Exploring the Practical Uses of Technology and Harnessing the Power of Big Data

Raul Florentin Drenta[1*], Diana-Elena Micle[2]

Abstract: *This scientific article explores the practical uses of technology and the power of Big Data. In the 21st century, the fusion of technology and Big Data has emerged as a transformative force, reshaping the way we live, work, and interact with the world around us. The research delves into the multifaceted applications of technology and the strategic utilization of Big Data to unlock unprecedented insights and drive innovation across diverse sectors. The article dissects the symbiotic relationship between technology and Big Data, shedding light on how their integration can revolutionize industries, streamline processes, and pave the way for unprecedented advancements. The insights gleaned from this exploration will not only contribute to our understanding of the practical uses of technology and Big Data but also provide a roadmap for harnessing their combined power to address some of the most pressing challenges facing society today.*

Keywords: *Technology; Big Data; Industry 4.0; The Internet of Things (Iot).*

1 INTRODUCTION

In the dynamic landscape of the 21st century, the fusion of technology and Big Data has emerged as a transformative force, reshaping the way we live, work, and interact with the world around us. This scientific exploration delves into the multifaceted applications of technology and the strategic utilization of Big Data to unlock unprecedented insights and drive innovation across diverse sectors. As we stand at the crossroads of innovation and information, this research aims to unravel the intricacies of harnessing the vast potential that lies within the convergence of cutting-edge technologies and the colossal datasets that define the era of Big Data.

The evolution of technology, from artificial intelligence and machine learning to the Internet of Things (IoT), has catalyzed a paradigm shift in how we approach problem-solving and decision-making. Concurrently, the exponential growth of digital information has given rise to the era of Big Data, where colossal datasets present both challenges and opportunities. This article endeavors to dissect the symbiotic relationship between technology and Big Data, shedding light on how their integration can revolutionize industries, streamline processes, and pave the way for unprecedented advancements.

As we embark on this scientific journey, we will navigate through real-world applications, exploring how technology and Big Data synergistically enhance different fields from our everyday life. The insights gleaned from this exploration will not only contribute to our understanding of the practical uses of technology and Big Data but also provide a roadmap for harnessing their combined power to address some of the most pressing challenges facing society today.

Technology can have different definitions depending on the industry niche in which we approach it, giving it relatively different meanings for different people, but basically technology can be summarized in the ability to create tools, either physical (gadgets, cars, heavy duty tools) or empirical (software or applications), that enable processing actions, all with the common goal of making life a little easier. Technology is the basic basis of our daily routines, developed by people for humans, and living without it would be unfathomable, given that we are surrounded by it, from banalities like paper and pen to more complicated things like electricity, vehicles, and computers.

2 SIGNIFICANCE

As a result of the fast acceleration of technological breakthroughs in recent years, it has become increasingly difficult to keep up with the changes and turnarounds that have occurred. However, the fruits of this advancement are visible in a range of inventions such as foldable phones, autonomous vehicles and tractors, and smart houses that appeared like they were lifted from a science-fiction movie just a few years ago.

One fascinating aspect to take into consideration is the fact that technology improvements have also brought a great deal of advantages to the realm of the internet. With the assistance of our various electronic devices, we are able to maintain a continuous connection with people all over the world now that we are living in an era of lightning-fast speed and incredible technology. We are able to communicate with our loved ones and friends from a great distance by sending them instant messages, images, audio messages, and even our position. It is possible for our pulse rate to be transmitted to our physician or exercise teacher. Additionally, we can have an application remind us to drink water, and our smartwatch may display the most recent email received.

The advancement of technology not only makes our day-to-day life easier by providing us with gadgets and a more comfortable way of living, but it also enhances the quality of healthcare, educational systems, and the safety of transportation, housing, and environments in metropolitan areas. In addition, its influence may be observed in the commercial and industrial sectors, where it improves efficiency and offers individualized solutions to issues that arise. When companies want to maintain their competitive edge, they

use technology to create new items that are tailored to the requirements of their customers, as well as to package and transport those products. If you want to keep your advantage in the market, it is very necessary to stay current with the latest technical breakthroughs.

Technology is an area that is both volatile and dynamic, and it adjusts to the demands of both consumers and industrial industries. As we transition from the industrial age to the information age, establishing a competitive edge does not require large quantities of money anymore; rather, it involves making good use of information. Technology has a significant role in modern business, as evidenced by the fact that even relatively small businesses are able to compete in highly competitive marketplaces.

