



Investigating the Potential of Technology to Promote Development and the Ethical and Social Implications of Technological Innovation in the Context of Development

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How to cite this paper: Ebua, E.J. (2023) Investigating the Potential of Technology to Promote Development and the Ethical and Social Implications of Technological Innovation in the Context of Development. *Open Access Library Journal*, 10: e9936. <https://doi.org/10.4236/oalib.1109936>

Received: February 27, 2023

Accepted: April 21, 2023

Published: April 24, 2023

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Abstract

This article provides a comprehensive investigation of the potential of technology to promote development, and the ethical and social implications of technological innovation in the context of development. Through a thorough review of the literature, we explore the concept of development and its relationship with technology, as well as the ethical and social concerns associated with technological innovation in development contexts. We draw on a range of sources, including scholarly articles, reports, and case studies, to analyze the potential of technology to promote economic, social, and environmental progress in developing countries. We also examine ethical frameworks and principles for evaluating technological innovation in development, including the United Nations Sustainable Development Goals (SDGs) and the principle of technology justice. Our findings suggest that while technology has great potential to promote development, its implementation must be guided by ethical considerations and a commitment to social justice. We conclude by highlighting the importance of interdisciplinary collaboration and participatory approaches in the development and implementation of technological solutions for development.

Subject Areas

Philosophy

Keywords

Technology, Development, Ethics, Innovation, Social Implications

1. Introduction

The concept of development has evolved over time and has been widely debated

among scholars and policymakers. In its simplest form, development can be defined as the process of improving the quality of life for people through economic growth, social progress, and environmental sustainability [1]. Development is a multifaceted and complex phenomenon that encompasses various dimensions, including economic, social, political, cultural, and environmental. The potential of technology to promote development has been recognized in various international development frameworks, including the United Nations Sustainable Development Goals (SDGs). The SDGs call for the use of technology to achieve various development goals, including eradicating poverty, improving health and education, promoting gender equality, and reducing environmental degradation [2].

Investigating the potential of technology in development requires rigorous research methods. This is because technology is not a panacea for all social and economic challenges. There are numerous factors that influence the success or failure of technology interventions, including social and cultural factors, regulatory frameworks, and economic conditions. Rigorous research methods are essential to identify the factors that contribute to the success or failure of technology interventions. Moreover, rigorous research methods can help to identify the unintended consequences of technology interventions. Technology can have both positive and negative impacts on society and the environment. Investigating the potential of technology in development requires an understanding of these impacts to ensure that the benefits outweigh the costs [3]. Investigating the potential of technology in development can help policymakers and practitioners design strategies to leverage technology's potential to transform various sectors, including agriculture, health, education, and infrastructure, among others. This information can help identify the most effective ways to use technology to promote development [4]. Technology can be used to deliver educational and healthcare services remotely, which is especially important in rural areas where access to these services is limited [5]. For example, telemedicine has made it possible for doctors and healthcare professionals to provide consultations and diagnoses to patients in remote areas using video conferencing technology.

Commenting on the potential of technology to promote development, Oyedele, A. argues that while technology can be a powerful tool for development, it can also exacerbate existing inequalities and create new forms of exclusion. Oyedele notes that the digital divide, or the gap between those who have access to technology and those who do not, is a major challenge to ensuring that the benefits of technology are equitably distributed [6]. Muro, M. and Katz, R. argue that technological innovation can lead to job displacement, particularly for low-skilled workers. They suggest that policymakers should focus on strategies to help workers transition to new jobs and develop the skills needed to participate in the digital economy [7]. Warschauer, M. and Ames, M.G. highlight the problem of e-waste, or the disposal of electronic devices, as a major ethical and environmental concern. They argue that responsible disposal of electronic de-

vices is necessary to prevent environmental harm and to ensure that valuable materials are not wasted [8]. Heeks, R. argues that the potential of technology to promote development is often limited by political and institutional factors. He suggests that policymakers should focus on addressing these barriers, such as corruption and weak governance, to ensure that technology can be effectively leveraged for development. The potential of technology to promote development is often limited by political and institutional factors, such as corruption and weak governance [9].

Furthermore, investigating the potential of technology in development can help identify the ethical and social implications of technological innovation. This information can help policymakers and practitioners design strategies to mitigate these implications and ensure that technology is used in an ethical and socially responsible manner [10].

2. The Relationship between Technology and Development

New technologies have brought enormous benefits which are visible but they have as well resulted in mounting environmental and human costs. The relationship between technology and development is complex and multifaceted, as technology can both enable and hinder development. On the one hand, technology can improve productivity, efficiency, and access to information and services, which can enhance economic growth, social welfare, and human development. On the other hand, technology can exacerbate social and economic inequalities, widen the digital divide, and have adverse environmental impacts. Technology and development is context-specific and varies across countries, regions, and sectors. Some countries and sectors may be more technologically advanced than others, and the benefits and challenges of technology may vary depending on the local context and the needs of the population ([10], p. 15). It is essential to take a holistic and nuanced approach to the relationship between technology and development, taking into account the local context, the potential benefits and challenges of technology, and the ethical and social implications of technological innovation. This approach requires engaging diverse stakeholders, including policymakers, practitioners, researchers, civil society, and communities, in a participatory and inclusive process of technology assessment, planning, and implementation.

