Human-Centered Artificial Intelligence

Subjects: Economics

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Artificial intelligence (AI) is currently being developed by large corporations, and governments all over the world are yearning for it. AI isn't a futuristic concept; it is already here, and it is being implemented in a range of industries. Finance, national security, health care, criminal justice, transportation, and smart cities are all examples of this. There are countless examples of AI having a substantial impact on the world and complementing human abilities.

Artificial Intelligence Fourth Industrial Revolution

1. Introduction

Artificial intelligence (AI) has progressed from a theoretical field to finding possible applications in various industries and everyday life in recent years [1]. Williams [1] went on to state that the development of sophisticated Machine Learning algorithms and models, with high predicted accuracy, has greatly contributed to the spread of AI. According to West and Allen [2], AI is a broad tool that allows people to reconsider how they integrate information, how they perform data analysis and apply the ensuing insights to make better decisions, and it is already revolutionizing every aspect of life. AI is, indeed, a technology that is revolutionizing every aspect of human life, even though people are not generally familiar with it. In the United States, for example, Davenport et al. [3] found that only 17% of 1500 senior corporate leaders were aware of AI. Many corporate leaders were unaware of what it was or how it might influence their firms, as West and Allen [2] put it. Many company leaders recognized that AI can significantly transform business processes, but they were unsure how AI might be used within their firms. AI isn't a far-fetched concept; it is already here, and it is being integrated and implemented across a wide range of industries [4]. West and Allen [2] indicated that the industries where AI is now being applied include "finance, national security, health care, criminal justice, transportation, and smart cities among many others".

One of the explanations for AI's growing importance is the enormous opportunity it provides for economic progress, as well as its ability to ensure that nations achieve sustainable development goals [4]. According to PriceWaterhouseCoopers [5], "AI has the potential to enhance global Gross Domestic Product (GDP) by $15.7 trillion, or 14%, by 2030. As articulated by West and Allen (2018) this can be outlined as advances of $7 trillion in China, $3.7 trillion in North America, $1.8 trillion in Northern Europe, $1.2 trillion in Africa and Oceania, $0.9 trillion in the rest of Asia outside of China, $0.7 trillion in Southern Europe, and $0.5 trillion in Latin America". China is making tremendous progress because it has established a national target of spending $150 billion on artificial intelligence by 2030, making it the world leader in this field. However, Linardatos et al. [6] pointed out that, despite increased AI and machine learning effectiveness, the models are becoming more complex, resulting in "black boxes" with which the processes are concealed from the user, making them difficult to comprehend.

Capone and Bertolaso [7] highlighted that the “black box” dilemma has sparked a great deal of debate, especially now that AI platforms are increasingly getting utilized to make vital decisions, such as aiding healthcare interventions, informing criminal justice, and assisting employment procedures, among other things. This emphasizes the importance of individuals realizing why Machine Learning methods make judgments to promote AI system knowledge, openness, confidence, and proper management [1]. Wang et al. [8] indicated that explaining capability is critical for reducing algorithm bias, strengthening human-machine collaboration, and boosting user confidence in systems. Vinuesa et al. [9] also claimed that the rise of AI, and its increasingly broad impact across various sectors, necessitates an examination of its impact on achieving the Sustainable Development Goals. In their research, Vinuesa et al. [9] discovered that AI can help achieve 134 targets throughout all goals, but it could also hinder the achievement of 59 targets. However, the fast growth of AI must be accompanied by the relevant regulatory foresight, monitoring, and supervision of AI-based technologies to facilitate long-term development. Without effective regulation, there may be inconsistencies in “transparency, safety, and ethical norms”. Furthermore, research shows that AI systems are mostly oriented toward areas of the SDGs, which are important to the countries where most AI researchers live and work [9]. According to studies, there are limited examples of AI technology being used to address SDG-related concerns in countries with weak AI research. For instance, Vinuesa et al. [9] argued that AI systems used in agriculture to optimize harvesting timing are mainly located in wealthy countries.

There is a case to be made that, if AI technologies are created and developed for technologically advanced contexts, they will exacerbate food production challenges in less developed countries [9][10][11]. There is widespread worry that advances in AI technology could exacerbate inequality both between and within countries, undermining the SDG’s overarching goal [9][12]. As a result, academics and funders must focus more on creating and developing AI solutions that address specific problems in less developed countries and areas. To boost the possibility of adoption and success, Vinuesa et al. [9] emphasized that projects doing this work should guarantee that solutions are not simply transplanted from technology-intensive nations but, rather, are designed based on a thorough appreciation of the local region and the culture.

