ADVANCED TECHNOLOGIES FOR REALIZING SUSTAINABLE DEVELOPMENT GOALS 5G, AI, BIG DATA, BLOCK CHAIN AND INDUSTRY 4.0 APPLICATIONS

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FOREWORD

In the grand tapestry of human history, there come moments when the convergence of innovation and purpose sets the stage for transformational change. We find ourselves in such a moment today, a moment where advanced technologies have the potential to unlock the doors to a more sustainable and equitable world. It is with great pleasure and anticipation that I introduce you to "Advanced Technologies for Realizing Sustainable Development Goals: 5G, AI, Big Data, Blockchain, and Industry 4.0 Applications."

This book is not merely a compendium of cutting-edge technologies; it is a beacon of hope, illuminating the path toward a future in which technology serves as an enabler of sustainable development. The Sustainable Development Goals (SDGs) established by the United Nations serve as a global blueprint for addressing the most pressing challenges of our time, from eradicating poverty and hunger to combating climate change and ensuring access to quality education and healthcare for all. Achieving these goals requires innovative solutions that transcend the limitations of traditional approaches.

The authors of this book, experts in their respective fields, guide us through the transformative potential of five of the most disruptive technologies of our era: 5G, artificial intelligence (AI), big data, blockchain, and Industry 4.0. They offer insights, analysis, and case studies that demonstrate how these technologies can be harnessed to tackle the complex and interconnected challenges articulated in the SDGs.

As we delve into the pages of this volume, we embark on a journey that spans industries, sectors, and continents. We witness how 5G technology is revolutionizing connectivity and enabling smart cities that enhance the quality of urban life while reducing environmental impact. We explore how AI is augmenting our decision-making capabilities, from healthcare diagnostics to sustainable agriculture. We delve into the vast ocean of big data, uncovering its potential to inform policies, drive innovation, and improve resource allocation.

Blockchain technology emerges as a trust-building force, underpinning transparent supply chains, enabling secure digital identities, and facilitating financial inclusion. Finally, we venture into the world of Industry 4.0, where smart manufacturing processes promise increased efficiency, reduced waste, and sustainable production.

While these technologies offer boundless opportunities, they also present complex challenges. The ethical considerations of AI, the security and privacy concerns of big data, and the regulatory landscape of blockchain are just a few of the critical issues that demand our attention. As we navigate this intricate terrain, we must remain steadfast in our commitment to ensuring that these technologies are deployed responsibly and for the greater good of humanity.

The authors of this book have taken on the admirable task of not only showcasing the potential of advanced technologies but also exploring their societal, ethical, and environmental implications. Their work serves as a reminder that innovation must go hand in hand with responsibility and that the true measure of technological progress lies in its ability to improve the well-being of all people while preserving our planet for future generations.

As we contemplate the remarkable journey that awaits us within these pages, I am reminded of the words of Mahatma Gandhi: "You must be the change you wish to see in the world." The contributors to this book embody this spirit, tirelessly working to harness the power of advanced technologies to realize the Sustainable Development Goals and create a world where prosperity, equity, and sustainability flourish.

I extend my gratitude to the authors, editors, and all those who have contributed to this remarkable volume. Their dedication to advancing the discourse on technology and sustainability is a beacon of hope for a brighter future. As you read these pages, I encourage you to not only absorb the knowledge within but also be inspired to take action, for it is through collective effort and shared vision that we will turn the promise of these technologies into a reality that benefits us all.

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PREFACE

As we navigate the tumultuous waters of the 21st century, it is evident that we stand at a crossroads of unprecedented technological progress and pressing global challenges. Our planet is confronted by a multitude of complex issues, from poverty and inequality to environmental degradation and healthcare disparities. Simultaneously, we are witnessing an explosion of innovation in the form of 5G, artificial intelligence (AI), big data, blockchain, and Industry 4.0, technologies that hold the potential to revolutionize industries, societies, and the very way we live our lives. It is within this dynamic context that the book "Advanced Technologies for Realizing Sustainable Development Goals: 5G, AI, Big Data, Blockchain, and Industry 4.0 Applications" emerges.

The book you hold in your hands, "Advanced Technologies for Realizing Sustainable Development Goals: 5G, AI, Big Data, Blockchain, and Industry 4.0 Applications", is a testament to our collective commitment to bridge the gap between technological progress and sustainable development. In these pages, we explore the transformative potential of some of the most disruptive technologies of our time and how they can be harnessed to address the pressing issues that confront humanity.

The Sustainable Development Goals (SDGs) established by the United Nations serve as a global roadmap for building a better and more equitable world by 2030. These ambitious goals encompass challenges ranging from eradicating poverty and hunger to ensuring access to quality education and clean water, all while safeguarding our planet's ecosystems. Achieving these objectives requires not just ambition but also innovation, collaboration, and an unwavering commitment to leaving no one behind.

In our book, we set the stage for the exploration that follows. We examine the current state of the world, highlighting the urgent need for sustainable development in the face of mounting crises. The section book underscores the role of advanced technologies as catalysts for change, emphasizing the potential of 5G, AI, big data, blockchain, and Industry 4.0 to be game-changers in the pursuit of the SDGs. We explore the historical context of these technologies, tracing their evolution and discussing their current capabilities. From precision agriculture and smart cities to healthcare breakthroughs and supply chain transparency, the applications are as diverse as the challenges themselves.

5G technology contributes to Sustainable Development Goals (SDGs) by fostering innovation, improving connectivity, and enabling transformative solutions. It supports industry growth and infrastructure development (Goal 9) through enhanced connectivity and high-speed data transmission. In smart cities, 5G facilitates sustainable urban development (Goal 11) with applications like efficient energy management and intelligent transportation. The technology promotes good health (Goal 3) through telemedicine and remote patient monitoring. In education (Goal 4), 5G enhances online learning platforms, increasing access to quality education. It aids climate action (Goal 13) by enabling IoT and smart technologies for environmental monitoring and efficient resource management. Additionally, 5G fosters economic growth (Goal 8) by creating job opportunities and supporting entrepreneurship. Collaborative partnerships (Goal 17) are crucial for successful 5G deployment, addressing various global challenges and contributing to the collective achievement of SDGs.

AI technology contributes to Sustainable Development Goals (SDGs) by driving innovation and addressing key challenges. It aids in healthcare (Goal 3) through diagnostics, personalized medicine, and telehealth, improving overall well-being. In education (Goal 4), AI supports personalized learning, increasing access and quality of education. AI contributes to gender equality (Goal 5) by reducing bias and promoting inclusivity in various sectors. In poverty reduction (Goal 1) and economic growth (Goal 8), AI facilitates job creation, entrepreneurship, and economic opportunities. Smart resource management powered by AI supports sustainable cities (Goal 11) and climate action (Goal 13). It enhances disaster response and recovery efforts, contributing to resilient communities (Goal 11). Collaborative partnerships (Goal 17) are crucial for responsible AI deployment and addressing ethical considerations, ensuring that AI technologies align with the principles of sustainable development.

Big Data technology contributes to Sustainable Development Goals (SDGs) by providing insights and solutions to address global challenges. In healthcare (Goal 3), Big Data enables better disease monitoring, predictive analytics, and personalized treatments. It supports education (Goal 4) through data-driven decision-making, adaptive learning, and improved resource allocation. Big Data helps in poverty reduction (Goal 1) and economic growth (Goal 8) by informing evidence-based policies, fostering innovation, and creating job opportunities. In sustainable cities (Goal 11), Big Data aids urban planning, traffic management, and resource optimization for more efficient and resilient urban environments. It contributes to environmental sustainability (Goal 13) by enabling climate modeling, natural resource management, and monitoring environmental changes. Collaborative partnerships (Goal 17) are vital for sharing data, ensuring privacy, and leveraging Big Data to collectively achieve SDGs. Big data, the vast ocean of information generated daily, is the focus of our book. We explore how big data analytics can unlock insights that drive sustainable decision-making. Here, we discussed the challenges of data privacy and security, as well as the potential for data-driven innovation in sectors ranging from agriculture to disaster management. Case studies highlight how Big Data is being used to combat climate change, track epidemics, and improve resource allocation.

Blockchain technology contributes to Sustainable Development Goals (SDGs) by enhancing transparency, traceability, and efficiency in various sectors. In healthcare (Goal 3), blockchain ensures secure and transparent management of health records, facilitating interoperability and patient care. It supports financial inclusion (Goal 1) by providing secure and accessible financial services, especially in regions with limited banking infrastructure. In supply chain management (Goal 12), blockchain improves transparency, reducing fraud and ensuring sustainable and ethical sourcing. For identity verification (Goal 16), blockchain enhances security and inclusivity by providing decentralized and tamper-resistant identity solutions. In climate action (Goal 13), blockchain enables transparent tracking of carbon emissions and supports sustainable practices. Collaborative partnerships (Goal 17) are crucial for standardizing blockchain solutions and ensuring widespread adoption for achieving collective SDG objectives.

Blockchain technology, known for its ability to establish trust and transparency, takes center stage in our chapters. We examine how blockchain is revolutionizing supply chains, enabling fair trade, and securing identities. The chapter also explores the potential for blockchain to enhance financial inclusion and support sustainable energy initiatives. Through case studies, we showcase the transformative impact of blockchain in various industries and its role in achieving the SDGs.

Industry 4.0, also known as the fourth industrial revolution, refers to the ongoing transformation of traditional manufacturing and industrial practices through the integration of digital technologies. It involves the use of advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, robotics, and other smart technologies to create more intelligent, connected, and automated industrial systems. The goal of Industry 4.0 is to improve efficiency, productivity, and flexibility in manufacturing and related industries by enabling real-time data exchange, smart decision-making, and the seamless integration of digital and physical processes. We explore the concept of Industry 4.0, a paradigm shift in manufacturing and production. We examine how smart factories, automation, and the Industrial Internet of Things (IIoT) are reshaping industries while reducing environmental impacts. The chapter discusses the implications of Industry 4.0 for job markets and sustainable manufacturing practices. Case studies illustrate how Industry 4.0 is driving innovation and sustainable development in diverse sectors.

The integration of 5G, AI, Big Data, and Blockchain technologies holds significant promise in collectively advancing Sustainable Development Goals (SDGs). 5G's high-speed connectivity supports innovative solutions in healthcare, education, and industry, contributing to SDGs related to good health and well-being (SDG 3), quality education (SDG 4), and industry innovation (SDG 9). AI and Big Data play pivotal roles in healthcare, facilitating diagnostics, personalized medicine, and improved patient care, aligning with SDG 3. Blockchain enhances transparency in supply chains, ensuring responsible consumption and production (SDG 12), and supports inclusive identity verification, promoting peace, justice, and strong institutions (SDG 16). These technologies collectively foster global collaboration (SDG 17) by providing tools for addressing challenges, enhancing sustainability, and creating a technologically advanced and inclusive future.

The contributors to this volume are experts, visionaries, and pioneers in their respective fields, offering insights that bridge the gap between theory and practice. Their research, experiences, and case studies shed light on how these advanced technologies can be harnessed to foster sustainable development, enhance the quality of life for all, and create a world where opportunities are abundant.

Yet, while these technologies hold immense promise, they also present ethical, social, and regulatory challenges. As we embrace the transformative power of innovation, we must remain vigilant in ensuring that the benefits are equitably distributed, privacy is safeguarded, and that the technology serves as a force for good.

As you delve into the pages of this book, we invite you to explore not only the fascinating applications of 5G, AI, big data, blockchain, and Industry 4.0 but also the broader implications for society and the global community. We hope that the knowledge and insights shared within these pages will inspire you to engage in the ongoing dialogue on how we can leverage advanced technologies to build a more sustainable and inclusive future.

Lastly, we extend our gratitude to the contributors, editors, and readers who join us on this intellectual journey. Together, we can harness the power of advanced technologies to advance humanity's most ambitious agenda to realize the Sustainable Development Goals and create a world where prosperity, equity, and sustainability thrive hand in hand.

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CHAPTER 1

Role of Energy-Efficient Technology to Build Sustainable Cities

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Abstract: The Sustainable Development Goal 11 aims to make cities inclusive, safe, resilient, and sustainable. With economic growth and development, the number cities has increased, and the slums are also increasing, which cause a number of problems like solid waste management, pollution, poor traffic systems, and many more. Among other major concerns, one significant concern is that of energy consumption. To protect the environment, it has become significant to act sustainably and choose sustainable ways to develop cities. Globally, there has been raising concern over the disparities and energy-related CO_2 emissions. With an increase in the number of people living in cities, the construction of sustainable cities has become necessary; hence in this regard, it has become crucial to concentrate on technological innovation in energy efficiency. The sustainable urban development path will transform cities to achieve Goal 11 for the path to a sustainable future. Energy efficiency is one of the most immediate aspects on which the whole world needs to work. This study seeks to explain the contribution of technology to support energy-efficient tools for constructing sustainable cities. This study represents dimensions of sustainable development and convergence of energy efficient technology enabling advanced levels of sustainable development along with the challenges and key policy recommendations to achieve Goal 11.

Keywords: Energy efficiency, Sustainability, Sustainable city, Sustainable development, Technological innovation.

INTRODUCTION

The United Nations General Assembly adopted the 2030 Development Agenda titled “Transforming our World” for Sustainable Development in 2015. The report

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spells out 17 Sustainable Development Goals (SDGs) for a great and prosperous future. The central ideas of sustainability have been environing for many years and now they have begun to apparent on international political sphere. This is because people are becoming mindful of how much pressure human beings are putting on the planet than what it can refill [1]. UN-Habitat is working universally to address Goal 11 (Make cities inclusive, safe, resilient, and sustainable). As a result of population growth, 7 out of 10 people are anticipated to shift to metropolitan areas by the year 2050 to make a living. This rise in the urbanization rate affects the wellbeing of people which sum up to create sustainable city or to reconstruct cities across the world into sustainable one and providing a safe and secure future.

Sustainable cities are the cities that lead the way to social, economic and environmental progress on the one hand and on the other hand, provide a stable home for the current population without compromising the needs of future generations to enjoy the same.

Technology plays an important role in achieving sustainability. The efficiency and effectiveness of sustainable development can be improved by technological advancement. Technological advancement helps in the completion of SDGs. Solutions for sustainable development and a sustainable environment are provided by technology by installing innovative and value chain gadgets in the cities [2]. One of the sustainable development goals (SDG 7) listed in the UN report is to ensure access to reliable, affordable, sustainable, and modern energy for all. This paper puts forward a discussion on energy-efficient technology paving the way for sustainable development.

OBJECTIVES

1. To understand different dimensions of sustainable development that support the designing of sustainable cities.

2. To find out the relationship between sustainability and energy efficiency.

3. To analyze the significance of energy-efficient technology in facilitating sustainable cities by an insight into the selected countries.

4. To analyze the policies related to energy efficiency.

SUSTAINABLE CITY

A sustainable city is one that addresses the economic, social, and cultural needs of present as well as future generations. A sustainable city assists in forming a sustainable living environment. Under the concept of sustainable development, hundreds of definitions have been circulating that represent multidisciplinary points of view on sustainable development. Sustainable development has mainly three dimensions:

• Social Dimension.

• Economic Dimension.

• Environmental Dimension.

Social Dimension

By ensuring the wellbeing of people and raising the standard of living through education, health, housing, employment opportunities, safety and security, *etc*., the fundamental principle of equality emphasizes reducing discrimination. The goal of governance is to ensure that there are ample resources to support sustainability programs. The notion of social cohesiveness explains the significance of unity among people and prompting them to participate in social activities.

During the 53rd session of the Commission for Social Development, the member states emphasized strengthening the social dimensions of sustainable development:

• By adopting strategies for poverty eradication.

• By introducing schemes and policies to provide employment opportunities and access to quality education, healthcare, sanitation, *etc*.

• By integrating social policies with environmental and economic policies at a wider level.

• By encouraging social responsibility among people (through awareness campaigns) to protect the environment.

CHAPTER 2

Blockchain Technology as a Potential Solution to Empower Women and Eliminate Bias: Opportunities, Challenges, and Limitations

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Abstract: This chapter explores the ways in which blockchain technology can be used to address the challenges of gender inequality in developing countries. It begins with an overview of gender inequality and its persistence in various areas, followed by an introduction to blockchain technology as a potential solution to some of these challenges. The chapter then focuses on three key areas where blockchain can empower women: access to financial services, elimination of bias, and enhancement of safety. Through examples of blockchain-based platforms, the chapter explains how women can use blockchain to participate in financial transactions, report incidents of harassment, abuse, or violence, and identify and eliminate discriminatory practices in various fields. The chapter also highlights the challenges and limitations of blockchain technology in promoting gender equality, including the lack of gender diversity in the tech industry and the risk of reproducing existing gender biases. Additionally, the chapter discusses factors such as connectivity, literacy, and access to technology that can limit the use of blockchain in developing countries. The chapter concludes with a call for diversity and inclusivity in the design and deployment of blockchain solutions and emphasizes the need to address underlying structural inequalities that affect women's ability to use technology and financial services.

