



Application of Emerging Technologies for Innovation in Nigeria: Prospects and Challenges in Post Covid-19 Era

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ABSTRACT

Covid-19 pandemic has undoubtedly upset completely the world and thus resulting in the new normal. The restriction orders and closure of borders demand efforts for survival and self-reliance strategies for every country most especially the developing countries like Nigeria. African leaders should endeavour to leverage the lessons from Covid-19 to ensure strong economies that can withstand unforeseen future. Nigeria as a nation has long been confronted with developmental challenges resulting in stunted economic growth, ailing infrastructure and poor health system. Emerging technologies are now a recurring terms globally with applications increasing more than ever even beyond imagination. Some of these technologies include artificial intelligence (AI), and machine learning (ML), Block chain, 3D Print, Mobile, Autonomous Cars, Mobile Internet, Robotic VR/AR, Wireless power, Quantum Computing, 5G, Voice Assistant, Cybersecurity, Cloud, robotics, etc. With the availability of these new technologies, there can be tremendous impacts as they serve as veritable tools for transformation if well harnessed. This paper examines the prospects of applying these emerging technologies in Nigeria viz-a-viz Security, preservation and conservation, education and training, research and development, health and medical care, maintenance and monitoring, infrastructure management and business automation. It also looks at the challenges hindering effective utilization of these technologies. Such challenges include electrical power supply, network connectivity, availability of devices, skills and misconception. This knowledge can help in policy formulation and planning for economic development. This is very relevant now as the nation struggles to cope with challenges of post covid-19 era.

KEYWORDS: Artificial Intelligence, Innovation, Internet of Things and Technologies.

1. INTRODUCTION

For many developing countries, Covid-19 pandemic has shown the need to develop home-grown technology more than ever before, not only for the revolution of health sector but survival of overall economy as well. While some of these countries in sub-Sahara Desert with poor health facilities and medical cares were naturally favoured to have escaped the onslaught of the pandemic, there is need to wake up and develop facilities and infrastructures to mitigate against future re-occurrence. It is a signal call to harness innovative technology for national development. In addition to this is the fact that there is huge infrastructure deficit begging for expertise solution and massive investment to accelerate economic growth in Nigeria coupled with high unemployment rate. One way to solve the problem is to leverage on Covid-19 challenge and conceive an appropriate technology to support day-to-day task through creative and innovative technology. With lockdown measures and restrictions of movements to curtail the spread of coronavirus, the abrupt change necessitates proactive approach to tackle such challenges at minimum time in the future. Innovation is the core thing that is going to determine the development of any society and organisation in post covid-19 era. From education sector to health sector, it is obvious that disruptive innovation is making tremendous impact in the society. Some tools such as Artificial Intelligence, robotics, virtual reality, augmented reality, RPA, IoT, have expanded the horizon of technologies both at home and industries. They have also redefined the way enterprises and organizations function, innovate and enhance their customer relations through better services, products and experiences (Preetipadma, 2020).



Technology is fast changing the way of doing things beyond imagination. Due to the rapid advances in technology, goods in vogue today soon become obsolete in the next moment with new and more efficient and upgraded version in place. For instance, searching for information has moved from traditional libraries and other such places containing books and records to fast-moving internet.

As the technology is dynamic and moving at a faster rate, there is need for dynamic approach as well. Nigeria therefore cannot afford to be static but employ dynamic approach to leverage on existing technologies for new innovation. With the evolution of emerging technologies, more rapid transformation is still expected more than ever. For instance, blockchain technology which allows digital transactions to take place with full trust between parties, without the need for human interaction is posed to replace the usual cooperatives systems. Simple machine learning algorithms for separating mail from spam and whether to recommend operations or not had existed for some time now (Goodfellow et al., 2016).

2. FUNDAMENTALS OF SOME OF THE EMERGING TECHNOLOGIES

Emerging technologies are now a recurring term globally with applications increasing more than ever even beyond imagination. Though no formal definition has been adopted for emerging technologies, yet they are associated with digital transformation (Halaweh, 2013, Litvinski, 2018). With the availability of these new technologies there will be tremendous impact in every areas of the society if the potential is fully utilised. Some of these emerging technologies are briefly discussed.

