Digital Transformation from Data Mining to Big Data and Its Effects on Productivity

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Introduction

Along with the developments in science and technology, there have been periodic changes and transformations in working life and social life. The last of these transformations so far is the digital transformation brought about by information and communication technologies (ICT). With the widespread use of ICT, digital transformation is experienced in every field such as production, industry, education, health, service sector, defence, shelter, nutrition, agriculture, social life, etc.

Depending on the "input-output" relationship within the working logic of digital technologies, data has begun to be produced in exponentially increasing amounts in all fields. When these data are processed in line with their purpose, they are a treasure for institutions. Data mining and big data techniques are of great importance in reaching this treasure. Thanks to the methods and techniques applied in the stages of accessing information from raw data, information management, and information-based decisions have become possible. The advantages of making decisions based on data/information, especially for institutions, are increasing.

Together with automation technologies, the realisation of works that require muscle power by machines, thanks to digital transformation, direct people to work in qualified jobs, thus ensuring efficiency in human resources. It brings many other benefits such as energy-saving, time-saving, resource-saving, etc. In a study, 34% of respondents who started digital transformation initiatives stated that they started to achieve tangible business results such as increased revenue or improved customer relations. Indicating that the sector with the most functional results from digital transformation initiatives in business processes is marketing, the participant managers stated that 74% of the digital initiatives in this field are in the implementation phase, and 41% have started to get results (Altuntas, 2018).

In the literature, the contribution of digital transformation applications to institutions and productivity in different fields has been researched and the importance of using data effectively and efficiently has been mentioned. In the research stating that the digital transformation in industry and production is carried out through the Industry 4.0 perspective, motivation, financing, infrastructure, and working environment are mentioned as the main elements of this transformation. Gulseren and Sagbas (2019) stated that digital transformation is an absolute necessity to overcome the efficiency and investment bottleneck when the current situation of the industrial sector in the world is evaluated. In addition, they also stated that it is a necessity in terms of productivity, growth, employment, and investment potential for the integration of digital technologies into traditional production models on the axis of national development.

Another area where the effects of digital transformation are experienced can be considered as marketing. In fact, this transformation process has also revealed the concept of digital marketing. Miklosik and Evans (2020) extensively investigated the effects of big data and machine learning on marketing. They mentioned that the data, which is increasing exponentially in marketing and the majority of which consists of unstructured data, can be processed by businesses with big data and machine learning. Sagtas (2021) stated in a study that the digital marketing process allows an increase in sales as it can reach a wider audience than traditional marketing methods. In addition, although online sales allow businesses to make transactions more easily since it is different from traditional sales, it is necessary to pay attention to product quality. Because the digital marketing process is one of the components that directly affect the productivity of businesses. Bayuk and Demir (2019) stated that businesses should determine the needs of the customer or the target audience and create marketing activities that will meet these needs. In addition to all these, they stated that the digital transformation experienced by artificial intelligence plays an important role not only in marketing but also in all other business processes, product development activities, data analysis, and all other related areas. Making use of these opportunities and contributing to operational efficiency has now become a necessity. Baltaci (2021) stated in his study that the Covid-19 global epidemic reinforced shopping habits such as contactless shopping and online shopping in human life and that people will continue these habits from now on. For this reason, he talked about the digital transformation process and strategic digital marketing practices that businesses should apply to respond to consumer demands and needs in digital marketing.

