Digitalization: A Primer

Matthew N. O. Sadiku[1], Uwakwe C. Chukwu[2], Abayomi Ajayi-Majebi[3], Sarhan M. Musa[1]

[1]Roy G. Perry College of Engineering, Prairie View A&M University, Prairie View, TX, USA
[2]Department of Engineering Technology, South Carolina State University, Orangeburg, SC, USA
[3]Department of Manufacturing Engineering, Central State University, Wilberforce, OH, USA

ABSTRACT
Digitalization is the process of employing digital technologies and information to transform work, enhance customer experience, ensure employee efficiency, create new solutions, and revamp the business operations. It is the most significant technological trend that is changing society, business, and everything we do. Digitalization occurs in all lines of life, including the fields of education, healthcare, economy, business, and manufacturing. It is a catalyst which will promote innovation and transform the operation of companies. This paper provides an overview of digitalization, its opportunities and challenges.

KEYWORDS: digital technologies, digitization, digitalization, digital transformation

INTRODUCTION
Modern societies are increasingly dependent on technology. Technology is in the cell phones we use, the cars we drive, and even the food we eat. Technology has spanned the globe, connecting device, and people of all nations. It has become integrated into personal, professional, and social aspects of our lives. In schools, workplaces, and communities around the world, technology is becoming increasingly embedded into daily tasks. Digital technologies are at the heart of our economic and social life. They have transformed everything from education and healthcare to social services. They affect all citizens. The digital world is real, and it exists today as their way of life [1].

Today, we live in cyber world where everything is digital and data is king. Digitization has developed and impacted our society in ways that were not anticipated. It is likely that that will continue to be the case. Digital inventions are being used in each sector of life, whether it is home, educational institution, workplace, hospital, or automobiles, digital devices/products are present. Digitalization is an on-going transformation of great importance for business and organizations. It helps transform an entire industry ranging from business processes to customer relationship. It offers exciting new potential to visionary companies. Forward-thinking companies can use their data to create safer, smarter, and more efficient processes.

BRIEF HISTORY OF DIGITIZATION
Digital technologies have advanced more rapidly than any innovation in our history. The invention of the semiconductor transistor in the late 1950s enabled analog computing to go digital. In the 1980s, the digital format of optical compact discs gradually replaced analog formats. In developed nations, computers were becoming popular during the 1980s as they made their way into schools, homes, offices, business, and industry. Motorola created the first mobile phone, Motorola DynaTac, in 1983. By the late 1980s, many businesses were using computers and digital technology. The World Wide Web became publicly accessible in 1991, which had been available only to government and universities. The concept of cyberspace or Internet was initially developed by government agencies, educational institutions,

military contractors, etc. It has now come to be used primarily by corporate users. Over the years, the Internet has become a simple-to-join, anyone-can-play system. It is now the playground and factory of digital labor. By 1999, almost every nation was connected to the Internet and individuals in several nations used the Internet on a regular basis.

The digital revolution radically changed the way individuals and companies interact. It spread to the masses in the developing world in the 2000s. In the early 2000s, cell phones, personal computers, and Internet access had gone global. In late 2005, the number of people using the Internet reached 1 billion. In the early 2000s, digital computers ranging from laptops to Internet networks came in many sizes. Around the 2010s, the digitalization of analog and manual systems was almost complete. The prevalence of apps, bill payments, bots, and other digital technologies has been embedded in our everyday lives [2,3].

DIGITAL TECHNOLOGY

Digital technology is the reality of the world we live in. It touches every aspect of our lives. It has dramatically transformed our society and every aspect of our lives. It is a major driver for growth, productivity, competitiveness, and innovative capacity. It is profoundly changing work and production processes. It has brought us autonomous systems, self-driving cars, Internet of things, social networking, mass surveillance, etc. It has also brought marked changes to communications, the production and distribution of goods, food production, medical treatment, and methods of warfare. Different technologies and skills can be used by individuals to accommodate both their age and their objective.

The term "digital" in digital technologies refer to intensive and extensive use of information and communication technologies (ICTs). Digitized information is recorded in binary code using digits 0 and 1, which represents words, images, and videos. Digital technologies are also reshaping our production, work, shopping, entertainment, and communications. With the development of ICT, new changes have occurred in the relationship between online production and consumption on the Internet platform [4].