Access to finance, according to How et al. [13], is a crucial factor in poverty alleviation, but financial institutions must know how to target the neglected effectively.

How et al. [13] went on to say that using artificial intelligence (AI) for data records can assist financial institutions in predicting how prospective clients will react when contacted. However, how et al. [13] suggested that implementing AI projects for financial service providers who are not computer programmers remains difficult. As a result, How et al. [13] developed a no-coding, human-centric AI-based methodology for simulating the probable dynamics between prospective customers’ financial profiles, obtained from 45,211 contact experiences and predicting their intention toward the financial goods being sold. Awan et al., [14] suggested, in another study, that artificial intelligence (AI) becomes an increasingly effective digital domain that promises to promote instant accessibility to facts, as well as efficient decision-making, in ever-increasing business situations. Despite the growing use of big data analysis for decision-making, Awan et al. [14] noted that too little is understood, regarding whether information administration skills contribute to improved data insight, for sustainable supply chain management and circular economy.

According to Awan et al. [14], the widespread use of big data analytics and artificial intelligence, by businesses, is a vital and necessary instrument for designing the supply chain 4.0 industry's future. Explainability methods should be established to make sure that users can learn the models' behaviours and that interpretations provided to users can be enriched with greater insights that foster the users' curiosity, resulting in an exploratory dynamic toward artificial intelligence applications and domain-specific troubles, thus enabling the development of trust, according to Roanec et al. [15]. One strategy to attain this goal, according to Rožanec et al. [15], is to enrich explanations with information gathered from other sources to supplement users' knowledge and assist them in making responsible decisions.

According to Goralski et al. [10], AI is rapidly entering a fresh boundary in the sectors of "business, corporate practices, and government policy, and the intelligence of machines and robotics with deep learning capabilities has had profound disrupting and enabling impacts on business, governments, and society". Aside from that, Goralski et al. [10] feel that AI is having an impact on global sustainability trends. Goralski et al. [10] also stated that "as the AI revolution affects the world, it may announce a utopian future in which humans and machines coexist peacefully, or it may herald a nightmarish future filled with conflict, poverty, and pain". The dilemma is whether AI will help researchers achieve the Sustainable Development Goals (SDGs) of the United Nations (UN) or whether it will lead researchers down a path of more economic uncertainty, environmental collapse, and social unrest.

2. Fourth Industrial Revolution, Artificial Intelligence, Sustainable Development, and the Global Goals

2.1. The Fourth Industrial Revolution (4IR)

The 4IR, also known as Industry 4.0, is defined as a "fusion of technology that blurs the barriers between the physical, digital, and biological spheres" [16][17]. The 4IR is not a continuation of the third industrial revolution, but rather, it is a new and distinct revolution. The 4IR is one-of-a-kind because of the breadth, speed, and systemic significance of the innovations, which have never been seen before. The industrial 4.0 revolution is bringing massive changes to every area of the economy; nevertheless, the potential to connect billions of people through mobile devices, with unparalleled power, storage capacity, and access to knowledge, distinguishes this revolution. Industry 4.0 is defined by emerging technology breakthroughs in artificial intelligence, robots, the internet of things, internet services, autonomous cars, 3-D printing, nanotechnology, materials science, energy storage, and quantum computing, according to Mhlanga [17].

2.2. The Background and Definition of Artificial Intelligence

The exact definition and interpretation of the term intelligence and, more specifically, artificial intelligence (AI), has sparked significant debate and uncertainty. For instance, one dictionary provides four interpretations of AI [18]. The following definitions were given by Kok et al. [18]. Firstly, in the realm of computer science, this is a field of research. Artificial intelligence is devoted to the development of computers capable of learning, reasoning, and self-correction in the same way that humans do. It can also be viewed as the idea that machines can be upgraded to have some

of the same skills as humans, such as learning, adapting, self-correction, and so on. It can also be viewed as a scenario where human intelligence has been extended via the use of computers, just as physical power has been stretched using mechanized equipment in the past. Lastly, in a limited sense, artificial intelligence can be viewed as the study of methods for more successfully using computers through enhanced programming approaches. Ramesh et al., [19] also defined AI as a branch of engineering and science focused on the computational study of what is generally referred to as intelligent behaviour, as well as the construction of objects that display it.

