Basic Technologies and Models for Implementation of Industry 4.0

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The Importance of the Application of the Big Data Concept for Small and Medium-Sized Enterprises

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Abstract: *Business operations of companies in modern conditions are subject to enormous market, social and especially technological pressures from the environment. Information and communication technologies have become so incorporated both in our everyday life and in the operations of every company, that without them we feel almost lost and helpless. Big Data, as a theoretical (philosophical) concept has existed for decades, but only recently, thanks to the extraordinarily rapid development of information and communication technologies, it has become applicable in practice, and as a business concept it has been recognized as a unique opportunity for success in the business world. Like all organizations, small and medium-sized enterprises can find a unique opportunity to improve their own business in the application of this concept. The number of users is growing exponentially, generating a huge amount of different data every second through different sources (YouTube, Twitter, Instagram, Facebook, Google, Skype, Internet, E-mail). All those unimaginably large amounts of data need to be stored somewhere: processed, analyzed, presented and interpreted, and then propose (suggest) specific business solutions based on those results. Realization of those activities in real or reasonable time, and often unexpected and surprising conclusions, are made possible by the Big Data concept. This article aims to shed light on the concept and technology of Big Data and its application at the level of small and medium enterprises. Big Data is a theoretical and technological concept, which is able to revolutionize the way of decision-making in companies and achieve extraordinary and concrete results. A secondary, but no less important, goal of writing this paper is to point out the importance of small and medium-sized enterprises, which outnumber the large ones. Most of them strive for a stable, dominant and high market position, so it can be concluded that they are extremely important for development and progress of each country.*

Keywords*: IT-supported decision-making in real time, Big Data concept, small and medium-sized enterprises, opportunities and benefits, enterprise performance, business result.*

1. Introduction to Big Data

One of the consequences of globalization is the generation of enormous amounts of data and information that exist in the business environment. The

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challengefacing all modern, and especially small and medium enterprises (SMEs), is to use as much data as possible, store it, separate the necessary from the unnecessary through filtering, and finally process the most important ones. The ultimate strategic goal arising from the aforementioned challenge is profit maximization, improvement of market, external and internal performance, strengthening of market position and long-term, profitable business. In order for as many data as possible to participate in the process of their transformation into information and knowledge, it is necessary to manage that data in the right way, that is, to overcome the difficulties that appear during their management. Managing data in enterprises is difficult for many reasons [1].

Firstly, the amount of data grows exponentially over time. A lot of historical data has to be stored for a long time, and new data arrives quickly. For example, to be able to serve the 40 million people who like to play ‘’fantasy football’’ (American Football League), websites such as ESPN.com, NFL.com and CBSSportLine.com must manage petabytes of sports data. A petabyte is about 1,000 terabytes or a trillion bytes or more precisely 1024 terabytes. An exabyte is about 1,000 petabytes or more precisely 1024 petabytes. Another example arelarge retailers such as Walmart stores which need to manage exabytes of data to support millions of customers. In addition, data is also scattered across different organizations and collected by many individuals, using different methods and devices. These data are often stored on numerous servers and locations and in different computer systems, databases, formats, and different human and computer languages.

Another problem is that data is generated from multiple sources [1]: internal sources (e.g., corporate databases and company documents), personal sources (e.g., personal intentions, opinions and experiences) and external sources (e.g., commercial databases, government reports, and corporate websites). Data is also generated from the Internet (from the Web) in the form of customer data. Click-through data is the data that visitors and customers produce when they visit a website and click on hyperlinks. That data leaves a trace of user activity on the Website, including user behavior and browsing patterns.

In addition to the above problems, other problems are created by the constant growth of data from new data sources, such as blogs, podcasts, videocasts, and radio frequency (RFID) identifier tags as well as other wireless sensors. Most of this data is unstructured, which means that its content cannot be reliably recorded in a computer archive. Examples of unstructured data are digital images and video recordings, audio recordings and musical notes in MP3 or MP4 format files. In addition, data becomes outdated over time. For example, customers move to new addresses or change other master data, companies abandon contracted work or procurement, new products are developed, workers are hired and fired, and companies expand operations to new countries. Data is also subject to destruction. Physical destruction of data refers primarily to

problems related to the media on which the data is stored. Over time, temperature differences, humidity, and light exposure can lead to physical problems with storage media that make it difficult or impossible to access data. Another aspect of data destruction is the inability to access data, due to malfunctions in the devices used to access the data or the inability to acquire an outdated device. For example, today it is almost impossible to find a 5.25-inch or 3.5-inch drive for writing and reading data from floppy disks. As a consequence, 5.25-inch or 3.5-inch diskettes have become relatively worthless, except in the case when the company owns a functional drive (device drive) or has converted data from diskettes to modern media such as CDs or DVDs. Security, quality and integrity of data are critical activities in every company, which should be taken care of, because they can be compromised very easily. In addition, legal regulations relating to data vary between countries, as well as between industries, and they change frequently.

The third problem derives from the fact that, over time, companies have developed information systems for specific business processes, such as transaction processing, supply chain management, and customer relationship management. Specific information systems supporting these processes impose unique requirements in relation to data, which can result in repetition and contradictions in data within the company. For example, the marketing function may maintain information about customers, sales territories, and markets. This data may be duplicated with data within the billing function of products or customer services. This situation can lead to non-compliant or inconsistent data within the company. Such data can prevent a company from developing a unified view of a potential problem to be solved [1].

Such problems make data difficult to manage. In response, companies are using databases and data warehouses to manage their data more efficiently. Therefore, it is necessary to analyze the life cycle of data, which should show how companies process data and manage it so that the managers can make decisions, create knowledge and use that knowledge for different purposes.

Business is based on data that has been transformed into information and knowledge. Managers apply that knowledge to business problems and opportunities. Companies transform data into knowledge and solutions in several ways. The general transformation process is shown on Figure 1. [1].

The process begins by collecting data from various sources and storing the data in a database (or databases). Data is then selected from the company's databases and processed to fit into a format suitable for the company's central data warehouse or local data warehouse. Users then access the data in the company's central data warehouse or local data warehouse for analysis.

Analysis is performed using analysis tools that search for patterns of data behavior, as well as using intelligent systems that support data interpretation.

These activities ultimately create knowledge that can be used in the decision-making process. Data (during the process itself) and knowledge (generated at the end of the process) must be presented to the users. Data presentation is done using visualization tools. The knowledge that is created can also be stored in the company's knowledge base and then used together with decision support tools to find solutions to organizational problems.

