Leveraging Emerging Technologies for National Development in Nigeria

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**Abstract**

 *Various administrations in Nigeria have formulated development strategies aimed at fostering economic growth, advancing national development, and enhancing the overall quality of life for the populace. Nevertheless, the implementation of these development plans has been ineffective in facilitating the country's transition towards a trajectory of sustainable development. Presently, Nigeria is confronted with a multitude of obstacles, including but not limited to the issues of kidnapping, banditry, pervasive hunger and poverty, corruption, inadequate infrastructure, and unemployment. The objective of this study is to analyse the contributions of new technologies in promoting national development in Nigeria. During the discourse, the subjects of national development and rising technologies were deliberated upon. The study also investigated the potential of these technologies to facilitate socio-economic progress in Nigeria. The study ultimately asserts that Nigeria has the potential to achieve substantial advancements in national development, economic diversification, governance, and the overall well-being of its population by embracing and properly harnessing technological advancements.*

**Keywords:** Emerging Technology, Leveraging, National Development, Artificial Intelligence, Big Data, Blockchain Technology

**Introduction**

Development is a complex notion with varying connotations based on context. To the uninitiated, the phrase means to grow or extend. The definition of development is a "comprehensive societal process to move the underdeveloped nations from their state of economic backwardness and slow sociocultural change to a dynamic state characterised by sustained economic growth and socio-cultural and political trans-formation that improves the quality of life of all members of society (Rabiu, 2016 p.8)". According to Ebeh (2015), development is a multi-dimensional process that incorporates the full person, including his political, economic, psychological, and social realities. Rabie (2016) defines development as "the process of putting specific economic and technical measures in place to make the best use of existing resources to spur economic growth and improve people's quality of life." Rabie went on to say that development is a vision as well as a programme focused on improving and reforming the economic, political, and socio-cultural conditions to accomplish the desired visions.

Development, from the standpoint of a nation, is the government's actions and visions aimed at improving the living standards of its population and industrialising the nation. Based on their level of development, countries are classified as developed or developing (Lawal & Abe, 2017). This classification of countries is based on their populations' economic standing, industrialization, and standard of living. Developed countries are industrialised nations with strong economies and cutting-edge technology. Developing countries, on the other hand, have a low per capita income and a slow rate of industrialization. According to Lawal and Abe (2017), the vast majority of people in emerging countries are impoverished. Rabie (2016) also observed that developing-country governments have developed development plans to improve their economies and enhance meaningful development.

In Nigeria, successive governments have devised development plans to boost the economy, develop the country, and raise people's living standards (Iheanacho, 2014; Shuaibu, 2020). However, according to Shuaibu (2020), these growth goals have failed to move the country forward. Shuaibu went on to say that the country is still dealing with issues like kidnapping, banditry, widespread hunger and poverty, corruption, a lack of infrastructure, and unemployment.

According to research, technology can assist poor countries in growing their economies and achieving development (Ally & Wark, 2020). They observed that upcoming technologies such as artificial intelligence, the Internet of Things, blockchain, robotics, and others can help expedite development in developing nations, ultimately closing the development gap. This study investigates the significance of new technologies on national development, with a particular emphasis on Nigeria.

**Concepts of National Development**

National development is the ability of a country's government to improve the living conditions of its population. According to Lawal and Abe (2017), national development is the total advancement of a country's or nation's collective socioeconomic, political, and religious advancement. Nkwocha (2016) defined national development as the collective activities of every human community aimed at eliminating the sum of perceived barriers to a higher standard of living, hence maximising residents' quality of life. Similarly, BYJU (2020) defined national development as a country's ability to increase the standard of living of its population through the provision of basic means of livelihood. National development is a process of societal advancement in which people's well-being is improved by a strong relationship between all levels of government.

According to Lawal and Abe (2017), national development can be best achieved through development planning, which can be defined as the country's development strategies. Development is a process that results in progress and beneficial improvements. Economic growth, increase in worker income, literacy rate, health care, and public services are all indicators of development. According to Lawal and Abe (2017), for a country to be defined as developed, it must exhibit the following characteristics:

i. A high level of life.

ii. High agricultural productivity.

iii. High technical productivity.

iv. Adequate exploration of the society's natural and mineral resources.

v. Less reliance on imported commodities.

vi. The presence of heavy industries.

vii. The population's high literacy and numeracy rates.

viii. Appropriate health-care delivery.

ix. Low unemployment.

