

Leveraging Emerging Technologies under Digital India

¹Vinay Thakur, ²Prof. M N Doja, ³Dr. Amir AA Faizi
¹Research Scholar, ²Director, ³Controller of Examination
¹Jamia Millia Islamia, Delhi,
²IIT Sonapat, Haryana,
³Jamia Millia Islamia, Delhi

Abstract - Digital India programme is a flagship programme of Government of India with a vision to transform India into a digitally empowered society and knowledge economy. Its vision areas are centered on 'Digital Infrastructure as a Utility to Every Citizen', 'Governance & Services on Demand' and 'Digital Empowerment of Citizens'. Digital India enables use of Information and Communication Technologies (ICT) for an efficient, smooth and transparent way of functioning of Government and also providing government services to its citizens in a cost effective manner. Furthermore, it has been proven that e-governance can enhance the speed and efficiency of operations by streamlining processes, lowering costs, improving research capabilities and improving documentation and record-keeping. E-governance can be viewed as a subset off e-governance, and its focus is largely on improving administrative efficiency and reducing administrative corruption. However, there is a relatively new emphasis that goes beyond the internal workings of e-government, where processes and technologies can directly engage the citizen with greater information and improve transparency, accountability and participation. Information and communication technology (ICT) is an emerging era and playing a vital role for the advancement of our society. As the popularity of ICT enabled application is increasing E-Governance has been established as a revolution not only in developed country but also in developing nations. The sole aim of E-Governance is to establish strong and transparent relationship between citizens, government organization and business organization so that a faith could be developed among all. In the paper the author has discussed about the use of different types of emerging technologies, their benefits and applications for achieving e-governance in a developing country like India.

keywords - Digital India, ICT, E-Governance, Cloud Computing, Internet of Things (IoT), Big Data Analytics, Blockchain, 5G, AR & VR, 3-D

I. INTRODUCTION

As India stands on the cusp of transforming itself into one of the world's fastest growing digital economies, a significant and landmark role is being played by the emerging technologies like Big Data, AI, IoT, Cloud computing, among other technologies. These technologies to a large extent are driving the digital revolution throughout the country, from a nation of relatively disconnected geographical pockets to one seamlessly interwoven into a web of connected nodes. It is the confluence of emerging technologies that are fuelling India's digital journey and also accelerating the pace of digital growth. The fusion of these technologies supported by availability of cheap data and large scale proliferation of smart devices among the country's masses is surely aiding and abetting a change in the pattern of consumerism, and bringing about societal and inclusive transformation. A convergence of such disruptive technologies into an effective system is bringing about a paradigm shift in the way businesses operate, from the traditional offline models to operating models that are based on the concept of instant input, door step delivery, zero inventory and connected devices.

Technology is changing our lives and business at an astonishing pace. Future advancements in technology are accelerating faster than an organization's ability to adopt or even adapt to them. From emergence of new technologies to digitization of our day-to-day activities, things are rapidly changing around us; and India, with its numerous digital initiatives, is changing with it. The country, on the back of technological advancements and speedy digitization drives, is steadily marching towards its vision of becoming a 'Trillion-Dollar Digital Economy'. As the digital infrastructure further expands and adoption of emerging technologies becomes widespread, the dominant role of three key stakeholders, namely consumer, companies and government is aiding in fostering an inclusive digital growth in the country. India's massive push towards digitization via the landmark 'Digital India' program has been made possible due to the proliferation and subsequent confluence of technologies within an ecosystem.

II. TECHNOLOGY DRIVERS

Digital India has already laid the foundation and created massive digitization by building on 'Digital Infrastructure', 'Digital Literacy' and increasing government's promptness by providing 'Governance and service on demand'. To further the process of becoming knowledge economy and empowered society - AI, Cloud Computing, Big Data Analytics, IoT, Mixed Reality, 5G, Robotic Process Automation(RPA), 3D Printing, Mixed Reality(AR/VR) are some of the technologies that have been identified as these technologies have established credibility in assisting and accelerating the growth of various economies of the world. Some basic features of these technologies are as :

- Artificial Intelligence(AI) – ability to do cognitive tasks such as speech recognition, language processing etc. Across the world, companies and governments are moving towards use of AI, it is poised to be a disruptive force in India.
- Cloud Computing – The spine of the IT systems with advanced technologies such as the emerging technologies mentioned above, cloud computing transforms the way IT applications work by providing IT resources as a service over the internet . Cloud computing being a vibrant application provides solution for all e-governance infrastructures at lower cost and less time requirements.
- 5G networks are the next generation of mobile internet connectivity, offering faster speeds and more reliable connections on smart phones and other mobile devices.
- Internet of Things(IoT) – is a boon for the Smart Cities programme. The proliferation of mobile and other handy electronic devices and sensors have resulted in information explosion at all levels. This information fed as data to through these sensors to the Big Data analytics systems that can provide real time predictions. Use in fields of threat analysis for security, disaster management and planning in order mitigate the impact of the calamity etc. are to name a few.
- 3D Printing – has already proved its mettle by reducing the cost of manufacturing in lot of niche sectors. 3D Printing is performed with utmost precision and delivery is very fast. This would be a great technology for developing prototypes for Government Departments such as Defense, Space, Scient & Technology etc.