Digital transformation in health is the only opportunity for both patients to receive a faster and more quality service in the processes of treatment and diagnosis and for healthcare organisations to work more efficiently (Aslan & Guzel, 2019). Successful implementation of digital health programs is imperative as it is becoming increasingly clear that digital solutions will underpin modern health care (Dendere et al., 2021). Thanks to the algorithms and techniques used in disciplines such as machine learning and deep learning, data analysis, and data-based decisions have become more common. Digital transformation with decision support systems increases the efficiency of doctors and hospitals, contributes to the treatment of patients, and accelerates pre-disease prevention studies. There are application examples of digital transformation in education in many different countries. In a study, Savas (2021) included the stages and strategies of digital transformation carried out in Türkiye within the framework of artificial intelligence. Mikheev et al. (2021), on the other hand, mentioned current trends in the digital transformation of higher education institutions in Russia. Spires (2017) mentioned the digital transformation and innovation studies in education in China, while Mhlanga and Moloi (2020) talked about the studies carried out in South Africa. In all these studies, it is seen that digital technologies are used in all elements in the field of education such as educational tools, teaching methods and techniques, measurement and evaluation processes, career guidance, etc. From this, it can be deduced that the world is changing with the development of technology, and with it, the diversity of education and training activities and the way of implementation have changed. However, since students' learning habits change, teachers should also improve their teaching habits. It is necessary to increase the competencies of the people who will use digital applications and those who will transfer data to these applications in the use of ICT. Teachers, who are the main actors of the teaching processes, also need to use digital technologies effectively in order to interpret the data obtained from it and provide feedback.

Teachers are not only users but also data providers. In line with all these explanations, policy makers for educational environments should take effective and solid steps for digital transformation in education (Savas, 2021).

The areas where productivity is achieved by using the data that emerged with the digital transformation brought by the age, together with data mining and big data studies, are increasing day by day. In the next sections of this chapter, the importance of data mining and big data in digital transformation is mentioned, the concepts of data mining and big data are explained, and the contributions of data analysis to efficiency are explained. In the last part, the contributions of these disciplines are discussed and the conclusions are explained.

The Importance of Data Mining and Big Data in Digital Transformation

ICTs are in continuous development. Besides, the number of areas which are using ICT is also spreading. The digital data produced in areas using these technologies continue to grow exponentially over time (Savas et al., 2012). All institutions using ICT save the data produced by computer systems and electronic tools in their institutions' data warehouses. The data kept in data warehouses reach huge amounts over time and it becomes difficult to reach meaningful information from these data when viewed with the human eye. This data only starts to make sense when it is processed for a specific purpose because it is not possible to make decisions based on raw data. It cannot be expected that the decisions taken will be appropriate and correct. The purpose of collecting data is to reveal the information contained in the data that cannot be seen or noticed with the human eye. Then, with this information, decisions are made for the future of the institutions. For this reason, programs, algorithms, and techniques that help analyse large-scale data have gained great importance today (Savas & Topaloglu, 2011). As we pass through the times of the data revolution, how and for what purpose these data will be processed remains an up-to-date question. Data is just as important today as raw materials were in the times of previous revolutions, and even more (Savas, 2021).

Especially after the 2000s, with the widespread use of computer systems in every field, manual calculations began to be insufficient. This is where data mining came into play and when the results it produced were successful, it became more and more widespread.

Data Mining

Data mining is the process of discovering patterns and trends hidden in large data sets (Buyrukoglu, 2021a; Thuraisingham, 2003; Uzut & Buyrukoglu, 2020). If we make a broader definition; data mining is the process of accessing and using meaningful data that can enable us to make predictions about the future from databases where a large amount of information is stored, in line with our purpose (Buyrukoglu, 2021b; Savas & Topaloglu, 2011; Uzut & Buyrukoglu, 2020). Data mining is one of the most important disciplines for businesses. Very-large-scale data, large-scale databases in different fields can be thought of as a data mine containing valuable data. The analysis of data of this size, the task of obtaining more meaningful information as a result of this analysis, and interpreting the information obtained exceeds what human skills and relational databases can do. In particular, the explosion of the increase in the amount of digital data and the constant number of people who research and practice on this data have forced studies towards data mining. As a result of these needs, a new generation of techniques has emerged for automatic and intelligent database analysis.

These techniques should be such that they can transform data into useful information in an intelligent and automated way. As a result of all these, data mining has been presented as an answer and has become an increasingly important research area. Due to its importance, it has become used in many different disciplines (Figure 1).