2.1 Artificial Intelligence (AI): With the application ranging from security to sales, AI is said to be the largest force in emerging technology today (CompTIA, 2020). Artificial intelligence has originally been defined as the science and engineering of making intelligent machines (Singh et al, 2013). It stemmed from the fact that the intelligence is exhibited by an artificial entity or machine rather than humans or animals. Intelligence which involves reasoning, planning, creativity, critical thinking, and problem solving has been defined in many ways as the capacity for logic, understanding, self-awareness, learning and emotional knowledge. More generally, it can be described as the ability to perceive or infer information, and to retain it as knowledge to be applied towards adaptive behaviour within an environment or context. It can be used to schedule trains, assess business risk, predict maintenance, and improve energy efficiency, among many other money-saving tasks (Duggal, 2020). Its applications span other areas including robotics, the Internet of Things (IoT), clouding computing, cognitive automation, security, finance, and many more (Louise, 2020). Figure 1 shows a more detailed branches of AI.

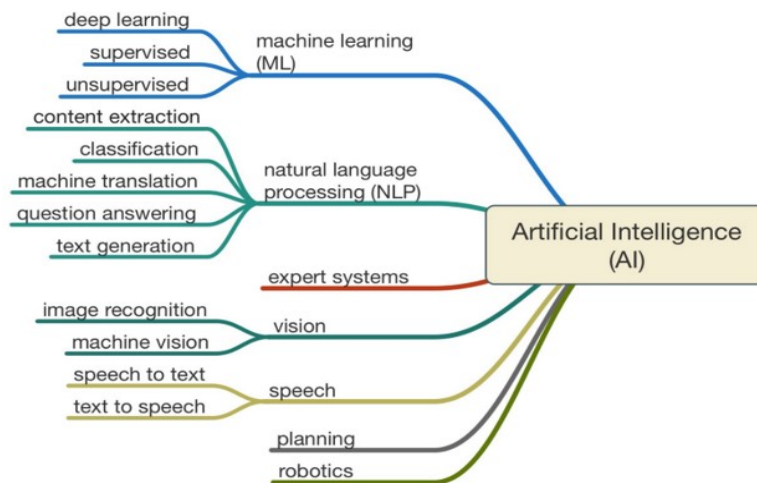


Fig. 1: AI branches (Mohammed, 2019)



Some of the technologies under AI are further discussed below.

Expert systems are the predecessors of artificial intelligence, deep learning, and machine learning systems designed to assist experts and not to replace them. They have been used in medical diagnosis, chemical analysis, geological explorations, virus detection, planning and scheduling, Stock market trading, and etc.

Computer Vision is to imitate the use vision for sensing the environments. The goal is to give computers powerful facility for understanding their surroundings. Examples include self-driving cars to make sense of their surroundings; facial recognition to authenticate the identities of their owners.

Machine Learning is a subset of AI where computers are programmed to learn to do something they are not programmed to do. The subsets of ML includes neural networks, natural language processing (NLP), and deep learning.

Deep learning is a computer software that mimics the network of neurons in a brain using Artificial neural network technology. It is a subset of machine learning and is called deep learning because it makes use of deep neural networks. ML models look for pattern in a data and try to conclude.

2.2 Internet-of-Things: (IoT) comprises a network of physical devices, automobiles, home appliances, and all those items that are connected to the Internet. It provides a platform that creates opportunities for people to connect smart devices such as actuators, electronics, sensors, and others and control them with big data technology. The technology consists of the extension of internet connectivity beyond personal computers and mobile devices as it can also reach a wide range of non-internet enabled devices (Duggal, 2020). Figure 2 shows the evolution of IoT devices.