**National Development Plans in Nigeria**

The inaugural national development plan in Nigeria was initiated in 1962, following the country's attainment of independence. Its primary objective was to bolster economic expansion and reduce reliance on foreign forces for national development. The second national plan implemented by the Gowon administration prioritised the fundamental concepts of social justice, equity, and peaceful coexistence, to foster a united Nigeria characterised by self-sufficiency and a robust culture of mutual respect. The third national development plan was launched by the Muritala Muhammad government in 1975. Its primary goals encompassed rural electrification, universal free primary education, specialised agricultural development skills, research and development in livestock and veterinary sciences, urban housing, health services, water supplies, and various other social development programmes (Shuaibu, 2020).

The fourth national development plan, formulated under the administration of Shagari in 1981, placed significant emphasis on various key areas, including industry, education, economic infrastructure, personnel development, enhanced income for the general populace, technological advancement, and the cultivation of strong work ethics. The Babangida administration introduced the fifth national development plan to address inherent flaws in the economy, fostering economic diversification, revitalising the agricultural sector, facilitating job creation, enhancing domestic production of raw materials for local industries, and improving the overall quality of life for the populace. This development plan was subsequently incorporated into the Structural Adjustment Programme (SAP) as documented by Shuaibu (2020).

The government led by Obasanjo introduced several economic initiatives, such as the National Economic Directive and the National Economic Empowerment and Development Strategy (NEEDS). The initiatives were designed to foster a robust economy, generating employment opportunities, enhancing infrastructure, advancing healthcare and education, and optimising the provision of social services, among other objectives. The Yar'adua government initiated Vision 20:2020, a transformative agenda aimed at enhancing the quality of life for individuals and positioning the country as one of the top 20 global economies by the year 2020. The administration devised a comprehensive seven-point programme encompassing power and energy, food security, wealth growth, land reforms, transportation, security, and education as key areas of focus. The Jonathan administration also implemented the transformation agenda, aiming to address many socio-economic challenges such as poverty reduction, employment generation, promotion of agriculture, support for small and medium enterprises, enhancement of security measures, and anti-corruption efforts.

The Economic Recovery Growth Plan (ERGP) formulated by the Buhari administration aimed to facilitate the recovery of the economy from a period of recession, speed up development, and restore sustainable growth. The aims of the plan encompassed the transformation of the economy, job creation, manpower development, infrastructure provision, and fostering digital-led growth (Shuaibu, 2020). The national development plan was introduced in 2021 as a continuation of the Economy Recovery Growth Plan during the administration of President Buhari. The objective of the plan was to generate employment opportunities, enhance quality of life in Nigeria, enhance the electricity supply, and develop infrastructure, among other goals. Despite the concerted efforts and substantial allocation of resources by various governmental bodies, the implementation of many development plans in Nigeria has been ineffective in effecting transformative change and enhancing the overall quality of life for its citizens. The nation is confronted with a multitude of obstacles, including but not limited to, the issues of kidnapping, banditry, terrorism, poverty, famine, corruption, unemployment, and an inadequate healthcare infrastructure. Therefore, it is imperative to utilise technology to effectively tackle these difficulties.

**Emerging Technology**

The concept of emerging technology has been employed in different academic areas. Researchers have endeavoured to establish a comprehensive understanding of the term by examining its various dimensions, including its inventive characteristics, practical applications, and societal implications. According to Srinivasan (2008), the concept of emerging technology pertains to a scientific invention that has the potential to establish a novel industry or bring about significant changes within an already established industry. According to Cozzens et al (2010), the term "emerging technology" refers to a scientific invention that has not yet been completely utilised to its maximum potential. According to Stahl (2011), emerging technologies can be defined as technologies that are expected to have social relevance within the next 10 to 15 years. According to Veletsianos (2010), the concept of emerging technology can be characterised by examining its inherent characteristics, as illustrated in the Figure 1

**Results**

**Table1: Demographic Characteristics of the Respondents**

**Figure 1** Meaning of Emerging Technology

*Source:* Veletsianos (2010)