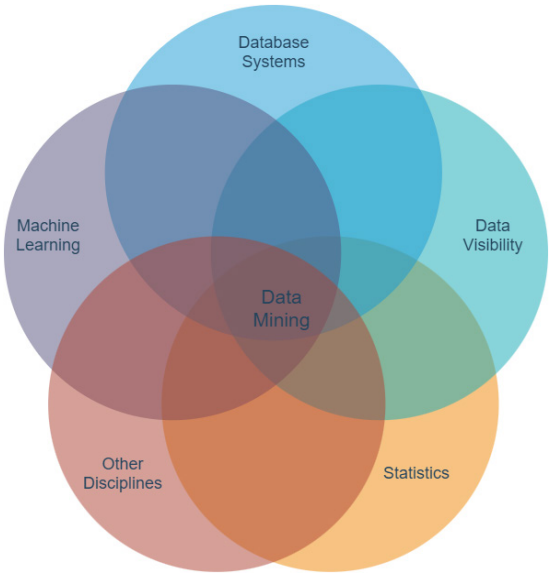

Figure 1. Data mining and other disciplines

The most important feature of data mining is that identifying similar trends and patterns among data groups can reveal interesting information within data warehouses that cannot be detected in the first place.

Data mining is basically affected by 5 main factors: “data”, “hardware”, “computer networks”, “scientific calculations”, and “commercial trends” (Akpinar, 2000). Data, which ranks first among these, is the most important factor in the development of data mining. In the hardware factor, the developing memory, processor speed capacities, and graphics card capacities have made it possible to work on data that could not be mined before. The most important element under the umbrella of computer networks is the widespread use of the Internet. The scientific calculations factor mostly covers the research/development studies of today’s scientists and engineers. Commercial trends are a factor that directs the work, because today, businesses must act faster, provide higher quality services, and consider the minimum cost and minimum work force in order to maintain their existence in a competitive environment.

Considering the data handled in exponentially increasing dimensions, the existence of many problems should be taken into consideration. In data mining operations, it may be necessary to deal with many problems such as residual data, empty data, uncertainty situations, dynamic data, missing data, handling different data types, noisy data, missing data, limited data, and database size.

Data mining is also a process. In addition to revealing the data by making abstract excavations among the data piles, it is also a part of this process to filter the patterns by separating them in the knowledge discovery process and make them ready for the next step.

The steps followed in the data mining process are generally as follows (Shearer, 2000):

- Defining the problem,

- Preparation of data,
- Establishment and evaluation of the model,
- Using the model,
- Monitoring the model.

After this process followed, knowledge discovery from databases is carried out. Data mining operations in the processes of accessing information are shown in Figure 2.

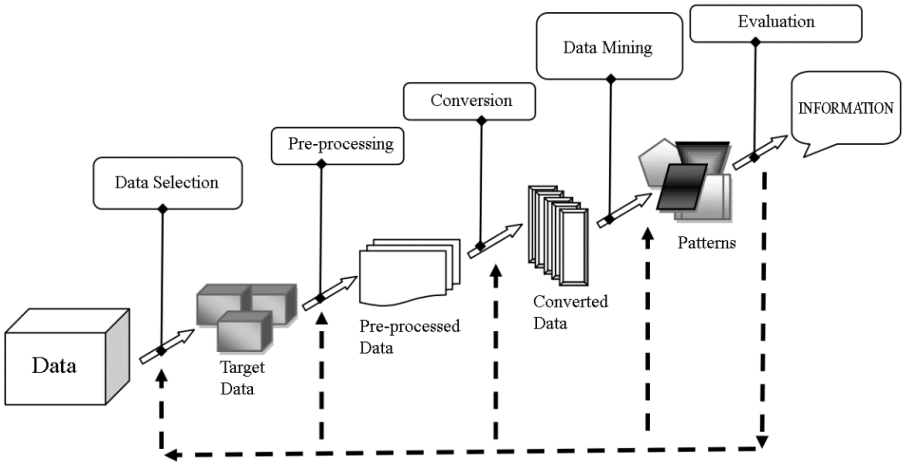

Figure 2. Data mining in the knowledge discovery process

As a result of scientific studies, the methods and algorithms used in data mining are constantly increasing. While some of the techniques used are based on traditional statistical methods, machine learning and deep learning methods have become frequently used, especially with the acceleration of artificial intelligence studies in recent years. Data mining models can basically be grouped under the headings of classification and regression, clustering, and association rules according to the functions they perform.