- A. Cloud Computing
- B. Internet of Things (IoT)
- C. Big Data Analytics
- D. Blockchain
- E. Robotic Process Automation (RPA)
- F. Mobile Internet 5G
- G. Mixed Reality (combination of AR & VR)
- H. 3D printing

III. CLOUD COMPUTING

Cloud computing is a new business paradigm in a service oriented model, delivering business applications and other IT resources as services over the internet. This technology is the delivery of computing services like servers, storage, databases, networking, software, analytics and more over the Internet ('The Cloud'). Cloud computing is one of the fastest growing digital technologies in India, in terms of adoption by both private enterprises as well as government services. Cloud computing provides a new service consumption and delivery model that is based on Internet Services. This technology can be used for implementation of e-governance architecture and establish a strong relationship and better collaboration between different departments of the government and citizens. Cloud computing being a vibrant application provides solution for all e-governance infrastructures at lower cost and less time requirements. This technology also helps Government to increasing efficiency and reliability of e0governnace projects at reduced cost, leading to user satisfaction, thereby also improving the government functioning. Cloud computing technology forms the fundamental backbone for facilitating the existence of other emerging technologies like Big Data, IoT and Artificial Intelligence. This technology is increasingly becoming a viable and an excellent platform to host e-governance applications for the users without compromising on security. The market in India is expected to witness strong growth, with increase in market size from USD 1.3 billion in 2016 to USD 4.1 billion in 2020. In India, this technology is useful for sectors like healthcare, education, safety and security which require extensive reach across the country. Cloud databases available for deployment offer high level of scaling without compromising on the performance.

A. Deployment Model for Cloud Computing

In terms of implementation of cloud computing, there are three types of cloud computing, namely private cloud, public cloud and hybrid cloud.

Private Cloud- The cloud infrastructure which is operated and used by a single organisation, also called internal cloud computing. It may be managed by the organisation or a third party, and may exist on or off premise.

Public Cloud- The Cloud infrastructure is made available to the general public or a large industry group and is owned by an organisation selling cloud services. This type of cloud is called external cloud computing and provides all the benefits of the cost reduction, scalability and easy maintenance

Hybrid Cloud- The cloud infrastructure is a composition of two or more clouds such as private, community, or public that interoperates together and enables high level portability to data and application. This type of cloud computing is seen as future of cloud computing.

B. Implementing eGovernance Projects using Cloud Technology

Some of the widely known benefits of cloud computing technology for ensuring e-Governance services are:

Cost saving: Leads to significant cost savings for implementation of an e-government project since computing resources is outsourced to the cloud providers. Also, a sit entails usage of computing hardware and software infrastructure and application s that are remotely hosted. As a result, governmental budget on ICT expenditure can be substantially reduced. Furthermore, expenses on ICT resources can be easily calculated as 'pay-per-use' method is used to charge utilization of resources. The government can save money on part of maintenance of resources since they are shifted to the cloud provider.

Simple & flexible system: Leads to a less complicated, more flexible system and quicker scaling ability as compared to usage of the conventional computing systems. Management of computing resources in the case of cloud computing is very direct and

hassle free because here the resources are outsourced to a cloud service provider. Simplicity of application of cloud computing can make the Government focus more on ensuring customer satisfaction and also serving the citizens.

Government agility: Support for government agility is another benefit of cloud computing utilization in Government. Agility is the ability to quickly and effectively respond to changing environment such as a rapid response to citizens' needs in the short term, performing strategic adaptation to trends and issues in the medium term. Unlike the conventional computing systems, computing resources can be gathered in minutes and portable applications/ services can be developed quickly, to be accessed anytime and anywhere using various devices.

Ready availability- E-government services are mostly accessible through the usage of Internet services, irrespective of time and place. To ensure reliability and availability, the conventional computing system uses redundant data centres. However, this being costly, the cloud service provider will definitely ensure high reliability and availability of its services as this is the source of its credibility. In addition, data recovery during a disaster such as flood, fire, etc can easily be supported as cloud computing technology is supported by myriads of servers co-located in different locations.