Digital technologies are electronic tools, devices, and systems that generate, store or process data. Examples include mobile phones, social media, online games, 3D printing, wearable technology, online games, cloud computing, 3D printing, and multimedia. Some of these technologies are illustrated in Figure 1 [5]. As digital technology has become ubiquitous, affordable, and portable, more and more number of

people worldwide are increasing their online participation. People use different technologies and tools for different reasons [6]. The use of technology has transformed every discipline and career, from engineering to medicine to politics. Digital technology is used in different sectors such as in business, education, media, healthcare, transportation, communication, manufacturing, travel, shopping, entertainment, etc.

WHAT IS DIGITIZATION, DIGITALIZATION, AND DIGITAL TRANSFORMATION?

Digitization, digitalization, and digital transformation are three terms we use when describing the impact of digital technology on society. There seems to be some confusion in the usage of the terms. Figure 2 shows the relationship between the three terms [7], while we clarity the terms here [8-10].

➢ **Digitization:** This is the process of converting analog records to digital. It is creating a digital version of analog/physical (or non-digital things) such as paper documents, images, audio, videos, etc. It may also be regarded as taking analog information and encoding it into zeroes and ones so that computers can store, process, and transmit that information. Digitization coverts information from an analog to a digital format. In this format, information is organized into discrete units of data known as bits. In a nutshell, digitization refers is turning something into bits and bytes, or 1's and 0's. Digitizing information makes it easier to preserve, access, share, filter, download, and analyze. It enhances productivity and efficiency while minimizing costs. It reduces unemployment, improve quality of life, and boost citizens' access to public services. A capability is a set of skills needed to perform a certain activity or achieve a goal. Digitization capability has the three dimensions shown in Figure 3 [11]. The list of what you can be digitalized is extremely long. For example, digitalizing your business leads to digital business, while digitalizing education produces digital education. Netflix converted its collection of movie cassette tapes into digital CDs and DVDs. Digitization is foundational and this is basically what we been doing since the 1960s. It is a dynamic process with standards changing with new technology.

➢ **Digitalization:** This is the process of using digital technologies to simplify your work, enhance customer experience, ensure employee efficiency, create new solutions, and revamp the business models [12]. It has become integral to the response of organizations and also their future plans. Digitalization is changing the world. The

world is gradually being transformed to a place where everything will be controlled, monitored, and analyzed digitally. It is moving rapidly towards ubiquitous connectivity that will further change how and where people associate, gather, and share information. In response to the inevitable change, experts foresee an ambient information environment where accessing the Internet will be effortless. Humans have set an environment using digital technologies to bring ease and comfort into their daily lives. Digitalization is most widely being used tool in human life [13]. The major impact of digitalization is shown in Figure 4 [14]. Perhaps the greatest impact of digitalization on the world will be universal access of all human beings to digital technologies such as the Internet. This will have a huge impact on digital literacy and lead to a more informed, educated world.

➤ **Digital Transformation:** This refers to changes in ways of working, roles, and business offering caused by adoption of digital technologies in an organization. The word "transformation" is often used to describe the impact of digital technologies on the industry and society. Today, we are living in the era of digital transformation. Digital transformation is the integration of digital technology into all areas of life, resulting in fundamental changes. It is harnessing technology to change the way you do things. For a business, for example, digital transformation begins and ends with how you think about, and engage with, customers. Digital transformation is a journey; it does not happen overnight. It is not a once-and-done deal. Digital transformation encompasses digitization and digitalization. An important component of digital transformation is technology. The main drivers of digital transformation include artificial intelligence, machine learning, big data, conversational bots, digital twin, privacy, and virtual/augmented reality. Organizations are going through digital transformation because the environments around them are already in motion. In order to make the greatest strides ahead of their competitors, organizations need to stop "doing digital" and start "being digital." Being a digital leader means embracing new tools and platforms to improve the customer experience. Digital leaders also need to collaborate with others, leverage data analytics, invest in the digital future, and make the most of the latest mobile technologies, AI capabilities, cloud computing, and other emerging technologies. Digital transformation leads to improving your service delivery through new

technological processes [15]. It is evident that digital technologies will continue to an important play role in their strategy and success.