Ian Barbour brings out three possible ways of considering technology. To him, these three views have some implicit value judgment. The three ways are conflicting in nature: technology as a liberator, technology as a threat and technology as an instrument of power ([11], p. 3). Modern technology often has been enthusiastically welcomed as our liberator from famine, disease and poverty. The first perspective on the relationship between technology and development is that technology is a driver of development. According to this view, technological advancements lead to increased productivity, efficiency, and innovation, which in turn promote economic growth and development. This perspective is supported

by scholars such as Muro and Andaluz who argue that technology has a positive impact on productivity and economic growth [12]. Barbour summarises the benefits into four kinds when one looks at its recent history. To him, we enjoy a higher living standard in this generation; new drugs, better medical attention, improved sanitation and nutrition have doubled the average life span in industrial nations within the past century [11].

On the other hand, there are some scholars point out the potential risks and negative impacts of technological change and view technology as a threat. Jacques Ellul, understands technology as an autonomous and uncontrollable force that dehumanizes everything it touches [13]. For instance, Appelbaum and Robinson argue that technological change can lead to job displacement and exacerbate social inequalities [14]. Similarly, Bauer and Erdogan argue that the use of technology can result in environmental degradation, which in turn can undermine sustainable development. According to Ian Barbour, the appropriate view of technology is that which holds that technology is a neutral power, in his own words he states:

Technology is neither inherently good nor inherently evil but is an ambiguous instrument of power whose consequences depend on its social context. Some technologies seem to be neutral if they can be used for good or evil according to the goals of the users. A knife can be used for surgery or for murder. ([11], p. 99)

The neutrality of technology is rooted in the fact that technical designs cannot be meaningfully interpreted in abstraction from their human context. This position is more likely to give prominence to social justice because they interpret technology as both a product and an instrument of social power. This can serve as a foundation for the perspective that holds that technology can play a transformative role in promoting development. According to this view, technology can be used to address some of the key challenges facing developing countries, such as poverty, inequality, and lack of access to basic services. This perspective is supported by scholars such as Deichmann *et al.*, who argue that technology can be a powerful tool for addressing development challenges, particularly in areas such as agriculture and healthcare [15]. However, it is important to note that the potential benefits of technology are not always evenly distributed across societies. As Appelbaum and Robinson note, the benefits of technological change may be concentrated among a small group of individuals or companies, while the costs and risks may be borne by broader segments of society. This underscores the importance of ensuring that technological change is accompanied by policies and institutions that promote inclusive development [14].

The historical relationship between technology and development has evolved over time, reflecting changes in technological advancements, global politics, and economic systems. According to the United Nations Development Programme (UNDP), the relationship between technology and development has gone through three distinct phases. The first phase, which began in the mid-18th cen-

ture and lasted until the early 20th century, was characterized by the Industrial Revolution, which saw the emergence of new technologies such as steam engines, electricity, and telecommunications. This phase was marked by rapid economic growth and technological advancements in Europe and North America, but it also resulted in social and economic inequalities within and between countries.

The second phase, which began after World War II and lasted until the 1980s, was marked by the emergence of development as a global agenda and the introduction of new technologies such as nuclear power, aviation, and computers. This phase was characterized by the spread of development aid and the establishment of international institutions such as the United Nations and the World Bank, which aimed to promote economic growth and social welfare in developing countries. However, this phase also saw the rise of neocolonialism and the perpetuation of global inequalities. The third phase, which began in the 1980s and continues to the present day, is marked by the emergence of new technologies such as the Internet, mobile phones, and renewable energy. This phase is characterized by the globalization of technology and the rise of the knowledge economy, which has transformed the nature of work, production, and communication. However, this phase also poses new challenges, such as the digital divide, cybersecurity, and environmental degradation ([10], p. 17).

Technological solutions have played a significant role in promoting development in developing countries. According to the World Bank (2019), a few examples of successful technological solutions in developing countries include mobile banking, renewable energy, and e-commerce platforms. One such example of a successful technological solution in promoting development is M-Pesa, a mobile banking service launched in Kenya in 2007. M-Pesa has revolutionized the way individuals in Kenya conduct financial transactions, especially those who previously had no access to traditional banking services. The service allows users to make deposits, withdrawals, and transfers through their mobile phones, with transactions secured by biometric identification. This has led to increased financial inclusion and improved economic opportunities for many Kenyans, particularly those in rural areas where traditional banking infrastructure is lacking ([16], p. 79).

Technological solution that has successfully promoted development in developing countries is renewable energy. Solar power, in particular, has provided a sustainable and cost-effective source of electricity in many developing countries, especially those in Africa where access to electricity is limited. For example, the installation of solar panels in a village in rural Rwanda has enabled residents to access clean and reliable electricity, leading to improved living standards and economic opportunities. E-commerce platforms have also been successful in promoting development in developing countries. For example, Jumia, an e-commerce platform operating in several African countries, has provided small and medium-sized businesses with access to a larger market, leading to increased sales

and growth. Additionally, the platform has enabled individuals in remote areas to access goods that were previously unavailable to them ([16], p. 100).