Ramesh et al., [19] stated that "the British mathematician Alan Turing (1950) was one of the founders of modern computer science and AI. He defined intelligent behaviour in a computer as the ability to achieve human-level performance in cognitive tasks, this later became popular as the 'Turing test'". As put clearly by Kok et al. [18] rather than looking at a broad definition of artificial intelligence, one could focus on the notion of artificially intelligent systems. There are numerous definitions available, but most of them fall into one of four groups, which include human-like computer systems that can act and think rationally. This will help researchers describe the general qualities of AI in **Figure 1** below.

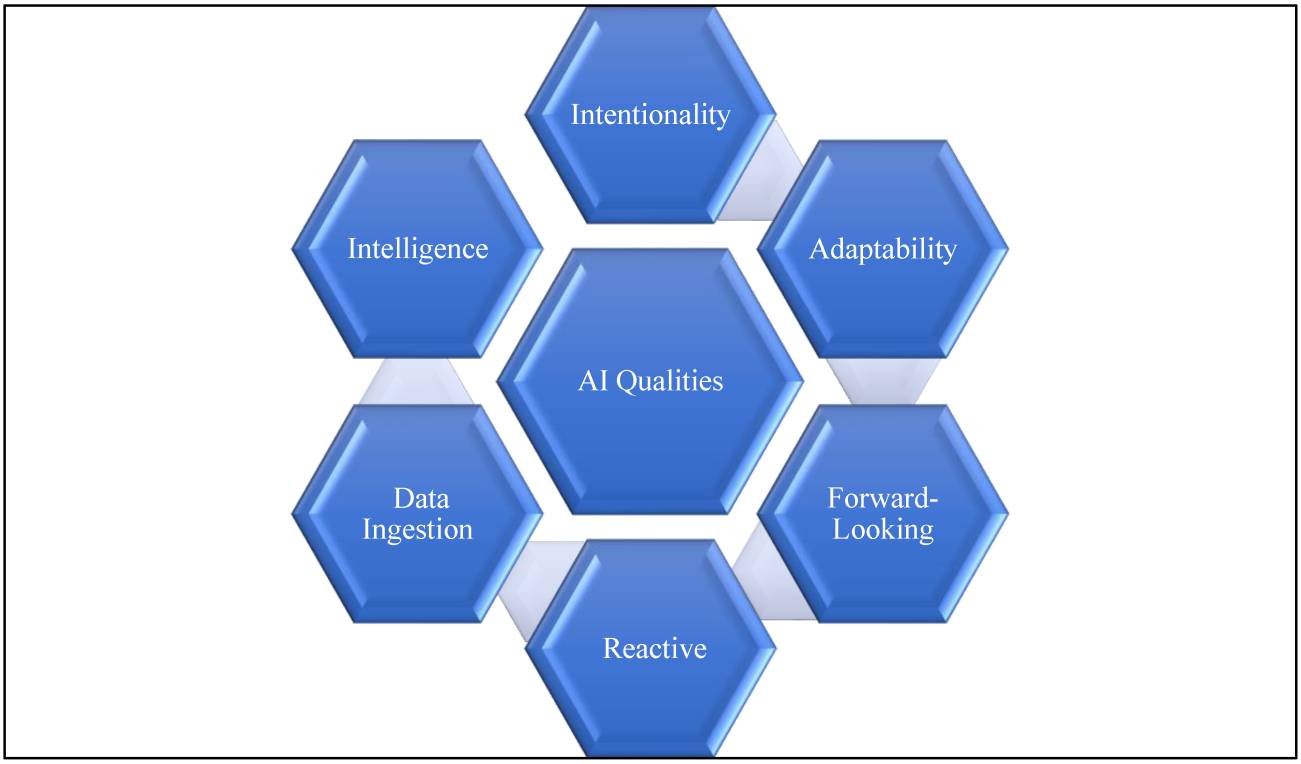

Figure 1. Qualities of AI Source: The Analysis by Author.