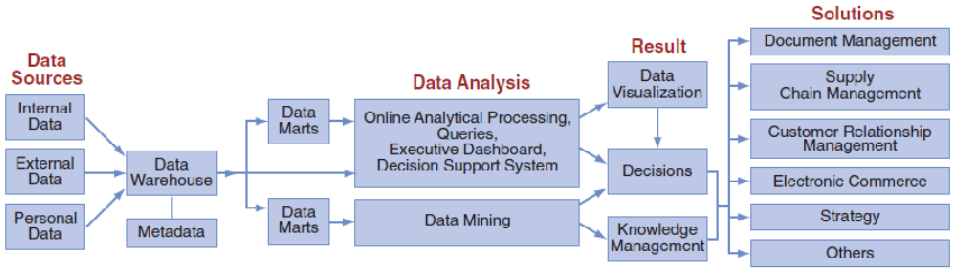

Figure 1. Data life cycle[1]

Authors Judith Hurwitz, Alan Nugent, Dr. Fern Halper and Marcia Kaufmantermin [2], believe that Big Data is not represented as a single technology, but something that includes both old and new technologies that, when used in combination, give companies the ability to manage large amounts of data from different sources, at the appropriate speed, and in the appropriate time frame. By Big Data, they mean the combination of many different hardware-software solutions, which are used for data management. Thomas H. Davenport [3] considers the concept of Big Data as a revolutionary opportunity with transformational potential for every business, but he characterizes the name itself as problematic. As a results of the imprecise term of this concept, he suggests to companies its decomposition, in order tosimplify the strategy, and based on that, determine what are the possibilities and goals of using data. Bernard Marr, [4] a Big Data expert, states that the name of the concept is misleading because the focus is not on big data, that is, large amounts of data, but on the possibilities of their exploitation and conversion into value. By combining traditional structured data with ‘’messy’’, companies use Big Data tools to create richer insights and make smarter decisions. Data generation today looks like a rolling snowball, according to forecaster William Higham [4]. He predicts that effective ways of using data will be more complicated at first, but will eventually become a daily part of both the business life of companies and private lives. Businesses will use Big Data technologies in an increasing proportion, and small and medium-sized enterprises must react quickly with the development of a strategy and its implementation, because a passive approach most often means disappearing from the market. Many companies are testing different approaches to data collection in order to uncover hidden patterns of

business significance. All data that is an integral part of the Big Data concept can be classified into three groups: structured, semi-structured and unstructured data.

Thomas H. Davenport [3] defines structured data types as clearly defined types that are easy to find using known, specific patterns. Unstructured data represents ‘’everything else’’, i.e., data that cannot be easily found and searched because they do not have a defined pattern and are not organized in advance. Semi-structured data does not have a corresponding structure with which we associate it - e-mail, word documents and diary documents. There are many reasons why small and medium-sized enterprises fail to cope with environmental pressure and follow trends. The traditional approach in business is no longer sufficient, and the benefit of historical data is a problem due to the rapid aging of data, which further leads to wrong decisions, and in the long term to loss of market competitiveness and exit or disappearance. Resistance to the introduction of the Big Data concept was previously caused by the high cost of implementing Big Data technology in companies, but today, thanks to cloud technology, data centers and analysis tools, the application of this concept has become economically acceptable and necessary for successful business. For most countries, the number of small and medium-sized enterprises constitutes the majority percentage in the structure of the state economy, and the successfully implemented Big Data concept means a key step in the growth and life of small and medium-sized enterprises. The value of SMEs is important regardless of the economic strength and position of the country, because they contribute to economic growth, job creation and social progress. The biggest challenges faced by small and medium-sized companies are inadequate financing, poor company management, lack of training and education, but also focusing on operational business activities instead of research and investment in new technologies that will improve operations. As a result of such practices, many of them cannot keep up with technological changes and innovations. The report of the European Commission *Skills for SMEs - Supporting specialized skills development: Big Data, IoT and Cybersecurity for SMEs*[5], states that many companies understand the benefits of data-driven decision making and invest in Big Data technologies and services. Worrying data shows that very few companies embrace digitization: in 2015, only one in five European companies showed a high or very high degree of digital intensity, while only 6% showed a strategic and intensive use of data. According to data from 2018, only 12% of European SMEs used forms of Big Data, compared to 33% of large enterprises. The result of the research shows that even 90% of small and medium-sized companies believe that they lag behind digital innovations [6].Although this concept was neglected and ignored by small and medium-sized companies until recently, the approach is starting to change significantly, and the goals of strategic planning and implementation of Big Data strategy are being created. We find benefits in

sales improvements, personalized user experience, arrival of new clients, control of production and distribution processes, reaction and reduction of error chances, but also active market analysis. Big Data is not intended only for large companies with large budgets at their disposal, but on the contrary, today this concept has more potential for small and medium-sized companies.

2. Defining the term Big Data

The problem of defining the term Big Data was most simply explained by the Israeli professor of Psychology and Behavioral Economics, Dan Ariely, with the following statement from 2013 [7]:
''Big Data is like teenage sex: everyone's talking about it, no one really knows how to do it, everyone thinks everyone else is doing it, so everyone says they're doing it too...''
Big Data is a term that has infiltrated our everyday world - from commercial applications to research in various fields such as psychology, geography, humanities or healthcare. Considering how often we encounter this term, it is extremely important to try to find an answer to the question: what exactly is meant and what does Big Data refer to? The name itself did not appear recently, and is not a novelty. It was probably used for the first time in the mid-90s at one of the meetings at Silicon Graphics (a company for the production of high-tech computer hardware and software solutions).
The first appearance in academic literature dates back to the early 2000s, in the field of statistics and econometrics, where Big Data is used to describe the explosion in the quantity and quality of available and potentially significant data, as a result of unprecedented progress in data creation methods and data storage technologies. [8]

The European Commission defines Big Data as [9]:
''Large amounts of different types of data generated from different sources such as people, machines or sensors. This data includes climate information, satellite images, digital images and videos, and GPS signals. Big Data can also be linked to personal data, i.e., any information linked to an individual, ranging from names, photos and e-mail addresses, bank details, posts on social networks, websites, medical data or computer IP addresses''.
Similar to the European definition, in the United States, the National Science Foundation (NSF) views Big Data as [10]:*''Various, diverse, complex, longitudinal and distributed data sets generated from various instruments, sensors, internet transactions, e-mails, videos, and all other digital resources available both today and in the future''.*
Despite the fact that most of these definitions are based on the same or similar elements, the term Big Data remains conceptually incomplete due to the

different ways in which it is used in different contexts. In order to solve this problem, experts are trying to propose a standard, that is, a commonly defined definition of Big Data. De Mauro and other authors [11] propose a consensual formal definition in which:

''Big Data represents an information asset characterized by high volume, speed and diversity, which requires specific technology and analytical methods to transform it into value''. Other experts like Floridi criticize traditional attributive definitions because they still remain vague and insufficiently precise, and do not clarify on the real way, what exactly does Big Data mean.

The problem is also in the part of the term ''Big'', because with the exponential growth of computer capacities, it is impossible to define a threshold for big data because they are relative and differ by factors such as time and type of data.

Despite all efforts to bring the debate on the definition of Big Data to an end, regardless of the various definitions set so far, a consensus on an adequate definition of Big Data has not yet been reached. The problem of using digital data sets, which on the one hand can have a significant benefit for research, but on the other hand, reveal sensitive data about research participants, is particularly highlighted. Another loophole in the law is the use of data from digital platforms (most often social networks), without the exclusive consent or awareness of the user. A scandal like Cambridge Analytica related to the presidential elections in the USA in 2016 drew attention to the weak regulation of research practices. Public outrage and pressure resulted in the planning and creation of strategies to protect private users.

According to a survey conducted among 39 Swiss and American researchers, the basic and practical definitions of Big Data were singled out (Table 1. and Table 2.) [8].

Table 1. Basic definition of Big Data based on attributes(Source: [8])

1. Essential Definition based on attributes/properties	
1.1 Several V s definition	Definition based on the traditional attributes of Big Data (4 Vs)
1.2 Volume	Vast amounts of data
1.3 Variety	Heterogeneous data, both structured and unstructured
1.4 Complexity	Very complex data compared to data that is traditionally collected
1.5 Impact	Data that has a huge impact and value for society

Basic definitions are based on attributes or properties. This would mean that Big Data is defined according to one or all of the ''V'' characteristics. The dimensions listed here are used to illustrate the numerous technical challenges brought about by Big Data technologies. The problem with this form of

definition is the establishment of the number of attributes, or the selection of the primary, most frequently selected one - quantity (volume), which is mostly mentioned in the sense of a large number of samples. Other respondents mention the diversity and complexity of data as well as more important attributes.