According to Veletsianos (Figure 1), emerging technology encompasses a range of elements such as tools, concepts, ideas, knowledge, hardware, or software. These elements, whether novel or pre-existing, are employed to enhance, transform, and exert impact on society, while also providing resolutions to unresolved issues. According to Veletsianos's definition, it can be inferred that the term "emerging technology" does not exclusively relate to new technologies. Rather, it can also encompass older technologies that have not been completely utilised, depending on the specific environment in which they are employed. Certain technologies may not be considered as emerging inside industrialised nations but may be emerging within developing or underdeveloped nations where technological advancements are still limited. Likewise, the emergence of technologies in the educational sector may not align with the emergence of technologies in more technologically advanced sectors such as the Information Technology (IT) sector. Veletsianos's concept further elucidates the dynamic nature of emerging technologies, highlighting their ongoing evolution. The emergence of new technology can be attributed to the modification and advancement of old technology to enhance its overall performance. The Fifth-Generation Wireless (5G) technology is derived from the advancements made in the development of the Fourth-Generation Wireless (4G) technology.

According to Rotolo et al. (2015), emerging technology can be characterised as a novel and swiftly advancing technology that maintains a consistent structure over time and possesses the capacity to have a substantial impact on the socio-economic sphere. This impact can be observed in terms of the composition of individuals and organisations involved, the establishment of institutions, and the patterns of interactions between these entities. Additionally, emerging technology is also associated with the generation of new knowledge. However, due to the delayed manifestation of its primary impact, the current stage of its development remains uncertain and unfamiliar. Rotolo et al. (2015) identified five key features associated with emerging technologies. These traits include radical innovation, which refers to the significant departure from existing technologies; relatively fast growth, indicating the rapid development and adoption of the technology; coherence, which refers to the internal consistency and logical structure of the technology; prominent impact, highlighting the significant effects and influence of the technology on various domains; and uncertainty and ambiguity, indicating the lack of clear understanding and predictability around the technology's future trajectory.

 According to Küfeoğlu (2022), emerging technologies can be characterised as technologies that are experiencing rapid expansion in terms of research and application sectors, while their technical and value potential remains largely untapped. According to Küfeoğlu (2022), emerging technologies encompass novel technological advancements as well as the outcome of the convergence of several systems that are moving towards similar objectives. Upgraded technology may be incorporated as a consequence of enhancing pre-existing technology. The utilisation of established technology in a novel domain has the potential to facilitate its emergence. Küfeoğlu (2022) provided a comprehensive list of developing technologies, including artificial intelligence, blockchain, augmented reality, virtual reality, digital twins, the Internet of Things, cloud computing, 5G, and big data.

Artificial Intelligence

The concept of artificial intelligence was initially formulated by Alan Turing in his publication titled "Computing Machinery and Intelligence," while it was officially coined as a word by John McCarthy in the year 1955 (Küfeoğlu, 2022). Artificial Intelligence, also referred to as machine intelligence, is a field within computer science that focuses on the examination and creation of intelligent agents capable of perceiving their surroundings and making decisions to optimise their likelihood of achieving desired outcomes (Sing, Mishra & Sagar, 2013). According to Küfeoğlu (2022), artificial intelligence is characterised as a computational framework capable of gathering data, acquiring knowledge, making decisions, and executing logical actions through the utilisation of various techniques such as machine learning and deep learning.

According to Küfeoğlu (2022), machine learning and deep learning play a crucial role in the development and functioning of artificial intelligence systems. Figure 2 illustrates that artificial intelligence encompasses various technologies, including expert systems, robotics, and human interface. Artificial intelligence is realised by techniques such as machine learning, deep learning and so on. Machine learning is a fundamental aspect of artificial intelligence that is responsible for acquiring knowledge and making predictions by analysing gathered data. Machine learning encompasses three main types: supervised learning, unsupervised learning, and reinforcement learning. The field of machine learning has exhibited ongoing development and is poised to further revolutionise society. According to Küfeoğlu (2022), deep learning is a computational framework that uses neural networks to emulate human speech and cognitive processes. This tool has applications across various disciplines. There is a wide range of artificial intelligence products already accessible in the market that can facilitate, expedite, and occasionally even preserve human lives (Küfeoğlu, 2022). Artificial intelligence (AI) is a technological field that is poised to undergo further development and exert significant influence on society in the coming years. This technology is anticipated to be utilised in various applications within the context of the fourth industrial revolution, characterised by the integration of robots and humans, digital collaboration without constraints, and the ability to make informed decisions.