An example of application of cloud computing technology is in the state of Tamil Nadu in the Education Sector, where the local Government has announced an agreement with Microsoft India to improve teaching and learning in the state, with the use of cloud computing technology. This collaboration aims to reform education sector and enhance digital literacy across all levels. Microsoft India will also adopt seven schools in the state of Tamil Nadu.

IV. INTERNET OF THINGS (IoT)

IoT refers to a network of interconnected 'Smart Devices' which are capable of integrating into a vast information network. According to NASSCOM, IoT market in India is expected to reach USD 15 billion by 2020, accounting for 5% of the global market, with an increase in the number of IoT devices from 60 million in 2017 to reach around 1.9 billion units by 2020. The global IoT market is expected to grow to over \$3 trillion in the same period, driven both by consumer and industrial applications. IoT consists of three components, namely Hardware (Sensors, processors, machines etc), Application (Mobile or handheld application) and Connectivity (Bluetooth, WiFi, 4G LTE etc).

In India, while sectors like manufacturing, automotive, transportation and logistics shall witness the highest level of IoT adoption, while sectors like healthcare, retail and agriculture are also treading and shall show significant progress in IoT adoption. A key enabler for IoT adoption across the said industries/sectors has been the Government of India's planned and proposed investment of approx USD 29 billion for the ambitious programme of 100 smart cities over next 5 years five years (FY2015-16 to FY2019-20).

A. Applications of IoT technology

There are several illustrious examples which can be listed in favour of applications of IoT technology in India:

Smart Cities Program: A significant and prominent usage of this technology has been in the case of Smart Cities Programme in India. As reported by Gartner, the world's leading research and advisory company, approx 70% of total world's population is expected to live in cities by 2050. Also, in another study, as predicted by UN, the world's urban population shall double and reach around 6.7 billion by 2050. This rapid urban growth is placing a considerable strain on existing infrastructure, and with more migration to urban areas taking place, it shall become worse and difficult to manage in time to come. To accommodate this swelling demand on cities, it is need of the hour to resort to Internet of Things (IoT) to tackle the pressure and challenges of urbanisation, increase efficiency, reduce costs, and further improve quality of life and make day-to-day living more comfortable and secure.

The Government of India's 100 Smart Cities project, Digital India programme, Make in India project and Smart Energy project are expected to proliferate the deployment of IoT devices in India. The government is also partnering with start-ups and mentoring them to develop innovative solutions in areas such as education tech, healthcare tech, e-governance, finance and agriculture. In India, Tamil Nadu has the largest number of Smart Cities and will witness IoT as a key component of the Smart Cities program. IoT is capable of providing smart solutions in domains of traffic management, smart grids, urban planning, sanitation problems, safety and security, waste management, etc.

Efficient water supply-IoT has the potential to transform the already existing water consumption patterns. Smart meters can improve leak detection and data integrity; prevent lost revenue due to inefficiency, and also boost productivity by reducing the time spent on entering and analyzing data. Also, these meters can be designed to feature customer-facing portals, and also provide residents with real-time access to information about consumption patterns and water supply. Thus, IoT technology can resolve complicated challenges surrounding water security, allowing governments to better define priorities for water supply, consumer needs and governance.

Innovative solution to traffic congestion: As migration to urban areas/ cities is on the rise, an existing problem of traffic congestion is going to get worse in the coming years. IoT as a technology can be used to bring improvements in this sphere that can benefit residents immensely. For example, deployment of smart traffic signals can help in adjust timings to accommodate traffic demand and ensure a hassle free driving experience, City officials can collect and aggregate data from traffic cameras, mobile phones, vehicles, and road sensors to monitor traffic incidents in real-time. Drivers can be alerted of accidents and directed to routes that are less congested. Such possibilities are endless, with impacts being substantial.

Reliable public transportation: Public transportation gets disrupted due to occurrence of road closures, bad weather, or vehicle breakdowns. Smart cities also ensure safe and efficient commute of its citizens from point A to point B. To achieve this, municipalities turn to IoT as a technology for development and implementation of smart traffic solutions. This can help in giving transit authorities some real-time insights required to implement contingency plans, ensuring safe, reliable, and efficient public transportation for all residents. Data and insights collected from IoT sensors, cameras and other connected devices placed at all public areas further help to reveal patterns of how citizens use transport facilities.

City Planning: IoT as a technology can be utilized and adopted by local governing bodies to analyse the complex factors of town planning. IoT supports cities by assisting in key areas like increase in population, zoning, water delivery, transportation patterns, food delivery, waste management, etc. This technology gathers data and available facts and generates more accurate records than contemporary analytics.