Table 2. Practical definitionsof Big Data (Source: [8])

2. Practical Definitions	
2.1. Source of Data	Data that comes from digital technologies
2.1.1 The Human Component	Data that is generated from people
2.3. Collection	Data collected with no purpose or with no informed consent
2.4 Data Processing	Data that needs sophisticated computational processes to be analyzed
2.5 Problem Solving Tool	Method that is capable of answering questions

Practical definitions, instead of being based on characteristics, are based on practical processes such as data collection and data processing as important components of the Big Data definition. Thus, practical definitions pay attention to the data source, even the human component of generation. These factors have created the opinion that Big Data does not imitate the real picture of the world, but that it even gives an incomplete and inaccurate representation of reality. Another key factor is data collection, especially in cases where there is no purpose. The typology of procedures in data analysis also enters as a defining factor, because the data belonging to Big Data are demanding and therefore require specific algorithmic and computer processes. Finally, one of the key components is a tool for solving problems, which is reflected in Big Data as a pragmatic ability to act as a tool for answering questions and finding timely solutions. Due to the lack of conceptual clarity, certain researchers did not even use the term Big Data, considering it a popular phrase, which is a cultural product of our living world, and not a separate entity in material form, and therefore can only create confusion. According to Timo Elliott, Table 3 shows seven types of definition creation, based on more than 33 Big Data definitions. Each of the definitions tries to describe a certain problem from one aspect. A comprehensive definition can become very complex and long.

Table 3. 7 most popular Big Data definitions(Source: [12, p. 10.])

No	Type	Description
1	The original big data (3Vs)	The original type of definition is referred to Douglas Laney's volume, velocity, and variety, or 3Vs. It has been widely cited since 2001. Many have tried to extend the number of Vs, such as 4Vs, 5Vs, 6Vs … up to 11Vs
2	Big Data as technology	This type of definition is oriented by new technology development, such as MapReduce, bulk synchronous parallel (BSP — Hama), resilient distributed datasets (RDD, Spark), and Lambda architecture (Flink)
3	Big Data as application	This kind of definition emphasizes different applications based on different types of big data. Barry Devlin [37] defined it as application of process-mediated data, human-sourced information, and machine-generated data. Shaun Connolly [38] focused on analyzing transactions, interactions, and observation of data. It looks for hindsight of data
4	Big Data as signals	This is another type of application-oriented definition, but it focuses on timing rather than the type of data. It looks for a foresight of data or new "signal" pattern in dataset
5	Big Data as opportunity	Matt Aslett [39]: "Big data as analyzing data that was previously ignored because of technology limitations." It highlights many potential opportunities by revisiting the collected or archived datasets when new technologies are variable
6	Big Data as metaphor	It defines Big Data as a human thinking process [40]. It elevates BDA to the new level, which means BDS is not a type of analytic tool rather it is an extension of human brain
7	Big Data as new term for old stuff	This definition simply means the new bottle (relabel the new term "big data") for old wine (BI, data mining, or other traditional data analytic activities). It is one of the most cynical ways to define big data

The right solution in defining is the use of rational reconstruction where it is necessary to determine the reasons behind practices, decisions and processes and make them easier to understand.[12, p. 10.]

The purpose of Big Data is to gain insight into the past – metadata patterns from historical data, deep understanding of problems and predicting the near future in a cost-effective way. However, these important and indispensable attributes are often omitted in many definitions that focus only on one problem or one aspect.

Bernard Marr, the world's leading expert on Big Data, also states that the name Big Data is simplistic and misleading. Marr shifts the focus from the amount of data to the human ability to work with that amount and create value. He also predicts that the term Big Data will disappear over time, and that the successor will be SMART Data, precisely because it is not the amount of data that brings fundamental changes, but the ability to analyze and convert different data into value, even with smaller and smaller need for supercomputers. He says the following about Big Data[4, p. 9.]
''The basic idea behind the phrase Big Data is that everything we do leaves a digital trail (or data) that we (and others) can use and analyze to become smarter. The driving force in the world is access to ever-increasing amounts of data and our ever-increasing technological ability to mine that data for commercial purposes''.

Thomas H. Davenport, [3, p. 1.] a professor and lecturer at MIT and Babson College, believes that Big Data is a misnomer and that it is just a catchy name for data that does not fit the usual framework. Davenport believes that attention is focused on the size of the data and the word ‘’Big’’, while in fact it should be focused on the shortage and lack of data structure. He also emphasizes that organizations can benefit from this modern term if it creates energy and enthusiasm. Together with other experts, he predicts a short lifespan of this term, and concludes that the term is accepted by the media and start-up companies, but that it is reluctantly accepted by technologically oriented companies. However, if we want to explain the wide range of new and massive types of data that started in the last decade, there is no better term for it than Big Data. Davenport explains [3, p. 1.]: *‘’Big Data represents data that is too large or too numerous to be stored on a single server, too unstructured to be represented in a row-column view of files, or they change too frequently to be retained in a standard data warehouse’’.*

Authors Judith Hurwitz, Alan Nugent, Ph.D. Fern Halper and Marcia Kaufman [2, p. 1.] consider Big Data to be a different combination of hardware and software solutions, i.e., numerous technologies for data management that enable companies to store, manage and manage huge amounts of data at the appropriate speed and in the right time to obtain the necessary benefits [2, p. 1.].

From the previous considerations, we can conclude that the very name of the term, which we are investigating, causes numerous polemics, discussions and many problems. However, although there are a large number of definitions, Big Data still does not have a simple, logical and understandable explanation. The use of the term causes discomfort and uncertainty when using the term because it is partially seen as a cultural phenomenon that includes the development of computer technologies, instead of a clearly defined entity or methodology. In order to correctly understand the essence of the concept of Big Data, it is necessary to decompose the concept into its various constituent parts, which would avoid generality and reach specific qualities. Until then, it is definitely necessary to put efforts in researching the conceptual definition of Big Data, that is, clearly defining and deciding what it is and what it is not.

3. Data attributes, which are part of the Big Data concept

Basic attributes, or data dimensions, that distinguish ‘’ordinary’’ data from data that is the subject of the Big Data concept:[13]

- **Volume** – large amount of data that is generated, collected, stored, processed and shared for analysis. Today, this amount is measured in terabytes, petabytes, exabytes and increasingly zettabytes. As an example of this attribute, we can take all transactions with credit cards in one day, in the territory of Europe.
- **Velocity** – the speed at which new data arrives is enormous and is higher than the speed of data processing, because it is about the permanent generation of a large amount of data in real time. For example, creating social media posts within an hour or a day.
- **Variety** – data is available in different formats and comes from different sources, and is mostly unstructured. This attribute refers to the variety of incompatible and inconsistent data formats and structures. An example of different formats can be audio and video recordings that we receive from surveillance cameras from different locations in a city.
- **Value** – as the 4^{th} characteristic, it starts from the assumption that the data in itself has a certain potential value, i.e., the value extracted from all the data.

Later on, some authors [14, 15] added some new attributes, which start with the letter ‘’V’’ like the attribute ‘’Vision’’ (new ideas with old data), then ‘’Verification’’ (the possibility of checking whether the data meets a certain set of specifications, with this process taking place before the data is subjected to any analysis), ‘’Validation’’ (checking whether the purpose of the data is satisfied and consistent, i.e., whether the same accurate and appropriate conclusions can be obtained from the same set of data regardless of the number of repetitions of the analysis, with the fact that this process takes place after the data have been subjected to analysis) or ‘’Variability’’ and ‘’Reliability’’, which have not yet spread.

