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MANAGERIAL AND APPLICATION ISSUES IN BIG DATA ANALYTICS

Abstract

Considering the fact that the importance of big data has been growing in the last few years, experts are considering the ways and means by which the changes brought by new technologies can be implemented in the company's operations. An increasing number of companies are focused on investments in big data analytics, with the aim of learning from it important lessons that can later provide them with a competitive advantage. Until now, the emphasis was on the technical aspects of this data, and special attention was paid to organizational changes and the ways in which big data should be used. As with any innovative technology, it is very important to understand the mechanisms and processes through which big data can add value to businesses, and it is also important to have a clear picture of the different elements of this technology and their interdependencies. This paper aims to present the latest trends in big data analytics, as well as the potential of this technology in the future. In addition, a brief overview of big data analytics tools and the domains in which they can be applied is given.

Key words*: Big data analytics, Domains of application, Big data tools, Managerial issues*

JEL classification: M15, L86

УПРАВЉАЧКА И АПЛИКАТИВНА ПИТАЊА У АНАЛИТИЦИ ВЕЛИКИХ ПОДАТАКА

Апстракт

С обзиром на чињеницу да значај великих података расте у последњих неколико година, стручњаци разматрају начине и средства помоћу којих се промене које нове технологије доносе могу имплементирати у пословање предузећа. Све већи број предузећа је фокусиран на улагања у аналитику великих података, са циљем да из тога изуку важне поуке које им касније могу обезбедити конкурентску предност. До данас, нагласак је био на техничким аспектима ових података, а посебна пажња је била посвећена организационим променама и начинима на које велике податке треба искористити. Као и код сваке иновативне технологије,

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веома је важно разумети механизме и процесе путем којих велики подаци могу додати вредност предузећима, а такође је важно и имати јасну слику о различитим елементима ове технологије и њиховим међузависностима. Овај рад има за циљ да прикаже најновије трендове у аналитици великих података, као и потенцијал ове технологије у будућности. Осим тога, даје се кратак преглед алата за аналитику великих података и домена у којима се могу применити.

***Кључне речи: а**налитика великих података, домени примене, алати великих података, управљачка питања*

Introduction

The use and management of big data in organizations when making decisions is attracting more and more attention, both in theoretical analysis and in practical application. An increasing number of companies are investing in this technology in order to better analyze big data and to take advantage it provides. Today, big data is analyzed and used not only in the field of informatics and information systems, but also in management and other social sciences. In addition, big data can be used in the media and journalism to personalize the content that is marketed, while in the oil and gas industry it can be used for risk assessment.

Given that big data is a relatively new technological paradigm, there are few researches on how to effectively manage it, and therefore there is a lack of theoretical research on the topic of using big data to gain a competitive advantage for companies. Today, in modern business conditions, the use of big data analytics will represent the difference between companies, which will provide advantages and success to companies that know and use it, while companies that are traditionally oriented and do not want to use it or have no experience or knowledge will not achieve market success. (Micallef et al., 2018).

In the first part of the paper, the concept of big data is defined and the importance of the analysis of this data for business operations is indicated. A brief overview of the traditional way of managing big data will be made, after which the modern way will be pointed out and a parallel between the two methods will be established. In addition, attention will be focused on the classification of big data analytics according to which there are the following categories of analytics: diagnostic, descriptive, predictive and prescriptive analytics.

In the second and third part of the paper, the advantages, but also obstacles and challenges in the implementation and use of big data analytics will be analyzed. This implementation is based on the use of various technologies and tools that are the basis of big data analytics, so here we will have a brief overview of them.

In the fourth part of the paper, the possibility of applying big data analytics in different domains, sectors and industries will be pointed out. Although very mention of big data analytics primarily refers to its use within the IT industry, today it is widely applied in healthcare, the chemical industry, but also in higher education and science in general. Different companies, depending on the industry, use different tools and give them primacy in a certain period of time.