In **Figure 1**, above, the general qualities of AI are given, which include: data ingestion, which is described as AI systems with a capacity to cope with massive volumes of data, in billions of records, generated at a high rate. Intentionality means AI-powered algorithms that can make judgments based on data that is often updated in real-time, and they are different from passive machines, which are limited to mechanical or pre-set responses. Due to the increase in storage capacity, the ability to process data at high speeds, and deep analytical capacity, AI is changing how researchers live and posing questions for society, such as what it means to be a human being, how

the economy is managed, and what systems of governance are better. Intelligence implies that AI systems can make informed decisions in conjunction with machine learning and data analytics. Here, the quality of data forms the most important part of the system: for algorithms to be able to recognize patterns that are useful for decision-making. Adaptability implies that, as computers make decisions, AI programs can learn and adapt. For instance, researchers have autonomous vehicles that can inform drivers and vehicles and are aware of the construction of roads along the highway, traffic obstructions, and potholes, among many other issues. Being reactive means that AI systems respond to changes in their environment. Forward-looking AI systems don't merely react; they frequently search through a space of possible scenarios to find a successful outcome. They achieve this by projecting several steps into the future.

2.3. The Three Main Groups of AI

AI is divided into three groups, which are artificial narrow intelligence, artificial general intelligence, and artificial superintelligence.

Artificial narrow intelligence—This generally refers to AI machines' specialization, which indicates that they can use machine learning and deep-learning tools to perform a specific activity. This technique has beaten chess and Go masters, and it has won Jeopardy, an American game show [20][21]. Artificial narrow intelligence systems have been here for a long period and are used in a range of systems today, including Google's search engine. One of the limitations of artificial narrow intelligence is that it can quickly respond to factual queries that people would find difficult to explain, such as the depth of the Atlantic Ocean, what global warming is, and what causes global warming, but artificial narrow intelligence cannot answer simple questions, i.e., it is unable to respond to a question about whether a cow can ride a bicycle, which is easy for humans to answer, even as toddlers.

Artificial general intelligence—Artificial general intelligence (AGI) refers to an AI computer that is as smart as a human across the board, capable of performing any intellectual work that researchers can, with the ability to comprehend, and reason with, its surroundings, as well as employ understanding to any challenge, instead of just one [22][23][24]. Strong AI and deep AI are two terms for AGI. According to Ranjitha [25], some of the characteristics of AGI are common sense, background knowledge, transfer learning, abstraction, and causality.

Artificial Superintelligence—This relates to a machine which is substantially smarter than the smartest humans in almost every subject, including scientific inventiveness, general knowledge, and social skills [26][27]. Artificial superintelligence is a far-fetched concept that AI will one day be able to outperform human intelligence, and computation algorithms must outperform human intellect in all dimensions and settings for artificial superintelligence to emerge and then, become a reality [17][27].

2.4. Applications of AI in Real Life Situations

AI is being used in a variety of areas of human existence and in numerous sectors of the global economy. **Figure 2** gives a summary of the sectors where AI is being applied the world over.