Energy-efficient buildings: IoT technology makes it easier for buildings with old infrastructure to save energy and improve their sustainability. Smart energy management systems, for instance, use IoT devices to connect different, nonstandard heating, cooling and fire-safety systems to a central energy management application, then highlight high usage areas and further take corrective measure and actions. Research shows that commercial buildings waste up to 30% of energy used by them, so deployment of a smart building energy management system can result in significant savings.

Smart parking: With the help of data collected from GPS devices and smart phones of drivers, smart parking solutions can be used to determine and create a real time parking slot occupancy map giving real time information on all important and required details of parking areas. This shall further assist and provide notification to drivers about free/ going to be free parking slot and drivers can then use the map services available on their mobiles to find the vacant parking spot faster and easier instead of blindly driving around.

Street lighting: IoT technology based smart cities make maintenance and control of street lamps more cost-effective. Equipping streetlights with sensors and further connecting them to a cloud management solution helps in adapting street lighting to the lighting zone. Such lighting solutions gather data on luminance, movement of people and vehicles, and then combine it with historical and contextual data (e.g., special events, public transport schedule, time of day and year, etc.) and analyze them to improve the lighting schedule. As a result, a smart lighting solution “tells” a streetlight to dim, brighten, switch on or switch off the lights based on the outer conditions.

Public safety: For enhancing public safety, IoT oriented smart city technologies offer real-time monitoring, analytics, and decision-making tools. Combining data from various sensors and CCTV cameras deployed in the city with data received from social media feed and analyzing it, the resultant public safety solutions can predict potential crime scenes. This will allow the police to stop potential perpetrators or successfully track them.

The complexity of the IoT system, however, requires essential rules on data management, security, and latency and reliability issues. Besides, IoT will require AI as a companion since IoT will help in generating huge volumes of data sets that will need to be intelligently analysed with the help of machine learning to be able to draw meaningful insights for businesses.

V. BIG DATA ANALYTICS

Big Data analytics is a set of techniques and tools to process and interpret large volumes of data, including data mining, profiling, business intelligence and visual analytics. This technology is characterized using 3Vs- “high-volume, high-velocity, and high-variety information assets that require new forms of processing to enhance decision-making, insight discovery and process optimization.

Big Data analytics is expected to play a key role in decision making for private enterprises; with an estimated 41 % CEO’s working in India using this technology over next 3 years. The use of this technology shall enable speedy processing of huge datasets, further enabling the Government to utilize the insights generated in developing a policy framework. Here, the Indian Government has shown a keen interest in adopting such technologies in day to day functioning especially in states of Karnataka, Odisha, Andhra Pradesh and Telangana, with the main aim to bring about transparency and efficient delivering services to the citizens. Indian enterprises are also increasingly adopting this technology in order to improve operations and enhance customer experience.

A. Big Data Analytics – Game Changer in eGovernance

Agriculture: In agriculture, Big Data means information can be collected along the full supply chain including supermarkets, weather sensing equipment and digital images to research papers. These data sets can later be transformed. An example of applications of Big Data is the gradual foray into Indian policy making decisions. Economists working at Ministry of Finance, Government of India have used preliminary data from Goods and Services Tax network (GSTN) to understand the various patterns of trade between states and enabling them in driving state specific policy initiatives.

In India, some of the leading data-driven projects existing across different sectors where Big Data is playing a significant role of an enabler for e- governance are as follows-into actionable information through analytics. For example, Tech Mahindra, an IT services company has developed a system called “Farm-to-Fork” that allows monitoring of conditions in food shipping containers. Alerts are sent out when alterations take place in temperature, humidity and oxygen levels and the problem then gets rectified either remotely or manually. Also, to help farmers prepare for extreme weather conditions which might damage crops, Big Data technology from the fields can be combined with weather patterns.

Geo-location: Geo-location has become one of the most sophisticated business tools of digital era. With advancement in data sciences, geo location is gaining prominence. With technology of Big Data, it has become possible for companies to collect huge volumes of consumer data and information, scrutinize the same and further use for spotting customer location. In other words, companies are now able to draw meaningful and constructive conclusions out of the datasets collected and analysed.

Education: Big Data has the potential to improve student learning. With help of Big Data technology, teachers and school administrators can track individual performances to further introduce improvements and customise ways in which students are taught. For example, International Financial Cooperation, an affiliation of the World Bank Group, mines large data sets for more than 63,000 students, collecting approx 14 million data points on annual student academic performance which is then used to impart instruction and objectives. By providing information on learning performance through Big Data technology, IFC helps students get the required assistance through individual learning plans developed by their teachers.

