there are 29 companies which exist for more than one century. The average age of companies which participated in research is 44 years. Measured with the number of employees, the largest number of companies (126) belong to category of large companies, while among them 74 companies have above 10000 of employees. The results show that Big Data technologies are used in companies from different industries. The largest number of companies are working in

Table 2 General information about respondents: age, gender, education, experience with Big Data technologies and managerial level

Variable	Answer	Frequency	Percentage
Age	Less than 26 years	18	8,4
	From 26 to 35 years	93	43,5
	From 36 to 45 years	60	28,0
	From 46 to 55 years	21	9,8
	Above 55 years	6	2,8
	Total valid responses	198	92,5
	Missing responses	16	7,5
	Total	214	100,0
Gender	Male	187	87,4
	Female	24	11,2
	Total valid responses	211	98,6
	Missing responses	3	1,4
	Total	214	100,0
Education	Primary School	0	0,0
	Secondary School	5	2,4
	Bachelor or master degree	166	77,6
	PhD degree	43	20,1
	Total valid responses	214	100,0
	Missing responses	0	0,0
	Total	214	100,0
Experience with Big Data technologies	To 3 years	107	50,0
	From 4 to 6 years	66	30,8
	Above 6 years	39	18,2
	Total valid responses	212	99,1
	Missing responses	2	0,9
	Total	214	100,0
Managerial level	Top level	29	13,6
	Middle level	51	23,8
	Operational level	132	61,7
	Total valid responses	212	99,1
	Missing responses	2	0,9
	Total	214	100,0

ICT and telecommunication industry (80) and after that in banking, finance and insurance (59). Companies are from almost all continents, but the largest number of companies are from Europe (74) or they operate on more than one continent (69). General information about respondents is presented in Table 2.

The average age of respondents is 36 years, while the oldest respondent is 64 years and the youngest 23. The largest number of respondents are those who are between 26 and 35 years old (43,5%), and after them the respondents who are from 36 to 45 years (28%). Regarding the gender, the most respondents are male (87,4%) which is not surprising having in mind the research topic and the fact that males are still dominant in the field of Big Data. Also, it is not surprising that regarding education, the largest number of respondents have bachelor or master degrees (77,6%) while 20,1% of respondents have PhD degrees. Only 2,4% of respondents have secondary school.

Average working experience with Big Data technologies is almost 5 years, 50% of respondents have less than 4 years of experience, 30,8% of respondents have between 4 and 6 years of experience, while the smallest number of respondents have more than 6 years of experience with Big Data (18,2%). The largest number of respondents are on operational managerial positions (61,7%).

3. RESEARCH FINDINGS AND DISCUSSION

The new job positions for working with Big Data technologies. Respondents were asked to select all the new job positions which are established in their companies due to the implementation of Big Data technologies. They also had the possibility to write positions which are not considered in the questionnaire but are established due to the implementation of Big Data technologies. The results are shown in Table 3.

Table 3 The new job positions established in companies for working with Big Data technologies

Job Positions for Big Data Technologies	Number of responses
Data Scientist	154
Data Engineer	146
Big Data Architect	132
Predictive Analytics Developer	98
Head of Big Data and Analytics	97
Hadoop Developer	93
Data Strategist	69
Digital Marketing Expert	58
Chief Data Officer	57
Social Media Expert	50
Chief Analytics Officer	48
Data Explorer	43
Data Governance and Ethics Professional	38
Data Steward	35
Chief Digital Officer	33
Company uses the services of external consultants for Big Data technologies	33
Data Hygienist	17

The results show that three most frequent job positions established in companies for working with Big Data technologies are: Data Scientist, Data Engineer and Big Data Architect. Data Scientists are employees who must have the abilities to identify all hidden patterns in any given dataset by asking the right questions, while Data Engineers are those employees who enable Data Scientists to do their jobs in the most effective way. Data Engineers collect, process and serve data to Data Scientists for further analysis. Big Data Architects are the connection between Data Scientist and Data Engineer and their main responsibility is to build the overall big data environment in organization. There are also new job positions on top managerial level (new C-level roles): Chief Digital Officer, Chief Data Officer, Chief Analytics Officer. Those positions are focused on collection, processing and management of data in order to create value for the company. Results show that some of the companies use the services of external consultants for Big Data technologies in order to apply those technologies in the most effective way. Engagement of external consultants is very important for companies, especially for those which are on the beginning of implementation of Big Data technologies and do not have enough knowledge and experience how to best use them.

Results from empirical research confirm *hypothesis 1* that companies that use Big Data technologies have established new job positions.