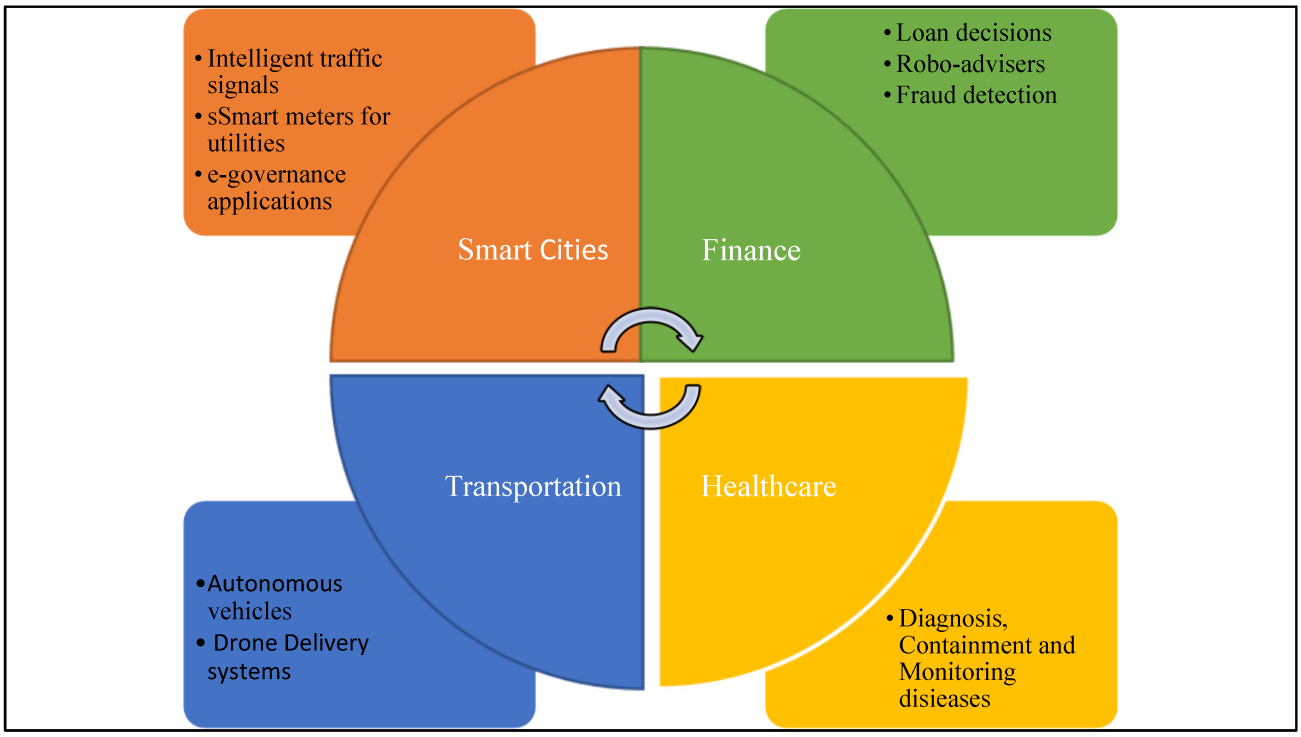

Figure 2. Applications of AI in Real Life Situations.

As shown in **Figure 2**, above, AI is being applied in various sectors of the economy, which include the financial sector, the healthcare sector, and the transport sector, in smart cities. Other sectors not included in **Figure 2**, where AI is being applied, including national security and the criminal justice system.

2.5. Research in Artificial Intelligence

AI research is progressing quickly, and the scientific debates surrounding this topic are dwindling with each passing decade. AI research output keeps rising steeply, as expenditures and profits rise year after year, and countries compete for dominance in this area [28][29]. Crew [29] stated that considerable ethical and technical difficulties remain to be overcome. Due to increased processing power, huge data sets, and unparalleled, algorithmic sophistication, the number of journal and conference publications referring to AI in the Dimensions from Digital Science database surged by more than 600% between 2000 and 2019 [29]. The “Nature Index provided the top 100 AI academic institutions”, dominating AI research in the world. For purposes of this study, the top 10 and lowest 10 institutions will be presented to assist in understanding how AI research is spread. The top ten artificial intelligence academic institutes are listed in **Table 1**.

Table 1. The top ten AI academic institutes.

Number	Institution	Location	Share 2015–2019	Count 2015-2019	International Articles (%)
1	Harvard University	United States of America (USA)	331.08	937	57.0%

Number	Institution	Location	Share 2015–2019	Count 2015-2019	International Articles (%)
2	Stanford University	United States of America (USA)	257.90	629	54.4%
3	Massachusetts Institute of Technology (MIT)	United States of America (USA)	209.04	620	59.4%
4	Max Planck Society	Germany	167.98	628	83.0%
5	University of Oxford	United Kingdom (UK)	132.34	495	85.3%
6	University of Cambridge	United Kingdom (UK)	130.68	485	84.9%
7	Chinese Academy of Sciences (CAS)	China	130.00	492	73.2%
8	UCL	United Kingdom (UK)	129.70	415	77.1%
9	Columbia University in the City of New York (CU)	United States of America (USA)	127.56	386	61.9%
10	National Institutes of Health (NIH)	United States of America (USA)	122.69	302	52.0%

According to the Nature Index [28], most institutions in the top ten dominants in AI research are all in America (**Table 1**). Only one German institution, three from the United Kingdom, and one from China made it into the top ten. The lowest ten of the top 100 artificial intelligence academic institutions, according to the Nature index of 2020, are listed in **Table 2**.

Table 2. The bottom 10 in the top 100 artificial intelligence academic institutions from the Nature index of 2020.