When defining the characteristics of data, which are the basis of the Big Data concept, a large number of data scientists from practice, as well as theorists, do not consider that only these 4 characteristics are sufficient to distinguish them from ‘’standard’’ data. At the same time, they try to ensure that each of the additional features begins with the letter ‘’V’’ [16].In this way, from the original characteristics of the data, which were marked with ‘’3V’’ it became ‘’4V’’, then ‘’10V’’ and finally to ‘’42V’’ [17].

4. Data sources that are the subject of the Big Data concept

Data is the driving force for the information society, without which the innovations on which modern man depends would be almost impossible. The data that is an integral part of the Big Data concept is at the center of modern science and business. The importance of that data is perhaps best illustrated by the fact that in 2013 the English government allocated 189 million pounds for research in the field of Big Data. Synthetic biology, as the next discipline in terms of the amount of money allocated, received 88 million pounds. Big Data sources include fingerprint databases, DNA databases, airline flight records, educational institution records, credit card transactions, Facebook pages, e-mails, public health records, etc.[16].
In the era of **BIG DATA**, the value of data lies in the sum of all its possible applications, and these values can be released in several ways [14]:

- **New use of ''old'' data**
  Since 2012, a group of companies (*IBM, Honda, Pacific Gas* and *ElectricCompany* of California) has been requesting data on the deployment of electric charging stations for electric cars. Their goal was to find out when and where electric cars could run out of power. They conducted the research on the basis of data such as: the charge level of the car battery, the position of the car, the time of day, the number of available charging points at the nearest electric charging stations, etc. To that data, they also added electricity consumption from the electrical network and archival (historical) records of electricity consumption models. Based on the data thus collected, IBM was able to build a model of optimal places for the construction of electrical stations. After the construction of the station, it will be possible to add data about the current weather, weather forecast, and the difference in prices in nearby electric stations to the model. They used primary information from data such as a battery level indicator that tells the driver when it's time to charge and data on energy usage, which is collected by the electrical grid to keep it stable. Then, from the same data, they calculated secondary information such as determining the time and place for recharging the battery, that is, determining the most suitable places for the construction of electrical stations. They added the additional use of information from GPS data on the car's position and historical data on the monitoring of energy consumption in the network to their calculations.
- **By merging, that is, by crossing different sets of data**
  Although many data are valuable in themselves, when cross-referenced with other databases their value can increase even more. Aggregation

orintegration of data can provide completely new insights into the field, enable some new uses, or provide data for some new innovations.

- **Extensible/multiple data use**
  If the data is not used only for the primary, i.e., the first purpose for which it was collected, but also finds some new application, then we can say that it is a multi-purpose use of data. Sometimes a new purpose is ‘’discovered’’ only after the data has been collected, but that does not diminish its power.
- **Using data ‘’exhaust gases’’ and opening ‘’tombs’’ of data**
  ‘’Exhaust gases’’ of data is a term that refers to those data that are created as a side product (by-product) of user interactions on the network, such aswhere users clicked, how long they stayed on the website, what they typed, and which companies can use to improveexisting services or offer new ones.
- **By opening the ‘’tombs’’ of data**
  Another place that can serve us as a source of Big Data is ‘’tombs’’ of data. It is a place where collected data is kept that was (perhaps) once used and then archived without further use. It is clear that not all data sources for Big Data will be successful, nor will all their applications. Research shows that even ¾ of hospital information systems in America were unsuccessful. In Great Britain, they rejected the investment of 17 billion dollars that was invested in the Big Data information system of the *UK National Health Service* center. In America, they stopped a $350 million project known as the Cancer Biomedical Informatics Grid that was supposed to develop standards for tagging and sharing biomedical data and data processing tools.[14]

Large data sets come from a variety of sources[16]:

1) **Social networks:** the growth of social networks such as e.g., YouTube, Instagram, Twitter, Facebook influence the exponential growth of the total amount of data.
2) **State government data:** state governments generate and collect large amounts of data, related to the total population, health care of the population, as well as various types of forecasts. These types of data are inevitable for Big Data analysis and research.
3) **Peer to Peer communication:**with the development of technology, the amount of data generated in this way also increases. These are e-mail messages, SMS messages, phone calls from mobile phones, various types of chats, etc.
4) **Media:** Various websites, portals, magazines, images, videos, blogs, podcasts, etc., all belong to the Big Data system.

5) **Customer interaction:** Almost all successful companies start building their customer databases, using websites, which are accessed by customers. The most common sources of data come from user data. For example, actions such as downloading, registering and filling out an account from a website. Companies are starting to collect that customer data, classify different types of customers and come up with strategies to do business with different types of customers.
6) **Other sources:**stated in Figure 2.

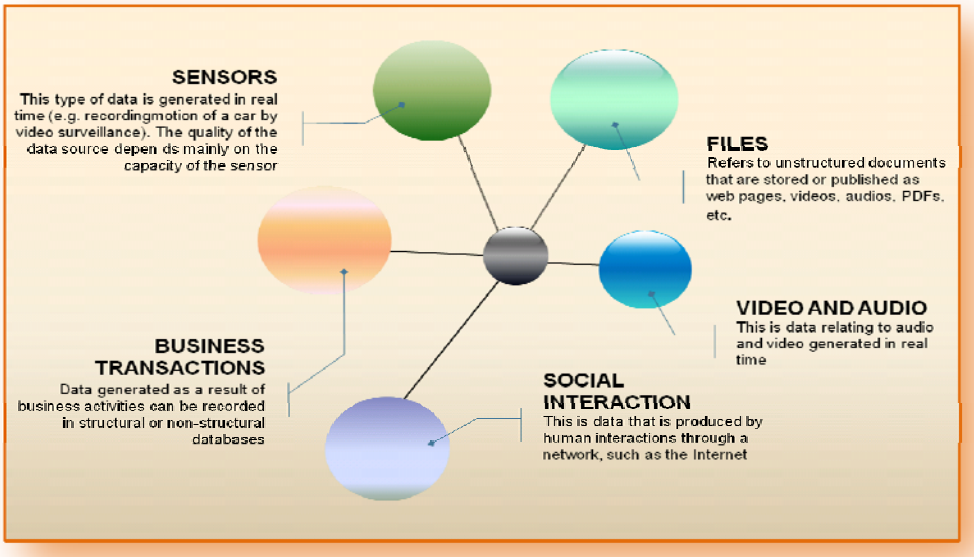

Figure 2: Additional data sources for Big Data
(Source: [16])