3. INFLUENCE ON THE MARKET

Industry 4.0 is the product of technology advancement and economic expansion in the industrial industry. It arose from the necessity for autonomous and networked industrial production, which necessitated a complete rethinking of the manufacturing process. Factory and the entire manufacturing chain, like smart gadgets, homes, and communities, are interconnected and capable of sending data to one another. Businesses may become more efficient, dependable, and environmentally friendly by decreasing waste via increasing precision with these innovative technologies.

Industrial digitalization is a strategic investment in better goods and more environmentally friendly industrial operations. The combination of speed and accuracy enabled by Industry 4.0 makes it more competitive and productive than traditional production (Zambon et al. 2019). According to a 2017 research by the Milan School of Management Observatory, applying Industry 4.0 concepts resulted in a 25% growth rate (Corallo, 2018). This emphasizes Industry 4.0's huge commercial worth, as shown in Figure 1.

With the emergence of Industry 4.0, cyber-physical instruments such as the Internet of Things and the Internet of Systems have risen to the forefront of the current industrial revolution. These digital technologies work as driving factors in the manufacturing industry, propelling it forward. The adoption of these technologies improves productivity and makes data collecting and analysis easier. Companies that analyze data are better equipped to comprehend market behavior and client demands and are so incentivized to develop innovative and sustainable goods and services. These advances will boost profitability for the industry by increasing manufacturing yields, lowering costs, and reducing environmental impact, while also providing greater customer safety (Rahardjo, B. *et al.* 2023).

Confindustria, Italy's largest industrial association, launched the "Fabbrica 4.0" project in 2014. The project was created to completely integrate Industry 4.0 concepts and serve as an example of the potential that information and technology have to offer when used properly (Zambon I. et al., 2019).

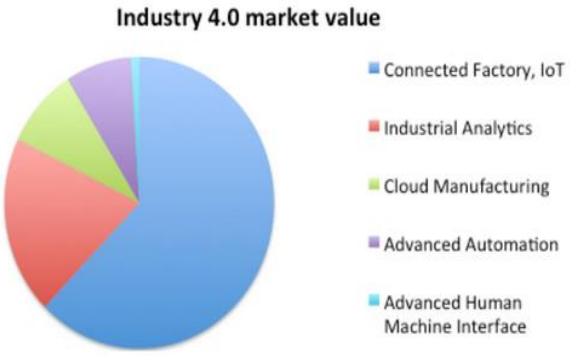

Fig. 1. Breakdown of the market value attributed to Industry 4.0
(Source: 2017 research of the Industry 4.0 Observatory of the Milan Polytechnic)

The Internet of Things (IoT) is a huge network that links diverse objects, continuously sharing data about their usage and surroundings. These sensors-equipped devices convey data about their operational circumstances, and the IoT platform serves as a common ground for their connection. The platform securely captures and combines sent data, and analytics are done to extract pertinent information. The outcomes are exchanged across connected devices in order to improve user experience, efficiency, and automation (Alshehri et al., 2020). IoT extends the internet into the physical world, allowing any device, at any time, anywhere, and in any context, to connect to it for any user, service, or company (Fig. 2).

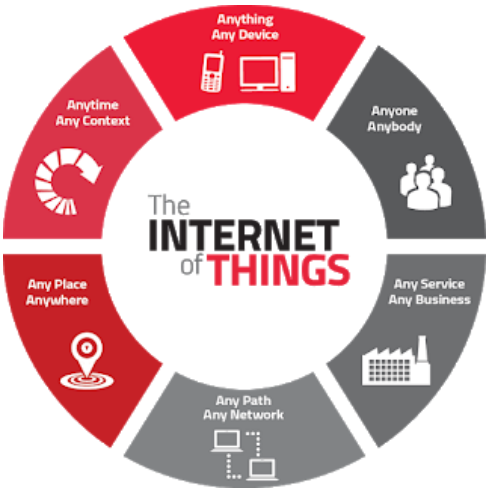

Fig. 2. Internet of Things interlinks
(Source: https://learninternetgovernance.blogspot.com/p/internet-of-things-iot.html)

The Internet of Things is a relatively recent technique that may be characterized as a technological linkage. When examined more closely, it may be characterized as a link between humans and computers. These instruments are used to collect and report data in the form of numbers or more complicated discoveries.

The Internet of Things is a topic of current interest in today's society, however not everyone is

familiar with this new idea. Simply said, IoT is a link between the internet and nearly everything around us (Tzafestas, 2018). IoT represents a situation in which anything in our surroundings may readily communicate without the need to connect with a physical machine. Apart from being a unique discovery, this new technology has the potential to benefit humanity in a variety of ways, but it will encounter significant hurdles.