Water supply: The Kerala Water Authority (KWA) of the Government of Kerala is using IBM's Analytics and Mobility solutions to analyse, monitor and manage water distribution in its capital – Thiruvananthapuram. Providing equitable water supply to all households is a challenging task and due to various reasons like bad pipelines and unauthorised water usage, water supply is not easily accessible to the city. With help of Big Data analytics technology, the KWA aims to achieve 100% success in equitable water supply with the ability to monitor and flag irregularities in water usage using sensors and intelligent meters. Also, Kerala Water Authority has been able to track water meters across the city, resulting in an improved revenue collection for the Government of Kerala.

Health: This sector is one of the most important areas that affect the well-being of poor section of society. Better health care also promises greater productivity and increasing income opportunities. Big Data can support wide range of medical and health care services like monitoring and surveillance of diseases, population health management, and medical decision support.

Banking: The Reserve Bank of India (RBI) has decided to gainfully harness the technology of big analytics by planning to set up a data science lab by 2018 end, which will help to improve its forecasting, surveillance and early warning detection that will eventually aid in policy formulation. This Lab shall be governed by a mixed team of engineers, economists and statisticians. With diverse responsibilities such as inflation management, currency management, debt management, banking regulation, financial inclusion, and overall financial stability, it has become crucial to employ relevant data for optimal analysis. Since in the digital world, a large volume of structured and unstructured real-time information is being sourced from consumer interactions, it has become imperative for RBI to utilise this data in policy making. On same lines, State Bank of India (SBI) is another central government bank which uses technology of Big Data and has set up its data warehouse in 2009.

Transport: Another major sector where provides potential for efficient energy management and congestion control is the Transport sector. On a global level, the country of Singapore is a fine example where data is collected, analysed and disseminated in real time on local road traffic conditions using a unified "i-Transport Platform". The platform analyses the amount charged at road tolls to optimize the use and efficiency of transportation infrastructure and further improves safety. On being processed into relevant and useful information, is further disseminated via electronic signboards on roads, web portals, and radio and mobile applications.

In India, Andhra Pradesh is employing Big Data and analytics to launch a system to real time monitor the performance of each department in the government. The main aim is to increase transparency in day-to-day functioning like understanding citizens' data, Government's expenditure patterns, consumption trends and success of various Government policies through Big Data technology. One can also obtain insights into the performance of government policies, analyze trends and predict future behavior of systems so that timely corrective measures can be taken.

I. Table - Application Areas of Big Data in E- governance

Area	Applications	Type of decisions using Analytics
Education	Student Tracking	Finding various factors that contribute to student success.
	School location planning	Identifying and planning location best suited for building school
	Administration	Planning and testing standards of schools
Health Care	Disease detection	Finding and reporting the occurrence of diseases
	Epidemiology	Identifying the causes, distribution and control of diseases
	Disease Prevention	Identifying factors that can prevent disease occurrence
Public	Problem Analysis	Helps in analyzing problem faced by public and finding solutions to it
	Information needs	Identifying and providing information requirements of citizens
Safety	Crime Analysis	Identifying type of crime and areas of occurrence
	Record keeping	Helps in keeping records of all crimes that have occurred in the past
Revenue	Tax Assessment	Calculating tax assessments and checking whether they are correct
	Fraud Analysis	Analyzing the fraud occurrence
Environment	Environment Analysis	Understanding which factors contribute to healthy ecosystem
	Water/ Air quality testing	Ensuring water/air standards are met
Business	Cost/ benefit Analysis	Understanding what can lead to be more cost effective
	Employee satisfaction	Finding employee expectations
	Resource Planning	Identifying required resources

VI. ARTIFICIAL INTELLIGENCE

Artificial Intelligence, an area of computer science refers to the ability of machines to perform a variety of cognitive tasks and activities like humans, such as speech recognition, learning, planning, problem solving, making decisions, etc. This technology is poised to disrupt India, being the fastest-growing economy with second-largest population in the world and holds a significant stake in the AI revolution. There are various types of technologies prevailing under Artificial Intelligence like Deep Learning, Deep Reinforcement Learning, Autonomous Vehicles, Cognitive Computing, Commercial UAVs (Drones), Conversational User Interface, Enterprise Taxonomy, Ontology Management, Machine Learning, Smart Dust, Smart Robots and Smart Workspaces. A 2017 survey by Statista, a statistics portal and leading statistics database from over 22500 sources on over 60000 topics for market data and market research, finds that globally 78% firms are either using AI extensively, or plan to use the same in near future. However, adoption of AI in India has been slow and remains limited. Estimates indicate that only 22% of the firms in India use AI in business processes but now that Government of India has realised the hidden potential of AI, things are bound to witness an increased improvement.