Definition and classification of big data analytics

Big data analytics is the process of collection, examination and analysis of the data, in order to obtain information about market trends, consumer demands, etc. Based on the data that is collected and analyzed, companies make decisions. At the same time, artificial intelligence is a very important tool that serves to adequately take data, which is unstructured or structured, from different sources and compose them into wholes.

Through big data analytics, businesses are enabled to improve and optimize their operations. These analytics also enable businesses to reduce costs, but also to provide better products to consumers, thereby inducing repeat purchases, as well as gaining a good reputation. Big data analytics was especially important during the Covid-19 pandemic, when it provided the governments of different countries with information on how to promote the need for vaccination, as well as for predictions about further solutions to contain the pandemic. (Sheng et al., 2021)

Big data analytics is a relatively new concept. However, if we look back into the past, we can see that during the 1950s, there was also some kind of simplified, basic analytics through manual analysis of numbers in tables. Back then, data was used and analyzed to make decisions in the future, while now, big data analytics, characterized by high speed and efficiency, allows data to be used to make immediate decisions.

The process of analyzing large amounts of different data sets using advanced analytical techniques is called big data analytics. Big data, in the terminological sense, represents data sets whose size or type exceed the ability to manage them in a traditional way. (Gupta & George, 2016)

Big data contains great variety, arrives in great quantities, at great velocity. When it comes to size as a characteristic of this data, it is a large amount of mostly unstructured data of low density. Velocity, as another characteristic, refers to the high speed of receiving data within the company. The data is received instantly, in real time, which enables immediate decisions to be made, rather than decisions for a future period of time. Thirdly, the large variety of data arriving in different forms (through tables, text, video or audio recording) complicates the analysis process, but also provides greater relevance and comprehensiveness. New technological solutions have exponentially reduced the costs of storing and managing data, which enables more precise and accurate decisions to be made.

The process of managing big data involves passing through three stages:

- Integrating data (big data is combined from different sources, after which it is entered, processed and formatted, where it is necessary to pay attention to the forms that business analysts in the company know and use),
- Organizing and storing data (the obtained data must be to be stored in the form in which bussines analysts judge that it is currently the best),
- Data analysis (the purpose of the collected data is to analyze it, in order to determine the best decision that can be made based on it and what needs to be corrected or improved).

The difference between traditional data and big data is not, as it might seem, only in size. There is no limit or point from which it is said that up to that certain data is of small amount, and thereafter of large amount. Since ancient times, man has processed

some data that served him to make decisions. However, today's data is in different formats, from different sources, and its volume is growing rapidly, so that traditional tools and approaches cannot be used to process it. Also, modern big data implies large sets of data, the analysis of which can solve major problems of companies, which was not possible with traditional data. Goals, tools, processes and plans are different today.

Big data is used to reveal trends and future movements in the market, on the basis of which the company's operations are directed. The more attention is paid to investing in technology for processing big data and its analytics, the deeper the search of big data, the more likely it is that good decisions will be made based on it and that the business of company will be directed in the right way. (Fan et al., 2021).

When it comes to the characteristics that distinguish traditional from modern data, the **first** and most striking is flexibility. The database of traditional data is fixed and static. It supported only structured data, which is a big obstacle in modern conditions, because most of the data is of an unstructured nature. Therefore, there was a need for a mechanism that supports the processing of unstructured data, using new methods for control and storage. (Mohamed et al., 2020)

Another difference relates to the time of analysis of the collected data. In the past, analysis was done only after all the data was collected and used to make future decisions, thus limiting progress in all areas in which it is used. In contrast, today data is processed in real time, which provides an opportunity for the advancement of medicine, biotechnology and the whole science in general.

The **third** difference relates to architecture. Traditional data was based on a centralized architecture, unlike today's, which is based on a distributed architecture.

The fourth, the difference is noticeable in the number of sources from which data is collected. A limited number of sources today has turned into an unlimited and infinite number of sources from which data is collected.