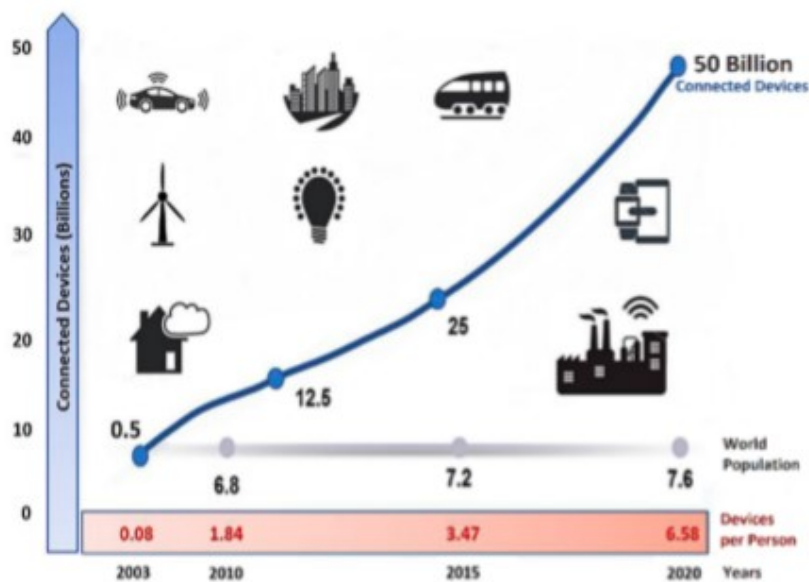


Fig. 2: Evolution of IoT devices (Saqlain et al, 2019)

Combined with other technologies such as AI, it essentially makes virtually anything “smart” as it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks (Tutorials Point, 2016). IoT is rapidly bridging the wall of physical and the digital connectivity thereby making the system smarter as it can be found in an array of devices at home, schools, industries, commercial centres, hospitals etc. For IoT to function effectively, there must first be device(s) with hardware like sensors for data collection. The data collected by the sensors is then shared via the cloud and integrated with software. The software then analyses and transmits the data to users via an app



or website. Some examples of Internet-of-Things (IoT) are connected appliances, smart home security systems, autonomous farming equipment, wearable health monitors, smart factory equipment, wireless inventory trackers, ultra-high speed wireless internet, biometric cybersecurity scanners, shipping container and logistics tracking. The way the myriad of interconnected devices will change and shape the future has been discussed in framework for IoT (Mohapatra et al, 2016).

Some of the advantages of IoT include (Tutorials Point, 2016): Improved Customer Engagement, Reduced Waste by effective management of resources, Technology Optimization, data collection, etc. However such issues as security, privacy, complexity, flexibility, compliance are some of the factors against the acceptance of the IoT.

2.3 Industry 4.0. This refers to a Fourth Industrial Revolution in which cyber-physical systems, automation, and the Internet of Things are combining to create a smart factory environment. The synergies created by these exciting new technologies promise huge gains in industrial efficiency and productivity. Industry 4.0 is just one term used to describe this new industrial landscape. Other names synonymous with it include the Industrial Internet, Smart Automation, Smart Manufacturing, Smart Factory and the Industrial Internet of Things. The number of internet-connected devices are getting increasing in industries more than ever before (Saqlain et al, 2020). IoT devices such as wireless sensors, software, actuators and computer devices are for transmitting data from one place to the other using internet. IoT has been extended to industries to have Industrial IoT or IIoT with the advent of Industry 4.0. IIoT is revolutionising industries in many ways beyond existing automation as many devices are getting connected and interactive capabilities increasing.

2.4 5G is a new global wireless standard after 1G, 2G, 3G, and 4G networks, which enables a new kind of network that is designed to connect virtually everyone and everything together, including machines, objects, and devices. It is meant to deliver higher data speeds, ultra-low latency, more reliability, massive network capacity, increased availability, and a more uniform user experience to more users. “5G has the potential to provide 20X faster data speeds and carries a massive amount of data for a large number of simultaneous users. So users in high-density areas – like airports, stadiums or urban areas – can still experience the fast speeds and low latency of 5G service (NCC, 2020). “The introduction of 5G will alter consumer expectations and lead to a change in how businesses deliver services,” due to its low latency, intelligent power consumption, high device density and network slicing. “Support for products and services will increasingly be delivered by video rather than via phone or email. This will allow businesses to demonstrate how to use products and solve customer problems, creating even greater engagement between businesses and their customers. 5G will make other technologies like augmented reality, smart cities and connected cars truly possible (CompTIA, 2020).

2.5 Augmented Reality / Virtual Reality (AR/VR) also known as mixed reality technologies. Similarly, it is being used with other technologies to enhance execution flexibility, operational efficiency and individual productivity (CompTIA, 2020). Virtual Reality (VR) immerses the user in an environment while Augment Reality (AR) enhances their environment. The possible use of VR/AR in training of doctors for surgery, entertainment, education, marketing, and even rehabilitation after an injury has been suggested (Duggal, 2020). Virtual Reality and Augmented reality are used to create an immersive virtual world.