Keywords: Blockchain technology, Bias, Gender equality, Gender-based violence (GBV), Sustainable development goal, Women empowerment.

INTRODUCTION

Gender inequality continues to persist in various areas around the world, with women facing challenges such as limited access to financial services, gender bias in the workplace, and pervasive gender-based violence. The Global Gender Gap

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Index [1] is a comprehensive metric that monitors advancements toward achieving gender equality in four key domains: economic participation and opportunities, educational attainment, health and survival, and political empowerment. The index ranges from 0 (no gender gap) to 1 (perfect gender parity). The World Economic Forum [1] has published the Global Gender Gap Report 2023, which provides insights and analysis on the global gender gap. These findings include the following significant points:

• **Global Gender Gap:** Despite a 0.6 percentage point reduction in the global gender gap since 2021, the current rate of progress suggests that it will still require approximately 132 years to completely close the gender gap worldwide.

• **Gender Gaps in the Global Labour Market:** Women make up 47.5% of the global workforce, but they are paid 22% less than men on average. They are also more likely to be in informal employment and to work in lower-paying sectors.

• **Gender Gaps in Political Leadership:** Currently, women occupy only 26% of seats in national parliaments and hold 22% of ministerial positions. At the existing rate of progress, it is estimated that it will take around 130 years to attain gender parity in political representation.

The reports gathered several facts that are worth mentioning (Table **1**) [1]:

Table 1. Gender gap statistics.

Subindex	Fact	Value
Economic participation and opportunity	Global labor force participation rate, female.	58.3%
Economic participation and opportunity	Global labor force participation rate, male.	80.1%
Economic participation and opportunity	Global share of women in managerial positions.	27.40%
Economic participation and opportunity	Global share of women in emerging roles (*e.g.*, computing, engineering, AI, *etc*.).	14.40%
Educational attainment	Global enrolment in secondary education, female.	76.6%
Educational attainment	Global enrolment in secondary education, male.	75.7%
Educational attainment	Global literacy gap.	6.50%
Political empowerment	Global share of women in parliament.	26.1%
Political empowerment	Global share of women in ministerial positions.	22.6%
Political empowerment	Global share of women as heads of state or government.	10.5%
Political empowerment	Average duration of a female head of state or government (2000-2020).	2.3 years

According to Heise *et al.* [2], prior to a child's birth, gender norms exert an influence on the child's future life and prospects. The process of gender socialization commences within the family and continues through interactions with teachers, friends, classmates, media, and religious figures. During this process, children absorb limiting expectations regarding their behavior and conduct based on their gender. For instance, boys are typically encouraged to display strength and independence, while girls are often perceived as more fragile and requiring protection.

Gender inequality is the unequal treatment or discrimination of one sex or gender over another based on differences in biology, psychology, or culture. It affects the opportunities, rights, and protections of girls and boys, as well as women and men in various domains such as health, education, and business life. The continuation of this social phenomenon in many societies is a violation of human rights and has consequences for overall economic growth.

According to a literature review by Santos Silva and Klasen [3], gender inequality hinders economic development in the long term by affecting fertility choices, human capital investments, labor market involvement, and innovation. They also pointed out that gender inequality differs depending on the region and culture, but it is usually more widespread and severe in low- and middle-income countries, particularly in conservative and conflict-affected environments.

The implications of gender inequality in property ownership and control are one of the most overlooked problems in social science research and policy [4]. Their restricted ownership and control over land subsequently restricts their access to credit, inputs, extension services, and markets. This, in turn, diminishes their ability to negotiate effectively within their households and communities.

Blockchain technology has emerged as a potential solution to some of these challenges, offering opportunities for greater financial inclusion, transparency, and security. A Blockchain is a digital ledger capable of securely and transparently recording transactions in a decentralized manner. It can facilitate peer-to-peer transactions, eliminating the need for third parties such as banks or governments. It can also create an immutable record of transactions, which makes it difficult to tamper with or alter. This technology has the potential to empower women by enabling them to participate in financial transactions and access financial services, as well as providing secure and decentralized platforms to report incidents of harassment and violence.

The goal of this chapter is to investigate the potential of blockchain technology to promote gender equality and address some of the challenges faced by women globally. The chapter will examine the ways in which blockchain technology can

CHAPTER 3

One-Dimensional Convolutional Neural Network for Data Classification

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Abstract: CNN has emerged as the de-facto standard for several machine learning (ML) and computer vision applications. It is known for its classification and feature extraction capabilities. Many ML techniques require separate handcrafted feature extraction steps before classification, which are "sub-optimal" in nature. Unlike these, CNN extracts "optimal" features directly from raw data, enabling it to enhance classification accuracy. Two-dimensional CNN (2D-CNN) is the most common one, where inputs to the CNNs are 2D in nature, such as images. Here, we used 1D-CNN for data classification as we used 1D inputs. 1D-CNN has lower computational complexity than 2D-CNN. Mainly for this, we preferred 1D-CNN over 2D-CNN. To demonstrate the superiority of the proposed generic classifier, we compared its classification accuracies with several other generic classifiers. We used 21 benchmark data sets from the UCI machine learning repository to achieve this. Tests prove the superiority of the proposed 1D-CNN-based generic classifier. Many 1D-CNN-based application-specific classifiers are proposed in the literature, but the proposed classifier is applicable for many types of tabular data *i.e.*, it is a generic classifier.

Keywords: 1D-convolutional neural network, Data classification, Machine learning.

INTRODUCTION

One of the crucial tasks in data mining (DM) is the construction of classifiers. The classifier can categorize records into a set of classes after a training data set has

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been used to train the classifier. The classification techniques can be grouped into hard computing-based methods and soft computing-based methods. Hard computing methods are primarily mathematical in nature and necessitate a precise analytical model. The tolerance for imprecision, ambiguity, and partial truth distinguishes soft computing from hard computing (traditional computing) [1]. Soft computing is based on some biologically inspired methodologies [2]. Artificial neural networks (ANN), deep learning (DL), and CNN belong to soft computing due to the above-mentioned characteristics.

ANN gives birth to CNN. CNN has begun to rule our daily lives, presenting answers that could only have been envisioned in science fiction films a decade ago [3]. CNN is a regularized version of the MLP [4]. During training, CNNs learn through the BP algorithm [5]. Except for input and output layers, CNNs have two types of hidden layers: 1) Convolution layers: convolution and sub-sampling (pooling) take place in these layers; 2) Fully-connected (dense) layers: these layers bear resemblance to the layers found in a traditional MLP. The neocognitron is a hierarchical, multi-layered ANN that has served as an inspiration for CNN [6]. Developers of the neocognitron drew inspiration from the work of Hubel and Wiesel [7]. In their work, they have established that in the human visual system, simple detectors can be "summed" to create more complex detectors. In 1981, their work earned them the Nobel Prize in Physiology or Medicine. This is the fundamental basis of CNN models. Shift-invariant ANN (SIANN) can be considered 2D-CNN [8]. LeCun *et al.* used the term "convolution" for the first time in their paper, [9] and for handwritten zip code recognition, they built a CNN. In the 1990s, among several proposed CNNs, one of the most well-known is LeNet-5. LeCun *et al.* introduced a groundbreaking 7-layered network for digit classification [10]. By utilizing a CNN, Alex Krizhevsky *et al.* attained the top image labeling performance in the ImageNet large-scale visual recognition challenge (ILSVRC). It is known as AlexNet [11]. AlexNet has 8 layers (5 CNN and 3 MLP layers), which achieved 83.6% accuracy in the ILSVRC [12]. This was almost 10% higher than the second-best solution, which employs a typical ML approach. With the publication of AlexNet, CNNs enjoyed a huge surge in popularity (which continues today). The usage of graphics processing units (GPUs) for faster computation allowed AlexNet to be executed. Krizhevsky *et al.* proposed a rectified linear unit (ReLU) [11] as an activation function, which we have also used in this work. In 2007, NVIDIA proposed the compute unified device architecture (CUDA), which enables the utilization of the parallel processing capabilities of GPUs to a greater extent [13]. In 2013, a new network, ZFnet [14], won the ILSVRC 2013. ZFnet has further increased the accuracy rate up to 88.3% on the ImageNet database. The visual geometry group (VGG) at the University of Oxford created VGGNet [15]. It won the localization task in ILSVRC in 2014. GoogleNet (or Inception V1) was proposed by the researchers of Google (with the collaboration of various universities) [16]. This architecture won the ILSVRC 2014, and VGGNet became the first runner-up. GoogleNet has achieved an accuracy rate of about 93.3%. GoogleNet has 22 CNN layers. With a remarkable accuracy of 98.46%, He *et al.* presented the winning entry of the ILSVRC 2015, a 34-layered residual network (ResNet) [17]. The latest one is EfficientNet-L2, winner of the ILSVRC 2021 with 98.8% accuracy [18]. https://paperswithcode.com/sota/image-classification-on-imagenet shows the history of image classification on ILSVRC.

The trend is to build lightweight architectures that do not sacrifice performance so that CNN can be applied to resource-constraint hardware. Google's MobileNets are compact, low-latency, low-power models for embedded devices like mobile phones [19 - 21]. MEGVII introduced ShuffleNet [22, 23], designed specifically for mobile devices. It is an exceptionally computation-efficient CNN architecture. Most CNNs extract a large number of redundant features during image recognition. In classic convolution layers, there are several comparable feature maps known as ghosts. Han *et al.* proposed GhostNet, where novel ghost modules generate more feature maps from cheap operations [24]. The primary reason for the prominence of CNN lies in its capability to extract hierarchical features. This success has transcended academia, piquing the interest of companies such as Google, Microsoft, AT&T, NEC, and Facebook, who have formed dedicated research groups to explore novel CNN designs [25]. Furthermore, the current achievements of deep CNNs can be partially attributed to the abundance of data and advancements in hardware.

Today, we can share any image instantly with others, and our brain can process it to find meaning, but for a machine, it is a complicated job. For a computer, an image is a 2D array of numbers. It becomes 3D when we take a color image, where the third dimension signifies the RGB value. The classifier provides class labels as output, whereas the inputs are regular images. Researchers initially invented and used CNNs for this purpose. However, CNNs are being used for many applications. 1D, 2D, and many-dimensional inputs are used in CNN, and it functions suitably. The distinctions are evident in the format of the input data. In the case of 1D-CNN, the 1D convolution kernel, referred to as a feature detector, scans across the data. Specifically, a 1D-CNN employs a filter with a size of 3, encompassing solely 3 feature vectors, whereas in a 2D-CNN, a filter of size 3 contains 3 x 3=9 feature vectors. The computational complexity of 1D-CNNs is significantly lower than that of 2D-CNNs due to the requirement of array operation in place of matrix operation during forward and backward propagation of signals through the 1D-CNN. The suggested architecture uses compact configurations with networks having less than 10 K parameters, similar to the majority of 1D-CNN applications. As opposed to practically all 2D-CNN

CHAPTER 4

Advance Technology and its Impact: A Sustainable Development Goal in the Maritime Sector

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Abstract: Nowadays, shipping firms have discovered faster connectivity for their ships, not only for the captains but also for the shipping industries. Most of the ships have developed floating offices in their ships that provide crews and captains with email, secure Internet connections, route planners, virtual networks, and a variety of other systems. However, this is the correct time for shipping firms to invest in emerging smart technology that can increase the ship's performance and streamline and even reduce the running costs of the ships. This is possible only with emerging technologies like artificial intelligence and machine learning. Smart computers can store enormous volumes of data and perform even more quickly than humans. The growth of smart technologies like machine learning, artificial intelligence, big data, and data science in collaboration with the shipping industry gives a significant benefit to the ship owners. The greater usage of AI, big data, and ML gives a greater investment. Machine learning algorithms can accommodate data that covers almost the entire history of a vessel's life. The aim of this paper is to provide a technological overview of smart technologies in the shipping industry.

Keywords: Artificial intelligence, Autonomous ships, Machine learning, Shipping industries, Smart technology.

INTRODUCTION

Nowadays, smart technology like artificial intelligence and machine learning not only plays a vital role in IT sectors but also in shipping industries like logistics and port side. Machine learning can also be possible by means of artificial intelligence. With the help of machine learning, one can work on small to large data collection by finding out and comparing those data to get the most common design and explore it. On the other hand, artificial intelligence is vast in scope [1].

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It is the branch of science and technology where human intelligence can work with artificial machines. For ML applications, data is the major requirement to achieve our credentials. This can be achieved with ML algorithms that help shipowners in enhancing data handling in a great way.

In the shipping industry, data mining is not that much developed nowadays. Accordingly, the usage of machine learning is also much limited in marine industries when compared to other sectors. Fig. (**1**) depicts the technologies that will help shipping industries in the future [2]. Maritime problems can be solved with the help of machine learning, which allows us to apply soft computing algorithms and find data that helps to direct the problems that arise in shipping transport, like logistic management. This method is very useful in the marine sector, especially in the field of marine network planning, voyage planning, cargo optimization, and maintenance process.

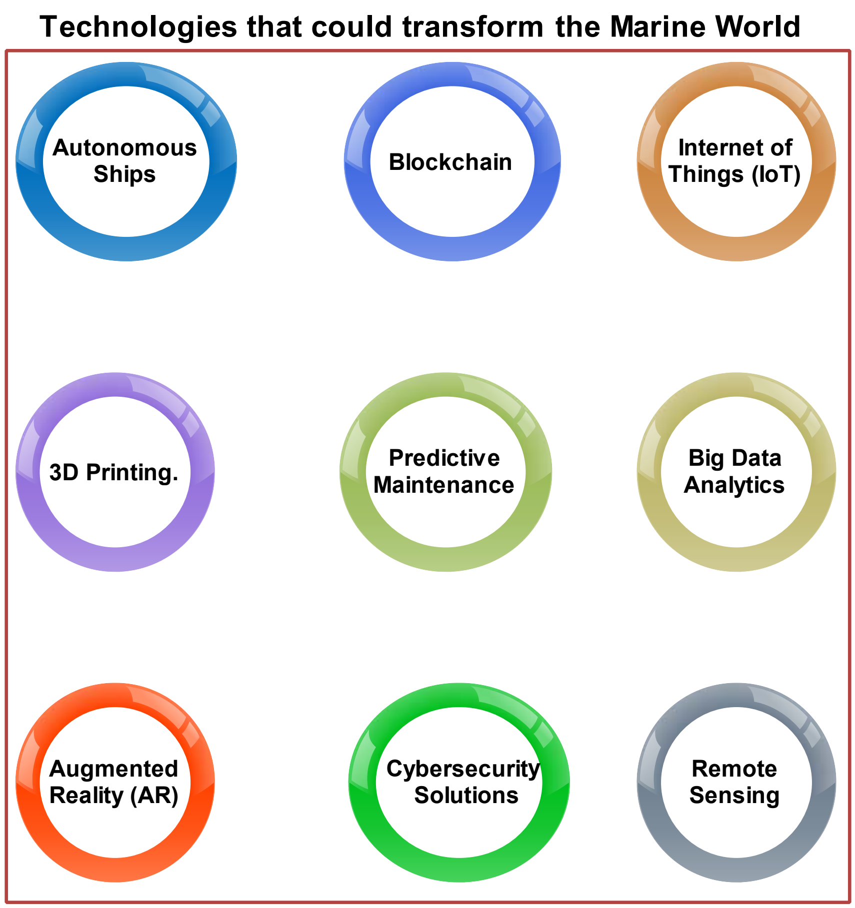

Fig. (1). Technologies that will enable shipping industries in the future.

Recent advances in microtechnology and, in particular, in micro-electromechanical systems (MEMS) and nanoporous media have necessitated the elucidation of flow and transport processes in small dimensions. This is also the case with several other industrial applications, which rely on low-pressure conditions. The molecular time and length scales are not sufficiently small compared to the characteristic macroscopic flow scales.

The remainder of the paper is organized as follows: The second portion features technologies that will enable smart ships in the future. The third portion discusses machine learning in marine logistics. The fourth portion discusses the significance of machine learning in the marine industry, and the fifth piece discusses how it might promote sustainable development. The sixth part contains concluding remarks.

TECHNOLOGIES THAT WILL ENABLE SMART SHIPS IN THE FUTURE

• Ships will be able to have greater autonomy; this may cause the crews to get a better understanding of their vessels.