5. Research and analysis of the application of the Big Data concept in SMEs

The aim of this paper was to check the impact of the Big Data concept on the operations of small and medium-sized enterprises, that is, to try to answer the questions: whether the application of this concept has direct and positive effects on small and medium-sized enterprises, whether the managers of these enterprises are generally familiar with this concept and the importance it carries, and whether the application of the Big Data concept affects the operation and business processes of small and medium-sized enterprises to be as simple and fast as possible. Every company expects to achieve market competitiveness and market survival in the long run. Nevertheless, small and medium-sized

enterprises have many concerns when it comes to market changes and changes in the way of doing business, which primarily refers to the use of Big Data in everyday business. Big Data is a very young research area when viewed through the theoretical and practical prism of application in small and medium-sized enterprises. By researching the relevant literature, one can come to the conclusion that the first relevant research on Big Data was not published until 2011. Even most of the research that has been done on this topic does not follow organizations of a specific size such as small and medium-sized enterprises, and yet most research shows that small and medium-sized enterprises approach Big Data activities with a degree of reluctance compared to large companies. The most common reason for this is insufficient knowledge of the Big Data concept. Although we have more and more information about Big Data technology over time, research on small and medium-sized enterprises is still at an early stage, and this is not an area that is interesting for many researchers. Small and medium-sized enterprises do not receive significant funds for research, and it is possible to argue that in most cases, they do not even accept them at all. This is why small and medium-sized enterprises are a relatively unexplored and unknown field, especially when it comes to the effects of the Big Data concept in their daily operations. Their positions are often limited and artificial. Of course, much more developed countries conduct more research on this topic. This research should provide insight into the attitude of small and medium-sized enterprises towards the application of the Big Data concept in their operations. However, we cannot say that small and medium enterprises are unimportant and just ignore their importance. On the contrary, small and medium-sized enterprises play a major role in the economic stability and total national income of each country.

The adoption of Big Data technology enables companies to create a clear picture of their users and their requirements with the aim of making the best possible decisions, based on facts and information, for setting appropriate marketing strategies. Managers of small and medium-sized enterprises, in turn, expect timely and high-quality market analysis and prediction of user behavior from Big Data technologies. The application of Big Data technology in small and medium-sized enterprises can lead to increased flexibility, efficiency and effectiveness, better and more adequate reactions and the possibility to meet the expectations of users, and thus to realize their competitive advantage.

The adoption and application of the Big Data concept in small and medium-sized enterprises depends on technological, organizational, managerial and environmental factors, as well as other factors that affect the company's operations.

5.1. Research Methodology

The research technique used in this paper is Desk research or the technique of secondary research, which implies the collection of existing data from existing and valid sources. Secondary data includes literature, i.e., books, magazines or scientific articles in printed and online editions, as well as relevant and confidential websites. Desk research consists of the following steps: defining research questions and topics, identifying sources, i.e., creating a list of potentially useful internal or external sources, conducting research, evaluating reliability and ranking potential sources, and finally, creating a summary, which can be a formal report or a visual a map. Due to the complicated system of identification, selection and contact with small and medium-sized enterprises in the territory of Bosnia and Herzegovina, it was not possible to carry out the planned survey. The lack of legal regulations for small and medium-sized enterprises also contributes to this, as well as the different procedures and laws that apply to small and medium-sized enterprises in certain parts of Bosnia and Herzegovina: the Federation of Bosnia and Herzegovina, the Brčko District and the Republic of Srpska. Unfortunately, on the territory of Bosnia and Herzegovina, there is no unified approach and view of small and medium-sized enterprises. Because the primary research was not possible, the best alternative is the desk research methodology. In this way, we can present the bigger picture, look at the details of importance, break down the research into elements and review many more examples for the proposed hypotheses. In addition, with this approach, we can find out what the situation is in other countries and how small and medium-sized enterprises differ or how they are similar to each other depending on the geographical location.

5.2. Research results

Research carried out in Iran in 2020, named *The Impact of Big Data Adoption on SMEs Performance*,[18](Narsollahi, Ramezani, & Sadraei, 2021), aims to test 20 hypotheses. This research begins with the introduction and definition of various factors. These factors are listed in Table 4. The items of evaluation and validation of components on which Big Data has an influence and vice versa, were extracted from various studies that were carried out earlier. All factors are rated on a Likert scale with numbers from 1 to 7, where 1 - I completely disagree and 7 – I completely agree. This survey was conducted on SMEs based in Iran, and the respondents of this study are top managers and middle managers working in SMEs in Iran, who responded to the survey via e-mail. A total of 2863 messages were sent in March 2020, and 836 responses were received, of which 612 were rejected due to incompleteness. The final number was 224 completed questionnaires.

Table 4. Description of influential factors in small and medium enterprises (Source: [18])

Construct	Definition
Feature factors (FEF)	Including: Trainability, Perceived simplicity, Observability, Complexity, and Data quality and integration.
Organizational factors (ORF)	Including: Organizational data environment, Business strategy orientation, Firm size, and Industry type.
Utility factors (UTF)	Including: Perceived compatibility, Appropriateness, Perceived benefits (advantage), Relative advantage, and Perceived usefulness.
Technological factors (TEF)	Including: Technology readiness/ technology resources, Wireless technology, Availability of big data tools, Internal versus external technologies, IS competence/IT structure (infrastructure), Technological capability, and Network challenges.
Stakeholders factors (STF)	Including: Vendor support, Competitive (Perceived industrial) pressure, Government support, laws and policy, Trading partner adoption/ readiness, and IS fashion.
Financial factors (FIF)	Including: Perceived financial readiness, Perceived cost, and Cost of adoption.
Processing factors (PRF)	Including: system integration, Security and privacy, Data control, Predictive analytics accuracy, and Interpret unstructured data.
Cultural factors (CUF)	Including: Organizational (learning) culture, information security culture, and Decision-making culture.
Wisdom factors (WIF)	Including: IT expertise, Knowledge about big data, and big data awareness.
Environmental factors (ENF)	Including: Supply chain connectivity, Risks of outsourcing, Market turbulence, and Marketing and inventory.
Managerial factors (MAF)	Including: Leaders' attitude towards change, Management support for big data, Change efficacy, and Willingness to change.
Skills factors (SKF)	Including: Human resources, Staffing, and Training.
Economic performance (ECP)	Economic performance reflects the firm's ability to reduce costs associated with purchasing materials, energy consumption, waste management, environmental fines, etc. (Green Jr, Zelbst, Bhadauria, & Meacham, 2012).
Operational performance (OPP)	Operational performance (OPP) is related to the firm's capability to increase product distribution efficiency to customers (Zhu, Sarkis, & Lai, 2008).
Social performance (SOP)	Social performance (SP) reflects the status of organizational beliefs about social responsibilities, social accountability methods, policies, plans, and the evident outcomes associated with the organization's social relationships (Younis, Sundarakani, & Vel, 2016).
Organizational performance (ORP)	Financial and marketing and performance of the organization compared to the industry average (Green, & Inman, 2005).

Based on previous knowledge and their results, 20 hypotheses were developed. Hypotheses H1-H5 and H7-H12 refer to various organizational factors that are claimed to have a positive and direct impact on the implementation of Big Data technologies in small and medium-sized enterprises(Feature, Organizational, Utility, Technological, Stakeholder, Processing, Cultural, Wisdom, Environmental, Managerial and Skill Factors). Hypothesis H6 claims that ‘’*Financial factors have a negative and reverse impact on BDA (BDA - Big Data Analytics)’’* [18].Hypotheses H13-H15 claim that ‘’BDA *has a positive and direct impact on operational performance; environmental performance*; *social performance’’*[18]. Hypotheses H16-H18 claim that *‘’Environmental performance has a positive and direct impact on operational performance; social performance; organizational performance’’* [18], and H19 and H20 refer to *‘’positive and direct impact on organizational performance*’’ of ‘’*Operational performance and social performance’’* [18]

The research model confirmed almost all hypotheses, and only two were rejected (‘’H15: *BDA has a positive and direct impact on social performance*, and H17: *BDA has a positive and direct impact on social performance’’*. [18]) Research has proven that organizational, technological, financial, cultural, managerial, environmental and stakeholder factors as well as process and skill factors have a positive and direct impact on the implementation of Big Data technology in small and medium-sized enterprises. Hypotheses 13 and 14 read: The implementation of Big Data has a positive and direct impact on the operational performance of the company and the implementation of Big Data has a positive and direct impact on the performance in the environment [18], and they have been confirmed and proven.