There are many case studies that highlight the positive impact of technological innovation in development contexts. Here are a few examples: M-Kopa Solar—M-Kopa Solar is a pay-as-you-go solar energy company that provides affordable solar power to households in East Africa. Customers can make small payments through mobile money systems until they have paid off the cost of the solar panel, after which they own the panel outright. M-Kopa has provided access to clean, renewable energy to over 600,000 households, improving their living conditions and helping them save money on energy costs ([16], p. 55). Mobile Money in Bangladesh—The use of mobile money has greatly increased financial inclusion in Bangladesh. According to a study by the World Bank, households that adopted mobile money saw an increase in savings, a decrease in borrowing from moneylenders, and an increase in business investment.

Telemedicine in Uganda—Telemedicine, which uses technology to connect doctors with patients remotely, has greatly improved access to healthcare in Uganda. Patients can receive medical consultations and prescriptions through their mobile phones, saving them time and money on travel and consultations. Telemedicine has also allowed doctors to reach more patients, particularly those in remote or underserved areas ([16], p. 67). Digital Financial Services in India—Digital financial services, such as mobile banking and digital wallets, have greatly increased financial inclusion in India. According to a study by the World Bank, the use of digital financial services in India has led to increased savings, increased business investment, and reduced poverty.

Agriculture in Kenya—Precision agriculture, which uses technology to optimize crop yields and reduce waste, has greatly improved agricultural productivity in Kenya. By using sensors and data analytics, farmers can optimize their use of fertilizers and pesticides, leading to increased yields and reduced costs. Technological innovation has had many positive impacts in development contexts, improving access to healthcare, energy, and financial services, and increasing productivity and economic growth. These case studies demonstrate the potential of technology to create positive change in developing countries, and serve as examples of the many ways in which technology can be harnessed for the greater good.

Despite the positive trends technology has brought, their impact remains in the hands of a few. The use of technology can exacerbate existing inequalities and create new gaps that hinder development. As noted by Joseph Stiglitz in his book “The Price of Inequality,” the digital divide between those who have access to technology and those who do not can widen the gap between rich and poor [17]. The use of technology can also perpetuate gender and racial inequalities. As noted by Safiya Umoja Noble in her book “Algorithms of Oppression”, algorithms used by search engines and social media platforms can perpetuate racist and sexist biases [18]. In addition, the use of technology can also lead to job dis-

placement and wage stagnation, particularly in low-skilled sectors. As noted by Erik Brynjolfsson and Andrew McAfee in their book “The Second Machine Age”, the rise of automation and artificial intelligence can lead to job losses in industries such as manufacturing and retail [19]. One problem that arises from technology is the potential for it to halt development and progress. As noted by Neil Postman in his book “Technopoly: The Surrender of Culture to Technology,” when we become too reliant on technology, we risk losing our ability to think critically and creatively [20]. How can technology, therefore, be used to drive sustainable development in emerging economies while avoiding exacerbating existing inequalities?

3. Challenges to the Successful Implementation of Technological Solutions for Development

To fully harness the potential of technology for development, it is crucial to understand and address the challenges that impede its successful implementation and draw strength from a thorough review of academic literature on the role of technology to development. There is a vast amount of research and analysis available on the challenges that arise when implementing technological solutions for development. This includes scholarly articles, reports, and case studies that highlight the challenges faced in various contexts and propose strategies for addressing them. On-the-ground research and analysis, particularly in developing countries and communities, is essential. This involves observing and engaging with the individuals and communities that are affected by technological solutions, understanding their needs and challenges, and developing solutions that are tailored to their specific context.

The implementation of technological solutions in developing countries has the potential to bring about significant positive changes, including improved healthcare, education, communication, and economic development. However, the successful implementation of these solutions is often challenged by a range of factors that can hinder their effectiveness and sustainability.

3.1. Lack of Infrastructure

One of the main challenges to the successful implementation of technological solutions in developing countries is the lack of basic infrastructure, including access to electricity, Internet connectivity, and reliable transportation. For example, in rural areas of sub-Saharan Africa, where electricity and Internet access are limited, implementing telemedicine solutions can be challenging [21]. This lack of infrastructure can also make it difficult to maintain and repair technological solutions, further hindering their effectiveness.

3.2. Cultural and Social Barriers

Cultural and social factors can also pose significant challenges to the successful implementation of technological solutions for development. For example, in

some communities, traditional beliefs and practices may discourage the adoption of certain technologies, particularly those related to healthcare [22]. Additionally, language barriers and low levels of literacy can make it difficult for individuals to use and benefit from technological solutions.

3.3. Financial Constraints

Financial constraints can also present challenges to the successful implementation of technological solutions for development. The high cost of implementing and maintaining these solutions can be prohibitive, particularly for developing countries with limited financial resources [23]. In some cases, funding may be available, but it may be difficult to secure and allocate resources in a way that is effective and sustainable.