2.6 Blockchain. This is to solve the problem of security and management of transactions across the internet. Distributed ledger technologies have proven valuable in managing data and supply chain challenges. Blockchain technology is a decentralized peer-to-peer network that stores records and transactions in immutable blocks secured by cryptography. The decentralization aspect of blockchain eliminates the need for trusted third party interceder (Parker & Bach, 2020).

2.7 Robotics is a programmable electro-mechanical device capable of carrying manual tasks. It is a reprogrammable multi-functional manipulator designed to move materials, parts, tools, or specialized devices through variable programmed motions for performance of variety of tasks.

2.8 Edge Computing: Due to the problem of latency, cloud computing seems to be becoming increasingly inadequate in handling of data as the quantity of data continue to increase astronomically. The problem of Edge computing is



designed to help solve some of those problems as a way to bypass the latency caused by cloud computing and getting data to a data center for processing. It can exist “on the edge” by being closer to where computing needs to happen. For this reason, edge computing can be used to process time-sensitive data in remote locations with limited bandwidth.

2.9 Drones/unmanned aerial vehicle: According to Rudra & Shukla (2020), vehicles are now being used in several commercial applications such as news coverage, delivery of goods and environmental monitoring. Amidst the outbreak of the Covid-19 pandemic, the use of drone technology has increased in government organisations such as defense and police force, but their demand can increase exponentially for e-commerce and logistics. With the massive popularity and development of unmanned aerial vehicle (UAV) technology over the past few years, the Directorate General of Civil Aviation (DGCA) has taken several initiatives to introduce drones in the commercial air space. With this step, the deliveries by drones have gained momentum over the past couple of years. Solutions by drones are now applied in various sectors, for commercial purposes, and also by the government in their defense space. Hence, scores of global companies are now experimenting with drone technology to provide state-of-the-art services, and various steps are being taken to make it more popular in the coming years. In the past few years, technologies such as machine learning, AI, GPS, and other new technologies have massively improved the functioning and efficiency of drones in the logistics industry. E-commerce and logistics companies are constantly trying to introduce more innovations among drones.

3. PROSPECTS AND POTENTIALS OF EMERGING TECHNOLOGIES IN NIGERIA

Innovation and creativity are the major requirements for sustainability in post covid-19 era in terms of both lives and properties as they are needed in healthcare systems, safety and economic recovery processes. They are needed for the nation to bounce back economically after as they serve as driving forces for higher productivity and profitability in today’s business world. Therefore, harnessing these technologies in the following areas can be of tremendous help to the country.

3.1 Security of lives and properties: In an era where security is of utmost concern both in terms of lives and properties, these technologies can be deployed for remote monitoring. With sensors embedded in a vehicle, both the state of the personnel and the vehicle can be ascertained anytime against kidnapping and theft. Alert can easily be used for notification in case of emergency. With a large number of data, AI can be used to detect danger and avoid potential risks. Computer vision and speech recognition can be used to enhance security at crucial places. Also, IoT with sensors can detect if a product is being tampered with in a storehouse. Biometrics will play an important role in improving security by allowing people and devices to authenticate and move seamlessly through our high-tech world (CompTIA, 2020). Cybersecurity refers to the practice of safeguarding networks, servers, devices, programs, and data from hackers. The increasing digitization across every industry, which delivers enhanced advantages to businesses also draws significant cybersecurity challenges. These challenges may include application security, network security, information security, operational security, and end-user security (Preetipadma, 2020). Drones can be effectively used to checkmate the activities of bandits in the forests.

3.2 Preservation and conservation of agricultural products: One of the most perennial challenges often faced in Africa is a lack of adequate facilities to preserve agricultural products over time. Enough farm produce that can meet export demand above local consumption are annually experienced. However, no sooner are they produced than they perish. AI can be used to get data to monitor the environmental data such as temperature, humidity etc. of different products and with sensors to maintain the temperature stability thereby minimising the wastage of perishable. It can also be used in genetically modified seed. For instance, a modified mango seed can take less years to develop with shorter height.