This research provides valuable results by determining the impact of the use of the Big Data concept by small and medium-sized enterprises on their organizational and business performance. Economic performance has a direct impact on the operational and organizational part, but what cannot be proven is the impact on the social factor of the organization. Finally, social and operational factors have a positive and direct influence on the organizational factor, and the results point to the improvement of various organizational units such as operational performance, which is reflected in the increased ability of the firm to increase the efficiency of product distribution to its users, and to increase the social performance that manifest in organizational beliefs about social responsibility, policies, plans and results. And finally, the most important fact is that the use of Big Data has a positive and direct impact on organizational performance, such as the financial and marketing effect of the organization compared to industry competitors.

This study also highlights the importance of understanding the potential that Big Data brings for better decision-making and performance improvement because by using Big Data, many strategic and profitable opportunities are created for small and medium-sized enterprises through which they can succeed in a business ecosystem where competitiveness and innovation are key drivers. Big Data is a new opportunity for SMEs to use new types of data to improve organizational agility and solve complex problems and achieve better results and performance. As a result of the application of the Big Data concept, fundamental changes are taking place in organizational operations and business performance, and consequently, organizations are moving towards a more accurate and better-informed decision-making and planning system. In the end, it can be concluded that the application of the Big Data concept represents a crucial resource for small and medium-sized companies that want to create new values, new knowledge, new processes and new products. The results of this research give managers a practical framework for deciding whether the introduction of the Big Data concept is necessary or not.

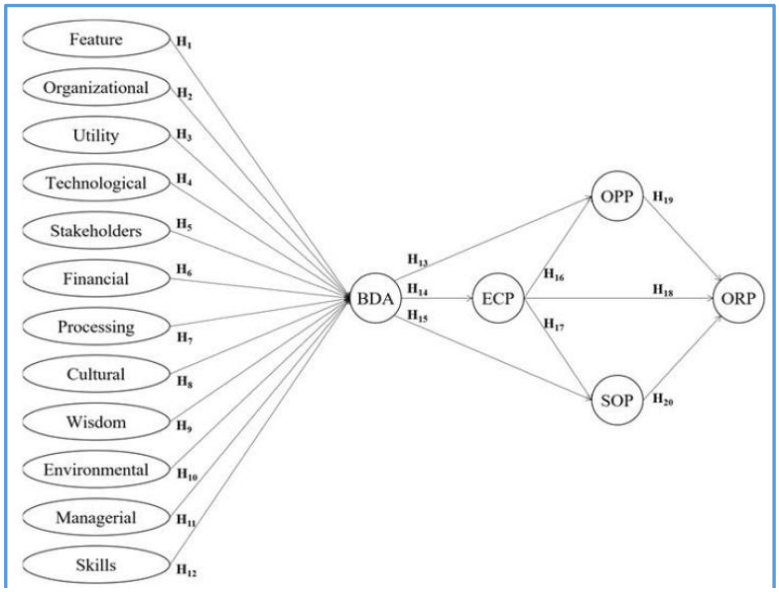

Figure 3. Cause and effect relationship of Big Data implementation
(Source: [18])

Big Data adoption in SMMEs research from 2015. [19], came to the result that small and medium-sized companies that successfully implemented Big Data strategy and analytics, achieved this precisely thanks to the influence of owners, top management, employees, that is, the general organizational culture of the company. Although a culture of case-based and evidence-based decision-making is necessary for Big Data, there are still important situations where judgment and experience are very important in decision-making.

Proactive and innovative organizations use experimentation as a risk management strategy when looking for an opportunity to commercialize Big Data. Small and medium-sized companies use Big Data to enrich internal data, and thus improve the decision-making process. Of all resources, human resources are the most important, so it has been confirmed that Big Data has a positive impact on human performance in small and medium-sized enterprises. These are people who will fit into the organizational culture, look for opportunities to use Big Data and who are able to face the various challenges that come with Big Data offerings. In this research, it was assumed that small and medium-sized enterprises, like large corporations, will use Big Data to process and analyze large amounts of data, enrich internal databases with external data and scan the external business environment. However, SMEs are unlikely to have huge amounts of internally generated data. In this paper, none of the small and medium-sized companies that participated use Big Data for these purposes, which does not mean that there are no such cases, but only

thatthey are very rare. This could be a big advantage for two reasons. First, small and medium-sized enterprises can avoid the fixed costs of storing internal data that they may not need to use, which is an especially important advantage for them when it comes to resource constraints. Second, recent research indicates that companies that have a lot of success with extracting value from internal data, may experience a delay with the intention of using Big Data to search for information from the environment. In the end, the research showed that decision-making and a strong entrepreneurial orientation definitely have an impact on the implementation of Big Data, but that this relationship is also reversed. Big Data has a positive influence on decision-making, operationalization of processes and entrepreneurial culture. Entrepreneurial leaders with their proactiveness and innovation have proven that maximizing the benefits of Big Data is possible, regardless of limited resources.[19].

In research*Expectations that influence Big Data usage of SMEs Business Entrepreneurs,* [20] which was done in the area of Thailand, it was proven that most managers from small and medium enterprises understand the meaning and advantages of the Big Data concept. They showed interest and attitude that Big Data is a necessary technology for organizations, because the implementation helped their companies to transform business and operations in the digital world and achieve business in the long run. They try to implement Big Data in both online and offline business. There is also an understanding of the need to research information and take the time to invest in people, technology and processes so that everyone can benefit from applying the Big Data concept. Managers expect to use Big Data in full capacity with the goal of achieving the mission and vision of the company. They expect that Big Data will also serve as a tool for solving problems such as increased sales volumes or generating new business opportunities. In a more advanced form, managers want to get support from Big Data in the areas of decision-making, creating demand predictions, inventory management, and deep analysis of user behavior, and in creating promotions and campaigns.

Small and medium-sized companies, in addition to the process of knowing theBig Data concept, also have certain expectations that they can identify and recognize. The first expectation that managers have is to personalize the experience for each individual user. The priority is reflected in retaining and creating user loyalty. Another expectation that has been identified is the help of Big Data in establishing effective prices. The importance of the price of a product/service when it comes to making a purchase decision is recognized, so Big Data wants to be used to analyze user behavior and establish prices accordingly, thereby achieving motivation among users to make repeated and more frequent purchases. The third assumption and desire concerns the conversion of visitors into regular users. Sales industries can use informationabout the online behavior of visitors, especially those who have not

yet madeany purchases. It is possible to come to the realization of what prevented them or refused to take that step [20].

The master's thesis *The influence of Big Data on retail activities and retail performance* from 2020 [21], takes as an example of two cases of using Big Data in sales activities, namely in the areas of South Africa and Italy. Both analyzed cases brought different results (Table 5). In the case of South Africa, it is evident that companies have advanced knowledge of Big Data, but that the way of using it is still in the early stages. In South Africa, retailers are still struggling to find the resources and reasons to take Big Data to the next level, while in Italy there is an excellent example of how investing in Big Data management and analytics can pay off, and lead to savings and performance improvements.