3.4. Political and Regulatory Challenges

Political and regulatory challenges can also hinder the successful implementation of technological solutions for development. In some cases, government policies and regulations may be inadequate or not supportive of technological innovation, hindering the adoption and diffusion of new technologies [24]. Additionally, corruption and bureaucratic inefficiencies can slow down the implementation of technological solutions, making them less effective and sustainable.

The successful implementation of technological solutions for development is a complex and challenging process that is hindered by a range of factors. These challenges include a lack of infrastructure, cultural and social barriers, financial constraints, and political and regulatory challenges. To overcome these challenges, it is important to adopt a comprehensive and integrated approach that takes into account the local context, engages local communities, and addresses the underlying systemic issues that hinder the adoption and diffusion of technological solutions.

4. Negative Consequences of Technological Innovation in Development Contexts

The implementation of technological solutions for development has been identified as a key driver of progress and development. However, as pointed out by Appiah and Kyeremeh, there are significant challenges to the successful implementation of such solutions. One of the primary challenges is the technical infrastructure required to implement technological solutions. As noted by the authors, in many developing countries, there are inadequate telecommunications and power infrastructures, which can hinder the adoption of technological solutions. Additionally, the cost of infrastructure development can be prohibitive, particularly for communities that lack resources. Another significant challenge is the lack of digital literacy and access to resources. According to Appiah and Kyeremeh, many individuals and communities lack the necessary skills and resources to effectively use technological solutions. This can lead to low adoption

rates and a limited impact on technological solutions.

Furthermore, the implementation of technological solutions often requires significant investment and coordination. This can be challenging for developing countries and communities that have limited resources and infrastructure. There is also a risk that the implementation of technological solutions can exacerbate existing inequalities and widen the digital divide between developed and developing countries. To overcome these challenges, there are several strategies that can be employed. For example, infrastructure development can be supported through public-private partnerships, international aid, and other forms of investment. Digital literacy programs can also be developed to increase the skills and knowledge of individuals and communities. Additionally, the development of open-source technologies and community-driven solutions can help to ensure that technological solutions are accessible and affordable to all [25].

Technological innovation has the potential to drive development and contribute to positive social and economic outcomes in developing countries. However, it also raises ethical and social concerns, particularly when it is introduced in contexts with existing power imbalances and social inequalities. One of the key ethical concerns associated with technological innovation in development contexts is the potential for technology to be used to reinforce existing power structures and social inequalities. As Nambisan and Nambisan (2016), technological innovation can exacerbate social inequalities by benefiting only a small group of individuals or companies while leaving others behind. This is particularly concerning in the context of developing countries, where existing social and economic inequalities are often more pronounced [26].

Technological innovation in development contexts can be used to infringe on human rights. For example, the use of surveillance technology in the name of development can violate the right to privacy and contribute to a culture of surveillance [27]. Similarly, the use of biometric technologies in the name of development can violate the right to bodily integrity and contribute to the stigmatization of certain groups [28]. One of these concerns is the potential for technological innovation to contribute to cultural erosion and the loss of traditional practices and knowledge [29]. Similarly, the use of technology in development can undermine the social fabric of communities by disrupting existing social networks and relationships [30]. Technological innovation in development contexts can have both positive and negative consequences. In this response, we will highlight some case studies that demonstrate the negative consequences of technological innovation in development contexts.

4.1. The One Laptop Per Child (OLPC) Initiative

The One Laptop Per Child (OLPC) initiative was launched in 2005 with the aim of providing low-cost laptops to children in developing countries. The initiative was based on the belief that access to technology would enhance educational outcomes and promote economic development. However, the OLPC initiative

had several negative consequences that have been documented in academic literature and media reports. One of the main criticisms of the OLPC initiative was that it failed to take into account the social, cultural, and economic context of the communities it was trying to reach. The initiative assumed that the provision of laptops would automatically lead to improved educational outcomes and economic development, without considering the challenges that communities in developing countries face, such as lack of infrastructure, access to electricity, and qualified teachers [31]. Another negative consequence of the OLPC initiative was the lack of training and support for teachers. Many teachers in developing countries lacked the necessary skills to effectively integrate technology into their classrooms, leading to underutilization of the laptops and limited impact on educational outcomes [32].

The OLPC initiative also failed to address the root causes of poverty and inequality in developing countries, leading to criticisms that it was a “silver bullet” solution that ignored the complexities of development [33]. The initiative did not address issues such as access to healthcare, food security, and safe drinking water, which are essential for human development and well-being.

4.2. The Aadhaar Biometric Identification System in India

The Aadhaar biometric identification system in India is a case study that highlights the negative consequences of technological innovation in development contexts. The Aadhaar system was launched in 2009 with the aim of creating a unique identification number for every Indian citizen. However, the system has been criticized for its potential to violate privacy rights and for its lack of transparency and accountability. One of the main concerns with the Aadhaar system is its potential to violate privacy rights. The system collects biometric and demographic data from citizens, including fingerprints, iris scans, and personal information such as name, address, and date of birth [34]. This has raised concerns about the potential for misuse of this data, including identity theft, surveillance, and profiling.