Figure 2 Relationship between AI, ML and DL

Source: Küfeoğlu (2022)

**Big Data**

The widespread use of mobile device technology and the expansion of social media platforms have resulted in a surge in the quantity of data generated on a global scale. Most of the data generated is comprised of textual content, videos, audio recordings, and photographs. The presented data exhibit a suboptimal structure and may be beyond the capabilities of conventional data processing tools or relational database management systems. According to Riahi and Riahi (2018), there is a lack of consensus over the definition of the phrase "big data" due to variations in its conceptualization among different stakeholders within the information and communication technology area. According to their perspective, the concept of "big" within this context may be subject to varying interpretations. Küfeoğlu (2022) posits that big data encompasses both structured data derived from organisational databases and unstructured data generated by emerging communication technologies, including mobile devices, the Internet of Things, and social media platforms, among others. The term "big data" encompasses a massive and complex collection of datasets that exceed the capabilities of typical data processing tools and relational database management systems in terms of analysis, management, and timely recording.

In a recent study, Batko and Slezak (2022) described big data as an extensive collection of datasets that surpasses the capacity for storage, processing, and analysis using conventional technologies. The authors assert that the data in question exhibit a lack of a clearly defined structure, rendering it exceedingly challenging for organisations to effectively search and analyse them. Consequently, tailored technology and methodology are necessary to convert the data into valuable insights. Big data encompasses a wide range of data sources, such as online transactions, videos, photos, audio recordings, emails, log files, clickstreams, social media posts, interactions on social networking platforms, scientific data, health records, sensor data, search queries, and data generated by mobile phones and its associated applications (Küfeoğlu, 2022). In addition to the aforementioned, certain scholars have delineated big data using attributes such as volume, velocity, and variety, commonly referred to as the 3V paradigm (Riahi & Riahi, 2018; Küfeoğlu, 2022).



**Figure 3** Three Vs of big data

*Source:* Riahi & Riahi, (2018)

The volume refers to the quantity of data that is generated, saved, and processed within the system. The observed rise in volume can be attributed to the corresponding increase in the quantity of data that is being generated and subsequently stored. Velocity pertains to the rate at which fresh data is produced, acquired, and disseminated from various sources, including social media and the Internet. Nevertheless, a significant obstacle lies in the effective and real-time management of the generated data (Batko & Slezak, 2022). Variety pertains to the diverse range of data that is handled by an information system. The data that is saved can exhibit various levels of structure, ranging from fully structured to semi-structured or completely unstructured. Structured data refers to data that has been organised in a manner that facilitates analysis, whereas unstructured data includes material that presents challenges in terms of analysis, such as videos, images, and audio files (Küfeoğlu, 2022). According to Batko and Slezak (2022), the notion of big data is subject to ongoing development and is anticipated to significantly impact organisational practices in the future.

Blockchain Technology

In recent times, there has been a significant amount of interest directed at blockchain, which serves as the underlying technology behind Bitcoin. According to Küfeoğlu (2022), blockchain is a technology protocol that facilitates the sharing of data through trusted-based transactions, such as identification and authorization, within a decentralised dispersed network environment. This is achieved without the requirement of consent or control from a central authority. According to Ocheja et al. (2019), blockchain is perceived as a decentralised and dispersed peer-to-peer network that incorporates a singular immutable public ledger including all transactions executed by participants inside the network. Every individual involved in the distributed network is assigned a distinct set of public-private keys for identification purposes. The utilisation of a public key enables public identification, whereas the owner's authorization of transactions necessitates the use of a private key. The possessor of a private key can assert ownership over an item that has been encrypted using the corresponding public key. A transaction generally consists of three main components: the public key of the sender, a data field, and the hash value of the previous transaction. Within the context of blockchain technology, transactions are systematically recorded and stored in discrete units known as blocks. Notably, each freshly generated block is intricately linked to its preceding block through the utilisation of a distinct identification number known as a hash.