Number	Institution	Location	Share 2015–2019	Count 2015–2019	International Articles (%)
90	Cold Spring Harbor Laboratory (CSHL)	United States of America (USA)	23.15	54	44.4%
91	Dartmouth College	United States of America (USA)	22.89	53	45.3%
92	Purdue University	United States of America (USA)	22.78	98	74.5%
93	Carnegie Mellon University (CMU)	United States of America (USA)	22.77	99	58.6%
94	Utrecht University (UU)	Netherlands	22.61	87	83.9%
95	Mount Sinai Health System	United States of	22.38	108	63.9%

Number	Institution	Location	Share 2015–2019	Count 2015–2019	International Articles (%)
	(MSHS)	America (USA)			
96	Fudan University	China	22.14	77	72.7%
97	National Institute for Nuclear Physics (INFN)	Italy	22.14	233	97.0%
98	Tel Aviv University (TAU)	Israel	22.05	137	86.9%
99	National University of Singapore (NUS)	Singapore	21.81	84	85.7%
100	University of Science and Technology of China (USTC)	China	21.50	119	78.2%

two from China, one from Italy, one from Singapore, and one from the Netherlands. This data is only showing that AI research is more common in America when compared to the whole world. According to Savage [30], over the last two decades, the United States has consistently been the global champion in AI-related research output, with the greatest number of articles. However, Savage [30] noted that China's output has risen in recent times. According to Dimensions, China produced more AI-related papers than any other country from 2016 to 2019. China's AI-related research production surged by a little over 120%, while the US output increased by over 70%. China published 102,161 AI-related articles in 2019, whereas the United States published 74,386. India finished third with 23,398 publications [30]. This was different from the information presented by the Nature Index 2020 where, AI-related publications, across all fields in the Dimensions database, China as the clear leader, in contrast to the Nature Index, where Western universities dominated in the application of AI in the natural sciences.

2.6. Sustainable Development and the Global Goals

Sustainable development is defined "as development that meets the current generation's needs without jeopardizing future generations' ability to meet their own" [4]. The notion of sustainable development "incorporates two major concepts: the requirements of the poor, particularly their basic needs, which should be prioritized, and the restrictions imposed on the environment's ability to supply existing and future demands by the state of technology and social organization" [4]. "Sustainable development" is described by Duran et al., [31] as "the juxtaposition of two major aspects". According to Duran et al. [31], "the first phrase, durable, refers to long-term viability and sustainability, whereas development refers to the process of extending or constructing one's potential; progressively bringing one's potential to a fuller, larger, or better condition". The term "sustainability" refers to a multifaceted strategy that is being discussed at a time when environmental concerns, caused by numerous human activities and, at the same time, the unavoidable changes caused by the Fourth Industrial Revolution, demand urgent action and remedies.

According to Dasgupta [32], the term "sustainability" became popular after the World Commission on Environment and Development published the Brundtland Commission Report, which defined sustainable development as "development that meets current needs without jeopardizing future generations' ability to meet their own needs", as defined by Mhlanga [4]. Dasgupta [32] went on to state that "the concept of sustainability is that each generation

should leave its successor at least as large a productive foundation as it inherited from its predecessor in terms of their respective demographic bases". If that happens, "the successor's economic prospects would be no worse than those it had when inheriting productive assets from its predecessor" [32]. The country's productive basis includes capital assistance and institutions, as well as cultural coordinates. However, in the current revolution, the country's productive capabilities have been extended to incorporate big data, which is a post-industrial possibility, sometimes referred to as the new oil, in the twenty-first century, fuelling AI for development. As new drivers of development and as part of the productive basis, data and AI must be deployed with humans in mind. Since the productive foundation of the country is the source of its well-being, there is a need for the deployment of these resources to be at the centre of the people to attain sustainable development.

Rees [33] posits that "Sustainable development is the positive socio-economic change that does not undermine the ecological and social systems upon which communities and society are dependent. Its successful implementation requires integrated policy, planning and social learning processes, its political viability depends on the full support of the people it affects through their governments, their social institutions, and their private activities". As a result, it is equally clear that the issue of human-centred application of AI is prioritised because, in its absence, sustainable development will have some challenges before it can be achieved. Tomislav [34] argued that, since its inception, the notion of "sustainable development" has gone through several stages of development. The concept has evolved to meet the current needs of a complicated global ecosystem, but the core concepts and aspirations, as well as the challenges of execution, have remained largely unchanged [34]. This is the primary reason why topics such as human-centred AI should begin to be discussed. According to Redclift [35], the concept of sustainability is frequently muddled. Some academics are worried about the natural resources base's sustainability, while others are concerned about current or future levels of output and consumption [35]. Redclift [35] asserts that there are significant variations in thought about how to attain environmental sustainability and sustainable development. Therefore, it's crucial to study the many aspects of sustainability independently, as well as the kind of global regulations that will be necessary to attain sustainable development.