Another negative consequence of the Aadhaar system is its lack of transparency and accountability. The system was implemented without adequate consultation or consent from citizens, and there have been reports of errors and inaccuracies in the data collected. There have also been concerns about the lack of oversight and regulation of the system, with critics arguing that the government has failed to put in place adequate safeguards to protect citizens' rights. The Aadhaar system has also been linked to exclusionary practices, as many people in India do not have the necessary documentation to enroll in the system. This has led to difficulties in accessing government services and benefits, with reports of people being denied access to food rations, healthcare, and other essential services [35].

The Aadhaar biometric identification system in India demonstrates the negative consequences of technological innovation in development contexts when it

is not implemented in a responsible and inclusive manner. The case study highlights the importance of considering the potential social and ethical implications of technological solutions, and of engaging with local communities to ensure that their rights and interests are protected.

4.3. The Use of Drones in Development Contexts

The use of drones in development contexts is a case study that highlights the negative consequences of technological innovation. While drones have been used in development contexts for a variety of purposes, including disaster relief, healthcare delivery, and agricultural monitoring, there are several potential negative consequences that need to be considered.

One of the main concerns with the use of drones in development contexts is their potential to violate privacy rights. Drones can capture high-resolution images and videos, which can be used for surveillance and monitoring of individuals and communities. This has raised concerns about the potential for misuse of this data, including profiling and discrimination. Another negative consequence of the use of drones in development contexts is their potential to displace local workers. Drones can perform tasks such as mapping and surveying more quickly and efficiently than human workers, leading to concerns about job loss and economic disruption. This can have a particularly negative impact on vulnerable communities, who may already be struggling to access employment opportunities.

The use of drones in development contexts also raises questions about who benefits from these technologies. Drones can be expensive to operate and maintain, and there is a risk that they will be used primarily for the benefit of wealthy individuals and organizations, rather than for the benefit of local communities [36]. The use of drones in development contexts raises concerns about the potential for technological solutions to be seen as a “silver bullet” solution that ignores the complex social, cultural, and economic context of the community. Drones may be seen as a quick fix for complex problems, without addressing the underlying issues that contribute to poverty and inequality.

4.4. Digital Divide

The digital divide is a significant negative consequence of technological innovation in development contexts, and it refers to the gap between those who have access to and can effectively use information and communication technologies (ICTs) and those who do not. This divide can have significant economic, social, and political consequences, particularly for developing countries. Here are a few examples of specific countries and their involvement in the digital divide.

Sub-Saharan Africa has the lowest rate of Internet penetration in the world, with only 24% of the population having access to the Internet in 2019 [37]. This is due to a range of factors, including poor infrastructure, high costs, and low levels of digital literacy. As a result, many people in the region are unable to access the benefits of technology, including education, healthcare, and economic

opportunities.

While India has made significant progress in expanding access to technology, there is still a significant digital divide in the country. According to a 2019 report by the Internet and Mobile Association of India, only 36% of rural Indians have access to the Internet, compared to 65% of urban Indians [38]. This divide has significant implications for economic development, as access to technology is increasingly necessary for job opportunities and economic growth.

Brazil is one of the largest and most developed countries in Latin America, but it also has a significant digital divide. According to a 2020 report by the Brazilian Institute of Geography and Statistics, only 66.5% of households in Brazil have access to the Internet, with even lower rates in rural areas [39]. This has significant implications for education, healthcare, and economic opportunities, particularly for those living in poverty.

While Bangladesh has made significant progress in expanding access to technology in recent years, there is still a significant digital divide in the country. According to a 2019 report by the Bangladesh Telecommunication Regulatory Commission, only 14% of the population has access to broadband Internet, with even lower rates in rural areas [40]. This has significant implications for economic development, as access to technology is increasingly necessary for job opportunities and economic growth. Overall, the digital divide is a significant negative consequence of technological innovation in development contexts, and it is important for policymakers and development practitioners to prioritize efforts to bridge this divide and ensure that everyone has access to the benefits of technology.

4.5. E-Waste

E-waste is a negative consequence of technological innovation in development contexts, and it refers to electronic devices that are discarded or no longer used. E-waste contains hazardous materials such as lead, mercury, and cadmium, which can be harmful to human health and the environment. Developing countries are often the destination for e-waste from developed countries, leading to significant negative consequences for these countries. Here are a few examples of specific countries and their involvement in e-waste.

China is one of the largest importers of e-waste in the world. According to a 2021 report by the Basel Action Network, China imported over 13 million metric tons of e-waste between 2015 and 2019, making it the largest importer in the world [41]. The importation of e-waste has led to significant environmental and health problems, including polluted air and water, and increased rates of cancer and other diseases.

India is another major destination for e-waste, with over 2 million metric tons of e-waste generated in the country each year [42]. Much of this e-waste is imported from developed countries, leading to significant negative consequences for human health and the environment. In addition, the informal recycling of

e-waste by workers in India has been associated with significant health risks, including exposure to toxic chemicals and heavy metals.