ADVANTAGES OF DIGITALIZATION

Digitalization present huge opportunities and challenges to organizations. It has led to a significant higher participation of women in employment, financial markets, and entrepreneurship. Digitalization has changed the rules of competition, the distribution of added value, and the nature of work, making digital skills essential for the modern workforce. Digital transformation is imperative for all businesses, from the small to the enterprise because it makes a business more efficient and profitable and creates a better customer and employee experience. Efficiency and productivity are the main benefits of digital transformation. Digital technology means that devices can be more compact, faster, lighter, and more versatile. Other advantages of d igitalization include [16,17].

➤ **Access to Information:** Digital technology helps us to have direct access to the Internet. This way we can take advantage of the information all around the world. Anyone with Internet access can get a huge amount of information and knowledge over the web. Lessons and courses can now be delivered virtually online. The wealth of information that is now available is amazing. Shopping online continues to provide consumers with increasing choices and value.

➤ **Digital Inclusion***:* The digital technology has given us new ways to connect people. Now the data revolution brings the challenge of ensuring that no one is left behind. Empowerment and participation in society are often put forward as the main goals of digital inclusion. It is estimated that the chances of women benefitting from opportunities accrued by the information society will be one third less than for men.

➤ **Automation:** Digital technology is making machines smarter. It enables the automation of the machines. Machines no longer need humans to operate them, preventing repetitive and boring tasks for workers. Digital technology is revolutionizing itself with automated and inbuilt analysis systems. Automation has improved manufacturing practices.

➤ **Convenience:** Technologies and digitization have delivered efficiency, transparency, and convenience. The mode of paying credit cards, using Internet banking, and driving automated car have saved us lots of time. The patients can consult their doctor's thousands of miles away.

➢ **Cost Efficiency:** The main objective of technology is to produce things that will be affordable and reasonable to general people. With the help of technology, we can compare prices across the world. Digital technology reduces cost and increases productivity.

➢ **Better Means of Communication:** In the past, letters were the most popular means of communication and it took weeks to get the reply letter. Replacing the old technology with modern technology (using emails) has made our lives easier to communicate with people worldwide. Internet speeds have increased exponentially, enabling the transfer of large amounts of information. One can easily communicate with most of the world's population.

➢ **Social Connectivity:** Digital technology makes it easy to stay in touch with friends, family, and work remotely. Websites, apps, and software have all been designed to help users to socialize.

➢ **Accurate Duplication:** Digital technology enables the exact duplication of media. For example, you can distribute multiple copies of photos to family and friends.

➢ **GPS:** Digital technology combined with satellite technology has transformed travel, making it easy for you to find your route to a destination. GPS services can give you lots of information.

➢ **Low Cost:** Besides from paying for an Internet service, you can obtain a lot of information free of charge. Sending an email and surfing the Internet, and shopping online are free.

➢ **Entertainment:** The popularity of the Internet and digital media is making a significant impact in entertainment activities. The games industry is one of the most lucrative industries due to the billion dollar sales of digital games. Digital technologies have made digital games to become part of human culture.

➢ **News:** Increasing numbers of people get their news online, either via a website or social media. Traditional sources of news such as newspapers have seen a dramatic decline in recent years, as digital media takes over. Many people now get their news via social media, as well as directly from news websites.

Figure 5 illustrates some of these advantages.

DISADVANTAGES OF DIGITALIZATION
The challenges of digital transformation need to be addressed in order to sustain in the long run. Digital transformations may fail for several reasons including poor leadership, poor communication, people, disconnects between IT and the business, lagging employee engagement, substandard operations, and put the cart before the horse [18]:

➢ **Poor Leadership:** A leader is considered poor if he cannot effectively communicate his plan and get full support of those under him. The process of digital transformation is inherently uncertain. Leaders need to make decisions quickly and involve groups from all over the organization.

➢ **People:** People can make or break your digital transformation. When employees perceive that digital transformation could threaten their jobs, they may resist the changes. If you do not put enough focus on people and culture, your initiative is bound to fail. Lack of understanding of the employees may lead to poor adoption and in turn, the overall enterprise technology transformation will fail.

➢ **Poor Communication:** If you do not communicate clearly and provide specific and actionable guidance before, during, and even after a transformation, your initiative would not make it very far. A well-communicated strategy will also address how the transformation will affect your customers and employees.

Disadvantages of digitalization include [19,20].