**Figure 4:** Blockchain technology working principle.

Source: Küfeoğlu (2022)

Blockchain technology offers a range of benefits, including enhanced security, transparency, expedited processing, cost-effectiveness, and a decentralised structure.

i. Blockchain technology enhances security by employing cryptographic techniques to safeguard the data stored within the network. The enhanced security of blockchain is attributed to its decentralised nature, which is complemented by the implementation of encryption techniques. The blockchain technology is characterised by its decentralised nature and its resilience against cyberattacks. The alteration of historical ledger records or the duplication of transactions (often referred to as double-spending) is unattainable due to the permanent recording and storage of all network transactions. This phenomenon undoubtedly fosters a sense of mutual trust. Blockchain technology has the potential to be utilised in several applications such as congestion management through the integration of electric vehicles into grid services, safe registration of energy data in an open ledger, and facilitating processes like billing, provider switching, and capacity swapping (Dena, 2019).

ii. Transparency: The blockchain database is accessible to all individuals, not limited to its users. Consequently, the control is perceptible. The information about a block's transactions, wallet addresses, transaction ID (shipping code), and quantities is accessible to all individuals. Open blockchain networks are characterised by their inherent openness. In the context of the Bitcoin network, it is feasible to get a comprehensive record of all the blocks generated thus far, along with the corresponding transactions conducted within them. Access to transaction information is facilitated through the utilisation of Blockchain.com.

iii. Rapid and Cost-Effective Nature: Blockchain technology surpasses conventional approaches in terms of its expeditiousness and affordability in various domains such as healthcare, the food industry, forensic investigations, and international corporate record- keeping. One compelling rationale for this phenomenon is the efficient and economical transmission of data between individual users. Transactions, particularly those of an international nature, are executed within seconds as opposed to a span of weeks.

iv. One of the ground-breaking aspects of blockchain technology is its decentralised nature, wherein transactions are processed concurrently by several computers. All computer systems are interconnected inside a shared network known as a peer-to-peer network (P2P). The model in question is commonly known as the "distributed trust model." The distributed architecture guarantees the replication of data among numerous nodes within the network. Transparency facilitates the monitoring of all transactions conducted within the network. The presence of immutability hinders the processing of data generated for the blockchain. Given its various characteristics, blockchain technology emerges as a potential contender for serving as the fundamental infrastructure of the novel Internet framework. Blockchain technology presents innovative advancements that hold the capacity to revolutionise the Internet and have far-reaching implications on a global scale. According to Küfeoğlu (2020), individuals can engage in peer-to-peer energy trading platforms facilitated by blockchain technology, enabling them to exchange surplus energy and engage in the buying or selling of carbon credits.

**Autonomous Cars**

Autonomous cars refer to vehicles that possess the capability to execute their tasks through artificial intelligence algorithms included inside their systems. These vehicles possess the ability to see their surroundings and operate independently, without requiring any human intervention. The rapid pace of technology advancements has led to notable advancements in the field of autonomous vehicle development. The automobile industry has made notable advancements in the mechanical and electrical attributes of vehicles, particularly starting from the 1920s.

The concept of autonomous vehicles has been widely regarded as a prominent goal in this domain. During the period from 1920 to 1980, some automotive companies and academic institutions undertook multiple endeavours to establish a leading role in the development of autonomous vehicles. According to Davidson and Spinoulas (2015), one of the early demonstrations in the 1920s used a radio-controlled driverless automobile. The significant advancements in the realm of science and technology throughout this era have played a pivotal role in shaping the landscape of autonomous vehicles, spanning from the 1980s to the present day.

The concept of autonomous vehicles has been contemplated since ancient times, but it was not until the 2010s that the necessary technological advancements were made, and practical progress was achieved. The operational framework of autonomous cars includes several extensively utilised components, including intricate artificial intelligence algorithms, high-performance computing devices, as well as sensors and actuators (Gowda et al., 2019). The integration of GPS (global positioning system), LIDAR (light detection and range), RADAR (radio detection and ranging), and video camera technologies has been reported by Ondruš et al. (2020). GPS plays a crucial role in assisting various stakeholders, such as car users, municipalities, and technology-driven enterprises, in the realm of transportation planning. By harnessing the mapping capabilities and data-driven functionalities of GPS, these entities can effectively navigate and optimise their transportation systems (Bayyou, 2019). Hence, the integration of GPS technology into autonomous cars has the potential to enhance vehicle efficiency using intelligent route optimisation strategies and the acquisition of environmental data. Furthermore, lidar may be described as a remote sensing technique utilised to determine the distance to a target by illuminating it with light particles and subsequently detecting the reflected light (Ondruš et al., 2020).