There has been massive increase in waste generation with its attendance result in poor environmental conditions. IoT can be used for a waste management by streamlining the waste collection process. This will ensure better living conditions by providing a clean environment which is the primary focus of any smart city. This requires efficient waste management for proper disposal and recovery, which also presents a huge market opportunity. Sensor enables users to



measure and monitor soil levels to gain insight about irrigation system efficiency and lawn/garden health. By measuring the amount of water at the deep root zone or a garden or landscape area, it will help to know where and whether to irrigate such areas.

3.3 Education and Training: AI and ML have transformed learning to improve its outcomes. Education and training took another dimension during the total lock down with the online programmes. Various platforms such as Zoom, Google Class, Microsoft Teams, were engaged during this period. Modes of assessment such as quiz, test and online examinations were also used during the period. These technologies can help tremendously in research and development. These new technologies help in collecting data related to several parameters such as the academic performance of students, skills of teachers, and the likes.

3.4 Research and Development: Related to education and training purposes of these emerging technologies are their applications in research and development. From data gathering abilities to sorting and analysis, the technologies have great potential as transformation tools. Such tools like AI can be used in product's development as well.

3.5 Health and Medical Application: Online health monitoring programme and AI driven medical equipment can now be used to improve health care service system. This is very relevant in rural areas where there is poor medical cares.

3.6 Maintenance and monitoring: Different types of maintenance such as preventive and predictive maintenance can be improved drastically with the help of AI and IoT technologies. They can be used to capture data related to optimal performance of equipment to determine the conditions at any time. Such data include temperature, pressure, humidity, and light exposure and other environmental conditions. They can be equally deployed to monitor and analyse carbon emission thereby controlling atmospheric pollution.

3.7 Infrastructural Management: Management of infrastructure is very essential and can be easily enhanced in a society which lacks maintenance culture. The era of infrastructure's decay can be eradicated with the deployment of these technologies to capture and track necessary data related to infrastructure. Ranging from electricity to water supply system, effective management and improved services can be obtained by employing these technologies.

3.8 Grid management: Technologies such as the IoT devices, edge computing architecture and machine learning can be used to modernise the grid. Examples include IoT-enabled backup generators that provide additional power to a home, electric vehicle charging stations or connected thermostats. These kinds of technologies are rapidly becoming extensions of the traditional grid.

3.9 Business automation and Ease of doing Business: As the migration towards digitalisation and digitisation continues, these technologies present an opportunity for automation of business activities more and more. AI and IoT can be deployed for increasing productivity and profitability to achieve greater success and growth in business world. They are used to automate day-to-day routine to enhance ease of doing business. Automatic stock taking, alarm for low stock, notification of near expiry products, customers' taste prediction etc. are some of the ways the technologies can be used. This results in increased productivity of warehouses, timely replacement of defective machinery parts, and prevention of accidents. They can easily be used to track movement of goods for monitoring purposes. Because of its ability to handle large data, they can also be used to study customer's behaviour for better services.

3.10 Youth Empowerment and Job Creation: An enterprising business organisation or talented youth can easily leverage on emerging technologies for innovation and creativity. The innovative ability of many came into forefront with a lot of creativity and inventions during the covid-19 pandemic outbreak. Examples include smart wrist watch or cap to alert closeness and maintain social distancing.

4. CHALLENGES OF APPLYING EMERGING TECHNOLOGIES IN NIGERIA



With numerous potentials and prospects for emerging technologies, there are challenges to overcome if the benefits are to be realised.

4.1 Electricity: Power supply is the number one problem that will impede the acquisition and implementation of these emerging technologies. With population of about 200 million and peak supply hovering around 5 MW, getting adequate power supply to make things turn around will be very difficult. The power supply problems have been a jinx yet to be broken in Nigeria. While many countries are enjoying uninterrupted power supply and perhaps celebrating it, Nigerians groan daily under epileptic power supply. Power surge, brown out, black out are the order of the day. In response to persistent call for power reform in some years back, the government unbundled the hitherto National Electric Power Authority (NEPA) to Power Holding Company of Nigeria (PHCN) comprising of eighteen separate entities with call for active private sector involvement without yielding any positive results. No doubt, energy crisis is not limited to Nigeria alone. United Kingdom sometimes ago adopted similar measure as a way out of their energy crisis. Adequate power supply is an unavoidable prerequisite to any nation's development, and electricity generation, transmission and distribution are capital-intensive activities requiring huge resources of both funds and capacity.