Ghana is one of the largest e-waste destinations in Africa, with over 215,000 metric tons of e-waste imported into the country each year [42]. The informal recycling of e-waste in Ghana has led to significant environmental and health problems, including polluted air and water, and increased rates of cancer and other diseases.

The United States is one of the largest generators of e-waste in the world, with over 6 million metric tons generated each year [43]. While the US has regulations in place to prevent the export of hazardous e-waste to developing countries, significant amounts of e-waste are still illegally exported to countries like China and India. Overall, e-waste is a significant negative consequence of technological innovation in development contexts, and it is important for policymakers and development practitioners to prioritize efforts to reduce e-waste and ensure that it is safely and responsibly managed.

4.6. Job Displacement

Technological innovation in development contexts has led to significant job displacement in many countries around the world. As technology becomes more advanced, many traditional jobs are becoming obsolete, and workers are being replaced by machines and automation. Here are a few examples of specific countries and how they are involved in job displacement due to technological innovation.

The United States has experienced significant job displacement in sectors such as manufacturing and retail due to technological innovation. For example, automation has led to the loss of millions of jobs in the manufacturing sector, and the rise of e-commerce has led to the closure of many brick-and-mortar retail stores.

China is one of the largest manufacturers of automation equipment in the world, and as a result, has experienced significant job displacement due to technological innovation. For example, the rise of automation in China's manufacturing sector has led to the loss of millions of jobs.

Germany is known for its advanced manufacturing sector, which has been heavily impacted by technological innovation. For example, the rise of Industry 4.0 has led to increased automation and digitization of manufacturing processes, leading to the loss of jobs in traditional manufacturing roles.

India has experienced job displacement in sectors such as agriculture and manufacturing due to technological innovation. For example, the use of automated farming equipment has led to the loss of jobs in agriculture, while the rise of automation in the manufacturing sector has led to the loss of millions of jobs. Overall, job displacement is a significant negative consequence of technological innovation in development contexts, and it is important for policymakers and development practitioners to prioritize efforts to support workers who are af-

ected by job displacement and to promote the development of new, sustainable job opportunities.

4.7. Cybersecurity

Cybersecurity threats in Africa pose significant challenges to technological innovation and development, and it is essential for policymakers and development practitioners to prioritize efforts to strengthen cybersecurity infrastructure and promote awareness of cybersecurity threats and best practices. The following is a critical analysis of the negative consequences of technological innovation in development contexts with a focus on cybersecurity in specific African countries. Africa has experienced significant growth in technology and innovation over the past few years. However, this has also led to an increase in cybersecurity threats, such as hacking, malware, phishing, and cyber espionage. The lack of adequate cybersecurity infrastructure and weak legal frameworks in many African countries has made them vulnerable to cyber-attacks, resulting in financial loss, reputational damage, and data breaches.

Nigeria has been hit hard by cybersecurity threats, with numerous reports of cyber-attacks on banks, government agencies, and other organizations. These attacks have led to the loss of valuable data, financial loss, and reputational damage [44]. Similarly, South Africa has also experienced significant cybersecurity threats, with attacks targeting critical infrastructure, including power grids and financial institutions. In addition, the country is grappling with the challenge of protecting personal data and privacy in the face of increasing data breaches [45].

Kenya has made significant strides in promoting technology-driven innovation, but it has also been the target of cyber-attacks. The country has experienced significant losses due to cyber-attacks on its financial sector, and there have also been concerns about data breaches affecting government systems [46]. Egypt has also been hit by cyber-attacks, with targets including government institutions, banks, and media outlets. In addition, the country faces challenges in balancing security concerns with the need to protect freedom of expression and access to information [47]. To address the negative consequences of cybersecurity threats, African countries need to prioritize efforts to enhance their cybersecurity infrastructure and legal frameworks. This includes investing in cybersecurity education and awareness, improving the capacity of law enforcement agencies to investigate and prosecute cybercrimes, and strengthening international cooperation on cybersecurity issues [48]. There is also a need for collaboration between the public and private sectors to develop and implement effective cybersecurity strategies and policies.

There are some countermeasures that can be taken to mitigate the negative consequences of technological innovation in development contexts. Firstly, it is important for policymakers to ensure that the benefits of technological innovation are equitably distributed among all members of society. As Appiah and Kyeremeh note, “the benefits of technological innovation should not be limited

to a privileged few but should be accessible to all, regardless of socioeconomic status.” To address the digital divide, it is important to provide training and support to those who may be less familiar with technology. Appiah and Kyeremeh note that “training and support programs should be provided to ensure that all members of society are able to benefit from technological innovation”. To address e-waste, it is important to ensure that technology is recycled and disposed of in an environmentally sustainable way. Appiah and Kyeremeh suggest that “governments and private organizations should invest in e-waste recycling facilities and implement policies to encourage responsible disposal of electronic devices.” While addressing job displacement, it is important to invest in retraining and education programs to prepare individuals for the changing job market. According to Appiah and Kyeremeh, “education and training programs should be developed to ensure that individuals have the skills and knowledge needed to succeed in a technology-driven economy.” [25]