The importance of hard and soft knowledge and skills for working with Big Data technologies. After we have identified the new job positions established in companies that use Big Data technologies, the goal was to analyze the key knowledge and skills which employees must have in order to successfully work with Big Data. By reviewing the literature, we point out that those employees must have both – hard and soft knowledge and skills (Lukić, 2013) and we prepare a list of the most frequently stated knowledge and skills in both groups. The respondents were asked to select the knowledge and skills they consider important for working with Big Data technologies. Results are presented in Table 4.

Table 4 Knowledge and skills which are important for working with Big Data

	Knowledge and skills	Number of responses
Hard knowledge and skills	Mathematics	156
	Statistics	188
	Analytics	188
	Programming	195
	Information systems and technologies	151
Soft knowledge and skills	Business acumen	140
	Communication skills	139
	Teamwork	135
	Creativity	157

Results show that respondents consider both important - hard and soft knowledge and skills for working with Big Data technologies. Regarding hard knowledge and skills the most frequently answered options are programming, statistics and analytics, while the most frequently answered options regarding soft knowledge and skills are creativity, business acumen and communication skills. In 1991 Guest stated that for future work with ICT, employees must be „T shaped professionals” who have large (expert) knowledge from one field (vertical line of letter T) while at the same time must have the knowledge and skills from other

disciplines and fields (horizontal line of letter T) (Guest, 1991). In Big Data era this is becoming reality because, as results show, the respondents truly believe that hard but also soft knowledge and skills are very important for working with Big Data technologies. In that sense, *hypothesis 2* that employees who work with Big Data technologies have multidisciplinary knowledge and skills is confirmed.

The placement of employees who work with Big Data technologies in company.

Regarding empirical results about the new job positions established in companies that use Big Data technologies, it is clear that there is a need for new organizational structure. By reviewing the existing literature, it was discovered that Big Data technologies have impacted on grouping of organizational units in companies. The goal of empirical research was to identify how companies place those employees who work with Big Data technologies. Grossman and Siegel identified three most frequent models for allocation of employees who work with Big Data technologies – centralized, decentralized and hybrid (combination of centralized and decentralized model) (Grossman & Siegel, 2014). But in the pilot research, through interviews with experts who work in companies that use Big Data technologies, we identified that besides those three models there are situations when new employees are placed in existing organizational department responsible for ICT. Therefore, the respondents were asked to select one of the following options which is true for their company regarding the placement of employees that work with Big Data:

- A specific organizational unit with employees who work with Big Data technologies has been established in our company (centralized).
- Employees who work with Big Data technologies are located in each business function which has the need for their support (decentralized).
- Some employees who work with Big Data technologies are located in specifically established organizational unit, and the other employees are in different organizational units (hybrid).
- Employees who work with Big Data technologies are placed in an existing part of the company which is responsible for information technologies and systems (existing ICT department – no change).

Results regarding the placement of employees who work with Big Data technologies are presented in Table 5 and Fig. 1.

Table 5 The model of placement of employees who work with Big Data technologies

Variable	Answer	Frequency	Percentage
The allocation of employees who work with Big Data in companies	Centralized	93	43,5
	Decentralized	25	11,7
	Hybrid	43	20,1
	Existing ICT department	46	21,5
	Total valid responses	207	96,7
	Missing responses	7	3,3
	Total	214	100,0

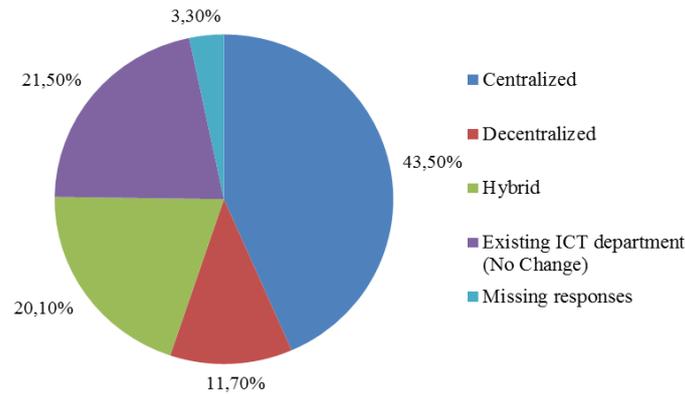


Fig. 1 The model of placement of employees who work with Big Data technologies

According to results, in the largest number of companies, the employees who work with Big Data technologies are placed in specific organizational unit which has been established for that purpose – centralized (43,50%), while the smallest number of companies place those employees in each organizational part which has the need for their knowledge and skills – decentralized (11,70%). Almost equal number of companies place employees who work with Big Data technologies using the hybrid model - some of the employees are centralized and others decentralized (20,10%), or place them in existing part of the organization responsible for ICT (21,50%). Results from empirical research confirm *hypothesis 3* that there are changes in organizational structure in companies that use Big Data technologies.