According to Forbes, IoT has surpassed Big Data as a subject of debate. The Gartner Hype Cycle outlines the lifespan of a technology from its development to its decline, with IoT now outpacing Big Data and expected to attain maturity in five to ten years. Forbes (2014)

The three areas of IoT research that receive the most attention are user experience, engineering, and design, with an emphasis on end-user and accessibility. Certain technologies, such as Microsoft Gadgeteer, may be used to produce a more user-friendly interface and even generate simpler embedded devices, which will play an essential role in the future owing to financial, technological, and societal challenges that must be addressed. It is also worth noting that progress is being made toward standardized international networking protocols (Uddin, L. Q et al., 2023).

Big Data (BD) is another digital technology array that has severely shocked the market, and it has quickly become a popular issue nowadays, with direct ramifications in many areas. According to Chen, M., et al., (2014), Big data is high-volume, high-velocity, and high-variety information assets that demand highly-effective information processing systems to provide greater support and increased understanding for an advanced decision-making system. According to Iqbal et al. (2019), the rapid proliferation of data presents organizations and industry with exponential difficulties and possibilities, while specialists in the area attempt to uncover patterns in the new results. When we talk about BD, the quantity of information gathered isn't as important as the capacity to filter and pick the most relevant data and then distribute it throughout the value chain towards the information being addressed.

Organizations use corporate information systems such as Oracle and SAP to store enormous amounts of structured data, such as papers. Unstructured data, which includes emails, blogs, websites, social media pages, and instant messaging groups, accounts for 85% of total information in a business (Iqbal et al., 2019). Although businesses are expanding their investments in big data technologies, a lack of knowledge in the industry delays the process, making it harder to exploit all of this data. According to Wikibon's "Taming Big Data" study, the digital world has a huge quantity of data, with Facebook alone storing, accessing, and analyzing over 30 petabytes of user-generated data, and the U.S. Library of Congress gathering 235 terabytes of data as of April 2011.

Big data may assist manage unstructured information regardless of industry or organization size, and data analytics can help firms uncover patterns and trends in performance, connecting data sets to identify new sources of revenue or possible problems (Chen, M., et. al., 2014). The European Commission is increasing its investments in big data technology to boost industrial competitiveness.

Given the speed and dynamic of BD, it is vital to understand that it has multidisciplinary applications and can be readily utilized in a wide range of industries such as education, healthcare, finance, manufacturing, and even agriculture. Another aspect to consider is that BD provides solutions for new project development, smart decision making, reduced costs, and time savings, but when combined with high-power analytics, BD can bring solutions to determine root causes of failures, issues in almost real time, as well as help predict customer buying habits while emitting coupons for them, as well as remake an entire risk portfolio in minutes or even detect fraudulent behavior.

4 LIMITATIONS

According to Lee et al. (2015), embedding artificial intelligence (AI) into IoT devices is critical for comprehending human information processing and interaction in diverse circumstances, hence tackling IoT's societal challenges. For IoT to become a practical and widespread reality, it must be completely connected with the Cloud and use the Internet Multimedia Subsystem. The widespread deployment of IoT devices and the internet has resulted in greater utilization of helpful apps; nevertheless, certain difficulties, such as Cross-Cultural Usability and Information System, require extensive investigation. The success of IoT is dependent on its influence on cross-cultural usability and stability. In order to produce the greatest results, humans must keep control over the technology by monitoring and documenting human users.

Things are a little different in the agricultural scene; aside from the limitations already mentioned, farming has a few more concerning adaptations to this new technology. The introduction of IoT in agriculture increases the complexity of the value chain, with new players and service roles being established to assure efficiency. The farm equipment company and competition environment must provide more comprehensive services rather than just traditional items.The rise of platforms: Important actors, often big industry firms such as John Deere or Monsanto, seek to use platforms to gain a dominating position in the market.

Standardization is required in order to run newer equipment with commonly used technologies. AEF and Ag Gateway accomplish agricultural standardization. Agriculture 4.0's new challenge is to connect many systems to cover all areas of agricultural exploitation. Another difficulty is farmers' capacity to upgrade their methods of production. They frequently confront constraints in terms of investment capacity and finance availability. Because the workforce is aging, digital skills are also limited, necessitating extra investment. There is a risk of developing disparities in technological investment between areas.