In India, NITI Ayog, the Government's premier policy think-tank has published a working paper namely 'National Strategy for Artificial Intelligence', which presents India's comprehensive vision of AI, including research and development of its applications. In this paper, NITI AAYOG states that India has immense potential to position itself among leaders on the global AI map "with a unique brand of #AIforAll". The working paper has identified 5 focus areas/ sectors like healthcare, agriculture, education, infrastructure, and transportation which are critical in driving India's inclusive growth. In words of McKinsey Global Institute, *'The contribution of AI to the transformation of society is happening 10 times faster and at 300 times the scale, or roughly 3000 times the impact of Industrial Revolution'*.

A. Applications of Artificial Intelligence – Real life cases and applications of AI technology are myriad, ranging across different sectors, some of the leading ones are:

Tax fraud detection: AI techniques can be applied in large-scale public initiatives ranging from crop insurance schemes to tax fraud detection to enhancing our security strategy. For example, AI algorithms can help in detecting fraud in filing of corporate tax returns by employing pattern recognition over large volume of pre-existing filed tax returns and similarly employ rule based analysis of tax regulatory codes to help in avoiding tax evasion.

LPG supply: LPG distributors can also leverage real-time data and integration to implement a dynamic pricing model, which ensures that the effective transfer of LPG subsidy directly to the consumers who actually need it by identifying customer accounts and pricing accordingly.

Banking: On same lines, another real life case of adoption of this technology is HDFC Bank, which has developed an AI-based chatbot, EVA (Electronic Virtual Assistant) built by Bengaluru-based Senseforth firm AI Research. Since launch in March 2018, EVA has addressed over 2.7 million customer queries, interacted with over 530,000 unique users, and held 1.2 million conversations. As per the Bank, EVA can assimilate knowledge from thousands of sources and provide answers in less than 0.4 seconds. Also, State Bank of India (SBI) has launched SIA, an AI-powered chat assistant which instantly addresses customer enquiries and performs the roles and duties like that of a bank representative. SIA has been developed by Payjo, a startup based in Silicon Valley (Bengaluru), and has been set up to handle approx 10,000 enquiries per second or approx 864 million per day, which equals to around 25% of queries processed by Google on daily basis.

Education: A significant real life application case is the use of facial recognition technology used in Chinese schools to monitor and analyze student's behavior as well as use library and canteen facilities by replacing ID cards and wallets. Student's facial expressions are also categorized into different emotions ranging from happy, angry, confused, or upset based on this technology. This system also cross-checks faces of all students against school database to accordingly mark attendance and also has the ability to predict if a student is feeling sick.

Indian Railways: An inclusive application of AI technology is the Indian Railways, which has adopted this technology to ensure hygienic food for on-board passengers. The Railway authority has installed CCTV cameras (monitored from IRCTC HQ, New Delhi) at 16 of the base kitchens for tracking real-time cooking and meal packaging. Other potential areas of AI adoption include crop management wherein AI can be used for purpose of crop prediction, health management, etc.

Clean India & Skill India initiative: In this case, deep learning being an integral part of AI technology can be used with greater impact and significance. For example, citizens can use mobile applications to photograph unhygienic locations and share with relevant municipal authorities with geo-tags and timestamps that facilitate remedial action. For Skill India initiative, India has entered into partnerships with public and private sector organisations both in India and abroad, to facilitate exchange of knowledge. This could prove to be a potentially ripe area to apply adaptive learning solutions to customize education for students to learn at different paces.

Agriculture: The technology of AI can be used in e-governance for traditional sectors in India like agriculture by using smarter production, processing, storage and distribution and consumption mechanisms. AI solutions can also help to provide site-specific, timely data on crops to enable application of appropriate inputs such as fertilizers and chemicals. NITI AAYOG, the premier policy 'Think Tank' of Government of India has entered into an agreement with IBM to develop a model for crop yield productions, using AI to provide real time advisories to farmers in backward districts. The partnership aims to use technology of AI to provide insights to farmers to improve crop productivity, soil yield and control agricultural inputs, with an overarching goal of improving farmers' incomes. For first phase, the project will focus on 10 Aspirational Districts in States of Assam, Bihar, Jharkhand, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh. These districts will be invigorated with cutting-edge technological support to leap-frog development of agri-based economies.

Also, ICT technology can be deployed in area of Livestock Information, Service and Knowledge Management, where applications like image based systems can be used for identification of Individuals, Breeds and Diseases of Pigs and Goats

VII. BLOCKCHAIN TECHNOLOGY

Blockchain technology primarily known for powering crypto currencies like bitcoins, is a form of Distributed Ledger Technology (DLT), which has been recognised for its potential application across multiple sectors due to its ability to validate data records in a remarkably transparent and efficient manner, increase transparency and reduce counterparty risk. Bitcoin is the name of the best-known crypto currency, the one for which blockchain technology was invented.