• AI-based solutions will be able to help crew in navigating and operating their ships in addition to enabling autonomy.

• Artificial intelligence applications in ships help to eliminate errors that are caused by humans and prevent accidents.

• With the help of blockchain, shipping companies will be able to work paperfree and reduce processing times.

• Smart contracts allow for transparent shipment tracking of the whole shipping value.

• The usage of blockchain will allow the crew for a more computerized and well-organized transaction process with collaboration and greater transparency.

• In unfavorable climatic conditions, augmented reality gives solutions that aid ship crews in gaining enhanced visibility of their surroundings.

• Virtual reality also allowship owners to provide practical training to their crew on board in order to get better exposure, which prepares them for their jobs.

• In association with augmented reality with big data analytics, it will provide a comprehensive ship navigation experience and be fully immersive.

CHAPTER 5

The Role of 5G in Creating Smart Cities for Achieving Sustainable Goals: Analyzing the Opportunities and Challenges through the MANOVA Approach

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Abstract: The next generation of mobile technology, known as 5G, poses a huge challenge to the existing state of the communications industry since it intends to solve the issues that have plagued the 4G network in its current iteration. This cutting-edge technology enables the establishment of multiple connections all at once and maintains network ubiquity even in settings that involve high levels of mobility or densely populated areas. As a result, smart cities and intelligent transport systems may stand to benefit from its use. 5G will make it possible for the actual Internet of Things and the Internet of Vehicles to become a reality if this plan is implemented. The advent of 5G will herald the beginning of a new era of opportunities for networks and services. It will help in maintaining an increased data rate, reduced latency, huge simultaneous connections, and ubiquity of networks around the world. 5G will also be a crucial enabler for a true Internet of Things because of its capacity to connect a vast number of sensors and actuators while following severe energy efficiency and transmission limits.

The Internet of Things (IoT), a new digital communication paradigm, has made it possible for things that are often found in daily life to interact with one another as well as with people [6]. As a result, the objective of the Internet of Things is to expand both the breadth and depth of the Internet. This will be accomplished by making it easier for

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a wide variety of devices, including vehicles, home appliances, security cameras, industrial actuators, and many more, to interact with one another in an unobtrusive manner. When 5G is applied to the Internet of Things in cities, it may be able to keep track of the total amount of energy that is consumed by all of the city's public services (including lighting, traffic lights, security cameras, and the heating and cooling of public buildings, amongst other things). Municipalities will, among other things, be able to manage their energy resources more effectively if they have access to this information.

Keywords: 5G network, Multivariate analysis of variance (MANOVA), Smart cities, Sustainable goals.

INTRODUCTION

When 5G is completely implemented, there will be a wide variety of new opportunities for networks and businesses to pursue and exploit. These opportunities will be to the mutual benefit of both parties. It will ensure network continuity, a greater data rate, lower latency, a great deal of simultaneous connections, and network ubiquity around the world, even in highly mobile environments such as trains, as well as extremely dense or sparsely populated environments such as stadiums and retail malls [1]. Because of its ability to link a huge number of sensors and actuators while adhering to severe energy efficiency and transmission constraints, 5G will be a crucial enabler for a genuine Internet of Things. This is because of its capability to connect a large number of devices simultaneously. As a result of this capability, 5G will become a vital enabler for a true Internet of Things [2].

The collaborative efforts of the business world and the academic community to define the criteria for 5G service [3] are providing a glimpse into the future and hinting at the impending arrival of the 5G era. The number of connected devices and the volume of mobile data traffic have increased at a rate that has never been seen before, and the technologies that are now available for 4G networks are insufficient to keep up with the accompanying deluge of data. This project is driven by the fact that the number of connected devices has expanded at a rate that has never been seen before [3]. The expansion in both the number of connected devices and the amount of mobile data traffic at a rate that has never been witnessed before is the impetus behind this initiative. If a 5G device has the capability to maintain a connection at all times and in any location, it will be able to interconnect any and all network devices. It is anticipated that the fundamental design of the 5G network will be able to sustain up to one million simultaneous connections in a single square kilometer. In this way, the groundwork will be prepared for the launch of a diverse range of novel service models for the Internet of Things [4].

The Internet of Things, also abbreviated as IoT, is a relatively new innovation in the field of digital communication that has made it possible for everyday things to communicate with one another as well as with customers. Because of this, the Internet of Things is an initiative that seeks to broaden the scope of the Internet and make it a more immersive experience by enabling direct contact with a range of objects. These objects include household appliances, security cameras, industrial actuators, traffic lights, and automobiles, amongst others. Because of this, the Internet will be able to cater to a more diverse user base and offer an experience that is more immersive [5]. Because there are so many devices that are connected to one another and are able to communicate with one another, this setting is perfect for the generation and collection of information because there are so many of these devices. Big Data, when combined with cloud computing, makes it a great deal less difficult to manage different types of data in line with needs [6]. This, in turn, provides the way for the development of services that are of more use to consumers. This kind of technology is essentially necessary in order to make it possible for the Internet of Things paradigm to function correctly in places with a high population density.

This location is also often referred to as a "Smart City." It conforms with the need that the great majority of government organizations implement some kind of solution that is founded on information and communications technology in order to manage public operations. This location is also sometimes referred to as a "Smart City" [7]. The concept that is being referred to as "smart cities" has several objectives, the most important of which are the optimization of the use of public resources, the improvement of service quality with an emphasis on convenience, maintenance, and sustainability, and the reduction in the cost of providing utility services. In addition, the "smart cities" mission is to enhance the quality of services provided by putting an emphasis on convenience, upkeep, and environmental responsibility [8, 9].

The Internet of Things may fundamentally be broken down into four distinct categories. "Personal and Home Applications" is the first category, and it includes e-healthcare services as well as home gadgets that provide medical practitioners with the opportunity to do remote monitoring of patients. This category is further broken into two more subcategories, bringing the total number of subcategories for this category up to three [10]. The second group of utility applications includes examples like surveillance cameras, air quality monitors, public safety systems, and emergency response systems. Other examples of applications in this group include public safety systems. In order to successfully complete these applications, it will typically be necessary for a variety of distinct industrial units to collaborate with one another. The third and last section of this document is devoted to a review of Mobility Applications, which are often referred to as

CHAPTER 6

Sentiment Analysis of Tweets Related to Russia-Ukraine Conflict Using Bi-Directional LSTM Network for Post-Traumatic Stress Disorder Early Detection

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Abstract: Techniques for sentiment analysis are crucial for examining people's opinions. People's attitudes are influenced by the constant and rapid growth in the amount of material provided on social networks. Most research, however, focuses on sentiment analysis to determine how a war will affect the global economy. Consequently, when studying international conflicts, national leaders and other influential figures tend to receive more attention than public opinion and emotions. The purpose of the article is to discuss the analysis of moods and focus on the analysis of emotions and social opinions during the Russian-Ukrainian conflict in order to detect the early signs of post-traumatic stress disorder (PTSD). Post Traumatic Stress Disorder (PTSD) and realizing Sustainable Development Goals (SDGs) are vital. PTSD, with its impact on mental health, poses challenges to achieving Goal 3 of Good Health and Well-being. Additionally, it hampers access to quality education (Goal 4), especially in formative years, and can disproportionately affect women, hindering progress towards Goal 5 of Gender Equality. In the context of conflict, PTSD impedes the establishment of strong institutions (Goal 16) and underscores the importance of collaborative efforts (Goal 17) to address the complex challenges associated with trauma for a resilient and sustainable society. This study is the first to propose a model that reflects the desire to analyze the impact of this war on mental health during the Russian-Ukrainian armed conflict. This can protect people from mental disorders and suicide and provide clues for future research in this area. The method used in this work is a bidirectional LSTM method with a focus-based network approach to analyzing the sentiment of English tweets, using positive, negative, and neutral classification in a multiclass approach to detect signs of PTSD. Sentiment analysis is a method for extracting emotional content from textual information using natural language processing (NLP). Our study aims to identify people with PTSD using sentiment analysis by training a deep learning (ML) model on text data. Based on text mood analysis, trained models can detect post-traumatic stress disorder (PTSD). We attained

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a 90.02% accuracy by combining the attentional mechanism with a bidirectional short-term memory layer (Bi-LSTM). The findings of the suggested framework demonstrate greater accuracy than earlier state-of-the-art investigations. By creating an early detection model, post-traumatic stress disorder (PTSD) symptoms may be lessened.

Keywords: Attention mechanism, Bidirectional LSTM-neural network, Deep neural network, Natural language processing (NLP), Post-traumatic stress disorder (PTSD), Sentiment analysis.

INTRODUCTION

War is one of the most mentally draining events a human being can experience. Even after the conflict has ended, its indirect effects can linger for years. According to the International Society for Traumatic Stress studies, traumatic stress disorder (PTSD) is a common mental illness that occurs as a result of a stressful experience. A person with post-traumatic stress disorder (PTSD) may experience the following symptoms: Nightmares, flashbacks, and returning symptoms that affect feelings and thoughts, such as depression, anger, worry, shame, guilt, and a loss of interest in enjoyable activities and difficulties remembering key things from the past. The symptoms of PTSD and Complex Posttraumatic Stress Disorder (C-PTSD) are very similar. C-PTSD may also be associated with emotional issues, such as difficulty controlling one's emotions and self-esteem issues. PTSD recovery requires an understanding of emotions. The role played by social support in healing and regaining the research-being has been demonstrated time and again [1].

Vietnam veterans developed PTSD after the war ended as a result of the psychological effects of war. It was also officially acknowledged that the diagnosis had been made. Psychiatrists were able to recognize victims of war and violence as patients as a result of this construction. As a result of the addition of diagnostic categories, the compensation claims of the researchers were also simplified [2].

The American Psychological Association defines cognitive processing therapy (CPT) as cognitive behavioral therapy designed specifically to treat PTSD and comorbid symptoms. Through trauma-related therapies, negative emotions and beliefs are intended to be changed. Assisting patients in dealing with such upsetting memories and emotions is one of the responsibilities of therapists [3]. Thus, understanding emotions in order to support mental health is crucial. In this paper, post-traumatic stress disorder (PTSD) is detected using sentiment analysis.

Emotions are a natural component of human existence.. This enables a greater comprehension of what individuals are experiencing and enables a more suitable reaction. Knowledge of human behavior requires knowledge of emotions. Making decisions about your needs and wants is simpler when you are conscious of your emotions. People who are emotionally aware are better equipped to express their feelings, avoid or end conflict, and control challenging emotions [4]. The study team led by neurosurgeon Antonio R. provides persuasive evidence of a basic link between emotion and decision-making. Damasio hypothesized that without emotions, individuals would not be able to make wise choices [5].

During conflict, a lack of social connection can lead to negative emotions such as anxiety and depression.When negative emotions are removed, depression, loneliness, social anxiety, and other mental health outcomes are significantly reduced [6]. Human behavior largely depends on opinions, as these opinions have a significant impact on how people behave when faced with decisions [7].

The general definition of "sentiment analysis" is the process of extracting and interpreting subjective and human-relevant information using important techniques such as natural language processing, text, and data mining. Various sources of information, such as text or speech, can be used in sentiment analysis. Entities can be events, topics, people, *etc.* Many other activities can be classified as sentiment analysis, *e.g.*, opinion mining and emotion mining. Emotions and feelings are closely related. Sentimental experiences, psychological reactions, and social reactions are the three components that make up the complex array of neural manifestations known as emotions [8]. The importance of early issue diagnosis cannot be overstated. One of the most crucial aspects of personal growth is the ability to understand emotions, which is a fundamental ability that resembles human intellect. The development of artificial intelligence and the closely connected issue of polarity perception are both centered on emotion processing. Nearly all studies in the fields of computational linguistics and natural language processing make the assumption that speakers have an emotive value or mood connected to particular personality traits. Information retrieval and human-computer interaction are used to build the fields of emotional computing and sentiment analysis [9].

The growing need to engage in research on opinion formation and social media content has made sentiment analysis (SA) one of the fastest-growing research areas. Because of their usefulness and efficiency, machine learning techniques are widely used to classify emotions. In addition, machine learning models are widely used for sentiment classification due to their high classification accuracy. The use of deep learning as a subfield of machine learning in sentiment analysis has also become increasingly popular in recent years. The structure and function of the self-learning human brain are a source of inspiration for deep learning algorithms. Machine learning and dictionary-based systems are the two main paradigms for

CHAPTER 7

Emerging Issues of Cyber Security toward Sustainable Development

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Abstract: Cybersecurity is a sensitive and critical issue across multiple domains. It is a range of technologies, techniques, and practices designed to protect sensitive, priceless data, well-configured networks, source code snippets, and system programs from attackers, damage and unauthorized access. But we are gyratory our daily lives with these concerns, there is a possibility that we setout truthfully suspicious about our own professional and personal safety. Cyber security is also formulating the process of malware detection more actionable, scalable and effective than traditional approaches, which require human intervention. At the same time web technologies and cyber security can contribute to the implementation of the concept of sustainable development. This study gives a brief description about promising issues like cyber space, cyber-attacks, cyber security, cyber-crime, cyber forensic, cyber defamation, cyber terrorism, cyber law and types of cyber-crimes impacts on professionals in the cyber-world. It also forecast how a professional can conscious of current cyber world and also a theoretical discussion and explore on the relationships between emerging issues of cyber security and sustainable development.

Keywords: Cyber Space, Cyber security, Cybercrime, Cyber forensic, Sustainable development.

INTRODUCTION

The modern era's buzzwords are cyber security, the development of promising technology, and communication hubs. Although the majority of professionals are ardent consumers, they are apprehensive of the technologies and advances that are at the forefront of computing devices like PDAs (Personal Digital Assistants), smart phones, and other gadgets with high Internet usage. These technologies and advancements are transforming both our personal and professional life. Due to a lack of knowledge about current technology advances and emerging trends, the

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tendency has evolved into one of self-suspicious thinking. As a result, we could be self-conscious and cognizant of our own personal and professional safety [1].

The modern cyberthief is educated and skilled at using computers. The keyboard is an input device, so a cyber-terrorist of the future might be able to cause more destruction with a keystroke than with a cyber-bomb. Phishing, credit card fraud, bank robbery, unlawful hosting or uploading, industrial espionage, child pornography, kidnapping children through chat rooms, scams, cyber terrorism, the production and dissemination of viruses, spam, and other crimes are all included under the umbrella category of “computer crime.” These are all computer-based crimes.

The present computer security initiatives focus on external threats by considering the computer as a reliable system. Some informed observers or professionals believe this to be a regrettable tendency and point out numerous consequences as well as the variations of security flaws in existing computer systems. Unknown users typically have access to the majority or all of a system's functionalities once an attacker has compromised one area of it without the usage of fine-grained security. The complexity of computer systems makes it impossible to guarantee their defect-free status, leading to insecure systems [2]. The government, software organization, digital professionals and other technical systems have made a number of practical attempts to create a secure, rigorous and reorganized cyber environment by implementing Cyber Laws. Presently the hackers and capable cyber criminals are able to operate freely on the Internet. But the cyber security advances will allow for more secured Internet usage and safe transactions with a less danger of cyber related frauds and attacks [3]. Cyber forensic is required as a standard language for computer forensics. Due to a lack of communication between academics and practitioners and a lack of actual understanding and self-consciousness, computer forensics lags behind other forensic fields.

Cybercrime in cyberspace is expanding at a rapid rate. The computer forensics must have scientific approaches as like other forensic investigation like malware analysis and Deoxyribonucleic Acid (DNA) analysis; by this it is possible to communicate about problems and difficulties of sufferers. The phrase “Cyber” is not single; there are numerous ways to understand the idea using various terminologies, including Cyber Space is a digital data-based, bit-created virtual universe. Cyber Economy: In this intricate web of linked, networked systems and their surroundings [4].

CYBER SPACE

A man-made ecology exists in cyberspace. It is made up of all connected networks, a database, and a source of knowledge. Cyberspace includes not just the people around it and social interaction inside this network and infrastructure, but also the software, hardware, data, and information system. In his 1982 short story "Burning Chrome," William Gibson first used the term "cyberspace" to describe a virtual world created by computers. However, following its inclusion in Gibson's novel Neuromancer, the phrase gained popularity in 1984. The word 'cyber' is derived from the Greek word kybernetes, which meaning ruler, governor, and pilot. The word cyber, also known as 'cyborg', represents a combination of Human and Machine with the help of cutting-edge high-tech gadgets. In terms of computer science, cyberspace is a worldwide network of computer networks that uses the transmission control protocol / internet protocol (TCP/IP) for communication to facilitate transmission and exchange of data. The cyberspace strengthening the national security, the economy, essential societal functions and public safety.