For IoT the authors identified the following limitations:

1. Compatibility: Because there is no universally accepted compatibility standard for IoT tagging and monitoring, some devices may be incompatible with one another, making it difficult to connect and interact and, as a result, preventing data gathering required to carry out the activities.

2. Complexity: Because IoT is complicated in nature, the likelihood of failure is considerable. For example, a defect in the program might cause it to do unnecessary activities automatically.

3. Privacy/Security: There is a significant danger associated with all data gathered, sent, and stored in a specific server, presenting itself as a high value target for hackers.

4. Safety: IoT has this drawback when a hacker disturbs the regular operation of a system and causes it to order items that the owner does not require. This might lead to severe consequences.

5. Complexity: "a blessing and a curse" since the repercussions of a system failure can be extremely significant and harmful. Furthermore, power outages can cause internet-connected gadgets to malfunction, resulting in undesirable actions being performed.

6. Lower employment: Unemployment difficulties develop as a result of the adoption of this technology since unskilled persons may lose their jobs. This issue can be solved if individuals have access to higher education.

7. Technology seizes control: People's life will grow increasingly reliant on technology. This is plainly apparent in people's already existing addiction to their electronics.

Even while big data analytics is a vital tool for organizations, it has some limitations in terms of what it can and cannot do. They will be discussed further in the next sections. The first restriction of huge data is the difficulty in selecting correlations (fig. 3). Correlation is often used by big data researchers. The issue emerges when analysts make inaccurate associations since correlation and causation are not synonymous.

Fig. 3. Big Data rewards and risks
(Sourcehttps://www.ciklum.com/blog/limitations-of-big-data-analytics/)

The second drawback of BD is the possibility of analysts providing incorrect answers to issues throughout the analysis process. Failure to deliver the proper answer to the relevant inquiry might be detrimental to the organization or its clients.

The third constraint is security problems, which may occur in any technical endeavor, including big data. Information disclosed to other parties may result in the abuse of sensitive data against the firm.

Another issue is one of transferability. The majority of data utilized in big data analytics is proprietary, and analysts must have technical competence to access it. When analysts lack the requisite skills, the information must be conveyed, which can be a difficult process.

Inconsistencies in data collecting are possible, as is the precision of some technologies (fig. 4). Every day, search engines such as Google produce new results. As a result, data sets established with Google will vary regularly, and the underlying correlations will move correspondingly.

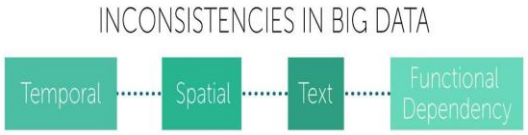

Fig. 4. Inconsistencies of Big Data
(Source: https://www.ciklum.com/blog/limitations-of-big-data-analytics/)

Another hurdle to large data analysis is poor data quality. This implies that data scientists and analysts must ensure that the information they get is correct and useful. They must also ensure that it is in the appropriate format so that data can be easily analyzed. If data quality concerns are not addressed, the analyzed data may be meaningless.

Many organizations that employ big data analytics seek for cultural transformation. The goal is to foster a data-driven culture throughout the organization. According to reports, just 32.4 percent of businesses are effective in developing a company culture.

Another major data analytics challenge that businesses are attempting to resolve is compliance with government rules. Companies must meet certain standards or regulatory criteria in order to ensure that sensitive information is handled appropriately.

Another disadvantage of large data is quick change, which implies that technology is developing at a rapid pace. This issue poses the possibility that businesses would invest in technology that will be rendered outdated a few months later as newer gadgets hit the market.

Hardware requirements can be another source of concern for businesses. In order to acquire the greatest results from data analysis, analysts must have access to the highest performing technology as well as enough storage capacity to contain the data. Some infrastructure issues can be solved by adopting cloud-based analytics, but not all of them.

Costs can also be a concern since, while businesses rely on open-source technology, there are additional expenditures to consider, such as hardware, manpower, equipment maintenance, and other associated services.

Then there is the issue of integrating legacy systems because most businesses store data in several locations, making it difficult to gather all of the data sources and consolidate them into a single one. This wastes time and adds to the price of dealing with BD.

5. CONCLUSIONS

The article emphasizes the transformative impact of the fusion between technology and Big Data in the 21st century. The integration of technologies like artificial intelligence, machine learning, and the Internet of Things (IoT) has catalyzed a paradigm shift in problem-solving and decision-making processes. The exponential growth of digital information has given rise to the era of Big Data, presenting both challenges and opportunities. The symbiotic relationship between technology and Big Data is explored, highlighting their potential to revolutionize industries, streamline processes, and drive unprecedented advancements.