**Cloud Computing**

Cloud computing is a technological innovation that offers flexible and scalable computing methods to meet the diverse information technology needs provided through different service models via the Internet. Additionally, this method provides a convenient means of sharing files with individuals and engaging in collaborative work with them using online platforms, utilising personal computers or network servers. The act of sharing can occur in either a private or public context. Cloud computing technology typically consists of multiple interconnected clouds, which establish communication with each other using application programming interfaces and web services (Mirashe & Kalyankar, 2010).

 Cloud computing has gained significant popularity among scholars, citizens, and governments in contemporary times. One contributing factor to this phenomenon is that when the memory capacity of personal computers becomes saturated, it inadvertently hampers their operational speed and overall performance. In order to mitigate this issue, individuals establish personal accounts by moving their data to high-capacity computer systems through the utilisation of the Internet. Hence, it is possible to have both storage capacity and computational power without compromising the memory of the personal computer. Cloud storage, as a sub-discipline of cloud computing, emerges as a means to alleviate the workload on user terminals, which is a primary objective in the realm of cloud computing.

Cloud storage services offer the dual functionality of data storage and business accessibility. The system comprises essential storage devices, consolidating them within the application programme for utilisation. Therefore, it can be regarded as a cloud computing system that is accountable for the storing of extensive amounts of data (Liu & Dong, 2012). Several firms, including Microsoft Azure, Amazon Web Services (AWS), Rackspace, and GoGrid, offer specialised cloud computing services (Chopra, 2017). These services can be advantageous to individuals of all backgrounds, as they are accessible through a monthly subscription cost. This service can be conceptualised as the provision of remote access to a computer system characterised by exceptional memory capacity and superior performance, hence enabling customers to utilise computing resources located at a considerable distance from their physical location. It is extremely handy because it does not require physical hardware to execute computation or storage. According to Huth and Cebula (2011), the data can be accessed from any location and at any time, provided that an Internet connection is available, due to its storage and the availability of other resources on the Internet.

Cloud computing offers customers convenience and user-friendliness, although it is characterised by a modular architecture and operates on a distinct operating system. Hence, to gain a comprehensive understanding of the concept of cloud computing, it is important to acquire knowledge on the process of selecting cloud service providers. First and foremost, it is imperative to discuss the concept of cloud providers. Each service provider offers distinct functionality that grants consumers varying degrees of control, contingent upon the type of provider. Hence, the selection of an appropriate provider assumes significance. There are three types of cloud, and they are the public cloud, the private cloud and the hybrid cloud. The public cloud is readily accessible to all users that possess an Internet connection. A private cloud infrastructure is established to cater to the needs of a group or an organization. This cloud infrastructure is only accessible to a specific group and/or organisation. Community clouds can be jointly utilised by multiple organisations that possess comparable requirements. Hybrid clouds are created through the amalgamation of many clouds, which may consist of either diverse or identical types (Abualkibash & Elleithy, 2012).

**3D Printing**

The process of 3D printing, which is sometimes referred to as additive manufacturing (AM), involves the production of a three-dimensional object with various shapes using a three-dimensional model or electronic data sources. This is achieved by depositing material in layers under the precise supervision of a computer (Dongkeon et al., 2006). Additive manufacturing involves the construction of products in a layer-by-layer approach, starting from the bottom. The layers are generated within the slicing programme by utilising a three-dimensional computational model of the object that is intended to be printed. The development of computational models is commonly carried out within computer-aided design (CAD) software, with subsequent exportation of these models in the form of .stl or .obj files for 3D printing. Like numerous other modern technologies, 3D printing exhibits both advantageous and detrimental outcomes.

The technology of 3D printing has gained significant popularity due to its widespread accessibility, enabling users to produce various things within the confines of their own homes, utilising personal equipment. Moreover, this technology has the added advantage of relieving manufacturers from the burdens associated with logistics and energy consumption, as it affords consumers the opportunity to create products in their homes, using their devices. Nevertheless, the utilisation of 3D printing technology by individuals has the potential to result in job displacement for people involved in the sub-production phases of the manufacturing process. Notwithstanding this, the technology of 3D printing presents a plethora of possibilities for innovation and streamlined manufacturing processes. The field of 3D printing has undergone significant advancements since the inception of the first 3D printer in 1984 (Küfeoğlu, 2022). Over time, these printers have become increasingly versatile and efficient, while simultaneously becoming more affordable for consumers.