Distinct national governments have distinct focal areas in the cyber ecosystem and strive to significantly contribute to the security of cyberspace. The total of all national and international security measures in this context determines the level of cyber security attained. NIST's definition of cyber security is "the ability to protect or defend the use of cyber space from cyberattacks."

CYBER CRIME

Cybercrime meant for a variety of illegal and sensitive activities where a network servers and computer are main sources for the crime. Numerous actions can be classified as belonging to one or more of these categories, which are not restricted in any way. The computer can be utilized in a variety of illicit activities, including financial crimes, the selling of illegal goods, the distribution of pornographic material, online gambling, theft of intellectual property, spoofing of emails, forgery, cyberbullying, and stalking. Mostly computers are used to commit crimes in unauthorized access to personal and business computer systems or networks to theft information stored in electronic form. The specific types of cybercrimes are cyberstalking, web jacking, trojan attacks, salami attacks, e-mail bombing and theft of Internet Time. Now a days internet is using for harassment, sexual, ethnic, religious and other forms harassments. Cyberbullying as a crime also introduces us to another connected topic of professional privacy violation [4].

Cybercrime is a sensitive criminal activity. It is involved in information technology infrastructure, unauthorised access, illegal interruption in non-public

CHAPTER 8

Enhancing Cyber Security: A Comparative Study of Artificial Neural Networks (ANN) and Machine Learning for Improved Network Vulnerability Detection

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Abstract: As we rely more on the internet in our daily lives, network attacks pose a severe threat to the safety of computer systems and networks. Cybercriminals utilize a variety of methods to access sensitive data without authorization by taking advantage of network flaws. Firewalls and intrusion detection systems, which are common security measures, have not been found to be effective in preventing network attacks. The connection between network vulnerability detection and realizing sustainable development goals lies in the broader impact of cybersecurity on the economic, social, and environmental aspects of sustainable development.

Deep learning, a kind of machine learning that makes use of neural networks with numerous layers to understand complicated patterns in data, has attracted the attention of researchers and practitioners in an effort to combat the sophistication of cyberattacks that are becoming more sophisticated. Deep learning has demonstrated potential in identifying network attacks due to its ability to automatically extract features from unprocessed data, enhancing its ability to identify previously unknown assaults.

These patterns may include unusually high or low levels of network traffic, adjustments to communication patterns, and other aberrant behavior that could be a sign of an impending attack. The first step in using a deep learning algorithm to detect network attacks is to collect and pre-process the data. In this analysis, we used the NSL-KDD dataset, a freely accessible dataset that includes information on both regular and attack traffic. We can start training our deep learning model once we get the data.

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Large amounts of data are fed into the algorithm during training, and the neural network's parameters are changed to reduce the discrepancy between expected and actual results. Different deep learning architectures, such as convolutional neural networks (CNNs), are available to us.

We can use the model to categorize fresh instances of network traffic as either benign or harmful after it has been trained. The model's performance can then be assessed using measures like recall, accuracy, and precision. Our test findings demonstrate that the suggested deep learning technique works better at identifying network assaults than conventional machine learning algorithms. Deep learning algorithms are better equipped to manage the complexity of network traffic data and extract useful information from it.

The security of computer systems and networks is seriously threatened by network attacks, and conventional security measures have not been successful in thwarting them. Our paper offers a thorough manual on how to detect network assaults using deep learning, which has shown potential in this area.

Keywords: Artificial neural network, Cyber security, Hacks, Machine learning, Network.

INTRODUCTION

What is Machine Learning?

One of the most revolutionary technologies of our time is machine learning. It symbolizes the height of human inventiveness in many ways—our capacity to imbue machines with thought and understanding. We have accomplished amazing engineering feats by developing algorithms that can recognize patterns and behaviors in data and use those patterns and behaviors to make predictions, classifications, and judgments without explicit programming. Machine learning-based technologies now have a daily impact on our lives, from social media feeds to medical diagnoses [1].

However, machine learning is fundamentally grounded in mathematical and statistical concepts rather than being a magical process. Machine learning algorithms are able to draw conclusions about fresh data by identifying correlations and patterns in big data sets.

Machine learning systems excel at finding patterns buried deep within massive datasets, discovering insights that humans could easily miss. Their ability to continually improve through experience without reprogramming grants them capabilities beyond what static software can achieve. However, for all their technical prowess, machine learning systems remain narrow in their scope of learning. The flexibility of human intelligence still eludes even the most advanced algorithms. Transferring knowledge and reasoning across different contexts remains an immense challenge for artificial intelligence [2, 3].

Looking forward, the possibilities of machine learning seem boundless. With more data and computing resources, we can solve problems of astonishing complexity and scope. Yet we must temper this enthusiasm with wisdom and thoughtfulness about how to ethically apply such powerful technology for the benefit of society, not its detriment. If wielded judiciously and applied to problems worth solving, machine learning can profoundly enhance human progress in the 21st century and beyond.

With cyberattacks growing in scale and sophistication, there is understandable excitement about using machine learning to bolster cyber defenses. However, this enthusiasm often glosses over fundamental challenges in applying machine learning to dynamic, adversarial domains like cybersecurity. While machine learning has made undeniable strides in structured domains like image classification, its effectiveness for messy real-world problems remains doubtful.

The fact that machine learning relies on extracting statistical patterns from previous training data is a major problem. However, cyber threats are always changing, making old practices outdated. Attackers aggressively search for ML models' blind spots, making them susceptible to fresh attacks. Additionally, it is challenging to define clean training examples in the first place due to ambiguities in real network data.

Many proposed systems approach cybersecurity as a conventional machine learning problem; they use pre-made classifiers to perform well on benchmarks with some network traffic data as input. Unfortunately, this does not take into account how particular the issue is. Data from networks is highly dimensional, heterogeneous, and time-dependent. The intricacy cannot be handled by crudely extracting clean features and fitting straightforward models.

For instance, due to their computational efficiency, support vector machines are widely used to detect network anomalies [4]. SVMs, however, are unable to simulate interdependencies and transitions in network behavior because they are fundamentally binary linear classifiers. Although they have a greater capacity for representation, neural networks are opaque and fragile. Deep learning models can have blind spots created by adversaries carefully manipulating a few features.

Some claim that adding more layers to create deeper models will result in more effective defenses. However, building sophisticated neural networks requires an absurd quantity of data that covers every imaginable circumstance. They can be manipulated by an adversary due to their open-ended representational capacity

CHAPTER 9

Navigating Sustainability in Cyber Security: Challenges and Solutions

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Abstract: Our daily lives are now completely integrated with internet access. The way we interact with one another, the way we meet new people, the way we communicate information, the way we have fun, and the way we shop have been transformed as a result. They have an impact on many of our daily activities. Today's digital environment has made cybersecurity a requirement rather than a luxury. Cybersecurity refers to a group of security techniques that can be used to protect user data and the internet against attack and penetration. A cyber defense system's primary goal is for data to be confidential, integral, and available.

With one of the world's fastest-rising technological hubs comes a heightened danger of cyberattacks, but India has swiftly emerged as one of them. Indian companies are dealing with a wide range of security issues, such as financial fraud, data breaches, and state-sponsored attacks. One of the biggest and most significant forces of sustainable economic and social growth is information technology.

More precisely, cyber security is now viewed as one of the most important components in guaranteeing global sustainable development. It has been noted that the United Nations Sustainable Development Goals (UNSDG) have prioritized cyber security to protect the cyber environment. To achieve the objectives stated in the Nation for Sustainable Development Goals, trust in ICT is essential. The goals of sustainable development might be challenging to achieve in the absence of a stable and secure cyberspace.

The chapter highlights the part played in establishing stronger cyber security standards as an impetus for sustainable development through the state, business, and other non-state individuals. In addition to improving online security and protecting India from cyber threats and vulnerabilities, more effective policymaking, improved tools and techniques, cyber architectural designing, and collaborative efforts of private parties like media, industry, civil societies, and other nations and international organizations will also play a vital role towards achieving the global sustainable development goals.

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Nations, as well as states, need essential cybersecurity that not only protects from the current threats but also enables proactive protection against emerging and forthcoming threats to be able to confidently respond to latest challenges as cyberattacks become more complex.

Keywords: Challenges, Cyber security, Information technology, ICT, Sustainable development.

INTRODUCTION

India is ranked 17th out of 20 countries in the “Massachusetts Institute of Technology (MIT)” Review Cyber Defense Index (CDI) 2022/23, which is a miserable result. According to the report, “India struggles despite having the world's largest IT-enabled service sector and a technologically progressive government” [1]. This dominant technological force lacks essential infrastructure, has a weak national digital economy, and has weak cybersecurity regulations.

India's CERT-In responded to more than 674,000 cybersecurity incidents during the first half of 2022, a significant rise from 2021. Due to India's lack of a national cybersecurity law and a specialized ministry, these calls were initiated. Using the information and tools on this page, users may protect their computers and gadgets. The Indian Computer Emergency Response Team (CERT-In) manages this facility according to the Information Technology Act of 2000 under section 70B.

The “Cyber Swachhta Kendra (Botnet Cleaning and Malware Analysis Centre)” is a component belonging to the Indian government, and it is a Digital India initiative under the” Ministry of Electronics and Information Technology (MeitY)”. Its goal is to establish a secure cyberspace by identifying Botnet infections in India. It also alerts and facilitates cleaning to secure end users' systems in order to prevent new attacks. The “National Cyber Security Policy” aims to develop a secure cyber ecosystem for the nation, and it also guided the establishment of the “Cyber Swachhta Kendra (Botnet Cleaning and Malware Analysis Centre)”. This center closely coordinates and collaborates with Internet service providers, product/antivirus companies, and other organizations to execute its operations [2].

After the COVID-19 pandemic, it is clear that the global digital economy is expanding. Businesses across a wide range of industries have enormous expansion potential thanks to the rapid development and widespread adoption of technologies like the Internet of Things (IoT), artificial intelligence (AI), 5G, and quantum computing. These advancements also broaden the attack surface, increasing the risk to cybersecurity and providing hackers with new ways to abuse, compromise, and damage critical IT assets. With regards to the “Indian

Computer Emergency Response Team", from January 2019 to June 2022 [3, 4], India recorded a startling 3.63 million cybersecurity events. Fig. (**1**) shows the annual breakdown.

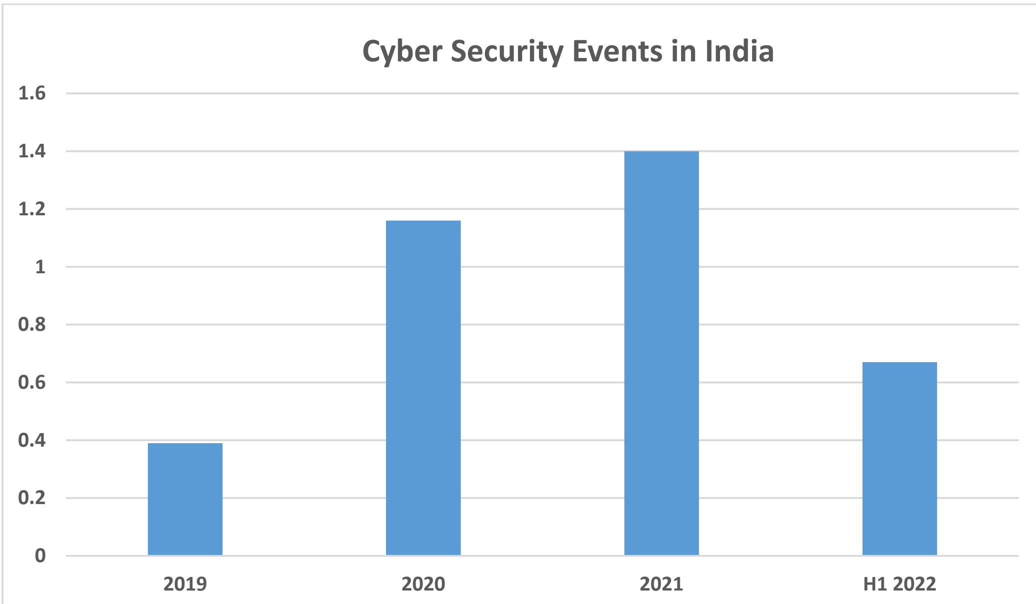

Fig. (1). Cybersecurity events in india.

By 2028, the IoT market is projected to grow to USD 1,854.76 billion, opening up a wide range of opportunities for providers and companies looking to capitalize on IoT. Given the increasing growth of the information technology sector and the demand for security, the cybersecurity sector is predicted to account for a sizable percentage of the IoT market.

During the year 2018 to 2023, the Indian cybersecurity industry revenue was predicted and showed an increased compound annual growth rate of 30.4% from 4.08 billion (United States Dollars) to 15.40 billion (United States Dollars), as shown in Fig. (**2**). The Indian cybersecurity industry adopted the main drivers like business-led innovation, cloud-first strategy, remote working circumstances, increased threat awareness, domestic and international compliance standards, an expanding threat landscape, and data privacy.

CHAPTER 10

Ml and AI Approach to the Global Healthcare Ecosystem

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Abstract: The global healthcare ecosystem is being changed thanks to substantial advancements in the fields of machine learning (ML) and artificial intelligence (AI). The potential of ML and AI to improve patient care, increase diagnostic accuracy, optimize treatment regimens, and reduce administrative procedures is covered in this chapter as we investigate the many methods and uses of ML and AI within the healthcare industry. ML and AI have the potential to change healthcare delivery, resource allocation, and disease prevention through the use of large-scale data analysis, predictive modeling, and intelligent decision-making systems. This chapter presents a thorough review of the existing ML and AI methods used in healthcare, emphasizing their advantages, difficulties, and potential future applications. The global healthcare ecosystem might be changed by the introduction of ML and AI, resulting in improved patient outcomes. ML and AI can help expand access to healthcare by enabling remote diagnosis and telemedicine, especially in underserved areas. This aligns with the goal of ensuring healthy lives and promoting well-being for all ages.

Keywords: Artificial intelligence (AI), Data analysis, Global healthcare ecosystem, Healthcare delivery, Machine learning (ML), Patient care, Predictive modeling, Treatment optimization.

INTRODUCTION

Background

In recent years, the fields of machine learning (ML) and artificial intelligence (AI) have made remarkable strides, revolutionizing several sectors and businesses. In the field of healthcare, ML and AI technologies are revolutionizing the international healthcare environment. To enable computer systems to learn from

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data and make correct predictions or judgments without explicit programming, machine learning (ML) entails the creation of algorithms and statistical models. The goal of AI, on the other hand, is to build intelligent computers that can replicate human cognitive functions and carry out activities that traditionally call for human intellect. The fusion of ML and AI has the potential to greatly increase patient outcomes, advance healthcare practices, and maximize resource use.

Motivation

The need for accurate and fast diagnoses [1], individualized treatment programs, effective resource allocation, and reduced administrative procedures are just a few of the difficulties the healthcare sector faces. These problems can be solved, and the way healthcare is provided may be transformed using ML and AI, which present special potential. Healthcare workers may make educated judgments and provide individualized treatment by utilizing ML algorithms to find trends, forecast outcomes, and unearth important insights by utilizing large-scale healthcare data [2]. Additionally, AI techniques like natural language processing, computer vision, and robots can automate jobs, help with the interpretation of medical imaging, and improve the overall effectiveness and accuracy of healthcare delivery.

Objectives

The goal of this chapter is to give an in-depth investigation of ML and AI techniques used in the global healthcare ecosystem. The main goals are as follows:

Investigating and understanding the terminology and concepts of ML and AI in the context of healthcare.

Focusing on the importance and value of ML and AI in healthcare, with a focus on how they might enhance administrative processes, diagnostic accuracy, and patient care.

Exploring different machine learning (ML) and artificial intelligence (AI) applications in diagnostics and medical imaging, including illness diagnosis, AI-assisted imaging, and computer-aided detection and diagnosis.

Studying the effects of ML and AI on patient care and healthcare delivery, including risk classification and predictive modeling [3], individualized treatment recommendations, and telemedicine and remote monitoring.

Discussing the application of ML and AI to handle healthcare resources, including analysis and insights from health data, projecting demand and allocating resources, and detecting and preventing fraud.

Discussing the use of ML and AI in the management of healthcare resources, including health data analytics, insights, demand forecasting, resource allocation, and fraud detection and prevention.

Exploring limitations, research opportunities, and the possibility for broad adoption while also identifying challenges and future directions in the integration of ML and AI into the international healthcare ecosystem.

Reviewing the most important conclusions, the consequences for the healthcare sector, and the future of the revolutionary potential of ML and AI in the healthcare sector.