The fifth, there is a difference in approach. With traditional data, the questions to which the analysts wanted to get answers were defined at the beginning, in contrast to the modern way of processing big data where the approach is exploratory. New questions are created daily, resulting in a greater volume of useful data and conclusions. Modern technological platforms are continuously developed and enable better processing.

In theory, there are a large number of classifications of big data analytics depending on different authors, criteria for classification, etc. Most often, big data analytics can be grouped into four basic types:

Diagnostic analytics. This type of analytics is the latest way to manage big data in modern business. Based on the data that has been collected and already realized situations, the analysis focuses on discovering the causes of the occurrence of a certain situation. As an example, we can take a drop in sales in a certain time interval. Diagnostic analytics makes it possible to find out with the help of big data what contributed to the decline in sales, assuming that there were no marketing efforts that the company changed. The situation is the same with the growth of sales, where it is analyzed and diagnosed what led to the increase in sales in order to continue the same trend in the future. The benefits of diagnostic analytics are great. They are related to a better understanding of the data, and therefore of the consumer's requirements through the answer to the previously mentioned type of question.

Descriptive analytics. Unlike the previous type of analytics, which is the most modern, descriptive analytics of big data represents the analytics most often used in

companies. It makes it possible to see trends in the environment, and is especially useful in the field of finance, production and sales. Its most important advantage is that it allows companies to understand a large amount of raw data, focusing on the most critical areas. With its help, the company can compare the current and past situation. Without that, it would not be possible to define the future, desired situation, that is, the position of the company.

Predictive analytics. The big data that is collected, with this type of analytics, is intended to enable future predictions. Machine learning and statistical modeling are tools that help with this. It enables accurate forecasting of the future, which can help the company using it to reduce costs, maintain inventory at an optimal level, and effectively manage future deliveries. In marketing companies or within the marketing sector in large companies, it enables attracting new and retaining existing customers in the future.

Prescriptive analytics. The last but not least type of analytics is prescriptive analytics as a combination of descriptive and predictive analytics. A well-known company that develops this type of analytics is Google. This type of analytics has been used to produce vehicles without human control. The benefits provided by this type of analytics relate to the improvement of processes, campaigns, strategies, production as well as customer service. It also helps define the company's priorities.

Benefits of Applying Big Data Analytics

Although the benefits of big data analytics are huge, reports on its use show that CEOs and executives are often hesitant to invest big money in analytics, due to previous disappointing experience and poor results from other companies that have applied this analytics in their business. The question arises as to why this kind of situation and skepticism among managers in companies is happening. The answer lies primarily in the high and unrealistic expectations of big data analytics, but also in the lack of knowledge for its application. (Milovanović & Marković, 2018)

However, if the company has knowledge and skills and is not averse to new ways of doing business, big data analytics can provide numerous advantages.

First, in the consumer segment, big data analytics can enable continuous observation and monitoring of consumer behavior patterns, on the basis of which a company can personalize its offer of products. For example, Amazon used this advantage offered by big data analytics, where based on previous purchases, it suggested to consumers what the next purchase would be good for them. (Saritas et al., 2021).

Second, focused and targeted promotions, made possible by big data, can lead to significant savings and prevent wasting a money on campaigns to the entire market, instead of focusing on the target market.

Thirdly, the identification and efficient management of risks is enabled with the help of big data, through optimizing decisions and predicting the future.

Fourth, the use of big data makes it possible to update existing products more easily through knowledge of consumer requirements, but also to create completely new ones through complete innovation.

Fifth, big data can significantly differentiate suppliers, which will make a big difference between those who use big data analytics and those who do not.

Sixth, the costs of data collection, storage and analysis are significantly reduced. The last but not the least important advantage is the achievement of efficiency.

In addition, a better understanding of market conditions can be cited as an advantage, as typified by the two fast food giants (McDonald's and Burger King), where the customer's order arrives either right on time or even earlier, which is the result of the use of big data. The next advantage is better decision-making, with the help of big data, as well as agile management of supply chains, especially in crisis conditions when supply chain disruptions, instability and high risks occur. (He et al., 2016).