➢ **Information Overload:** We are increasingly becoming overwhelmed by the information overload that modern technology brings, as we are bombarded by irrelevant emails, sales telephone calls, text messages, Internet advertising, etc. Digital technology enables the storage of massive amounts of information in relatively small spaces.

➢ **Complexity:** The complexity of the program is one of the major disadvantages of digital technology. If a non-tech customer has problem operating the technology, they will certainly be disappointed with the purchase they made

➢ **Losing Job Opportunities:** The Internet allows employees to do the same task at minimum wages. The situation will diminish the job opportunities for workers. Their job opportunities will get replaced by digital technology.

➢ **Security:** In an environment where everything is connected to the Internet, it is a great challenge to handle security and privacy concerns. Data security is risky as digital technology can be hacked. Digital technology allows individuals and companies to store data. Criminals, hackers, terrorists, foreign enemies can get access to the

data. Security is a major disadvantage of digital technology.

➢ **Privacy:** Using digital technology can result in losing our privacy. It is becoming harder to have personal privacy and control personal information in the digital world. It is now easy for someone to steal your personal information and gain access to your private accounts. Stealing our financial details, personal photos, videos, or account can severely harm our reputation.

➢ **Lack of Socialization:** With digital technology, face-to-face conversations, socialization is rare. The situation will lead to social isolation, depression, and mental health issues for each individual.

➢ **Lack of Human Relations:** Online social networking is replacing real face-to-face and physical contact, causing alienation to increase. Human beings are less and less valued in the workplace as their roles are replaced by robots and computers.

➢ **Addiction:** Today people are addicted to digital devices such as mobile phones. Addiction to social media, computer games, messaging, and dating websites can be dangerous. Many health issues worldwide taking the lives of the users have been published.

➢ **Marginalisation:** Digitally marginalized citizens are usually described as people who are in unequal positions concerning the use of as the Internet. Human poverty is seen in skill shortages, disguised unemployment, gender inequity etc. Marginalisation implies treatment of a person or group as insignificant or peripheral. The reasons for the marginalization include lack of awareness of the benefits of affordability, digital illiteracy, lack of access to Internet, and lack of digital literacy.

➢ **Digital Divide:** This is closely related to marginalization. The information and communication technologies (ICT) has created digital divide or digital inequality at both individual and global levels. Digital divide refers to the inequality of access to the Internet technology. It is about the disparity between the technological haves and have-nots. It has polarized society into two groups—those who have access to ICT and those who do not. At the individual level, digital divide refers to the gap between information rich and poor. At the global level, developing nations are digitally disadvantaged countries.

➢ **Gender-based Barriers:** This is gender digital divide that prevails across the globe. The world of ICT is dominated by men, with the prevailing notion that women and girls are second-class citizens. Women and girls continue to face gender-based barriers that prevent them from utilizing digital tools at the same level as boys and men. This digital gender gap still exist, in some instances it has even grown wider in recent years. This gap holds back women and girls and negatively impacts their economic contribution. Increasing presence and participation of girls and women in the ICT sector has economic and social benefits.

➢ **Intellectual Property:** Intellectual property theft and piracy have made it more and more difficult for creative people to make money from their work. Media can be distributed easily across the Internet.

➢ **Cybersecurity:** The Internet is fertile ground for malevolent forces to operate. Cybersecurity has become a major concern in the digital era. Terrorists use social media to promote themselves and encourage others. Many core services such as hospitals, power grids, airports, rail and road transport systems, and military defenses can now be knocked out by cyber criminals. Cybersecurity involves reducing the risk of cyber-attacks. Cyber risks should be managed proactively by the management. Cybersecurity technologies such as firewalls are widely available. Cybersecurity is the joint responsibility of all relevant stakeholders including government, business, infrastructure owners, and users.

Figure 6 shows some of these disadvantages.

CONCLUSION

Digitalization has revolutionized almost every aspect of our lives. It has transformed home, work, shopping, music, movies, television, photography, travel, transportation, manufacturing .and communications. Digital technology is driving new ways of working and thinking while creating new opportunities. Since digitalization is transforming everything, acquiring digital skills has now become a prerequisite for the success of individuals and organizations. It is time to embrace digital transformation's potential in your organization.