By examining these objectives, this chapter seeks to shed light on the significant contributions of ML and AI in reshaping the global healthcare landscape while recognizing the challenges and ethical considerations that need to be addressed for successful implementation.

OVERVIEW OF MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

Definition and Concepts

This section provides the basis for the next discussion by providing an in-depth understanding of machine learning (ML) [4, 5] and artificial intelligence (AI). It describes ML and AI while emphasizing their unique qualities and capabilities. The section discusses how ML and AI systems learn and create predictions by examining basic ideas, including algorithms, models, training, and inference. Additionally, it provides a common understanding of the area and introduces pertinent vocabulary.

Key Techniques in ML and AI

In this section, the chapter delves into the fundamental methods used in ML and AI. It addresses a variety of approaches and algorithms that allow robots to learn and carry out intelligent activities. The topics covered include reinforcement learning [6], where agents learn to make decisions through interactions with their environment; unsupervised learning, which focuses on finding patterns and structures in unlabeled data; and supervised learning, where models are trained using labeled data to make predictions. The chapter gives a thorough overview of

CHAPTER 11

Enhanced Healthcare Solutions: Leveraging Big Data and Cloud Computing

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Abstract: Big data is utilized in healthcare to save costs, cure diseases, increase revenues, anticipate epidemics, and improve the quality of life by averting fatalities. This is where the voyage through big data in healthcare gets started, covering some of the most widely utilized applications of big data in the healthcare sector. The source of big data in healthcare is large electronic health databases, which are extremely difficult to maintain with standard hardware and software. Making sense of all this data and using it wisely for treatment plans, clinical operations, and medical research is a problem for the healthcare business because 80% of healthcare data is unstructured. Big data and cloud computing can help healthcare providers optimize resources, reduce administrative costs, and improve operational efficiency, making healthcare more affordable and sustainable (SDG 3). By analyzing big data, healthcare providers can identify and predict disease outbreaks, track the spread of diseases, and develop effective prevention and management strategies, contributing to the goal of reducing the global burden of disease (SDG 3). Cloud computing provides secure and scalable storage solutions for health data, ensuring privacy and security while enabling data-driven decision-making for better health outcomes (SDG 3, SDG 9). Big data analytics and cloud computing support medical research and innovation by providing researchers with access to large datasets and computational resources, leading to the development of new treatments and technologies to address global health challenges (SDG 3, SDG 9).

Keywords: Big data, Cloud computing, Digital healthcare, Fog computing, Hadoop, Healthcare data management, SaaS.

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INTRODUCTION

Big Data in Healthcare

The stage is set for a global discussion on Big Data sharing in healthcare (Fig. **1**) with the EU General Data Protection Regulation coming into effect in 2018. Is there a way to frame the discussion of obstacles, risk-benefit ratios, and potential privacy and discrimination problems that moves away from the typical pros and cons of potential dangers? Health data, particularly genetic data, are deemed "sensitive" [1]. Future digital healthcare initiatives that use big data will need to strike a balance between the advantages of improving patient outcomes and the risks of raising physician fatigue as a result of bad implementation, leading to additional complexity [2]. The healthcare sector uses a variety of big data sources, including Internet of Things (IoT) devices, patient medical data, hospital records, and test results. Big data vital to public healthcare is mostly derived from biomedical research [3]. More growth is being seen in unstructured data than in semi- and structured data. In the healthcare sector, the main phases of big data management include data collection, administration, storage, analysis, and visualization. Almost 90% of all big data is unstructured [4]. The biomedical and healthcare sectors are increasingly utilizing big data to improve patient care, early disease detection, and community services. Poor or inadequate medical data compromises the accuracy of analytical results [5]. The healthcare system had previously progressed along with technology to enhance living quality and preserve lives. The healthcare system is currently paying attention to big data, one of the most significant areas of future technology [6]. The integration and analysis of a substantial amount of complex heterogeneous data, such as biological data and data from electronic health records, is known as big data analytics in medicine and healthcare [7]. The main ethical concerns this transition raises are the transparency and accountability of judgments made by AI-based systems, the risk of algorithmic bias causing harm to the general populace, and the duties and integrity of physicians [8]. Public-private partnerships (PPPs) are established to specifically harness the potential of Big Data in healthcare and can include partners working across the data chain to produce health data, analyze data, use research results, or create value from data [9]. A fundamental shift in the method of problem-solving used in medical research and therapy is required to enhance clinical decision-making and patient care in multi-morbidity. Advanced big data analytics and artificial intelligence (AI) offer interactive research in addition to the classic reductionist method [10]. Future digital healthcare initiatives that use big data will need to strike a balance between the advantages of improving patient outcomes and the risks of raising physician fatigue as a result of bad implementation, leading to additional complexity [11].

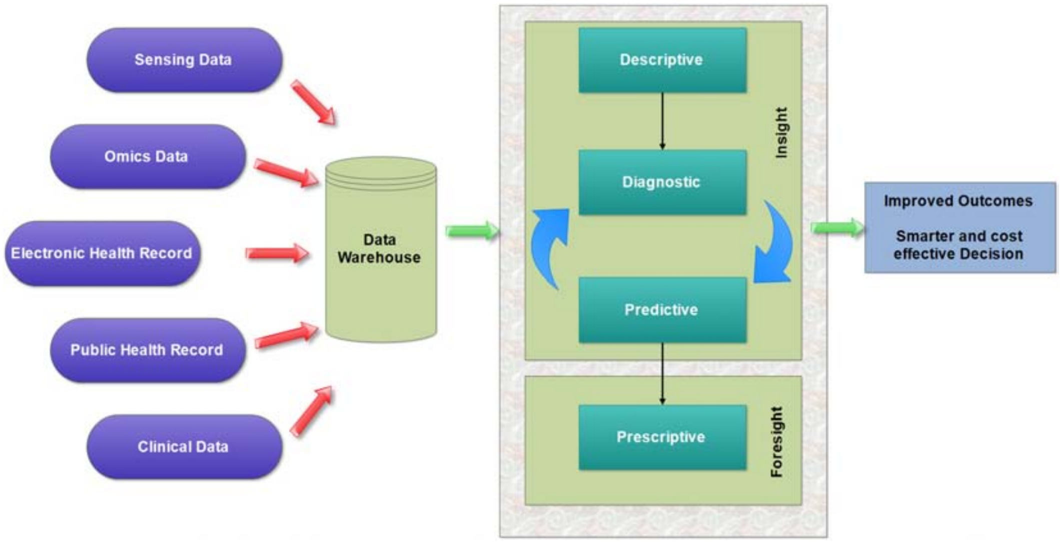

Fig. (1). Workflow of big data analytics [11].

Cloud Computing in Healthcare

The public sector, the research community, and businesses all have a keen interest in the IoT application domain of healthcare. In the medical sector, the growth of IoT and cloud computing is enhancing worker satisfaction, patient safety, and operational effectiveness [12]. Many of these previously impossible issues are now feasible because of the introduction of cloud computing in the healthcare sector [13]. They are increasingly utilized in tandem with one another since healthcare equipment offers proper monitoring and patient health records are transmitted and gathered *via* cloud computing services like SaaS, which stands for storage as a service [14]. Hospital visits may increase a person's risk of getting sick. Raising the standard of healthcare services offered to patients has been made possible by the use of technologies like the Internet of Things (IoT) based on fog computing and cloud computing [15]. Security and efficiency still pose problems for IoT-based healthcare systems. Fog computing tackles some of the issues with cloud computing by providing processing and storage capabilities at the network's edge [16]. Such vast amounts of data can no longer be processed using conventional methods. Hadoop is a platform that can manage huge data processing in a distributed environment. It may be used in a cloud environment to process large healthcare data [17]. To apply the prediction model and link it with the already used wearable CGM model to give patients the forecast of future glucose levels, cloud computing and IoT technologies are taken into consideration [18]. The idea of cloud computing and e-health (Fig. **2**) are only two of the many attempts that have been launched to overhaul the healthcare sector [19]. To

CHAPTER 12

An Empirical Investigation into the Role of Industry 4.0 Tools in Realizing Sustainable Development Goals with Reference to Fast Moving Consumer Foods Industry

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Abstract: In recent years, there have been a number of challenges that have posed a danger to the food security of the globe. These issues include the growing population of the world, the consequences of climate change, and the emergence of new pandemics. Because of this, it is of utmost importance that we come up with innovative strategies to strengthen the food system's resilience in the face of these challenges. The technologies that underpin the Fourth Industrial Revolution (also known as Industry 4.0) are causing widespread upheaval throughout a wide range of production and consuming businesses, including the food and agriculture industries. This chapter will provide a general overview of green technology and Industry 4.0 strategies, focusing on how they apply to the food sector. We are going to focus on and investigate the linkages between green food technologies, such as green preserving, processing, extraction, and analysis, and the enablers of Industry 4.0, such as artificial intelligence, big data, smart sensors, robotics, blockchain, and the Internet of Things. Green food technologies include those that preserve food without the use of harmful chemicals, as well as those that extract and analyze food's constituents. The Sustainable Development Goals (also known as SDGs) are relevant to these linkages. The Sustainable Development Goals (SDGs) are becoming increasingly difficult to achieve without the help of environmentally friendly technologies and the Fourth Industrial Revolution. These advances have the potential to speed up digital and ecological transitions in fast-

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moving consumer goods, which will have positive effects not just on individuals but also on the planet. With the assistance of green and digital solutions, which are anticipated to be implemented at a larger rate in the next years, it is conceivable to realize a future that is not only more robust but also healthier, more intelligent, and friendlier to the environment.

Keywords: F1 score, Fast moving consumer goods, Industry 4.0, Sustainable goods.

INTRODUCTION

The interplay of a number of factors, including ongoing pandemics like COVID-19, the escalating impact of catastrophic climate change manifested through phenomena like droughts and floods, and the potential disruption of food supply chains as a result of conflicts and wars, is a cause of concern regarding the likelihood of global food insecurity in the years to come. The cumulative effect of these factors contributes to an increased likelihood that people throughout the world will not have appropriate access to food supplies. The rapid increase in the number of people living in the world makes it even more urgent to boost food production while also protecting the environment, guaranteeing the quality of food, and maintaining human health. The current state of food systems is marked by the development of enormous volumes of waste, which demonstrates an inherent lack of sustainability and has a major effect on the phenomena of climate change. In addition, the current state of food systems is distinguished by an inherent lack of sustainability. It is necessary to make a paradigm shift towards increased food sustainability possible in order to successfully contribute to the achievement of the Sustainable Development Goals (SDGs). This shift must be made a priority. The United Nations (UN) formally presented the Sustainable Development Goals (SDGs) [1] to the world in 2015, which served as a watershed moment in the history of the agenda for the global development of the world. The overall aim of attaining complete execution of these objectives by the year 2030 was taken into consideration throughout the formulation of these goals. The COVID-19 pandemic has made it more difficult to stick to the schedule that was originally established. Therefore, it is necessary to undertake transformational measures and new ways in order to ensure enough food supply for both the current population and the population that will be born in the future.

The Sustainable Development Goals (SDGs) were created by the United Nations (UN) in 2015, and there is a strong link between the food system and these goals. At least 11 of the 17 Sustainable Development Goals are intimately connected to the food system in some way. These objectives need a reassessment of the structure and management of the food system in order to accomplish, or at the very least, make significant progress towards the first two Sustainable

Development objectives (SDGs), which are "No poverty" and "Zero hunger". There is a substantial amount of academic interest in the relationship that exists between the Sustainable Development Goals (SDGs) and the production techniques that are used in the food and agriculture industries. By using environmentally friendly food processing methods, it is possible to extract valuable compounds from agricultural by-products and bio-residuals without the need for any chemical solvents or reagents. This is made possible *via* the usage of green food processing techniques. Numerous studies have been carried out in order to study the potential of the Fourth Industrial Revolution, also known as Industry 4.0, to solve global concerns such as the quality and traceability of food. The academic community and industry professionals have not yet arrived at a unified understanding of the specific meaning of the term "Industry 4.0". The term "Industry 4.0" refers to a wide variety of digital developments and cutting-edge technologies that have recently found use in the agricultural and food processing sectors of the economy. Robots, big data analytics, the Internet of Things (IoT), the Internet of Smart Things (IoST), blockchain, smart sensors, artificial intelligence (AI), and digital twins are some examples of these technologies [2].

Recent research has indicated that the deployment of technological innovations related to Industry 4.0 offers substantial potential in supporting the achievement of food sustainability goals. This conclusion was reached based on the findings of the study. These improvements have the potential to support more ecologically sensitive practices in food production as well as consumption, which would be beneficial to the planet. The use of technologies related to Industry 4.0 has excellent potential for accelerating the integration of smart technology in both agricultural and production systems. This includes smart and precision agriculture and farming, in addition to smart factories in the sphere of food production. Several recent scholarly works have highlighted the significance of Industry 4.0 technologies in the reduction and utilization of food waste, the enhancement of food quality [3, 4], the reinforcement of food traceability, and the facilitation of the development of healthier and more sustainable food products.

The application of Industry 4.0 technologies to the area of smart farming has the potential to improve agricultural practices in terms of their sustainability and resilience. This may be accomplished by the increase of resource efficiency, mitigation of environmental effects, and optimization of yield levels, especially with respect to water and other inputs. Additionally, this can be accomplished through the optimization of environmental consequences. The implementation of the next generation of smart agriculture, which makes use of technology that incorporates the Internet of Things (IoT) and artificial intelligence (AI), offers a great deal of potential in the context of agricultural practices. This cutting-edge

CHAPTER 13

A Critical Investigation into the Impact of Big Data in the Food Supply Chain for Realizing Sustainable Development Goals in Emerging Economies

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Abstract: In light of the present circumstances, corporate executives, government officials, and academics may now place a higher priority on the collection and analysis of crucial data as a potent instrument for solving the issues of managing the contemporary food supply chain. As food and beverage (F&B) companies place a greater emphasis on collecting, processing, and analyzing relevant data from a variety of sources throughout their respective food systems, data management has become an invaluable resource in modern food supply chains (FSCs). This is because modern FSCs are designed to be more efficient than traditional supply chains. In this context, the phrase “big data” (BD) has only very recently begun to be used to refer to huge quantities of heterogeneous and geographically dispersed data assets that have fast rates of change, a wide variety of sizes, and high volumes of information. Recent research has stated that implementing BD in FSCs might result in a yearly gain in value that ranges from USD 120 billion to USD 150 billion. The current study is focused on analyzing the impact of big data in the food supply chain for realizing sustainable development goals in emerging economies. The researcher intends to collect data from primary and secondary sources. This paper focuses on understanding the conceptual framework that incorporates the relationship between FSC performance and BD applications.

Keywords: Big data application, Food supply chain, Machine learning, Neural network, Sustainable development goals.

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INTRODUCTION

In recent years, there has been an increase in the number of researchers and industry professionals who have come to the realization that the utilization of large amounts of data collected as a crucial and effective instrument is necessary in order to meet the challenges of current food supply chain management (FSCM). This realization has been brought about as a result of the realization that large amounts of data collected are necessary in order to meet the challenges of current food supply chain management. As food and beverage (F&B) companies place a higher emphasis on collecting, processing, and assessing usable information acquired from various sources across their respective food systems, data management has grown into a significant asset in modern food supply chains (FSCs). This is because F&B companies place a greater emphasis on collecting usable information received from numerous sources throughout their respective food systems [1]. This is a result of the fact that modern FSCs have placed an increased emphasis on maximizing productivity while also minimizing waste. The term "big data" (BD) has only very recently started to be used in this context to refer to large volumes of scattered and various data assets. As indicated by its velocity, diversity, and volume, "big data" (BD) has only very recently come to be used in this context. The application of BD in FSCs has the potential to result in an annual value of between USD 120 billion and USD 150 billion being generated.

This is of utmost importance given the fact that the amount of information that is available is increasing at an exponential rate. It is essential that these data assets be managed appropriately inside the FSC framework if food and beverage companies are to be in a position to fully benefit from data-driven insights for the purpose of improving the decision-making process in FSCM [2]. This is due to the fact that only by doing so will food and beverage firms be able to fully benefit from the insights that are produced by data. In order to ease the sharing of data and information as well as the application of big data analytics (BDA), the establishment and deployment of the data analytics capacity (DAC) inside food systems is necessary [3-6]. BDA has the potential to play a pivotal role in modern FSCs by assisting in the identification of new opportunities and the improvement of food quality and safety across all activities of the supply chain through the integration of enormous data volumes produced from both historical and real-time market information [7-9]. This could pave the way for BDA to become an integral part of the modern food supply chain [10]. It is possible that this will pave the way for BDA to become an essential part of contemporary FSCs (Fig. **1**). Because of this, it is becoming increasingly important to take advantage of the capabilities that BD has to offer in order to properly manage the ever-increasing complexity of these systems. This study is more focused on understanding the impact of big data on the food supply chain for realizing sustainable development goals in emerging economies [11-12].