2.7. The Global Goals

According to UNICEF [36] "the Sustainable Development Goals (SDGs) were adopted by all United Nations Member States in 2015 to end poverty, reduce inequality and build more peaceful, prosperous societies by 2030". The Sustainable Development Goals (SDGs), often known as the Global Goals, are a call to action to achieve a world where no one is left behind [36]. **Figure 3**, below, outlines all the 17 global goals.

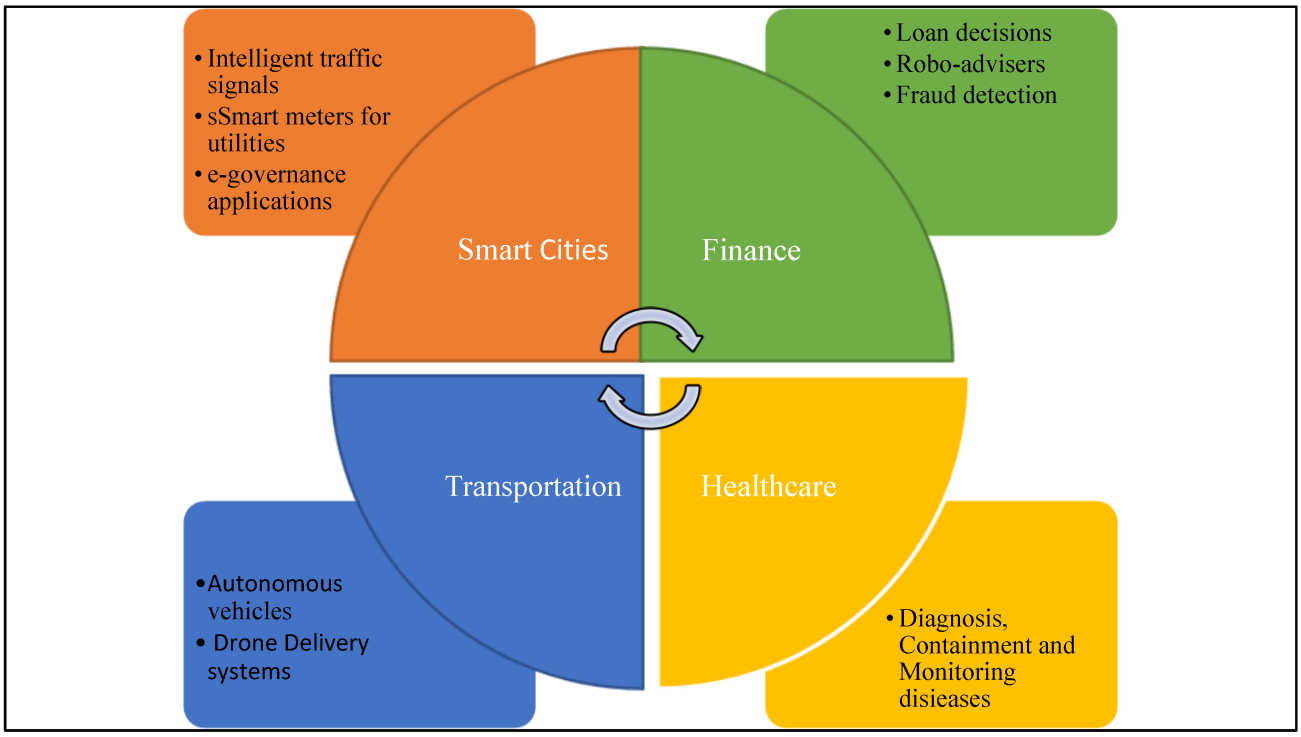

Figure 3. The 17 SDGs. Source: Author's Analysis.

Figure 3 outlines the 17 SDGs, which include "no poverty, zero hunger, good health and well-being, quality education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, reduced inequality, sustainable cities and communities, responsible consumption and production, climate action, life below water, life on land, peace, justice, and strong institutions, partnerships for the goals".

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