In order to further determine and analyze the impact of Big Data technologies on placement of employees who work with Big Data, the respondents who answered that in their company is established specific organizational unit for employees who work with Big Data, were kindly asked to write the name of it. Collected answers were analyzed using the free online word cloud generator and tag cloud generator <http://www.wordclouds.com/> [accessed 01 June 2016] which, among other things, creates a picture with the most frequent words (Fig. 2).



Fig. 2 Word Cloud with the most frequent words that respondents wrote regarding the name of new organizational unit established for employees who work with Big Data

The most frequent names for new organizational units in which are placed employees who work with Big Data technologies are: Big Data, Big Data Center, Big Data Office, Big Data and Analytics, Big Data Team, Business Intelligence and Big Data, and Data Analytics.

CONCLUSION

The question regarding the impact of modern technologies on organizational design is raised one more time due to the development of Big Data technologies. One of the first changes that comes with the implementation of Big Data technologies is establishment of new job positions because companies must have employees who are competent for their use. For that reason, the aim of this paper was to identify the new job positions for working with Big Data technologies, required knowledge and skills of those employees and how they are placed in the company.

Empirical research was conducted by using the specially designed online questionnaire for that purpose. After two months, relevant answers were collected from 214 companies worldwide that use Big Data technologies. Analysis of collected answers confirmed all imposed hypotheses. Firstly, the research results showed that there are new job positions in companies that use Big Data technologies. The most frequent job positions for working with Big Data technologies are Data Scientist, Data Engineer and Big Data Architect, but there are also new positions in top managerial level (new C-level roles): Chief Digital Officer, Chief Data Officer and Chief Analytics Officer. Secondly, results showed that employees who work with Big Data technologies must be T shaped professionals with both hard and soft knowledge and skills. It is not enough for those employees to have only hard knowledge and skills like programming, statistics, analytics, they also must have soft knowledge and skills like creativity, business acumen and communication skills. Thirdly, analysis of research results showed that companies in the most frequent cases establish new organizational unit and place there employees who work with Big Data technologies.

The importance of this research lies in the fact that any modern company which implements new technologies must be focused on its most important resources – employees, because the destiny of implemented technologies is in their hands. The results of empirical research may be of value to companies which want to implement Big Data technologies but also to new candidates who want to work with Big Data, because they can see what are the most frequent job positions in companies and what knowledge and skills are considered valuable.

Empirical research was accompanied by some limitations that should be considered. The first limitation of the research is that the population was not known in advance - there is no list of all companies that use Big Data technologies. Therefore, the question of representativeness of the sample is opened, and consequently the possibility of generalization of conclusions. Also, the possibility to conduct a longitudinal study on the level of the whole sample in order to examine the impact of Big Data technologies on job positions, knowledge and skills of employees over time is limited.

During analysis of results from conducted empirical research, some proposals for future research appeared. One of the directions for future research might be to investigate the impact of Big Data technologies on new job positions, necessary knowledge and skills through the verification of the hypotheses on a sample of different structure of employees – those who are not in managerial positions. Also, it would be very interesting to explore the impact of these technologies on establishment and functioning of multidisciplinary teams that

include employees who work with Big Data technologies and other employees from different organizational units.

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NOVE RADNE POZICIJE ZA RAD SA VELIKIM OBIMOM PODATAKA I NJIHOVO MESTO U KOMPANIJAMA ŠIROM SVETA: REZULTATI EMPIRIJSKOG ISTRAŽIVANJA

Zahvaljujući razvoju tehnologija za rad sa velikim obimom podataka, uticaj tehnologije na organizacioni dizajn je ponovo postalo važno i aktuelno pitanje u teoriji i praksi menadžmenta i organizacije. Tehnologije za rad sa velikim obimom podataka predstavljaju nove tehnologije, tehnike, alate, znanja, veštine i metode za prikupljanje, obradu i analiziranje podataka koji imaju nove osobine (količinu, strukturu, brzinu). Sa jedne strane, ove tehnologije predstavljaju faktor okruženja i suočavaju kompanije sa podacima koji imaju nove osobine, dok sa druge strane predstavljaju resurs organizacije koji omogućava kompanijama koje ih primenjuju da kreiraju vrednost na osnovu raspoloživih podataka. Jedna od prvih promena koja se dešava u kompanijama koje implementiraju tehnologije za rad sa velikim obimom podataka jeste pojava novih radnih pozicija jer su kompanijama potrebni zaposleni sa novim znanjima i veštinama. Cilj rada jeste da kroz empirijsko istraživanje identifikuje nove radne pozicije u kompanijama koje primenjuju tehnologije za rad sa velikim obimom podataka, potrebna znanja i veštine koje ti zaposleni moraju imati, kao i način njihovog raspoređivanja u kompanijama.

Ključne reči: veliki podaci, organizacioni dizajn, T oblikovani stručnjaci, čvrsta i meka znanja i veštine