As stated in a June 2017 paper by the World Economic Forum (WEF), Blockchain is "pulling us into a new era of openness, decentralization and global inclusion".

A. Applications of Blockchain Technology

Land Records - Blockchain technology will enhance the security of digitised revenue/land records. This will ensure that data is tamper-proof and secure, especially since agricultural land records in revenue villages are to be updated before the implementation of small and marginal farmer subsidy scheme.

Good and Services Tax (GST) System: Usage of this technology to implement the GST system with different states and governance bodies, and a distributed ledger that provides a single trusted version of the transactions to all states in the country, will result in an error-free and conflict-free way of documentation and transfer of taxes between the central government and state governments.

Banking: The Reserve Bank of India has successfully tested block chain technology for trade application and settlement purposes. In 2018, the World Bank has mandated the Commonwealth Bank of Australia to arrange for the world's first blockchain bond. The Kangaroo bond, referring to foreign bonds issued in Australia in the local currency, has been named bond-i, according to a recent CNBC report. In India, recently the Telangana State Information Technology, Electronics and Communication department (ITE&C) has signed a MoU (Memorandum of Understanding) with Tech Mahindra to launch India's first Block chain District Telangana. This district will be a centre of excellence for Blockchain, an incubator for technology and process development with infrastructure and facilities to foster growth of Indian blockchain start-ups and companies. Tech Mahindra as a founding member will provide platform and technology assistance to all incubators in this Blockchain District. Further, the Telangana ITE&C department will provide regulatory and policy support to enable and promote Blockchain growth both in India and globally.

In India, banks have formed 'BankChain' (an alliance of banks) in February 2017 to explore and build blockchain-based solutions. The BankChain community has 37 members, with representations from 28 Indian banks, including State Bank of India, ICICI Bank Ltd, Kotak Mahindra Bank Ltd, HDFC Bank Ltd and Yes Bank Ltd.

Medical & Education: Blockchain technology can also disrupt public health by creating a secure and flexible ecosystem for exchanging electronic health records (EHRs); also for recording patient's medical condition and history. Student records, faculty records and educational certificates can be maintained with the application of blockchain technology. It can also help to reorient the education system and deliver academic transparency.

Telecommunications: An application of this technology is in the Telecom sector. A recent development in India has been that the Telecom Regulatory Authority of India (TRAI) has extended deadline for telecom operators to implement new rules namely 'Telecom Commercial Communications Customer Preference Regulations 2018', to curb the menace of unwanted/ unsolicited commercial calls (UCC) and text messages from December 16 2018 to February end 2019, with the help of blockchain technology. The extension has taken place as the telecom operators are finding the process of establishing a new ecosystem coupled with deployment of blockchain technology tedious and time consuming on part of all the concerned stakeholders in the process. TRAI shall be working with telecom operators to harness the power of blockchain to ensure cryptographic security of data. The telecom companies now will have time till end of February 2019 to de-recognise handsets/ mobile devices which don't support apps which enable customers to choose the calls and messages they wish to receive.

Data Security: Adoption of blockchain technology is expected to increase significantly with a rising importance of data in the country since it enables significant ease in data management along with providing transparency and security. Going forward, blockchain has a key role to play in maintaining transparent records, prevent corruption and data theft. For example, in India, Hyderabad is adopting and integrating this block chain technology to integrate into its government affairs, especially for data security purposes in next 12months time period. Andhra Pradesh being the first state in the country, has launched pilot projects for the Department of Civil Supplies & Land Records in order to protect data of subsidies and land ownership from scam artists, cyber attacks and fraudsters. Similarly, this technology is used in transport department to streamline titles of the vehicles.

Real Estate sector: The government can transform real estate sector in the country by implementing a blockchain-based land and property registration which can ease the administrative process of property registration, title transfer, and make them transparent. According to McKinsey Global Institute, distortion to India's land markets is a barrier to faster growth, accounting for 1.3 % of lost GDP growth every year. Putting India's land records on blockchain technology would help in reducing fraud, increase efficiency and in return boost economic growth. Once the data is on block chain technology, all concerned parties can track the deal.