Table5. Differences in Big Data Usage[21]

SOUTH AFRICA	ITALY
Retailers do not use real-time analysis	Retailers do not use real-time analysis
Retailers do not analyse unstructured data	Retailers analyse unstructured data
Retailers do not use BD to optimize business processes	Retailers use BD to optimize business processes
Retailers outsource most of the BD analytics	Retailers outsource most of the BD analytics
Segmentation of clients is not performed upon BDA findings	Segmentation of clients is performed upon the findings of BDA

South African retailers explained that the use of Big Data is still in its infancy. Big Data analytics is done internally and continues to be done in a basic way, without an expert data team dedicated to the advanced analytics that would give businesses a competitive edge. Furthermore, the analysis of unstructured data is performed externally, which also indicates a low commitment to data analytics. While big data can offer marketers a huge advantage, it can also bring costs and obstacles that can discourage businesses from using it. This appears to be an issue for South African respondents as they are reported to still be reconsidering the trade-off between investment costs and improved business performance[21].

The first obstacle South African retailers face is the significant capital investment required for Big Data. Investing in big data platforms, hiring data experts and then paying their salaries is a long-term commitment that South African retailers are not yet ready for. Another obstacle they face is the lack of available analytical skills. Finding skilled employees, educated in the field of Big Data and retail, seems to be a big problem. Another possibility is to educate their employees, but that requires time, money and, most importantly, the willingness of their employees to take such a step. Outsourcing Big Data analytics seems to be the preferred option in these circumstances, but the

costissue would still be present. However, the biggest problem seems to be the need to justify the costs of implementing Big Data [21].
When it comes to the Italian retailers who participated in the case study, it could be seen that they had already developed an advanced management system with Big Data. Used in various fields, Big Data analytics has increased the effectiveness of companies and reduced many costs to a minimum. Of course, at one point they encountered obstacles that had to be solved by investing significant time, money and resources. It is interesting that the Italian traders who responded to this challenge discovered an excellent solution for finding employees with the necessary skills. It was reported that at the beginning of Big Data implementation, it was difficult to find employees with the right skills. To solve this, managers started working with universities, posting job offers with the required skills for that job. Students would then see the offer, educate themselves knowing that a job awaits them. This method could also be used in South Africa and would help solve the problem of finding employees with the necessary skills [21].
Furthermore, since Italy is a different, more competitive market with more demanding consumers, it was necessary to take steps to introduce Big Data. However, using it turned out to be extremely beneficial for them. In addition, looking at this example, the trade-off between the advantages offered by Big Data and the investment costs proved to be appropriate. Likewise, when comparing the Italian retail industry with the South African one, it could be seen that the level of competition is much higher and more serious in Italy. Evidence to prove this comes only from the fact that most large Italian retailers had to adapt to the use of Big Data as soon as possible in order to maintain a competitive advantage. While in South Africa, no commercial enterprise has indicated the possible implementation of internal Big Data analysis in the near future, as the obstacles are difficult to overcome. That being said, it is possible that as soon as one South African manager implements a more advanced Big Data system, others will follow [21].
As for the knowledge of Big Data, for the South African case it was concluded that the interviewed managers are well acquainted with the values that the Big Data concept can bring, but that the full potential is not used, only a limited part. In the Italian case, all managers expressed high awareness and knowledge of the Big Data concept, approach it without skepticism, are aware of the value they can get from Big Data, and are ‘’open-minded’’ when it comes to use. In terms of usage itself, in addition to many areas that have been improved, managers singled out marketing and the logistics chain as key areas, with huge potential for improvement with Big Data analytics in the future. Data-driven decision-making has also proven once again to be a driver of competitive advantage. When making important decisions, managers take into account the results of Big Data analysis, which significantly reduces the risk of failure. Additional

advantages obtained from the implementation are reflected in the improvement of customer segmentation, optimization of processes in the company, optimization of logistics processes, and the use of predictive analytics for planning processes [21].

Another master thesis, *Why SMEs lag behind in big data: an explorative study of Dutch consultancy firms*, from 2019 [22], deals with the question of why SMEs lag behind in the adoption of Big Data in the Netherlands. Primarily, the research results showed that the majority of respondents are familiar with the Big Data concept and that their definitions fit the basics of Big Data. All disagreements, such as using only large data sets, occur due to the vagueness of the term itself. Regarding the success of Big Data implementation, human resources are cited as the biggest barrier. As Big Data is a complex adaptation, it requires expertise and special skills that are difficult to acquire without special training. As a result, SMEs have difficulty finding and retaining the right people to work on Big Data technologies. What enables the successful implementation of a Big Data strategy is the flexibility of the organization when it comes to changes and the implementation of new innovations. An internal organizational culture that is flexible, curious and where experimentation is desirable is considered very valuable in the process of being successful, and recognizing and using opportunities such as Big Data. Big Data is used as an organizational resource in the interviewed sample. The transformation to data-driven organizations has not yet been achieved, but there are aspirations towards it, and it is highly likely that it will happen in the near future. Small and medium-sized enterprises are experimenting with extracting insights and hidden information, which can significantly influence learning and capacity development. For example, the use of Big Data to understand and optimize processes will certainly lead to changes in the routine itself, as well as in dynamic capacities. Big Data currently complements the decision-making process for SMEs with evidence and data. Table 6 shows all the projects that the interviewed managers consider to fall under Big Data. It also shows how Big Data is applied. Among the 14 SMEs interviewed, 9 of them can be said to be using Big Data, while the rest have no active projects that can be classified as Big Data [22].

Table 6. Application of Big Data in Dutch SMEs
(Source: [22])

Firm no.	Description of big data	Which V's?	Big data?	Application
1	Not size, but the use case is important	Volume	Yes	Process optimization with multiple goals: customer experience, working more efficiently, saving costs
2	Something that does not fit in excel and cannot be processed on a single computer	Volume	No	Maintenance of technological infrastructure and (B)DAaaS
3	Data with half a million rows	Volume	No	Increasing validity of product (advice) with data
4	Big data is predicting, difficult data is about volume	Volume	Yes	Increasing validity of product (advice) with data
5	Hundreds of thousands of photos	Variety, Volume	Yes	Improving customer experience
6	Data on three hundred thousand people	Volume	No	Increasing validity of product (advice) with data
7	Five hundred million rows per day	Volume, Velocity	Yes	Increasing validity of product (advice) with data
8	Collection of structured and unstructured data	Variety	Yes	Increasing validity of product (advice) with data.
9	Using advanced statistical analyses	Volume	No	Process optimization with multiple goals: customer experience, working more efficiently, saving costs
10	Connecting different data sources	Variety	Yes	Extracting (hidden) insights from big data
11	Unstructured data with no use in mind that is transcending more than one application	Variety	Yes	Extracting (hidden) insights from big data
12	Too large to use on a single computer	Volume	No	Process optimization with multiple goals: customer experience, working more efficiently, saving costs
13	Reach of 1.7 million people	Volume	Yes	Targeted marketing
14	Connecting systems with multiple data sources to each other. Has data on 3.5 million people	Volume, Variety	Yes	Process optimization with multiple goals: customer experience, working more efficiently, saving costs

We must bear in mind that global market-technical-technological trends are eroding the dominance of large companies over small ones, and that flexible and technologically savvy companies with adequate strategies (and financial support) have a real chance to get closer to the market leaders and tackle the battle for market shares[23]. Research by Lufti et al. from 2022 [24] was aimed at identifying the determinants of Big Data application in the context of a developing economy on the example of Jordan. The authors analyzed the influence of technological, organizational and environmental factors on the application and adoption of Big Data in the context of Jordanian SMEs, using PLS-SEM for analysis. As a theoretical basis for the research, a hybrid

modelwas developed for the analysis of factors influencing the adoption of Big Data by combining the technological–organizational–environmental (TOE) model and diffusion of innovation theory (DOI) as the theoretical foundation. In the mentioned model, the Technological Factors included: Relative Advantage, Complexity, Compatibility and Security; Organizational Factors included: Top Management Support, Organizational Readiness, and Environmental Factors included: Competitive Pressure and Government regulations. Empirical results showed that Relative Advantage, Complexity, Security, Top Management Support, Organizational Readiness and Government regulations influence BD adoption.For the factors Competitive Pressure and Compatibility, the influence on the adoption and implementation of Big Data in the research of Lufti et al. from 2022 has not been confirmed. The authors identified top-management support (''in the form of sufficient financial and technical support, employment of suitably skilled employees and provision of relevant training for current employees'' [24]) and government regulations as the most important factors supporting the adoption of Big Data by SMEs.