The significance of technological advancements is evident in inventions such as foldable phones, autonomous vehicles, and smart houses. Technology has brought numerous advantages, especially in enhancing communication, healthcare, education, transportation, and industrial efficiency. The influence of Industry 4.0 on the market is discussed, emphasizing its role in making businesses more efficient, reliable, and environmentally friendly.

The Internet of Things (IoT) is explored as a network that continuously shares data, connecting devices to improve user experience, efficiency, and automation. It is a technological linkage that connects various objects, extending the internet into the physical world.

Industry 4.0, driven by technological advancements, contributes to more competitive and productive manufacturing through interconnected systems.

The article underlines the commercial worth of Industry 4.0, as evidenced by a 25% growth rate in businesses applying its concepts. The role of IoT in facilitating communication and data sharing is highlighted, with examples such as smartwatches, health monitoring, and environmental sensing.

The limitations and challenges associated with the integration of technology and Big Data are discussed, including compatibility issues, complexity, privacy/security concerns, and safety issues.

The multidisciplinary applications of Big Data are emphasized, with its readiness for use in various industries such as education, healthcare, finance, manufacturing, and agriculture. The article concludes by recognizing the significant role of technology and Big Data in addressing real-world challenges, enhancing decision-making processes, and contributing to the development of a data-driven culture in organizations.

REFERENCES

[1] Alshehri, Fatima & Muhammad, Ghulam. (2020). A Comprehensive Survey of the Internet of Things (IoT) and Edge Computing in Healthcare. *IEEE Access. PP. 1-1*

[2] Chen, M., Mao, S., Zhang, Y., & Leung, V. C. (2014). Big data: related technologies, challenges and future prospects *(Vol. 100). Heidelberg: Springer.*

[3] Corallo, A., Latino, M. E., & Menegoli, M. (2018). From industry 4.0 to agriculture 4.0: a framework to manage product data in agri-food supply chain for voluntary traceability. *International Journal of Nutrition and Food Engineering, 12(5), 146-150*.

[4] Iqbal Muhammad & Alam Kazmi, Syed Hasnain & Manzoor, Engr. Dr. Amir & Rehman, Abdul & Hussain Butt, Shujaat & Adeel Shaikh, Khurram, (2019). A Study of Big Data for Business Growth in SMEs: Opportunities & Challenges, *International Conference on Computing, Mathematics and Engineering Technologies.*

[5] Lee Inn, Lee Kyoochun, (2015) The Internet of Things (IoT): Applications, investments, and challenges for enterprises, *Business Horizons, vol. 58, 4, 431-440.*

[6] Rahardjo, B., Wang, F. K., Yeh, R. H., & Chen, Y. P. (2023). Lean Manufacturing in Industry 4.0: A Smart and Sustainable Manufacturing System. *Machines, 11(1), 72.*

[7] SPYROS G. TZAFESTAS, 2018. The Internet of Things: A Conceptual Guided Tour, *European Journal of Advanced Engineering and Technology, vol. 5, 10, 745-767*

[8] Uddin, L. Q., Betzel, R. F., Cohen, J. R., Damoiseaux, J. S., De Brigard, F., Eickhoff, S. B., ... & Spreng, R. N. (2023). Controversies and progress on standardization of large-scale brain network nomenclature. *Network Neuroscience, 7(3), 864-905*.

[9] Zambon, I., Cecchini, M., Egidi, G., Saporito, M. G., & Colantoni, A. (2019). Revolution 4.0: Industry vs. agriculture in a future development for SMEs. *Processes, 7(1), 36.*

[10] ***https://www.forbes.com/sites/bernardmarr/2018/09/02/what-is-industry-4-0-heres-a-super-easy-explanation-for-anyone/#1c85c4749788

Authors addresses

[1] *Raul Florentin DRENŢA, dr., Department of Engineering and Technology Management, Faculty of Engineering, Technical University of Cluj Napoca, Baia Mare, Dr. Victor Babeş Street no. 62, Romania, raul.drenta@imtech.utcluj.ro*

[2] *Diana-Elena MICLE, drd, Department of Economic Sciences, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, 3–5 Manastur St., 400372 Cluj-Napoca, Romania; e-mail: diana.micle@usamvcluj.ro*

Contact person

[*] *Raul Florentin DRENŢA, dr., Department of Engineering and Technology Management, Faculty of Engineering, Technical University of Cluj Napoca, Baia Mare, Dr. Victor Babeş Street no. 62, Romania, raul.drenta@imtech.utcluj.ro*