In addition to the above advantages, there are also certain obstacles that completely or temporarily prevent companies from using big data effectively. Small and medium-sized enterprises, for example, find it more difficult to use big data for at least two reasons. The first is untrained employees and the second is the lack of finances to implement big data analytics. The lack of adequate staff is not only a problem for small and medium enterprises, but also for large enterprises. (Schroeck et al., 2012)

In addition, it is difficult to find those data that are relevant for the company's current operations from a pile of data. A lot of data from the data pile is completely worthless data that can only complicate the analysis process. This problem especially occurs when the data is collected from different sources and when it is unfiltered. Also, outdated data stored in databases can create problems, because decisions made based on them will lead to poor business performance.

In large companies, it is a very common situation that the data needed in one sector are stored in the database of that sector and are unavailable or partially available to other sectors. This is a big disadvantage, because one sector manages a limited database and has no communication with other parts, which leads to incomplete decisions.

The greater the amount of data in the company, the greater the fear of losing that data and the violation of security. Therefore, the larger the database, the more modern technologies need to be applied in order to increase security, in order to reduce the risk of data loss to a minimum.

In order to perform quality big data analytics, the use of technology is essential. Predictive analytics, for example, are used to avoid risk in decision-making. Hardware and software solutions enable scenario evaluation and risk minimization.

Non-relational (NoSQL) databases are used to manage data across a scalable number of storage nodes. Tools for discovering new knowledge are also used, which search data from different sources. Stream analytics is used when data resides on multiple platforms in different formats. It also enables connection to external sources. (Kolhe, 2023)

In-memory Data Fabric as the next technology helps to better distribute large amounts of data, which leads to lower latency. Data visualization as the next tool allows applications to retrieve data without technical constraints such as data formats and physical location.

In big data analytics, technologies are used to clean and transform data into information that is then used to make business decisions. After "mining" the data, algorithms and models are performed with the help of certain tools (e.g. Apache Spark, Splunk). Apache Spark is known for its speed and efficiency in running applications. It uses RAM (Random Access Memory) and supports a wide range of data analysis tasks and queries. Splunk is a tool used to analyze big data in order to get certain insights

from the pile of data. It has the ability to generate tables, graphs and dashboards. The big advantage it provides is the possibility of incorporating artificial intelligence into data processing.

In addition, data integration tools are used to simplify the data through numerical representation. It is not important to only provide quantity in the data, because without quality the result is not achieved. For this, data quality assurance software is used, which has the task of cleaning and enriching the data set through parallel processing. All tools are very important and, depending on the activity, primacy is given to some of the above. (Jahani et al., 2023)

Regardless of the stage in which the big data analytics development project is or the stage of the company's life, in big data analytics different options are used that result in good decisions, some of which have been used for a long period of time (e.g. Cloud, MapReduce, Complex Event Processing) to those that have been used recently, such as data visualization and predictive analytics.

Challenges in the applying of big data analytics

The problems or challenges arising from the large amount of data that needs to be processed and analyzed can generally be divided into two groups. The first group are technical challenges related to activities such as storage and efficiency in processing and analytics. On the other side are the semantic challenges arising from the unstructured nature of big data. These challenges include heterogeneity, incompleteness, scalability, timeliness, privacy and security (Jayashree & Abirami, 2018).

Heterogeneity. The collected data are from different sources, which causes the problem of heterogeneity of data formats. Data is mostly in unstructured form (email, pdf files, graphics, sound, animations, medical x-rays and so on). Converting all this data into a structured form is a big challenge where new technologies and methodologies must be adopted to solve the problem.

Incompleteness. Incomplete data occurs when the values of some fields are missing. Missing values can occur due to sensor repairs, system crashes, and other unpredictable events. Incomplete data makes good analytics impossible, so various data mining algorithms have been developed to deal with missing data or values.

Scalability. Scalability is one of the most important challenges in analytics, because we are dealing with huge amounts of data. Parallel data processing methods that were once used to process data are no longer efficient, as the size of data is increasing rapidly and continuously. Therefore, new approaches are being developed to solve the problem of increasing data size or elasticity.