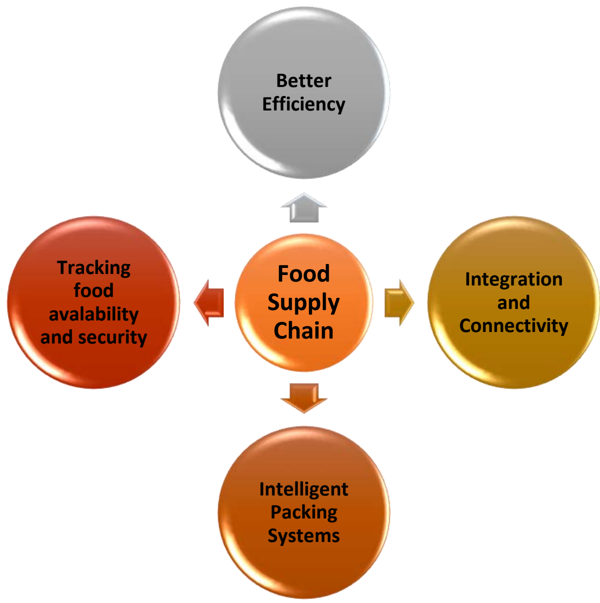

Fig. (1). Conceptual model.

The discoveries obtained from recent research on human brain tissue have had an impact on the creation and advancement of neural networks, a new kind of artificial intelligence. Neural networks have been affected by these findings [13]. The core idea that underpins this technique is to recreate the complex architecture and fluid functioning that is shown by the human brain. The area of artificial intelligence (AI) has benefited from the increased use of neural network technology, which is a technique that is extensively used in a variety of sectors [14]. This has made it easier to explore the frontiers of the subject. It has shown that the efficiency and accuracy of other AI approaches cannot be compared because of the differences between the two [15]. The BP neural network model's learning process may be broken down into two separate stages, which are referred to as the forward phase and the backward phase. In the case that errors are encountered, a procedure known as error backpropagation will take place along the route that comes before the return phase. To be more specific, this procedure entails adjusting the connection weights, first beginning at the output layer and then moving on to each intermediate hidden layer in turn. This modification is executed in order to rectify the faults that were noticed [16-18]. At the same time, information is being propagated in a forward direction, beginning at the input layer, moving through the intermediate concealed layer, and finally arriving at the

CHAPTER 14

Enhancement of Crop Yields and Resource Management for Sustainable Farming in Smart Agriculture: A Multi-Modal Approach Using Machine Learning and Deep Learning

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Abstract: Smart agriculture is a new sector that integrates cutting-edge technologies for transforming conventional farming methods into sustainable farming methods, such as increasing crop yields, lower expenses, and conserving natural resources. Machine learning (ML) and deep learning (DL) are two significant techniques for smart agriculture that can be used to analyze enormous volumes of data and extract significant insights to enhance agricultural practices. In this context, ML and DL may be utilized for a number of tasks, including crop yield prediction, disease and pest detection, weather pattern monitoring, and irrigation and fertilization management. The proposed chapter investigates the utilization of ML and DL in smart agriculture and highlights some of the most promising uses of these technologies. The study addresses the obstacles and potential of adopting ML and DL in agriculture, such as data quality, privacy problems, and the requirement for specialized hardware and software. The study also looks at some of the most important developments in smart agriculture, including the usage of sensors, drones, and other IoT devices, as well as the integration of ML and DL with other technologies like precision farming and robotics. Overall, we believe that ML and DL have the ability to transform the way we produce food and manage our natural resources by empowering farmers to make better decisions, decrease waste, and boost production.

Keywords: IoT, Machine learning, Precision farming, Sustainable farming.

INTRODUCTION

The term “smart farming” refers to the practice of improving agricultural practices with the use of modern technological devices. It is expected that advances in tech-

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nology, such as the Internet of Things (IoT) and cloud computing, will make the increased employment of robots and artificial intelligence in agricultural settings possible. [1]. Cloud computing and other cutting-edge technologies, like the Internet of Things (IoT), are anticipated to accelerate growth and open the doors for the use of robotics and artificial intelligence in agriculture [2].

Sustainable agriculture measures the durability and sustainability of food grains grown in an environmentally responsible manner [3].

Sustainable agriculture promotes farming practices and techniques that enable farmers and resources to survive [4, 5]. It takes care of the soil, stops soil damage, saves water, adds more kinds of plants and animals to the land, and keeps the environment natural and healthy [6]. Sustainable farming is important for saving nature, sustaining different kinds of life, and reducing pollution that causes climate change. Sustainable farming is a way to keep the environment safe for the future and make farming better.

The main accomplishments of smart farming in terms of sustainable agriculture, resulting in a safer environment, are crop rotation, deficit control in crops, recycling, pest and disease control, and water harvesting. Living species depend on biodiversity, which is harmed by waste emissions, the use of fertilizer and pesticides, decomposing dead plants, and other factors [7]. The multiple factors in smart agriculture sustainability are represented in Fig. (**1**).

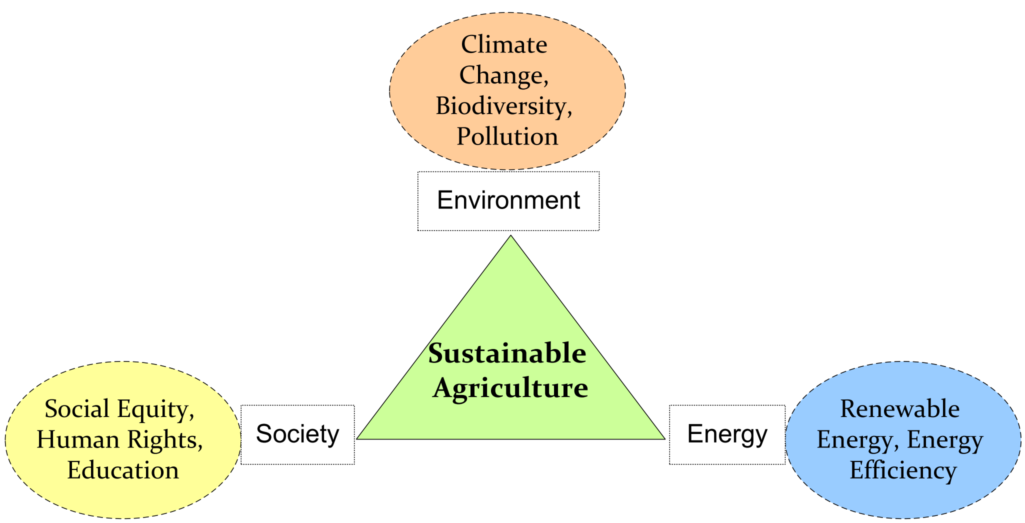

Fig. (1). Multiple factors of smart agriculture sustainability.

Agriculture is India's greatest contributor, accounting for 18% of GDP and employing around 57% of the population. India's overall agricultural output has increased over time, while the proportion of growers fell from 71.9% in 1951 to 45.1% in 2011 [8]. According to the Economic Survey 2018, the proportion of agricultural employees will fall to 25.7% in 2050 [9, 10]. Because the world is on the edge of a digital revolution, now is the moment to connect the agricultural landform with wireless technology in order to introduce digital communication to farmers.

Precision agriculture is made possible by cutting-edge technology like IoT, data mining, artificial intelligence, and data science [11]. The Internet of Things (IoT) is a network of linked computing things, including sensors and smart gadgets, that can communicate and share data [12]. Wireless sensor networks are being utilized in agronomic applications to remotely monitor ambient and soil variables in order to forecast crop health [13]. The watering schedule of agricultural fields may be forecasted using WSN as a forecasting method. Data is generated for wireless sensor networks using environmental variables, including humidity, pressure, and temperature, as well as salinity, soil moisture, and conductivity [14].

TYPES OF SUSTAINABLE SMART AGRICULTURE

Sustainable agriculture is the application of advanced field technology and practices to increase production, save resources, reduce environmental impact, and promote long-term sustainability [15]. A few instances of sustainable smart agriculture are shown in Fig. (**1**). There are several types of sustainable agriculture, some of which are discussed in this sub-section of the chapter. The discussed types of sustainable agriculture are precision agriculture, vertical farming, aquaponic, remote sensing and IoT, renewable energy integration, data analytics and predictive modeling, farm management systems, and conservation tillage [16, 17].

Precision Agriculture

Regardless of commonality in agrarian practice, the reality is that agricultural science diligence is more exact and aggressive than before. The emergence of IoT-based technology has transformed practically every industry, including “smart cities”, “smart health”, “smart grid”, and “intelligent homes”, as well as “smart agriculture” or “precision agriculture”[15, 16]. In the agriculture sector, using machine learning with IoT data analytics can provide new benefits by increasing the quantity and quality of crop output to meet rising food demand [20]. Such earth-shattering breakthroughs are challenging present agricultural techniques and providing unique and great opportunities despite a number of limitations [18]. With the growing need for increased efficiency in food

CHAPTER 15

Revolutionizing Health Services: Industry 4.0 Aligned Systems for the Future

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Abstract: Pharmaceuticals and associated industries, manufacturers of hospital supplies, equipment, and services, healthcare facilities, managed care, medical services, and health insurance are the basic sub-segments that may be used to classify the core segments of the healthcare business. The goal of technology-assisted virtualization is to personalize healthcare for patients, professionals, and other stakeholders. In brief, the "Health 4.0" movement uses technology to increase communication among healthcare stakeholders and elevate the quality of healthcare services. Healthcare is progressing beyond conventional healthcare resources and toward more virtual, dispersed care that makes extensive use of cutting-edge technologies, such as deep learning (DL), genomics, artificial intelligence (AI), data analytics, robots, home-based healthcare, and 3D printing of tissue and implants.

Keywords: 3D printing, Artificial intelligence (AI), Cyber-physical systems (CPS), Data analytics, Healthcare 4.0, Home-based healthcare, Internet of Medical Things (IoMT), Robots, The Internet of Health Things (IoHT).

INTRODUCTION

Public health improvement strategies were prioritized in Healthcare 1.0. Healthcare advanced to version 2.0 as a result of significant production concepts and technical developments. To improve the quality of medical care, bigger hospitals and better medical schools were constructed, and physicians received specialized training [1]. Artificial intelligence (AI) was employed to support real-time forecasting, diagnosis, and monitoring as Healthcare 3.0 evolved into Healthcare 4.0. The main objectives of Healthcare 4.0 are to provide top-notch

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medical care services, increase effectiveness and efficiency, and achieve the best cost and resource management [2]. Researchers' and practitioners' awareness of the advantages technology may provide to a sector as complicated as healthcare is growing, according to new patterns seen in academic literature and industry practice [3]. Industry 4.0 technologies have created an efficient supply chain management system to meet personalized healthcare needs. Also, the COVID-19 pandemic has been aggressively combated, and value-added services in the healthcare industry have benefited from the usage of the Internet of Things (IoT), AI, Big Data, and 3D printing [4]. The healthcare industry is transitioning from a hospital-centric model to one that is more virtual and distributed and heavily relies on the most recent technologies in the fields of home healthcare, robotics, genomics, data analytics, deep learning, artificial intelligence (AI), and 3D printing of implants and tissue [5]. Various hospital levels in a workflow are mentioned in Fig. (**1**).

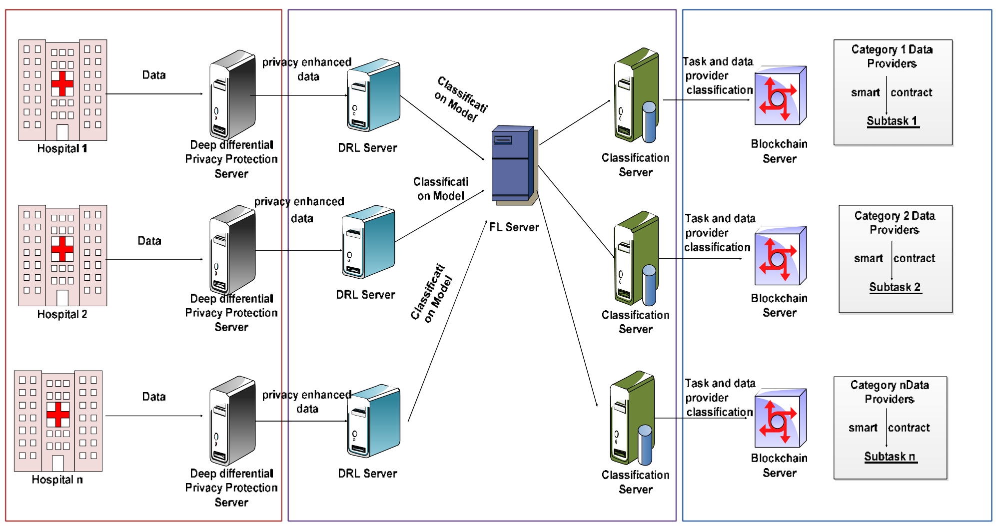

Fig. (1). Various hospital levels in a workflow.

LITERATURE REVIEW

The demand for better healthcare for elderly people is growing along with greater life expectancies. During the decade, new Healthcare 4.0 technology, from mobile computing to cloud computing, has matured dramatically and is now prepared to be used as networked, commercially available systems [6]. To prevent data from being compromised by the authorized user's components of E-healthcare systems, security considerations must be made while accessing, storing, and exchanging patient medical information on the cloud [7]. Blockchain-based EHR solutions are well-liked in the healthcare sector as they encourage trust, secrecy, and anonymity. It employs blockchain and deep learning technologies to share EHR data among different healthcare providers [8, 9]. The significance of data is recognized more consistently and effectively in Healthcare 4.0. It can draw attention to areas that require development and facilitate intelligent choices. Moreover, it aids in the transition of the whole healthcare sector from a fee-fo--service, reactive system to a value-based, outcome-based system that provides predictive prevention [10]. Making multifunctional wearable intelligence solutions for elderly care accessible is very challenging due to several variables, including the number of linked wearable devices, the scarcity of readily available wearable sensors, the desire for compatibility, *etc* [11]. The advent of the Internet of Systems (IoS), Internet of Things (IoT), and wireless body area networks in the healthcare ecosystem has sparked a revolution in sophisticated machine learning (ML) and artificial intelligence (AI) [12]. The technology used in Healthcare 4.0 includes computers, actuators, biosensors, communication interfaces, and other devices. Healthcare 4.0 makes remote observation of patient surgical operations possible [13]. Healthcare 4.0 uses contemporary industrial technologies as a technical accelerator for extended growth. It is a very recent concept that emerged from Industry 4.0 to satisfy various healthcare industry requirements [14]. The Industrial Internet of Things (IIoT) and additive manufacturing, two of Industry 4.0's components, have emerged as reliable autonomous alternatives. Healthcare 4.0 may be enhanced and aided by 3D printers (3DPs) in the IIoT when data is collected and successfully managed to counter pandemics in the present as well as in the future [15]. A smart healthcare system based on blockchain data network protocols now provides efficiency, transparency, faster and simpler access, security, and other advantages. Cognitive computing, edge computing, fog computing, cloud computing, the Internet of Things (IoT), IIoT, AI, and other healthcare 4.0 approaches are the examples [16]. The Internet of Medical Things (IoMT) evolved as a subclass of IoT. These gadgets, when outfitted with the most modern AI algorithms, provide a new level of awareness of their surroundings as well as the capacity to make convenient judgments at the appropriate time [17]. Numerous elements of IoT adoption in healthcare have been evaluated, including security and privacy concerns in IoT-enabled healthcare systems, as well as IoT for elderly care [18]. Supervised ML algorithms are paired with a time-series model, such as the seasonal autoregressive integrated moving average denoted as the SARIMA model, to anticipate a patient's health condition [19]. Wearable technologies in healthcare like wristbands, smart bands, fitness bands, and other gadgets generate huge amounts of data. Even though these data inputs pass *via* several utility nodes, sensor nodes, and user nodes, the security and privacy of the previously mentioned data values are highly protected [20]. Fig. (**2**) illustrates the proposed Healthcare 4.0 model.