4.2 Network connectivity: Another major problem against utilisation of these emerging technologies is the issue of connectivity. Without any doubt, interconnected world demands inter-connectivity through communication technologies. Though mobile broadband coverage in Nigeria is increasing, access to network connectivity is a major issue (Reiter, 2020). The advent of mobile technology is playing an increasingly central role in the country's economy and, for the majority of Nigerians. Mobile broadband technology is popularly used for Internet connectivity as many Nigerians are daily subscribing to different mobile network. However, the problem of connectivity still persists from both network providers ability to provide quality services and affordability of data cost by end-users. During covid-19 pandemic total lock down, the only available means of human connection emotionally remained online as measures are in place to reduce human contact. The availability and non-availability of network connectivity therefore determines many activities such as social interaction, education, meetings etc. The network coverage to support emerging technologies is still low especially in the rural areas. As of now, network strength is stronger in urban areas. As such, agricultural implementation may be hampered in those areas.

Access to network by individuals also hinges on available data in addition to network operator or service providers. Due to poor economy, access to network is relatively high and data cost is unavoidable by many especially low-income earners which form the majority of the population. The average cost of data in Nigeria is estimated to be about N600 (\$1.39) per gigabyte (GB). Only the high-income earners could sustain such a high cost for meaningful online transactions. Many public schools could not engage in online study during the lockdown due to high cost of data for connectivity. Reducing the tariff for affordability by majority is a necessity for tapping the benefits of emerging technology.

4.3 Devices: Access and affordability of mobile devices to support different apps are major challenges facing the populace. With income below one dollar per day and minimum wage of thirty five thousand naira, getting relatively good phones may be a luxury for many who are living below poverty lines.

4.4 Skills: Appropriate skills are needed as humans in charge of powerful technologies would have to be trained, coached, and managed effectively. The ability to use the technologies for innovation and creativity will determine the benefits of these technologies. Inadequate skills and knowledge are one of the major reasons for low development in Africa (Reiter, 2020). This is fueled by lack of leaders with vision for development. Low investment and budget for education with less than 26% UNESCO recommended annual budget have been the bane of many poor countries such as Nigeria.

4.5 Perception and Misconception: A lot of misconception and rumours are associated with these technologies especially with 5G. It is widely believed that 5G will be harmful to living things and as such any technology associated with it is usually perceived in that light. Such misconception can only be eradicated with proper campaign and awareness



creation. The future implication and impact of AI is still subject of research among the scientific community. It is feared that AI may pose a threat to man with advanced knowledge. Regulatory standards coupled with strong legislation will be required to moderate the applications of these technologies especially on ethical issues.

5. CONCLUSION

It is imperative for total digital transformation, more than ever before now, and not just computer literacy, to realise the full potential of emerging technologies in this digital age. There is need to canvass towards technological literacy in our society more than ever. More is still needed to be done locally for meaningful progress in the quest for technological advancement in this modern time. The reasons are obvious. This is an era of technology-driven age. Knowledge is increasing at alarming rate. The engine of growth of industrial community is technology. Social lives, comforts and tastes of people are now a function of available technology. The strength of any nation today, both economically and politically is also determined by the level of her technological advancement. Nigeria can soon come out of the present economic doldrums by embracing and imbibing the culture advocated in this article. The consequence of failing to attain technological literacy is palpable in the land. Those who do not have opportunities to develop basic technological skills and understanding will be left behind in the job market as adults. The world has drifted toward a society where riches and wealth are no more determined by mere natural resources but intelligent use of those resources. The trends are towards economy of head and no more of hands, the higher the imagination the higher the premium.

There is need for heavy fund of investment into research, design, and development. African leaders should endeavour to leverage the lessons from Covid-19 to ensure strong economies that can withstand unforeseen future. This calls for sound technological literacy among the politicians and policy makers. It is hard to imagine members of National Assembly let alone average citizens making reasonable judgments about these emerging technologies without having a better understanding of technology than most now possess. The technological savvy policy maker can assess critically the risks and benefits of new technologies, thereby participating intelligently in the democratic process, rather than being swayed by purely political or emotional arguments.

6. RECOMMENDATIONS

- i) There is need for framework and implementation strategies for emerging technologies to harness them properly.
- ii) Inclusion of these technologies in curricular across educational sectors is necessary to grasp the concept early enough.
- iii) Government should make it a priority to increased funding for research & development to local technologies applications.

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