Educational institutions need to .equip their students with the 21st century skills needed for today's labor market. Educational institutions should play a key role in preparing youths for life in today's rapidly developing digital world. Educators should envision a future for students that includes digital technology as

a tool for realizing their dreams. Students should graduate from their program confident in their ability to use technology to be problem solvers and become lifelong learners of technology. More information about digitalization can be found in the books in [21-27].

REFERENCES

[1] Dominion Fund Management, "The world is becoming irrevocably digital," 2021, https://dominion-funds.com/insights/2021/03/the-world-is-becoming-irrevocably-digital/

[2] "Digital revolution," *Wikipedia*, the free encyclopedia, https://en.wikipedia.org/wiki/Digital_Revolution

[3] B. Heslop, "A brief history of digital transformation," December 2019, https://supplychainbeyond.com/a-brief-history-of-digital-transformation/

[4] X. Wei, "Value production, measurement, and distribution under digital capitalism: A critique of the theory that the law of value has failed," *World Review of Political Economy,* vol. 12, no. 4, March 2020, pp. 472-492.

[5] Elnur, "Digital transformation and digitalization technology concept," https://stock.adobe.com/search?k=digitalization&ef_id=CjwKCAjwquWVBhBrEiwAt1Kmwlp10Chn92U30KFNn_kTi1VLqTKlCEQXkTA6pQUvV-fht_0gmVsi-hoCAl4QAvD_BwE%3AG%3As&s_kwcid=AL!3085!3!514860269679!!!g!!!2089170876!84594855331&as_channel=sem&as_campclass=nonbrand&as_campaign=US%7CCPRO%7CStock%7CAWAR%7CDSA_Website_pages%7CGG%7C%7C&as_source=google&as_camptype=acquisition&sdid=85665X9X&mv=search&as_audience=core&gclid=CjwKCAjwquWVBhBrEiwAt1Kmwlp10Chn92U30KFNn_kTi1VLqTKlCEQXkTA6pQUvV-fht_0gmVsi-hoCAl4QAvD_BwE&asset_id=316858449

[6] C. Brown, "Chapter 1: Introduction to digital literacy," https://pressbooks.library.ryerson.ca/digcit/chapter/chapter-1/

[7] B. S. Gupta, "What is digitization, digitalization, and digital transformation?" March 2020, https://www.arcweb.com/blog/what-digitization-digitalization-digital-transformation

[8] A. Olechowski, "Digitization, digitalization, and digital transformation – W hat are the differences?" February 2021, https://codete.com/blog/digitization-digitalization-and-digital-transformation-what-are-the-differences

[9] "Digitize vs digitalize: Why you need to know the difference," August 11 2020, https://nextservicesoftware.com/news/digitize-vs-digitalize-know-the-difference/

[10] C. Singh, "Digitization vs digitalization vs digital transformation: Know the relation & differences," December 2020, https://www.appventurez.com/blog/digitization-vs-digitalization-vs-digital-transformation/

[11] T. Ritter and C. L. Pedersen, "Digitization capability and the digitalization of business models in business-to-business firms: Past, present, and future," *Industrial Marketing Management,* vol. 86, April 2020, pp. 180-190.

[12] S. Ramiel, "Forecasting the future of digitalization of the world," May 2020, https://www.legalreader.com/forecasting-the-future-of-digitalization-of-the-world/

[13] P. Parviainen et al., "Tackling the digitalization challenge: How to benefit from digitalization in practice," *International Journal of Information Systems and Project Management*, vol.5, no. 1, 2017, pp. 63-77.

[14] N. Altadonna, "Digital transformation: How technology is changing business," January 2022, https://www.apty.io/blog/digital-transformation-how-technology-is-changing-business#:~:text=Digital%20Transformation%20makes%20a%20business,to%20adapt%20to%20market%20changes.

[15] R. Suhr, "Four ways organizations can prepare for a digital future," February 2021, https://www.ey.com/en_us/digital/four-ways-organizations-can-prepare-for-a-digital-future

[16] Srinka, "21 Advantages and disadvantages of digital technology," June 2022, https://yocover.com/advantages-and-disadvantages-of-digital-technology/

[17] P. Goodman, "16 Advantages of digital technology," January 2022, https://turbofuture.com/computers/Advantages-of-Digital-Technology

[18] "What is digital transformation?" https://www.salesforce.com/products/platform/what-is-digital-transformation/

[19] M. N. O. Sadiku, A. E. Shadare, E. Dada, and S. M. Musa, "Digital divide," *Journal of Multidisciplinary Engineering Science and Technology*, vol. 3, no. 10, Oct. 2016, pp. 5661-5663.