A research team from Pakistan, Igbal et al. [25] directed its research into the practice of adopting Big Data technology in SMEs to identify the main potentials and threats in the process of using Big Data Analytics and determining the best practices in the use of Big Data Analytics in small and medium-sized enterprises. The authors focused on the following questions: awareness of the possibilities offered by BD, the availability of DB experts, the availability of computer infrastructure for storage, processing and production of functional information from DB, availability of consulting services for Data Analytics, availability and development of the software market, lack of User-friendly, Economical Software, security and privacy issues, Lack of Business Concept and Organizational Structure suitable for exploiting the potential of Big Data,and the availability of financial resources to support the finalization of these processes as well as appropriate legal regulations. The authors particularly emphasize that small and medium-sized enterprises must undertake cultural changes if they want to take advantage of the potential of Big Data. This requires that SMEs identify the tools and methods for handling the data available in the environment and be ready to use all the potential that Big Data offers for decision-making processes. However, using the opportunities offered by Big Data simultaneously implies facing different challenges at different levels for all participants: national and international policy makers, the IT community, the business community and the academic community in accordance with the principles of the Triple-Helix Model [26, 27, 28].

In 2020, a team of Indian scientists [29] addressed the identification of the mediating role of BDA in the influence of nine factors: top management, project knowledge management focus on sustainability, green purchasing, environmental technologies, social responsibility, project operational

capabilities, project complexity, collaboration and exploratory learning, and project success on ‘’Project Performance’’. The results of research conducted on a sample of 321 responses from 106 Indian manufacturing small and medium-scaled enterprises ‘’shows that project knowledge management, green purchasing and project operational capabilities require the mediating support of big data analytics. The adoption of big data analytics has a positive influence on project performance in the manufacturing sector’’ [29]. The research underlines the importance of eliminating difficulties in the adoption of BDA and formulating strategies for effective project management in small and medium-sized enterprises adapted to the specific contexts of enterprises and economies in which these enterprises operate.
Similar to the previously described research, the duo Seseni and Mbohwa from South Africa [30],based on desk research of secondary data, identified in their research the key effects of Big Data application in SMEs: productivity, profitability, business innovation, efficiency and creation, sophisticated skills, mining and analyzing data, but also the key problems faced by SMEs in extracting benefits from BDA, which are reflected in the difficulties of using Big Data tools and technologies. The authors suggest that academic and governmental institutions should develop appropriate support programs to overcome these difficulties. Universities should develop and implement education programs to train small and medium-sized enterprises in the use of BD tools and technologies. The government should develop financial and non-financial support programs for SMEs so that they can acquire and use advanced technologies necessary for competitiveness in modern markets. Additionally, the academic community and BD practitioners should work to develop BDA tools and technologies tailored for SMEs to provide them with the technical and technological support necessary to compete in today’s market [30].

5.3. Conclusion of the research

Through inductive thinking, we can draw the conclusion that small and medium-sized companies, using the Big Data concept, realize numerous improvements in their daily business, both in internal and external processes. All this is possible, if and only if the implementation of the Big Data concept has been successfully finalized, if all challenges have been resolved, if responses to potential risks are ready and if the knowledge of the Big Data concept is at the desired, predicted level. Small and medium-sized companies are generally familiar with what Big Data is and what this concept can mean for their position and their future business. Small and medium-sized enterprises with leaders who have an entrepreneurial mindset and are motivated by growth, have a reputation for being more agile and better at exploring market niches than their competitors, which include large corporations. Although they have limited resources, theystill

have a great advantage in using the opportunities that Big Data analytics can identify for them. In general, we can conclude that all research shows that Big Data strategy in small and medium-sized companies has positive correlations with decision-making and company orientation. The availability of clod services, as well as online tools, allows small and medium enterprises to go beyond the expected and develop an absolutely new business model that will allow them to create analytical and operational skills identical, if not greater, as is the case with large organizations. Managers, with their proactivity and innovation, can very well recognize and take advantage of the advantages that Big Data will present, regardless of the limited resources that most small and medium-sized enterprises struggle with. The fact is that even limited resources can force companies to innovate that larger competitors haven't even thought about.

The implementation of Big Data in small and medium-sized enterprises not only affects the business itself, but also has a positive impact on all other organizational and business factors of the company, from the internal culture, process efficiency, human resources and the very operationalization of the business.

Small and medium-sized enterprises and their leading managers are familiar with the meaning of the Big Data concept, and can identify the benefits that will be obtained by implementing the strategy. The significance, importance and desire for implementation was recognized, all with the ultimate goal of long-term survival and market dominance.

Big Data facilitates all internal and external business processes of small and medium-sized enterprises, shortens unnecessary processes, enables an easier flow of information through the enterprise and helps deliver better products/services to the market.

6. Conclusion

Today, when every decision is based on experience, and all companies, regardless of their size, are fighting for the loyalty and favor of clients, as well as for differentiating their brand on the market, there is nothing more valuable than the data itself. Data provides the insights needed for constant growth and advancement. Big Data, as a concept that has changed and progressed over time, finds its use in every modern enterprise, both in large corporations and in small and medium-sized enterprises. With the right analytics, technology and tools, as well as people and ideas, there is nothing businesses can't accomplish or achieve. All this is possible only if Big Data is viewed as a collection of several separate items, each of which carries equal importance. This concept is not an end in itself, and it is necessary that all elements function smoothly, so that it can be said that Big Data works together with us, in the realization of our mission and vision. In addition, this concept puts the primary focus not on the data itself,

but on the technologies, processes, tools and people who will work with this data and extract the maximum value, knowledge and profit from it. Big Data does not belong only to large corporations, nor can anyone claim this concept as their property and copyright it. That is why it is very important that small and medium-sized enterprises, as pillars of state economies, familiarize themselves with this concept, with all the opportunities and possibilities that the implementation of Big Data strategy will bring to their business. Small and medium-sized enterprises, regardless of numerous limitations, financial and operational, should not avoid new approaches in their business, but rather the opposite: look for examples and inspiration in the good practices of large enterprises, and learn from the best. Based on the research results, we have seen numerous positive impacts that Big Data has for small and medium-sized companies, and of course, we can also find additional inspiration in the examples of market leaders. Big Data is already becoming, and it can be assumed that it will soon become a standard in the business of small and medium-sized companies. The future that lies before us definitely depends on us and the technologies we use to facilitate and improve people's lives in every possible way. With proper use, with the necessary skills, knowledge, vision and creativity, as well as the technologies at our disposal, the world that lies before us will become a pleasant, bright, warm and desirable place for every human being.

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