Timeliness. In order to ensure the timeliness of the data, the data request must be processed much faster, which is very difficult due to the huge amount and heterogeneity of the data.

Security and privacy. The most important challenges that must be solved in big data analytics are security and privacy, because a breach of data security can do a lot of damage. For this reason, in order for users to store and process data in a secure manner, they must apply techniques and algorithms related to encryption, logging, honeypot mechanisms and fraud detection.

Databases store a large amount of sensitive data related to medicine, insurance, diagnosis, personal characteristics of the end user, etc. That is why organizations must store all data in a secure manner and each user must be authorized to view only the data that is relevant to him. All these data management issues related to privacy and security must be addressed taking into account the necessity of sharing data and information and investing in data protection. Each organization maintains its own data center that must ensure data confidentiality. Some data cannot be shared in order not to violate privacy. For example, data sharing becomes a challenge in a smart city, as data needs to be shared between different devices. Therefore, it is necessary to follow established procedures for sharing and exchanging information between different devices and departments. A large amount of data is updated and stored in various formats in real-time applications. Therefore, it is difficult to create a general data format and extract information directly from the application in real time.

Solving privacy and security issues requires huge investments. For example, in smart cities, sensors are used to record every single activity, accessed by several government and security agencies. As a result, location-based data is transmitted over the network, that is a particular threat to privacy. If security issues are not addressed properly, it can lead to malware attacks or hacking by some users who do not have good intentions. Since confidential information about people is collected and stored in the database, several security policies and procedures must be followed to protect the data from unauthorized users and from viruses or bug attacks. The privacy rights of organizations and individuals must be clearly stated and protected. In certain cases, such as medical records, banking and financial records, stricter data protection measures must be applied.

Domains of application of big data analytics

The use of big data today provides great benefits that enable the company to gain a competitive advantage over other companies that do not apply analytics in their business. Although the investment in equipment and knowledge of employees who work with big data is large, the advantages and benefits that are realized exceed the initial investment.

Big data has influenced changes in a large number of areas, from professional sports and media, to manufacturing, finance and education. The use of big data is of great importance in the healthcare sector, where there is a large amount of data on patients, then on supplies, capacity availability, etc. The use of big data, for example, during the Covid-19 pandemic made it possible to determine priorities in cancer treatment during that period. Also, retail is a sector that contains a large amount of data: data from loyalty cards, data on previous purchases, data from social networks. Big data analytics allows it to be better analyzed in order to personalize the offer delivered to consumers. Big data analytics is also important in the field of production, where it enables the evaluation of the degree of capacity utilization, the evaluation of the operation of machines and the people who work on them, etc. In finance, big data analytics can provide stock price data, evaluate potential investments and calculate risks. In the field of transport, it is possible to optimize routes, improve driving, etc. (Seddon & Currie, 2017)

Facebook, Google, Yahoo and Falcon generate large volumes of data. Also, Wal-Mart generates over a million customer transactions in 6,000 stores in one hour. Amazon Web Services was also successful in IaaS (Infrastructure as a Service) and achieved 70% market share, including the most popular Elastic Compute Cloud (EC2). Simple Storage Service (3S) enables the processing of 500,000 queries for millions of merchant terminal operations every day. Akamai was also able to analyze 75 million events per day. However, the most notable element in big data analytics is value. Thus, data has become extremely valuable in businesses for increasing productivity and for business predictions. (Saritas et al., 2021)

A key challenge in the field of engineering is to discover techniques that have the ability to process data about machines and the Internet of Things. It is estimated that by 2030, the size of IoT data will be one trillion(Wang et al., 2022). A large volume of data in engineering is generated by a wide range of sensors, through power plants, machine data and GPS, as well as electronic devices.