CHAPTER 16

The Integration of Robotics in Advancing Smart Health Echo Systems

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Abstract: Healthcare 4.0, often known as the fourth manufacturing revolution, is a new concept. The concept relies on intelligent robots with access to huge amounts of data and the ability to make decisions without the assistance of humans. The employment of robots in healthcare involves the difficulty of integrating new technology into an already complex, highly regulated system. Although robots have made multiple activities easier, some unforeseen consequences have changed ethical rules and pharmacist employment. **Lio**, a personal assistive **robot,** was immediately modified during the COVID-19 pandemic to handle additional functions like disinfection and remote detection of elevated body temperature. It complies with ISO13482 - personal care robot safety rules, allowing it to be tested and deployed directly in care facilities. To keep up with the speed of rapidly changing technologies, a low-cost, highly efficient localization solution for wireless sensor technologies is critical. The suggested system provides a solid foundation for future testing and optimization in collaboration with the user, ensuring a useful and appropriate mix of sensors and technical equipment with which the user is familiar.

Keywords: CPS, HRS, Human-robot interaction (HRI), Robotics, Robot therapy, Robotic process automation (RPA).

INTRODUCTION

Next-generation homecare robotic systems based on cyber-physical systems with faster and more accurate intelligent execution are being developed as an example of such a revolution. Manufacturing-derived technologies are driving the fourth healthcare technology revolution (Healthcare 4.0) [1]. The growing interest in personal robots as a technical solution in decentralized health services over the last decade has resulted in a diverse range of healthcare and personal helper robot research and implementations [2]. Healthcare robots are anticipated to assist practitioners and healthcare professionals in a variety of ways, including real-time

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monitoring of patient's physiological conditions, facilitating advanced interventions like robotic surgery, helping patients with disabilities and cognitive challenges, supporting patient care at the hospital and at home, and giving company to senior and mentally/physically challenged patients [3]. The healthcare sector may benefit from robotics and AI-enabled robots. Hospitals regularly employ robotic systems for rehabilitation, walking assistance, and the care of children, the elderly, and individuals with disabilities [4]. Elders may benefit from health help from technology, particularly healthcare robots. These services include a wide range of characteristics of healthy aging on the social, cognitive, and physical levels [5]. Robots that engage with humans and cognitively challenge them while providing services are called human-interactive robots. Such robots not only amuse but also direct, treat, instruct, and enhance communication. The innovative employment of robots in a treatment known as "robot therapy" is piquing the curiosity of a growing number of academics and psychologists [6]. In addition to helping individuals working in rooms and labs, mechanical and virtual robots have helped all people with a range of other jobs. Administration, telemedicine, medicines, helping youngsters with autism, and lifting or moving patients are a few instances of robot intervention [7]. Understanding how robots function can help nurses give better care, which is the aim of nursing robotics. Research on the major creation of robots to aid and collaborate with nurses, physicians, and other healthcare workers in the real world is conducted by an interdisciplinary discipline called robotics in nursing [8].

LITERATURE REVIEW

A couple of mechanical, ultrasonic, laser, optical, and aural sensors are used for safe navigation and environment perception. The ROS-enabled setup enables researchers to access raw sensor data and has complete control over the robot [9]. To interact with humans and complex environments more effectively, soft robots are beginning to utilize flexible materials and structures, borrowing a strategy from evolutionary biology [10]. While maintaining the ability to check on patient's health, the goal is to encourage their independent life at home. It is a fascinating circumstance where patients' symptoms and their surroundings are both changing with unknowable factors playing a role in monitoring patients using robotic telemedicine devices [11]. In several settings, the distribution of vaccinations has been greatly facilitated by several robots and Robotic Process Automation (RPA) systems. Those dealing with untreated mental health disorders have benefited from this cutting-edge technology by getting comfort from it [12]. Researchers are working diligently to create an entity that can guide, assist, encourage, and support tasks that call for precision and laborious work, maybe becoming the ultimate interactive companion. To do this, it is necessary to go far beyond the existing advanced robotic implementations to further the non-verbal communication that serves as the basis for human-robot interaction (HRI) [13]. In general rooms, critical care units, and operating rooms, robotics technology is the primary [14] focus of medical services, lowering risks for physicians, nurses, and patients. It is also used in laboratories to collect samples, transport those samples, if necessary, preserve them, and analyze them for long-term storage [15]. Surgical robots have transformed the operating room before other medical robotics applications, and they now improve a variety of healthcare products. Anyone can have real robotic surgery for knee replacement, colon resection, and hernia repair [16]. To keep up with the pace of quickly expanding technologies, it is essential to design and construct a low-cost, highly effective localization technique for wireless sensor technologies [17]. The robot may help with clinic maintenance in addition to offering free delivery of supplies to patients who isolate themselves. Automated workstations speed up operations in pharmaceutical companies [18]. In the domain of medicine, social robots are used to aid the old and sick, as well as to inform hospital patients about their health. They are utilized for geriatric and emotional care, drug delivery, and recuperation. Social robots improve the efficiency and standard of medical care in this way [19]. Robotic surgery can speed up surgical procedures, increase surgical efficiency, and boost surgical output. Robotic orthopedic surgery will develop further [20]. Robotic surgery appears to improve surgical ergonomics and dexterity, which leads to improved patient outcomes. There are many studies on the safety, efficacy, and precision of robotic-guided technology, which reveal significant advances in treatment quality, proving its utility [21]. A social robot and a variety of wearable and non-wearable sensors are being integrated into a health monitoring system with the dual goals of promoting autonomy and assisting carers. The user's subjective health condition is ascertained using patient-reported outcome measures (PROMs), which are recorded as they engage with the social robot [22].

RECOMMENDATIONS

We investigated numerous challenges and worries regarding introducing healthcare robots. Utilizing a socio-ecological framework, we structure and define these difficulties in terms of individuals, care partners, community healthcare, and so on.

In terms of logistics, we look at service robots that deliver medical supplies, laboratory-based samples, and meals, as well as blood-testing and sorting robots. Robotics in nursing is an interdisciplinary discipline that investigates methodologies, technology, and ethics in the development of robots that assist and interact with physicians, nurses, and other healthcare professionals in the field.

CHAPTER 17

A Conceptual Framework on Migrant Workers: Evaluation of Sustainable Rural Development through MGNREGS

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Abstract: Public policies like the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) are designed to mitigate unwarranted unemployment and develop rural infrastructure and resources to have sustainable development in rural India. The pandemics (*e.g.*, flood, drought, and COVID-19) pose the greatest livelihood challenge for these migrant workers. Does MGNREGS provide them with minimum support for the sustainability of their familiesthrough wage employment? Does MGNREGS work to contribute to rural sustainable development? To answer these questions, this study attempted to have an appraisal of the performance of MGNREGS both qualitatively as well as quantitatively across the country by taking a five-year study period (including the COVID-19 period). The study was supported by a focus group interview of migrant laborers who returned to Odisha during the initial phases of the pandemic in India. In the second part, the previous five years' data was collected from the official website. A comparative cross-sectional analysis of employment generation through MGNREGS in the pre and post-COVID-19 period was made. An administrative efficiency index (AEI) of the program was prepared and compared to the period from April- September 2016 to 2020 for the entire nation. The results explored that there was a significant employment generation through MGNREGS for migrant workers during this pandemic. A conceptual model of 'migrant employment during the pandemic' was proposed on the basis of the empirical results. The model has both theoretical and practical implications.

Keywords: COVID-19, Employment, MGNREGS, Migrant workers, Reverse migration.

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INTRODUCTION

Now when the whole world is devastated by the pandemic, India is going through the critical issue of finding a trade-off between life and livelihood. A crisis of such a scale influences everybody to a certain extent, but the most affected are the migrant laborers residing in different parts of the country. The awful pictures of groups of migrant laborers returning to their hometown in April 2020 affected the entire nation. Migration has a tremendous effect on people's lives [1]. The troubles of hardship, to a great extent, ended up being so unforgiving to them that they directly affected their endurance. It wasn't at all an easy homecoming as the work has now gone, they have to face extraordinary social grievances, hostility and even more basically they have to reboot their life by and by. The government faced the daunting task of providing wage employment to these workers. In this uncertain and unwarranted situation, MGNREGS became the best option for their work and means. A significant portion of rural household income comes from migrants' daily wages. In their study [2], researchers found that there has been a decline in migration due to MGNREGS. Public policies certainly have an incremental effect on employment [3]. Mass employment programs like MGNREGS are considered a modern instrument of general development policy, which also has tremendous potential to reduce poverty as part of mainstream economic policy [4]. The time lag between employment demanded and employment provided becomes a key deterrent for a large number of migrants to prefer other daily wage works as compared to MGNREGS in some cases. Therefore, policymakers must come up with innovative changes to handle the twofold effect of reverse migration. It is essential for the government to make timely and necessary policy reforms to reap the maximum benefits of the public policies. This scheme also has the potential to provide alternative jobs, which will affect the rural job market [5]. The dichotomy of eventualities is that MGNREGS remained the best and most effective alternative for the migrant laborers through the unique demand-driven feature of the program to provide wage employment to these unemployed youths who are willing to do unskilled manual work [6], but, eventually, it failed to provide the immediate livelihood support. Policy implementation is the principal reason for rural-urban migration [7]. The states can leverage reverse migration by skilling these migrant labours [8]. In COVID-19 the reverse migration makes daily wage earning and earning from welfare program more significant role to play in migrant worker's life. In addition to addressing unemployment, MGNREGA promotes a number of other sustainable development goals and tenets, such as the sustainability of the economy, agriculture, forests, income, and health. Because the majority of the population in India lives in rural areas, the country's sustainable development is more dependent on the rural sector. Poor rural areas are the root cause of many of the issues that affect sustainable development, including environmental deterioration, deforestation, poverty, and other social hindrances [9]. Therefore, it is essential to evaluate whether the program is really effective in providing immediate livelihood support to them. Whether MGNREGS is comparatively better than that other similar programs with respect to the overall benefits provided by them. How the MGNREGA is contributing to sustainable rural development. The informal sector has a significant role in providing employment in urban-rural migration [10]. It is more pertinent at this stage to find out the number of reverse migrants, the number of migrants employed through MGNREGS and the number of repeat migrants who moved back to their original workplaces, then that will be a correct estimation of the efficacy of the program.

LITERATURE REVIEW

Reverse migration and MGNREGS

There was a notable increase in demand for MGNREGS work during the pandemic. The unprecedented return of around six crores of migrant labourers from different cities to their respective villages asks for their immediate livelihood arrangements from the state. Reverse migration presents the greatest crisis in rural India [11]. The data from the official site (MORD, 2020) shows that in June'2020 just around 43.7m families looked for work in MGNREGS which is a record in recent years. In another investigation, the interest for the work for MGNREGS exceeded by 86% in May 2020 when contrasted with that time of 2019. An additional reserve of Rs. 40,000 crores expanded the MGNREGS budget to Rs. 100,000 crores for 2020-21, the highest in the plan's existence. Venkatiah [12] revealed that containing migration to the cities and creating employment in the rural areas are the major highlights of the schemes of the government.

Sustainable Rural Development and MGNREGS

It is debated whether there is a connection between reducing poverty, economic growth, and environmental sustainability. One argument makes the connection between environmental damage and the use of natural resources and economic development [13]. While some assert that growth and environmental sustainability may become independent of one another [14]. The projects undertaken in accordance with MGNREGS revitalize the natural resource base and address the factors that contribute to chronic poverty, such as drought, deforestation, soil erosion, floods, and poor rural connectivity; these factors are also crucial components of sustainable development.

CHAPTER 18

The Role of Big Data Analytics as a Critical Roadmap for Realizing Green Innovation and Competitive Edge and Ecological Performance for Realizing Sustainable Goals

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Abstract: Big data analytics (BDA), as an important tool, is now available to companies who are struggling with problems related to sustainability. However, there are not many case studies of BDA in the academic literature, despite the fact that it has the potential to increase the eco-efficiency of manufacturing. This study focuses specifically on the manufacturing sector to investigate the impact of BDA on green innovation (GI), competitive advantage (CA), and environmental performance (EP) in the context of the manufacturing industry. Big data analytics, also known as BDA, is a relatively new field that has emerged as a result of the growth of contemporary computers and their various uses. The relatively new subjects of business data analytics (BDA) and business analytics (BA) have piqued the attention of both working professionals and academics.

The purpose of this article is to conduct an analysis of the influence that Big Data has had on four important performance indicators: innovation, competitive advantage, productivity growth, and support with decision-making. Big data may help organizations obtain vital insights about their consumers, products, and operations, despite the fact that it does come with a few negatives. Businesses are in a better position to quickly implement new ideas, provide better service to customers, increase efficiency, make decisions that are better informed, and ultimately outperform their rivals when they have access to data insights. The expansion in both the amount and

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quality of the data that is now accessible has led to improvements in the capacities of organizations as well as the opening of new doors leading to growth. Businesses are renouncing established practices in favor of new, inventive, and innovative techniques in order to redefine creativity, competitiveness, and productivity. It is vital, for the sake of achieving sustainable objectives, to have an understanding of big data analytics as a critical component of the road map for green innovation, competitive advantage, and ecological performance.

Keywords: Big data, Competitive edge, Green innovation, KNN analysis.

INTRODUCTION

The term “Big Data” is commonly used to refer to data collections that contain a significant amount of information. The characteristics of big data can be broken down into four categories: volume, velocity, diversity, and value. The amount of data that is created each day is staggering, and the internet is making it easier for people all over the world to communicate with one another. It was anticipated that the volume of data would increase considerably by 2020 and beyond. IDC projected that the size of the digital world would increase by a factor of 300 between 2005 and 2020, from 130 exabytes to 40,000 exabytes. Kudyba and Davenport [1] predicted that in the years to come, big data and data insights will have a substantial impact on and transform practically every aspect of business and economic activity. According to Gantz and Reinsel [2], it was anticipated that the quantity of digital items would have increased by around 50% by the year 2020. Our thoughts immediately go to the tremendous amounts of data that is being processed when we hear the term “big data”, which leads to the question: what exactly is meant by the word “enormous data?” [3, 4] The “3Vs”, or volume, velocity, and variety, are three properties of big data that have just started to be recognized as being important. When we talk about “volume”, we refer to the enormous volumes of data that companies create or collect over the course of their existence. In this study, you will discover information that is both ordered and unorganized. Every year, the quantity of data increases at a rate that is just amazing. This is the rate at which fresh data is created and processed from a variety of different sources. Real-time processing, as opposed to batch processing or processing that is delayed, is used by the vast majority of businesses in today's world. According to a forecast that was published by Gartner [5], there will be an increase of 20.8% in the number of connected devices in the world by the year 2020. The application system determines whether the data is structured, semi-structured, or unstructured [6]. Data can arrive in a wide range of forms, from photos and sounds to videos and clickstreams to sensor readings. These forms of data can be structured, semi-structured, or unstructured.

According to Jagadish *et al.* [7], the insights gained from the analysis of large amounts of data have a substantial influence on a variety of industries, including mobile services, retail, manufacturing, financial services, health sciences, and physical sciences, to name just a few. Big data analytics is one of the newest tools that a firm has at its disposal, and it is becoming increasingly important for driving innovation, outperforming the competition, and reducing the threat of new entrants. According to Hallman, Rakhimov, Plaisir, and Bernard [8], big data has the potential to have a significant impact on our everyday lives, much in the same way that investments and discoveries in information technology have historically increased competitive performance and productivity. According to Hallman *et al.* [9], businesses are obtaining significant insights into the behavior of their customers as a result of the use of big data, which in turn influences the development of new services and the evolution of those already in existence.

REVIEW OF LITERATURE

It is abundantly evident that big data analytic instruments are essential to the process of big data analysis. This is because big data analysis cannot be performed without big data analytic instruments, and big data analysis is reduced to simple data in their absence. According to the findings of Stubbs [9], the utilization of big data and big data analysis jointly led to an increase in the number of discoveries made. To clarify, an invention is a one-of-a-kind work, whereas innovations frequently do not represent anything wholly novel or paradigm-shifting in their respective fields. They do this by expanding or improving what has already been produced. Because of the examination of large amounts of data, our understanding is expanding, advancing, and improving.