It is important to ensure that technological innovation is implemented in a way that is environmentally sustainable. According to Appiah and Kyeremeh, “there is a need to ensure that technological innovation does not lead to further degradation of the environment.” It is important to ensure that the negative social consequences of technological innovation are identified and addressed. For example, Appiah and Kyeremeh suggest that “innovations that have negative consequences on social relations, such as cyberbullying and online harassment, should be discouraged and sanctioned appropriately.” Finally, it is important to involve local communities in the design and implementation of technological innovations, to ensure that the innovations are culturally appropriate and meet the needs of the local population. Appiah and Kyeremeh note that “local communities should be engaged in the innovation process, and their concerns and feedback should be taken into consideration.” [25].

5. Ethical Frameworks and Principles for Evaluating Technological Innovation in Development

In recent years, technological innovation has been identified as a critical driver of development. However, it is important to consider the ethical implications of technological innovation, particularly in the context of development. The rapid advancement of technology has also raised ethical concerns and challenges related to privacy, security, and access. To address these issues, ethical frameworks and principles have been developed to guide the evaluation of technological innovation in development.

5.1. Utilitarianism

One ethical framework that is commonly used to evaluate technological innovation is utilitarianism. Utilitarianism is based on the principle of maximizing happiness and minimizing suffering for the greatest number of people. In the context of technological innovation, utilitarianism can be used to evaluate the

impact of innovation on the well-being of individuals and communities. For example, if a new technology can improve access to healthcare for a large number of people, it would be considered ethical under the utilitarian framework [49].

5.2. Deontology

Another ethical framework that is commonly used is deontology. Deontology is based on the principle of duty, and it considers the intrinsic nature of actions rather than their consequences. In the context of technological innovation, deontology can be used to evaluate the ethical implications of the development and use of new technologies. For example, if a new technology violates individual privacy rights, it would be considered unethical under the deontological framework [50].

5.3. Virtue Ethics

Virtue ethics is an ethical framework that focuses on the character of individuals and communities. It considers how the development and use of technology can promote virtues such as honesty, integrity, and compassion. In the context of technological innovation, virtue ethics can be used to evaluate how technology can be developed and used in ways that promote the well-being of individuals and communities [51].

5.4. Feminist Ethics

Feminist ethics is an ethical framework that focuses on the experiences and perspectives of marginalized groups, particularly women. It considers how the development and use of technology can either reinforce or challenge systems of oppression. In the context of technological innovation, feminist ethics can be used to evaluate how technology can be developed and used in ways that promote gender equality and social justice [52].

5.5. Protecting Human Rights

One of the primary goals of ethical frameworks and principles is to ensure that technological innovation in development does not infringe on human rights. These frameworks aim to protect the right to privacy, freedom of expression, and other fundamental rights that may be threatened by the misuse of technology. For example, the Universal Declaration of Human Rights sets out basic principles that can be used to evaluate the impact of technological innovation on human rights.

5.6. Promoting Social Inclusion

Ethical frameworks and principles can also promote social inclusion by ensuring that technological innovation in development is accessible and affordable to all. These frameworks aim to reduce the digital divide and ensure that marginalized

communities are not left behind in the digital age. For example, the United Nations Sustainable Development Goals include a target to “significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020” [2].

5.7. Enhancing Security and Privacy

Ethical frameworks and principles can also help to enhance security and privacy in the digital age. These frameworks aim to ensure that technological innovation in development is used responsibly and does not pose a threat to national security or personal privacy. For example, the European Union’s General Data Protection Regulation (GDPR) sets out strict rules on the collection, use, and storage of personal data to protect the privacy rights of individuals [53].

5.8. Ensuring Sustainability

Finally, ethical frameworks and principles can ensure the sustainability of technological innovation in development. These frameworks aim to reduce the environmental impact of technology and promote sustainable development. For example, the principles of the circular economy can be applied to the design and development of technology to reduce waste and promote the reuse and recycling of materials [54].

Ethical frameworks and principles are essential for evaluating the impact of technological innovation on development. These frameworks can protect human rights, promote social inclusion, enhance security and privacy, and ensure sustainability. As technology continues to evolve rapidly, it is important to develop and apply ethical frameworks and principles to guide its responsible use and ensure that it benefits everyone in society.

The United Nations Sustainable Development Goals (SDGs) were adopted in 2015 as a global call to action to end poverty, protect the planet, and ensure peace and prosperity for all. Technology has been identified as a critical enabler for achieving the SDGs. However, the principle of technology justice must also be considered to ensure that the benefits of technology are distributed equitably. In this paper, we will analyze the United Nations Sustainable Development Goals (SDGs) and the principle of technology justice. The SDGs are a set of 17 goals and 169 targets that were adopted by the United Nations General Assembly in 2015. The goals cover a range of areas, including poverty, hunger, health, education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, reduced inequalities, sustainable cities and communities, responsible consumption and production, climate action, life below water, life on land, peace, justice and strong institutions, and partnerships for the goals.