Large enterprises from various industries have started to implement their big data strategies and have started to use the benefits that it brings. Also, similar companies in the same sector or in other sectors have started to learn from them in order to design a framework for implementing their own big data strategies. Therefore, in all domains, big data analytics allows the company to determine what it is doing well and what is bad, provides a clear work plan without relying only on intuition and enables the rationalization of business activities.

Therefore, an increasing number of companies within various industries are investing in the construction of big data management systems, realizing that this is not just a luxury, but a necessity in the modern world, where we are all overwhelmed by a large amount of information that needs to be properly processed and analyzed.

Application of big data analytics in healthcare

The use of big data in healthcare is widely used, primarily due to the need of healthcare workers to provide their patients with the best possible conditions and treatment. By looking at historical data, which is combined with current data, it is possible to provide the whole picture, which enables the setting of better therapy, but also lower costs at the level of healthcare as a whole. Big data analytics help determine which treatments are most effective, which patient populations are at greatest risk, how to better allocate resources, etc. Also, good analytics provide a good basis for predicting and optimizing the future treatment. For example, if a trend of increasing certain diseases is noticed, the analysis determines whether it is necessary to build new facilities and hire new staff.

Big data analytics is used today to predict the outcome of decisions made by doctors, to predict the outcome of operations that have been performed, but also to make the above-mentioned predictions regarding overall capacity. Big data analytics in healthcare can be used in the treatment of cancer, genetic diseases, for the prevention and treatment of cardiovascular diseases, psychological diseases and other diseases. Big data analytics makes it possible to define, based on the information, the steps that make it possible to achieve healthy daily habits, in order to reduce the number of sick people. Furthermore, it allows patients to get the right care they need, then enables healthcare

providers to know what the best treatment option is for each individual patient at a given moment, then creates new ways of treatment and improves quality and value provided by healthcare providers to their patients. (Xie et al., 2018).

The benefits provided by big data analytics in healthcare relate to early diagnosis of diseases, then prevention of side effects, faster development of vaccines, prevention of spread of infectious diseases, prediction of crises and timely response. In the future, we will witness an increasing application of big data analytics. However, here too there needs to be a certain degree of caution related to increased protection of privacy, security, establishment of standards, as well as further improvement of tools and technologies used to process big data. (Akter & Wamba, 2016)

Due to the increasing volume of data in healthcare, experts in the field of information technology have more and more work to devise a way to implement big data analytics in healthcare organizations, with the aim of faster and more efficient treatment. The increase in the volume of data is due to the increase in the world's population, thus the number of patients, and the need to increase capacity and employed staff. (Chen & Zhang, 2014)

Application of big data analytics in the chemical industry

The chemical industry includes production facilities that process raw materials to reach the end product. In doing so, processes such as distillation, extraction, absorption, chemical reactions, etc. are used. As in other industries, including in the chemical industry, in addition to investing in the development of big data analytics and needed technology, it is necessary to invest in people who have knowledge about it, but also have knowledge about the chemical industry, which is specific in itself. The involvement of scientific research organizations, academic institutions and the government is recommended, in order to include machine learning and programming in the process, which, together with statistics, enable a more efficient application of big data analytics in this industry. (Cheng et al., 2017)

The application of big data in the chemical industry has been increasing over the years, with the tendency of further growth in the future, proportionally to the growth of the chemical industry. (Betty Jane, & Ganesh, 2020). In the area of production in the chemical industry, big data analytics will enable the right decisions to be made based on the data related to the layout and the way the equipment is used. A higher degree of utilization of equipment capacity as well as a more rational use will contribute to the reduction of waste in production, but also to an increase in yield. The equipment used in the chemical industry (turbines, compressors) are equipped with sensors that are used to collect data that make it possible to prevent stoppages, to maintain the equipment on time and to ensure that production runs continuously.