Rapid prototyping finds applications across diverse industries such as research, engineering, the medical sector, the military, construction, architecture, fashion, education, and the computer business among numerous others. The plastic extrusion process commonly referred to as "3D printing" was first developed under the name "fused deposition modelling" (FDM) in the year 1990 (Küfeoğlu, 2022). The sales of 3D printing machines have experienced a substantial surge in the twenty-first century, accompanied by a consistent decline in their price. During the early 2010s, the terms "3D printing" and "additive manufacturing" emerged as interchangeable phrases to describe technologies related to AM. The former gained popularity among consumer-maker communities and the media, while the latter was officially adopted by industrial AM end-use part producers, AM machine manufacturers, and global technical standards organisations.

**5G Technology**

The 5G technology represents a modern innovation that provides novel interfaces to both end-user devices and network components. The pursuit of 5G technology arises from the swiftly evolving aspiration to construct a profoundly interconnected and globalised society, whereby the availability of information and data is readily accessible to anyone worldwide. Technological advancements aimed at improving access to information and data have undergone substantial enhancements, with ongoing development of novel technologies to rectify the limitations of preceding versions. The fifth generation (5G) of wireless communication technology is anticipated to rectify the limitations of its predecessor, 4G, and enhance the advancements first envisioned by 4G.

According to Gupta and Jha (2015), 5G technology offers several advantages over 4G, including increased capacity and data throughput, reduced latency, enhanced device connectivity, decreased prices, and improved quality consistency. The implementation of 5G technology enables the concurrent connection of a larger number of wireless technology users to more advanced and efficient predecessors, resulting in enhanced speed and intelligence. The utilisation of 5G technology enables network connectivity through Internet technology that is tailored to meet the specific requirements of power, battery life, size, and cost for applications related to the Internet of Things (IoT). The advent of 5G technology presents a novel and advanced technological solution in the realm of wireless technologies. It introduces unprecedented opportunities for mobile connectivity that is beyond the current capabilities, hence enabling the utilisation of new applications across diverse scenarios (Painuly et al., 2020).

**Role of Emerging Technologies in National Development in Nigeria**

i. Artificial Intelligence (AI) and Machine Learning have the potential to augment decision- making processes, optimise resource allocation, and promote efficiency across various sectors. In the Nigerian context, artificial intelligence (AI) has the potential to be utilised across various sectors, including healthcare, agriculture, and public administration. Specifically, AI may contribute to healthcare by aiding in the diagnosis and treatment of medical conditions. In the agricultural sector, AI can be leveraged to anticipate crop yields and effectively manage pest control. Additionally, AI can enhance public administration by facilitating automated service delivery and enabling efficient data analysis.

ii. The Internet of Things (IoT) is a technological framework that allows for the interconnection of various devices and sensors, hence enabling the seamless collection, monitoring, and control of data. In the Nigerian context, the Internet of Things (IoT) has the potential to be effectively employed in several sectors such as agriculture, transportation, and infrastructure management. Specifically, IoT may be leveraged in agriculture to enhance productivity through the implementation of smart farming techniques and efficient irrigation systems. In the transportation sector, IoT can contribute to improved traffic management and vehicle tracking systems.

iii. Blockchain technology provides a robust and transparent system for managing data, thereby promoting trust and accountability. In the Nigerian context, the use of blockchain technology can be observed in various domains, including finance, supply chain management, and governance. In the realm of finance, blockchain offers enhanced security and efficiency in conducting transactions. Similarly, in supply chain management, blockchain facilitates traceability and aids in the prevention of fraudulent activities. Furthermore, blockchain may contribute to governance by establishing transparent voting systems and maintaining accurate land registries.

iv. Renewable Energy Technologies: Nigeria possesses ample renewable energy resources, and the use of technologies such as solar, wind, and hydropower has the potential to mitigate the energy shortfall, foster sustainability, and stimulate economic development. Investments in the development and establishment of renewable energy infrastructure, as well as the allocation of resources towards research and development in this field, have the potential to yield several positive outcomes, including enhanced energy accessibility and the generation of employment opportunities.