Big Data

On the one hand, data mining methods and information discovery processes continued, on the other hand, the variety of data produced in cyber environments continued to increase, especially in the last 15 years. With many work areas and structuring included in human life such as Industry 4.0, Internet of Things, Social Networks, Sensor Technologies, and Automation Systems, the size, speed, and diversity of data flowing in cyber environments have almost become the limits. With that, a new discipline has emerged, now called big data.

Big data means storing, accessing, and processing information in a wide variety of high-volume and high-speed data. Processes such as analysing these data, recognizing patterns, and revealing hidden connections mean big data analysis and are at the top of the agenda of technology companies in today's world, both because of their performance and management difficulties, and to create competitive advantage (Sagiroglu & Sinanc, 2013). It is not possible to manage, process, and extract information of high volume, complex, and high-speed data with traditional database management systems. Therefore, it requires different algorithms, techniques, and technologies, such as software running in parallel on server clusters (Jacobs, 2009).

For these reasons, platforms such as Hadoop and Spark are used instead of traditional computing approaches, computer clusters, distributed file systems such as HDFS and RDD, traditional programs, and programming languages. These technologies, which have started to be used in data storage and processing, have also affected the machine learning methods used in data analysis. Machine learning algorithms are used for many purposes such as sentiment analysis, accuracy detection, recommendation systems, social network discoveries, medical discoveries, discovery, and classification of web content (Hallac, 2014). The elements that make up big data include volume, velocity, variety, veracity, and value (5V) (Zikopoulos & Eaton, 2011).

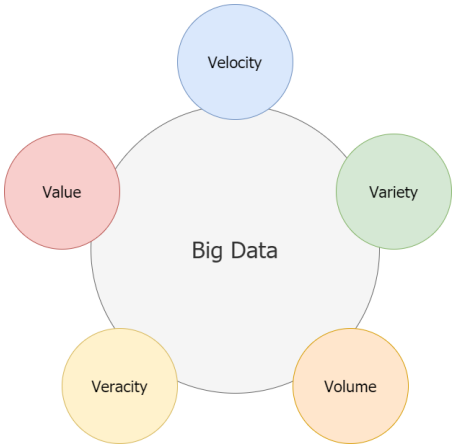

Figure 3. Big data components

***5V*:** Large volumes of data are often mandatory for big data because with this feature the data becomes unmanageable (Volume). If data is stored fast and data processing elements cannot keep up with this fast-loading, the system becomes inefficient or data loss begins. Because there is a general principle in information systems. Fast adapts to slow (Velocity). In most big data applications, there are more sources or data types than a single data source or data type. For example, most companies provide information about the target audience for their advertising campaigns; they personalise their campaigns by taking places such as social media shares, comments, internet navigation information, searches in search engines, location information, and interests. Thus, structured and unstructured data are brought together (Variety). As the volume of data increases, its quality must also be preserved. Especially before processing the data, the type of sensor needs to be determined. The data type also needs to be validated. Fake data needs to be separated from real data (Veracity) (Savas, 2020). The data is a treasure for the digital age (Value).

Data Mining and Big Data in Digital Transformation

The age we live in is now called the digital age. It is known that digitalization increases the efficiency of companies of all sizes and makes them more competitive. Since the limits are lifted in the digital world, although not physically, the brand promise should be positioned not only for the current markets and target audience, but also according to the target audience in the global market, and the brand value should be tried to be increased (Altuntas, 2018). Technological developments, which are accelerating day by day and are included in our lives, force businesses to participate in the digital transformation movement to increase their efficiency and competitiveness in the market. Driven by data mining, big data, cloud-based technologies, digital document workflows, and customer

experience enhancement applications, digital transformation constantly provides new opportunities for businesses to work better, improve collaboration, and make business decisions based on objective data (KYOCERA, 2021).

Digital transformation is the use of information technologies in many different fields, as a result of rapid access to information, and saving time and money. Transformation refers to the rapid shift of all fields to technological channels and the continuation of activities in the digital field. It is possible to see this in many daily activities, especially in the business world. In most areas, many works that were done in the physical environment can now be completed in seconds in the digital environment (Yazilim, 2021).