[20] P. Goodman, "The advantages and disadvantages of technology," January 2022, https://soapboxie.com/social-issues/The-advantages-and-disadvantages-of-technology

[21] S. Greenfield, *Mind Change: How Digital Technologies Are Leaving Their Mark on Our Brains*. Random House, 2015.

[22] N. Urbach and M. Roglinger (eds.), *Digitalization Cases: How Organizations Rethink Their Business for the Digital Age*. Springer, 2019.

[23] D. R. A. Schallmo and J. Tidd, *Digitalization*. Springer International Publishing, 2021.

[24] J. Schou and M. Hjelholt, *Digitalization and Public Sector Transformations*. Springer, 2018.

[25] N. B. Thylistrup, *The Politics of Mass Digitization*. The MIT Press, 2019.

[26] D. R. A. Schallmo and C. A. Williams, *Digital Transformation Now! Guiding the Successful Digitalization of Your Business Model*. Springer, 2018.

[27] C. Musik and Alexander Bogner, *Digitalization & Society: A Sociology of Technology Perspective on Current Trends in Data, Digital Security and the Internet.* (German and English Edition). Springer, 2019.

Figure 1 Some digital technologies [5].

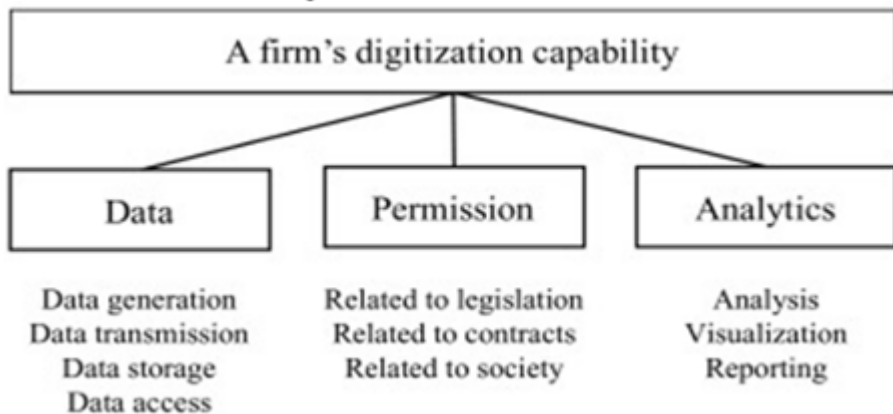**Figure 2 Relationship between digitization, digitalization and digital transformation [7].**

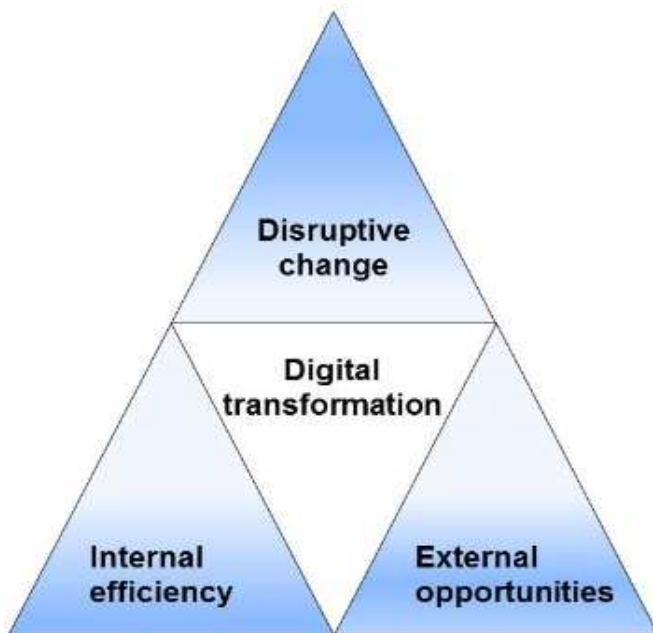**Figure 3 The three dimensions of digitization capability [11].**

Figure 4 The major impact of digitalization [14].

Figure 5 Advantages of digital technology.

Figure 6 Disadvantages of digital technology.