Big data analytics makes it possible to better manage supply chains in this industry, as well as to plan better, in order to respond in a timely manner in possible crisis situations. Chemical pricing strategy can be determined more reliably through the analytics of big data collected from various sources, rather than based on past prices and traditional methods where there is an incomparably greater possibility for errors. In addition, the process of innovation is accelerated and the time for bringing products to the market is shortened, as well as optimal energy management, which is a special

feature of the chemical industry, where several plants operate simultaneously. Then, with the help of the sensors on the machines, smooth simultaneous work is enabled. Sensors provide multiple data points and control non-standard process variables, which increases energy efficiency.

The monitoring of complex serial processes, then the evaluation of controller performance, as well as integrated planning, are possible with the help of big data analytics. Modern petrochemical and chemical plants that are integrated contain a large number of production units that are grouped in a specific location. According to a Pricewaterhouse Coopers survey, 88% of chemical plant managers believe that the use of big data is critical to maintaining a competitive advantage (Wang et al., 2022). It is one of the industries that first saw the importance of big data and started using it.

Application of big data analytics in science and higher education

In science, researchers use a large amount of data that can possibly lead them to new scientific discoveries or improvement of existing ones. They often face the problem of understanding and interpreting the available data. For example, through the study of the genome by scientists, gene mutations are associated with both developmental disabilities and cancer. Also, the number of articles published in the world increases every year, where the annual average is 1.8 million articles (Hariri et al., 2019). As the average researcher reads between 200 and 300 articles annually, it is impossible to be familiar with all the articles that are published annually. There is room here for the use of big data analytics and technology that, together with machine learning, will enable better scientific articles and research, as well as better scientific work by researchers around the world.

A field closely related to science is higher education. Technology was introduced into higher education strategically and planned, with the aim of improving the process. It is under the scrutiny of the agencies that carry out its accreditation, then the state apparatus, but also society. In higher education institutions, there is a lot of data that needs to be processed. The application of big data in the future would affect administration, teaching, learning and overall academic work. Also, it would lead to the creation of innovations in this area, better planning, creation of better programs, teaching methods, which is especially important today, when it is necessary to adapt learning to the modern lifestyle of the youth. (Constantiou & Kallinikos, 2015)

Recruiting, admissions processing, financial planning, tracking student results, making administrative decisions, assisting students, tracking and managing donations, are some of the application areas of big data analytics. There is data from Arizona (Mikalef et al., 2019), where one university, when conducting online classes, monitored the number of mouse clicks by students, the number of views of sent content, how long they stay on certain topics, etc. Also, if this kind of analytics is used on courses organized by the faculty, it can be determined already after the first week with an accuracy of about 70% which participants will complete and which will not complete the course they are attending. In this way, those who lag behind others are identified, at the right moment, in order to help them at that moment and to increase the success of the course to the highest possible level.

In addition, big data analytics in education supports curriculum designers to manage course content, develop personalized recommendation modules, and the

concept of smart education using natural language processing and text summarization technologies. Also , data generated through massive open online courses (MOOCs) helps to identify difficult-to-master course content and support students to improve teaching and learning.

Other application areas of big data analytics

There are other areas of business and industry that have benefited from big data analytics. These areas generate a huge amount of data that requires analysis for effective decision-making. These application areas include telecommunications, network optimization, travel estimation, retail, finance, and energy consumption, to name a few. These application areas are explained below (Ajah & Nweke, 2019).

Network optimization. Business analytics and big data technologies can be used to design mobile networks to provide efficient services. This area includes content-centric analysis, network traffic analysis, and network signaling to ensure efficient service delivery and quality of service delivery. Network operators typically collect, store, and analyze network user data for efficient signaling, traffic variation and congestion prediction, intelligent optimization and automatic network self-configuration, and the development of intelligent data transport across the network.

Travel prediction. Mobile users generate a large amount of data during calls that can be recorded in the form of call data records (CDRs). Based on CDRs, travel data can be aggregated, stored, processed, and analyzed to recommend routes, track locations, determine the origin of travelers to work, plan destination, and manage transportation. Mobile big data can be analyzed to recommend routes in a complex environment by implementing a smart multimodal platform that uses personal data and global constraints. Algorithms monitor the state of cities in real time and identify congestion on specific routes to recommend alternative routes that are less congested. These algorithms have already been applied in drone routing, infectious disease, and identification of hotspots in emergency situations. To ensure data privacy and security, data sets are usually anonymized using computer-generated unique identifiers to replace subscriber phone numbers. The application has shown that mobile big data analytics for trip assessment can significantly assist in transportation and travel planning.