Developed and developing countries of the world attach importance to data mining and big data studies in their digital transformation processes. In Türkiye, it carries out its big data studies with strategically determined studies. A digital transformation office has been established for these processes and large-scale studies are being carried out. As of September 2021, 56,491,566 users benefit from e-government services, which is Türkiye's digital transformation gateway, and 5,971 services are provided by 818 institutions on this platform.

The Digital Transformation Office of the Presidency of the Republic of Türkiye states the importance given to this issue in Türkiye as follows:

"*While the determinant of the last century was the production power and the added value obtained from it, today the determinant of the power is expressed as the data and the ability to process them. The basis of the data economy is to process data and turn it into a value. The fact that the owned data is not only an economic response but also a value that can affect every stage of political and social life affects the struggle for the existence of countries and causes them to develop new policies. This new economic and social model, which is based on data and whose rules have not yet been clarified, reshapes every stage of life. The transformation of data into value is only possible with a domestic and national understanding. Just as every inch of our country's land has value for us at the expense of our lives, we look at every byte of our data with the same eye. In this context, it is of great importance that every byte of data remains within our own borders and is protected. In order to generate value from data, the big data we have must be anonymized and transformed into a usable form*" (TCCBDDO, 2021).

Digital transformation provides organisations with benefits such as time, efficiency, reduction in expenses, reduction of errors caused by personnel, sustainability, consistency, automation, instant analysis, and effective management process. "Technology", "Process", and "Human" elements are very important for digital transformation (Yazilim, 2021). While focusing on technology and process elements, the human factor, in particular, should not be overlooked. Because digital transformation, with the automation of routine processes, will cause some professions to disappear in the coming years. According to the future professions report published by the World Economic Forum in 2016, employment in many sectors will decrease and some professions will disappear due to increasing automation and robotic technologies, and at the same time, new jobs and new employment areas will be created due to new needs (Forum, 2016).

Many professions made using physical strength are in danger of extinction because they can be easily done by robots with the effect of digital transformation technologies. Occupations that will be most affected by digital transformation are those with the highest probability of computerization (computer-based automation).

Various occupations, such as secretarial and administrative assistant, assembly line worker, machine operator, logistics, cargo and shipping agency, travel officer and agency, tour guide, accountant, bank clerk, office clerk, cashier, driver, train driver, shop, restaurant, hotel personal, financial advisor, personal insurance advisor, retail sales job, library technician, courier, farmer, security guard, call centre operator, laboratory technician, and repairman are at risk (Gokalp et al., 2019; Lorenz et al., 2015; TUSIAD, 2017).

There is an increase in employment in engineering and computer-based professions with adaptation to technologies within the scope of digital transformation (Lorenz et al., 2015). Due to digital transformation, new professions are expected to emerge such as industrial data scientist, robot coordinator, autonomous vehicle fleet manager, cloud computing specialist, industrial user interface designer, internet of things solution architect, industrial computer engineer, 3D printer engineer, wearable technology designer, data security specialist, network development engineer, smart city planning specialist, edge IT specialist, virtual shopping consultant (Gokalp et al., 2019).

When attention is paid to these professions, it will be easily seen that almost all of their raw materials and/or results are "data". This is where the concept of big data comes into play, and future-oriented decisions are made with big data analysis or data mining.

Contribution of Data Analysis to Productivity

Productivity generally means "effective use of resources and is defined in two ways as partial factor productivity and total factor productivity. While the productivity of the factors indicates partial factor productivity, production per total input is defined as total factor productivity. In other words, it shows the remaining part of economic growth that is not caused by factor increases, that is, after the contribution of inputs to production is calculated (Shackleton, 2013). Increasing productivity is accepted as the main determinant of economic growth in the long run (Unlu, 2021).

Processes that become more sustainable, productive, and efficient with digital transformation contribute to good planning of production. To put it more clearly, the efficiency of processes can be defined as the elimination of repetitive work, more efficient use of human resources, and employment in innovative works thanks to automation systems. Thus, digital transformation contributes to saving time and money by increasing productivity directly and indirectly. Thus, innovative ideas such as a domino effect will make it possible to introduce new products.