5.9. The Principle of Technology Justice

The principle of technology justice is based on the idea that access to technology

and its benefits should be distributed equitably. It recognizes that technology can exacerbate existing inequalities if it is not developed and deployed in ways that benefit all individuals and communities. Technology justice also acknowledges the importance of participation and empowerment in the development and use of technology [55].

5.10. Analysis of the SDGs and Technology Justice

The SDGs and the principle of technology justice are closely related. The SDGs provide a roadmap for achieving sustainable development, and technology can be a critical enabler for achieving these goals. However, technology must be developed and deployed in ways that promote technology justice to ensure that the benefits of technology are distributed equitably.

For example, SDG 9 calls for the development of resilient infrastructure, inclusive and sustainable industrialization, and innovation. Technology can play a critical role in achieving this goal, but it must be developed and deployed in ways that promote technology justice. This could include ensuring that marginalized communities have access to technology and the skills needed to use it effectively, and that the benefits of technological innovation are shared equitably.

Similarly, SDG 7 calls for access to affordable, reliable, sustainable, and modern energy for all. Technology can play a critical role in achieving this goal, but it must be developed and deployed in ways that promote technology justice. This could include ensuring that communities that have been historically excluded from access to energy, such as those in rural areas or low-income communities, have access to affordable and sustainable energy solutions.

The United Nations Sustainable Development Goals (SDGs) and the principle of technology justice are closely related. Technology can be a critical enabler for achieving the SDGs, but it must be developed and deployed in ways that promote technology justice to ensure that the benefits of technology are distributed equitably. By prioritizing technology justice in the development and deployment of technology, we can ensure that the benefits of technological innovation are shared by all individuals and communities. The development and implementation of technological solutions for development bring about numerous benefits, including improved access to information, enhanced efficiency, and increased productivity. However, ethical considerations are critical in ensuring that these technological solutions are developed and implemented in a responsible and sustainable manner that takes into account the needs and interests of all stakeholders.

According to Johnson *et al.*, ethical considerations in the development and implementation of technological solutions for development include issues related to privacy, security, and data protection [56]. For instance, the use of mobile applications (apps) in healthcare has raised concerns about the privacy and security of patients' personal and medical information [57]. Therefore, developers of such apps need to implement robust data protection measures to ensure

the privacy and security of patient data.

Moreover, ethical considerations also relate to issues of accessibility and inclusivity in the development and implementation of technological solutions for development. For example, the use of apps for financial services may exclude individuals who do not have access to smartphones or the Internet [58]. Therefore, developers of such apps need to consider the needs of all stakeholders, including those with limited access to technology. Ethical considerations are critical in the development and implementation of technological solutions for development. Developers must ensure that their solutions are developed and implemented in a responsible and sustainable manner that takes into account the needs and interests of all stakeholders. Failure to do so may result in negative consequences such as privacy breaches, security breaches, and exclusion of certain groups from accessing these solutions.

6. Conclusions

The paper explores the potential of technology to promote development, as well as the ethical and social implications of technological innovation in the context of development. Technology has the potential to promote development by improving access to education, healthcare, and economic opportunities. However, there are several ethical and social implications of technological innovation, including inequality, the digital divide, e-waste, and job displacement. The arguments suggest that policymakers and organizations should take measures to ensure that the benefits of technological innovation are equitably distributed, and that access to technology is affordable and accessible to all members of society. Additionally, the authors suggest that training and support programs should be provided to ensure that individuals are able to benefit from technological innovation, and that responsible disposal of electronic devices should be encouraged to address e-waste. Finally, the authors suggest that education and training programs should be developed to prepare individuals for the changing job market and address job displacement.

The development and implementation of technological solutions for development require collaboration across different disciplines and the involvement of various stakeholders to ensure that these solutions meet the needs and interests of all involved. Interdisciplinary collaboration and participatory approaches are critical in achieving this goal and ensuring that technological solutions are sustainable and have a positive impact on society. According to Kensing *et al.*, interdisciplinary collaboration involves bringing together individuals from different disciplines to work on a common problem [59]. This approach ensures that technological solutions are developed from multiple perspectives and take into account the diverse needs and interests of stakeholders. Participatory approaches, on the other hand, involve involving stakeholders in the design, development, and implementation of technological solutions [60]. This approach ensures that technological solutions are user-centered and meet the needs of the communities

they are designed to serve. The benefits of interdisciplinary collaboration and participatory approaches in the development and implementation of technological solutions for development are numerous. These approaches enhance innovation, improve the quality of solutions, and ensure that solutions are sustainable and have a positive impact on society. Additionally, these approaches promote inclusivity and diversity, ensuring that technological solutions are accessible to all members of society. Interdisciplinary collaboration and participatory approaches are critical in the development and implementation of technological solutions for development. These approaches ensure that technological solutions are developed from multiple perspectives, are user-centered, and meet the needs of the communities they are designed to serve. Furthermore, these approaches promote inclusivity and diversity, ensuring that technological solutions are accessible to all members of society.

Conflicts of Interest

The author declares no conflicts of interest.

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