v. The utilisation of data analytics and big data in Nigeria has the potential to yield significant insights that can inform decision-making processes based on empirical evidence. Nigeria has a substantial volume of data, making it an ideal candidate for leveraging data analytics techniques to extract valuable information. The use of big data applications can be observed in various sectors, including healthcare, urban planning, and education. In the healthcare domain, big data is employed for disease surveillance and prediction. Similarly, in the field of urban planning, big data is utilised for tasks such as traffic management and infrastructure construction. Lastly, in the realm of education, big data applications are employed for personalised learning and the analysis of student performance.

vi. The implementation of 5G networks has the potential to significantly transform connections, facilitating enhanced communication that is both faster and more dependable. The implementation of 5G technology in Nigeria, has the potential to facilitate progress in various domains, including but not limited to e-commerce, telemedicine, virtual reality, and remote education. This advancement can contribute to inclusive growth and foster creativity.

vii. The integration of robotics and automation has the potential to significantly improve production, efficiency, and safety in various industries. In the Nigerian context, the technologies have the potential to be used across several sectors such as manufacturing, healthcare, and agriculture. The industry can benefit from the adoption of automated production lines. The healthcare sector stands to gain from the utilisation of surgical robots and telemedicine. Lastly, the agricultural sector can leverage autonomous farming and harvesting techniques to enhance productivity and efficiency.

**The Way Forward**

To effectively harness emerging technologies for national development in Nigeria, the following measures can be implemented:

1. Both the government and private sector must allocate resources towards the enhancement of essential physical and digital infrastructure elements, such as broadband connectivity, power supply, and data centres. These investments are crucial for facilitating the successful integration and utilisation of emerging technologies.

2. The promotion of research and development in emerging technologies is of utmost importance to stimulate innovation and cultivate domestic capabilities. The synergy of academia, industry, and research organisations has the potential to foster technical progress that is specifically attuned to the unique requirements and obstacles faced by Nigeria.

3. The topic of discussion pertains to policy and regulatory frameworks. It is imperative to establish rules and regulations that are conducive to innovation, safeguard intellectual property rights, and guarantee the confidentiality and integrity of data. The government must establish a conducive atmosphere that facilitates the responsible integration and implementation of developing technology.

4. The cultivation of a proficient labour force that possesses the ability to effectively utilise developing technology is of utmost importance in the realm of skill development and education. Educational institutions must integrate pertinent courses and training programmes that specifically address developing technology. Additionally, the implementation of continual professional development initiatives can effectively assist professionals in adapting to the ever-changing demands of their respective fields.

5. Public-private partnerships (PPPs) have emerged as a means of fostering collaboration among the government, corporate sector, and academics to expedite the implementation and utilisation of innovative technology. Public-private partnerships (PPPs) have the potential to facilitate investments, foster information exchange, and promote collaborative initiatives aimed at harnessing emerging technology for the advancement of a nation's development.

6. Encouraging the proliferation of startups and entrepreneurial endeavours within the technology industry has the potential to foster innovation and generate employment prospects. Various initiatives, such as the implementation of incubation programmes, provision of finance support, and facilitation of mentorship opportunities, have the potential to cultivate a robust ecosystem conducive to the growth and success of technology entrepreneurs.

**Conclusion**

Since gaining independence, Nigeria has witnessed the implementation of numerous development initiatives by succeeding governments. The implementation of these development plans has been ineffective in facilitating the country's transition towards a trajectory of sustainable development. According to various economic and social indicators, the Nigerian economy is currently experiencing a period of stagnation or decline. The economy exhibits significant levels of unemployment, pervasive poverty, low literacy rates, declining social and physical infrastructure, technological underdevelopment, urban overcrowding, an unsustainable debt load, sluggish growth in agricultural output, and a high incidence of diseases. The utilisation of technology possesses the capacity to facilitate advancement across all sectors of the nation and stimulate economic growth. This phenomenon is apparent in nations such as China and India. The Nigerian government ought to strategically utilise emerging technologies to facilitate national development inside the country. This can be achieved by the implementation of appropriate policies and substantial investments in human capital and infrastructure, which would effectively promote the integration and widespread acceptance of these technologies. Nigeria can foster economic growth, social empowerment, and sustainable development by embracing and effectively using emerging technologies.

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