Customer-driven design insights, which are obtained from the examination of internet reviews and consumer input (on websites such as Amazon, Best Buy, and Walmart, amongst others), are the new way that is igniting the fire of innovation. Reading reviews written by other customers is the first step in the process, and it will teach you about the features and benefits of the product. Insights are utilized to inform the development of many models with the purpose of improving existing products. These models are developed using research that was conducted in the past [10]. The input of the public can be quickly accessed through various social media platforms and the internet. Big data is employed by many businesses for a variety of reasons; however, the most typical reasons are to improve customer service, streamline internal procedures, and increase output. New companies are making headway in three distinct areas: data gathering and storage, data analysis, and data processing. There are a growing number of startups that are developing innovative strategies for utilizing sensors and collecting the data that they produce. Because the cost of storing data is significantly lower now than

CHAPTER 19

A Study Analyzing the Major Determinants of Implementing Internet of Things (IoT) Tools in Delivering Better Healthcare Services Using Regression Analysis

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Abstract: The new advancements in healthcare systems are influenced majorly by the adoption of the Internet of Things (IoT). This is especially important in light of the present state of affairs in the healthcare, social welfare, and energy sectors. By understanding the interconnected problems such as energy efficiency and sustainable development, it may be possible to enhance the well-being of both humans and the environment. The incorporation of sensors and other intelligent devices is crucial to the accomplishment of the aims of sustainable development. In todays rise in population, there is a key area in which the latest scientific developments really need to be put into practice: public health. For the sake of the well-being of future generations, it is essential toconduct research on the ways in which the SDGs have an impact on the uses of sensors and the Internet of Things in human environments. Peoples lives are being influenced by applications of technology, sensor networks, intelligent systems, and the Internet of Things (IoT), all of which are having a positive impact on the environmental sustainability and energy efficiency of the world.

The digitization and application of intelligent systems and the Internet of Things devices are carried out in blocks of analysis, organized in a variety of disciplines, in urbanized settings, and in human-inhabited communities; nonetheless, they all have

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a similar center of gravity, which is the trilogy: human, technology, and sustainability. The management of effective and healthy resources, enhanced governance, and programs that encourage the adoption of new technological solutions are all necessary for sustainable development in better healthcare services. The study is focused on the major determinants of implementing Internet of Things (IoT) tools in delivering better healthcare services.

Keywords: Decision tree analysis, Healthcare services, Internet of things, Regression analysis, Sustainable development goals.

INTRODUCTION

Public health and energy efficiency are two issues that have a major impact on the manner in which and the regions in which contemporary technological discoveries are applied and put into reality. Understanding the effects that the Sustainable Development Goals (SDGs) will have on sensor and Internet of Things applications that incorporate human contexts is essential for the success of the area over the long run. There is an undeniable link between environmentally responsible practices, the effective use of energy, and peoples physical and emotional well-being [1]. All aspects of technology, including sensor networks, intelligent systems, and applications for the Internet of Things (IoT), have an effect on the way in which we live our lives.

It is anticipated that the implementation of smart grids and smart cities will make a variety of jobs simpler, such as obtaining medical treatment, being able to visit a healthy environment, and having a sense of community safety and contentment. A communitys infrastructure, services, and strategic planning can all be improved by the application of technology such as the Internet of Things, the Internet of Energy, artificial intelligence, and the installation of sensors throughout the built environment [2].

We need to design and develop high-tech buildings that are equipped with sensors so that we can enhance public safety and health while keeping a level of productivity that is in line with our energy requirements. This will allow us to meet our needs in terms of both productivity and energy consumption [3, 4]. The integration of intelligent systems ought to be as efficient as is humanly possible in terms of the technology used, the amount of money spent, and the level of risk that is involved. Because of the interconnected nature of the Internet of Things platforms, energy management, and health, it is essential to take all of these elements into consideration in any research that pertains to the wellness of human beings. There are enormous prospects for the growth of urban areas and communities not only in the present but also in the not-too-distant future, thanks to sensors, intelligent systems, and technological designs. The Internet of Things (IoT) application cases, as well as the technology that supports those use cases, are always evolving and expanding.

The classification tools provided by decision trees are characterized by their exceptional efficacy and offer a high level of effectiveness. This tool sees a lot of action in the realm of data management thanks to the wide variety of customization options it provides and the intuitive nature of its user interface. After the procedure for collecting the data has been finished, the tree itself will be the one to decide the decision rule. The application of this particular strategy makes possible the following:

Segmentation: It is absolutely necessary to carry out a thorough investigation if one wishes to ascertain the primary categories that should be utilized when classifying a particular item. This necessitates conducting an in-depth analysis of the characteristics, properties, and attributes of the object in question, with the objective of pinpointing the most pertinent categories that adequately characterize its distinguishing qualities. One is able to identify the primary elements that are responsible for the classification if one takes a methodical approach to the problem. It is absolutely necessary to assign each item to a particular category within the divisions of the list that have been designated in order to comply with the categorization protocols that have been established.

Prediction: It is imperative to adhere to a set of guidelines in order to enhance the accuracy and reliability of forecasting specific occurrences. This will allow for improved accuracy and reliability. These guidelines provide a structure for carrying out rigorous and methodical analyses, which in turn enables researchers to make educated guesses. By adhering to these guidelines, researchers can reduce the likelihood of errors and biases, thereby increasing the validity of their findings. In the process of data analysis, one of the most important tasks is to find ways to reduce the dimensionality of the data. Researchers strive to simplify the data representation while maintaining a datasets essential qualities by cutting down on the number of variables or features contained within it. It is very necessary to recognize and single out the most important pieces of data that need to be considered before attempting to develop accurate and trustworthy models of a certain phenomenon. The determination of critical pieces of information is absolutely necessary in order to guarantee the accuracy and completeness of the models that are produced as a result.

Identification-Interrelation: The purpose of this research is to determine and investigate the factors and correlations within the groups that have been

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CHAPTER 20

An Application of Distance Measure Function of Fermatean Fuzzy Set in Urban Sustainable Development Appraisal

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Abstract: Due to its quantitative capacity to differentiate Fermatean fuzzy sets (FFSs), distance measurement is a research hotspot in the Fermatean fuzzy set. For Fermatean fuzzy sets, we used cosine distance, a novel distance metric. In this study, measures of cosine similarity and cosine distance amongst FFSs are taken into account when trying to solve a multi-attribute decision-making problem based on sustainable development goals. In this study, we used the cosine distance measure for Fermatean fuzzy set theory to rank a set of urban cities according to many factors, including poverty, health, industrial development, and climate quality. Additionally, a suitable example is used to illustrate the superiority and logic of the present formulation.

Keywords: Cosine distance, Cosine similarity, Fermatean fuzzy sets, Multi-attribute decision making, Sustainable Development Goals.

INTRODUCTION

Zadeh [1] created the concept of the fuzzy set (FS) in 1965 to deal with ambiguity and vagueness in everyday circumstances. The decision-making concept used to find difficulties with uncertainty was first articulated by Bellman and Zadeh [2]. DM is a methodical process for picking the best option from a range of available possibilities. As a result, the decision maker is vital in real-world settings [3]. Making a wise choice can have a significant impact on how someone lives their

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life. The final selection made by a decision maker examines the advantages, characteristics, and restrictions of every alternative.

Because the membership degree is the only variable used to define an FS, in recent decades, a number of academics have described various higher-order FSs. Atanassov [4] developed the idea of Intuitionistic fuzzy sets (IFSs), a concept that can handle complexity and uncertainty. It has been thoroughly studied.

and applied by many academics to DM issues. Three factors, membership, nonmembership, and hesitant margin are used to construct an IFS, with the total grade for both membership and nonmembership less than or equal to 1. The membership and nonmembership can be added together andis frequently larger than 1. Yager developed Pythagorean fuzzy sets [5] as an expansion of the intuitionistic fuzzy theory to address these issues. PyFS meets the requirement that the square sum of its MG and NMG is less than or equal to 1 and is defined by a membership grade and nonmembership grade. As a result, PyFS is better than IFS in expressing the fuzziness of information. There are several methods for resolving actual (MADM) problems in the field of PyFS. In a Pythagorean fuzzy environment, several academics have also offered real-world uses. However, the combined cubic volume of the MG and NMG is one or less. The Fermatean fuzzy set (FFS) was recently established in this context by Senapati and Yager [6], demonstrating that FFSs can withstand higher levels of uncertainty than IFSs and PyFSs, have more degrees of uncertainty than intuitionistic fuzzy sets and PyFSs, and can overcome MCDM problems.

In order to address MADM issues in a number of areas, such as pattern recognition, information measures are a crucial idea. There are various established forms of information measurements, including inclusion, distance, similarity, and entropy metrics. Measures of similarity, distance, inclusion, entropy, and some operators are typically used in the MADM process. Due to the importance of the degree of similarity measurements in data mining applications, there has been a lot of attention paid to them lately. Szmidt and Kacprzyk [7 - 10] extended well-known distance metrics like the Euclidian distance and Hamming distance to the IFS environment and contrasted them with methods of traditional fuzzy sets.

Researchers have become increasingly interested in PFSs and IVPFSs in a relatively short period of time. In the topic of PFS, there are numerous approaches to solving actual multi-criteria decision-making issues. Numerous scholars have also suggested practical uses in a Pythagorean fuzzy setting. The degree of resemblance is regulated between two things in numerous areas, including pattern recognition, medical diagnosis, personnel appointment, *etc*. Pappis and Karacapilidis [11 - 13] established a variety of similarity measurements. One of these has been suggested by Li and Cheng. However, to the best of our knowledge and belief, no one has looked into the cosine similarity measure, which is based on the score function between FFSs, or the distance-based similarity measure. As a result, in this research, we have suggested the distance-based similarity measure and the cosine similarity measure of FFSs to choose information on sustainably developed urban areas. In addition, we resolved group decision-making issues that are highly intriguing in the actual world by using the proposed similarity metrics.

Different similarity and distance measures have been researched and introduced in the paper to quantify the similarities or differences amongt FFSs. A few of these measures, which are applied to various regimes of important applications, are listed here. Chen (2002) [14] developed a distance for PFSs based on the Minkowski distance metric and applied it to issues with investing in R&D projects and Internet stocks, among other real-world issues. Xuecheng L [15, 16] suggested various distance metrics for Pythagorean fuzzy numbers and PFSs and showed their utility with examples. Peng [17 - 19] introduced 10 distinct kinds of cosine-based similarity measurements for PFSs and showed how useful they are for pattern detection and medical diagnosis issues.

Fuzzy, intuitionistic fuzzy, and Pythagorean fuzzy cosine similarities are a few extensions of the traditional cosine similarities. The cosine similarities now perform better as a result of these extensions. Compared to IFSs and PFSs, FFSs are better able to deal with ambiguity and missing information issues. The majority of distance functions for Pythagorean fuzzy are introduced as a generalization of their IFS equivalents, as we can see from a summary of the literature. Few of them had even undergone normalization, thus they were reintroduced after the necessary normalization. On the other hand, some distance measurements' popularity and usability as useful mathematical tools are hampered by their convoluted mathematical form. Additionally, none of the available measures were able to clearly distinguish between extremely unclear PFSs or PFSs with very low membership and non-membership grades. These PFSs are encountered when there is little information or expertise accessible about a system. In order to deal with such PFSs, a proper distance metric is required. We offer a novel distance function with a straightforward mathematical form for PFSs to close the gaps mentioned above. This distance function can handle extremely uncertain PFSs and is similarly successful in other situations. Consequently [20 - 23], some studies constitute the work's primary contributions.

- A new distance metric for FFSs is introduced.

- To avoid calculating complexity, a straightforward mathematical form was constructed.

CHAPTER 21

Fintech Revolution: Role in Achieving the Sustainable Development Goals

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Abstract: Every nation in the world is striving to achieve the Sustainable Development Goals (SDGs). In keeping with this, a sound global financial system is now required to fulfill its mandate to encourage the mobilization of private capital for the achievement of sustainable development and consistent economic growth. The fintech revolution has significantly altered the financial industry and improved financial inclusion in the nation by offering digital financial services. Fintech has contributed positively to the SDGs by providing increased access to funds and financial services, which, in turn, has resulted in improvised saving opportunities for a large group of people. A wide range of application developments, comprising blockchain, IoT (the Internet of Things), AI (artificial intelligence), big data, and mobile platforms, have recently been part of digital transformation and technological advancement, particularly in the finance sector. These application developments promised to improve performance in the financial sector. It becomes clear that financial applications for digital technology can overcome significant funding challenges for inclusive and sustainable growth. In this scenario, the chapter provides an overview and in-depth examination of the most recent advancements in financial technologies (Fintech) that support the SDGs. It also reviews the significance and effectiveness of fintech in achieving sustainable development goals like education, health, equality, *etc*.

Keywords: Digital finance, Fintech, Financial inclusion, Global financial system, Sustainable development goals (SDGs).

INTRODUCTION

Today's global market presents the financial sector and its companies with a number of obstacles as well as several difficulties that require prompt responses. “Digital revolution” is a byproduct of globalization, which also brought about new technologies and digitalization. Businesses nowadays must go through a digital transformation, integrating new technology into their operational processes to provide value, secure their position, and gain an advantage. Digitalization and

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digital transformation have a big impact on and modify how financial institutions operate [1]. The term "financial technology" (abbreviated as "FinTech") has become widely used. It is supported by three things. These include the development of cutting-edge technologies like blockchain and artificial intelligence, their confluence, and their facilitation of novel application domains and business models. The term "InsurTech" is sometimes used in conjunction with the term "FinTech" to describe technological improvements in the insurance sector, such as micro insurance or on-demand insurance, provided through mobile apps or online channels. Along with big data, cloud computing, artificial intelligence, and other technologies, blockchain is one of the core fundamentals of the FinTech and InsurTech industries. They all allude to cutting-edge concepts at the intersection of technology and finance, and they are commonly used interchangeably [2].

Financial institutions with significant global investments are now adopting these financial technologies, which are deployed in consumer and industrial environments. Four technological families—IoT, Big Data, artificial intelligence, and blockchain—are at the heart of the fintech industry. Each technology has contributed to the "data revolution" and altered how we engage with the online environment. The use of data by institutions to improve decision-making, facilitate customer understanding, and foresee trends at various spatial and temporal scales is at the heart of the fintech revolution. The SDGs are being pursued at the national and international levels in tandem with the data and fintech revolutions.

The SDGs stand for the most significant and difficult problems of the twenty-first century—problems that are so complicated that comprehending people and their environment across vast areas is necessary for their solution. If fintech innovations can be modified to promote social and environmental concerns in addition to the commercial capital, a more sustainable world will be achievable. IoT, big data, AI, and blockchain are the four technological families at the center of the fintech industry. They are regarded as essential components of the digital information highway. Each stands for data collection, curation and storage, accountability and trust, and understanding and analysis.

Due to the crucial role that finance plays in all economies, there must be a structure in place that can help the nation advance sustainably. At the same time, innovation has emerged as a crucial component of the financial system. Health, education, food security, equality, and peace are some of the SDGs that financial inclusion as a policy goal has been observed to have a linear influence on. Financial inclusion is crucial for attaining development and is not merely a goal in and of itself. The SDGs can be considered the paramount objective for all nations in the world. In keeping with this, a sound global financial system is now required to fulfill its mandate to encourage the mobilization of private capital for the achievement of sustainable development and consistent economic growth.

Blockchain, IoT, big data, and artificial intelligence are just a few of the recent technical advancements that have been made possible by digital transformation and innovation, notably in the finance sector. These applications are expected to improve financial sector performance. It becomes clear that financial applications for digital technology have the ability to overcome significant funding challenges for inclusive and sustainable growth. This chapter seeks to provide an overview and in-depth examination of the most recent advancements in financial technology that support the SDGs and future sustainable global trade.

In order to alleviate poverty, safeguard environmental protection, and promote human prosperity, the 194-member nations of the United Nations established the Sustainable Development Goals (SDGs) in September 2015. Long-term inclusive and sustainable economic growth is strongly encouraged by both the SDGs and the 2030 Agenda for Sustainable Development. The G20 summit also emphasizes the need to consider other aspects of sustainable development in addition to the environmental perspective in order to benefit from private capital mobilization to promote sustainable development and the stability of the financial system. As a result, it suggests that the phrase "sustainable finance" be used more widely. Sustainable finance can be broadly recognized as providing money for linked institutional and market arrangements that work together to generate strong, stable, healthy, and inclusive growth. This recognition comes through direct and indirect support of the SDG framework. The goal of this movement was to achieve the positive effects of investments for social and economic gains, including job creation, technological advancement, poverty reduction, and social integration. Mobilizing private capital to spur economic growth and stabilize the banking system is a significant issue in the current global financial situation. Digitalization spans a wide range of technological advancements, including big data, AI, mobile platforms, blockchain, and IoT, notably in relation to its intersection with finance (also known as digital finance or financial technology). Financial system reform to embrace digital technology is not new. Automated technology and transformation have significantly improved performance in the financial business over the past 20 years. The ability of digital finance to overcome challenges affecting the expansion of financing for sustainable development is becoming more and more clear.

The phrase "digital finance" often refers to the use of digital expertise or the digitalization of the financial sector. The trend includes technological developments, financial services industry services, and applications like Internet

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