User behavior modeling. User behavior modeling helps in understanding the patterns that occur during navigation. The goal of understanding these patterns is to develop user-centric applications. These applications are important in detecting anomalies, fraud, and spam in social media and enable changes in social behavior for targeted marketing.

Human mobility modeling. People are characterized by the fact that they follow a regular movement pattern over a period of time. The repetition of such a pattern allows for effective prediction of global movement, which can be used in disease prevention, disease containment, transportation planning, and emergency situations. For this purpose, big data from social networks, GPS data, call records, and geo-tagged data is used for analysis.

Service recommendation. Big data and business analytics technology can be effectively used in service recommendation, targeted advertising using information about user location, product reviews, time, and product purchase behavior. Customer

reviews can be analyzed to understand the advantages and disadvantages of products, determine predictors of review readability, and increase sales.

Energy consumption analysis. Determining the amount of energy consumed in a household is a way to promote efficiency, green energy use, and environmental protection. Big data technology is used to analyze energy usage patterns to promote green energy. This is achieved by using embedded sensors and communication networks in the electricity supply that help digitize, store data, and analyze energy consumption rates. In addition, big data technology helps energy companies improve energy sales and ensure return on investment.

Finance. Since financial institutions are accessed via the Internet, the creation of large amounts of data is a natural consequence, which further implies the application of big data technology for effective decision-making. Analysis of financial statements and data would help in detecting money laundering activities, financial statement fraud, financial spam, impersonation, identity theft, and other cases related to financial fraud.

Sports. Another interesting area of application of big data is sports, where coaches, players, and managers in sports recognize the possibilities of big data analytics. For example, in athletics, athletes are monitored in the following parameters: speed, performance, time, kilometers run per day, etc. Statistical methods and techniques are applied to the collected data to determine the capabilities of the athletes. Based on this data, coaches can easily identify which player needs additional support, training and instructions for further work. This will certainly help to increase the performance and progress of the player.

Video games. People who play video games typically collect three main groups of data: game, player, and session data. The amount of data that players generate every day is growing rapidly. By analyzing the collected data, such as user behavior, rewards, activity, leaderboards, character selection, game developers will be able to improve or upgrade game features and versions. Game improvements help to improve the gaming experience.

Telecommunications. A very big challenge facing the telecommunications sector is the volume, variety, and complexity of telecommunications service provision. To overcome this challenge, a combination of different technologies is used, such as data warehouses, traditional databases, and big data. These technologies store and process a huge amount of data generated by location sensors, IPv6 devices, clickstreams, CDR, 4G networks, and machines. In addition, these technologies manage various forms of unstructured data, such as data from mobile devices, the web, email, etc.

Conclusion

Big data analytics as a process of collecting, processing and analyzing large amounts of data in order to make decisions is attracting the attention of a large number of researchers and practitioners from different fields. The topicality of this topic is increasing over time, considering the increase in the number of data that needs to be analyzed. With its application, it is possible to monitor customer requests, focus on the target market, manage risks and collect data from various sources. However, the limitations that companies most often face are the lack of trained people to manage big data analytics, as well as the necessary investments in technology to process them.

The widespread use of big data in a large number of activities is the current situation. In healthcare, it is used for better decision-making about diagnoses, then for unifying all patient data, but also for better management of procurement, etc. In the chemical industry, it is used to better manage a large number of plants that work together, while in science and higher education, it is used to analyze student data, create lesson plans, and analyze the large number of articles that are published on a daily basis.

Predictions regarding the growth of big data analytics say that its use will increase year by year and that more and more companies around the world will start using it. Growth is fueled by the development of technology and tools that shorten processing time and increase its accuracy.

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