In human resources management processes, the importance of digital transformation has emerged as less time, budget, and human resources are used for many tasks that were previously performed manually, and thus lower costs are needed. In addition, digital transformation facilitates the processes of collecting, recording, recalling, and documenting human resources management data when necessary, can be said that it is effective in making strategic decisions for business managers, and finally, it enables business personnel to work more efficiently. However, thanks to digital transformation, businesses increase the speed of processing, obtain higher quality outputs, and significantly reduce stationery costs (Calp & Dogan, 2019). Considering the value created by the data for the institution, the collection and cost-effective storage of operational data is extremely valuable in terms of being a source for future analysis studies. Mainly in the big data industry, predictive maintenance, production, quality optimization, digital twin, autonomous digital factory, flexible production methods, online factory, integrated planning, production planning, sales forecasting, and many more.

The use of instant data and its prospective storage is the most sensitive issue for accurate analysis. With machine learning, it is aimed to make decisions with big data by providing minimum human intervention. Information is obtained by collecting and analysing data from devices. Experience is gained by gathering and evaluating information, and wisdom is achieved based on these experiences (ISODijital, 2019). In the management of institutions, the control of operations and making important business decisions based on objective data is the most critical issue for a business. The widespread use of data analysis platforms, the increasing prevalence of business analytics applications, and the development of data collection tools thanks to the Internet of Things are among the most important factors of this transformation. One of the most prominent benefits of digitalization is the increase in the quality of the meaningful data obtained and the support of these meaningful data in making decisions that will have positive results in terms of business efficiency, resource use, and customer satisfaction (TrioMobil, 2021).

Emerging applications such as smart production processes and product lifecycle management have started to come to life in real life with big data. Active preventive maintenance in smart production systems can be implemented through big data analytics. With the support of big data in the production area, many real-time device data such as device alarms, device problem records, and institution notifications can be collected in order to evaluate the status of production devices and to detect malfunctions in advance. Armed with the insight that big data can provide, the industry can improve quality, reduce losses, and acquire key transactions in today's highly competitive market. The increasing number of analytics-based manufacturers means more agile business decisions and faster problem-solving. With the analysis of big data, great development and innovation will be achieved in all areas of the industry (ISODijital, 2019).

Discussion and Conclusions

The common conclusion to be drawn from the studies examining the effect of digital transformation on employment management is that the management of automation that provides continuity with digital transformation will cause many complexes to arise, and with this complexity, their professional capacities should be fed with much more complex competencies (Gokalp et al., 2019).

Digital transformation will especially contribute to the economies of countries, such as meeting customer expectations, flexibility, appropriate value decision making, resource efficiency, and effectiveness, creating value opportunities with new services, responding to the demographic change of the workplace, work-life balance, and being a competitive economy even with high wages (Kagermann et al., 2013; Kurt, 2020).

To survive in competitive environments, the most important issue of businesses at the micro-level and the states at the macro level is to use data, which is the raw material of the digital age, effectively and efficiently. In every period of history, the raw material has been valuable depending on the state of the industry. In our age, digital data comes to the fore as a raw material with Industry 4.0. Data collected from almost every device, every platform, every individual, and community is collected regularly and continuously in data warehouses. These data do not make sense when they are stand-alone. This is where data analysis comes into play. Data mining and big data disciplines are the most important disciplines in reaching information from data and making informed decisions. Informed decision-making is one of the most important factors for productivity. Because today, managers of institutions base their predictions on data analysis.

Today, prevention of many disadvantages such as loss of effort, loss of time, unnecessary use of human resources, and energy consumption, in other words, efficient use of all resources, is only possible by making decisions based on data analysis. Data mining techniques offer important opportunities to make and implement these decisions. Big data analysis, on the other hand, contributes to getting out of structures that are more complex, making predictions for the future, and making business decisions more effectively. In addition to all these, the need for experts to work on these issues will increase in the future. Productivity is no longer a need for businesses and becomes a state policy. Thus, there will be a need for the workforce to implement these policies. Increasing productivity by making data-based decisions shows itself as a need in every field from energy to production, from human resources to management mechanisms. In our age of data revolution, accelerating data mining and big data studies and giving the necessary importance has become a necessity, not a choice.

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