Preventing Cyber Attacks: India was recently affected by ransom ware attack WannaCry, so in this case, technology of blockchain would make a huge difference in fostering secure transactions. This technology is the only trust protocol that guarantees safety of all digital and financial assets. The main characteristic is that data cannot be modified after it is created as a result can prevent and detect any form of tampering. In India, the state of Andhra Pradesh is spearheading this revolution by embracing the technology of block chain. The state's adoption of blockchain technology will help in securing government data and also help the police force to prevent cybercrime. In order to secure the data from ransomware or cyber attacks, the state of Andhra Pradesh is establishing a R&D centre for cryptocurrency in association with RC Bose Center for Cryptology & Security at the Indian Statistical Institute. Other initiatives also include specialized centers of excellence in collaboration with Thomson Reuters, Broad ridge for blockchain. This State also plans to build the largest repository of blockchain technology use cases in areas like transport, finance and digital security. Other states like Telangana, Maharashtra, Karnataka and Kerala are also following suit and have supported the technology of Blockchain and announced pilot projects to ramp up e-governance transparency.

VIII. ROBOTIC PROCESS AUTOMATION (RPA)

RPA continues to gain popularity amongst firms in India as a way of automating repetitive, tedious tasks to handle higher-value analysis and decision-making. It is estimated to generate 2 lakh related job opportunities in the country by 2021. In India, the early adopters of RPA have been sectors like banking and financial services, telecom, insurance and healthcare. In the manufacturing sector in India, RPA is playing a key role as enterprises strive to venture towards smart, efficient and cost effective manufacturing techniques. Also in India's insurance sector, RPA can help the insurance companies to automate workflows and streamline operations. This technology also has the capability to boost profit margin of such insurance companies, subsequently help them to improve insurance coverage in India.

IX. MOBILE INTERNET (5G)

5G networks are the next generation of mobile internet connectivity, offering faster speeds and more reliable connections on smart phones and other mobile devices. The state of the art 5G telecom network is expected to roll out in India by 2022 in keeping with other Asian nations that are planning to roll out 5G services. This new technology has advantages of massive connectivity, low power consumption and boasts of download speeds and capacity that can enable autonomous vehicles, drones, remotely assisted surgeries and traffic control.

With 5G technology at its helm, it is possible to envision an India where emerging technologies like Internet of Things (IoT), Artificial Intelligence (AI), Smart cities, AR & VR shall be in mainstream, designed to improve the quality of e-governance, enable financial inclusion, and show impactful results in sectors like agriculture, healthcare and transportation system and be finally deployable for mass use.

The Government of India has already taken steps to roll out this technology, like for example setting up of a 5G test bed at IIT-Madras, to enable Indian companies to conduct research experiments on the latest generation of mobile telephony. This facility will also act as a torch-bearer for this ambitious and multi-institutional project involving IIT Madras, IIT Bombay, IIT Kanpur, IIT Delhi, IIT Hyderabad, IISc Bangalore, CEWiT (Centre of Excellence in Wireless Technology, IIT Madras) and SAMEER in Chennai. The Test Bed is expected to be fully operational by 2021.

X. MIXED REALITY – VIRTUAL AND AUGMENTED REALITY

Virtual reality (VR) is an artificial, computer-generated simulation or recreation of a real life environment or situation. There are various types of Virtual Reality like Windows on World (WoW) (also called Desktop VR), Immersive VR, Tele-presence, Mixed Reality and Distributed VR. Another component of Mixed Reality is the Augmented reality (AR) which is a technology that layers computer-generated enhancements atop an existing reality in order to make it more meaningful through the ability to interact with it. Augmented reality has been termed as the next big paradigm shift in computing, tantamount to the kind of transformational changes brought about by usage of internet and availability of smart phones. Global technology leaders, including Google, Microsoft, Facebook, Snapchat and Apple, have staked significant claims in Augmented reality “digital rush”. In the words of Apple CEO Tim Cook, *a significant portion of developed countries, and eventually all countries, will have Augmented reality experiences every day, almost like eating three meals a day.*

As the name suggests, Mixed Reality mixes both realities (VR & AR) in a bid to capture the best of both worlds. Gartner Inc, the world’s leading research and advisory company predicts that by 2019, AR, VR and MR solutions will be evaluated and adopted in 20% of large-enterprise businesses. The global Mixed Reality market size is expected to reach \$2.8 billion by 2023, according to research firm Reportbuyer.com. The rapid growth will be driven by the need for increasing demand for innovative and wearable products. Some of real time applications of technology of VR are in sectors like manufacturing, medicine, movies, Video Games and Education and training. Similarly sectors like defence (military), medical, education, etc shall witness the usage and adoption of technology of AR in application phase.

A. Applications of Augmented and Virtual Reality

With the ability to provide data in real time, engage users, and simulate real-life experiences in minute details, both AR and VR have massive potential to transform government services and citizen interactions. Some leading and prominent *real life applications cases are:*

Police Force: Police officers would be better prepared to handle dangerous situations when equipped with AR systems that provide relevant details on the environment. For example, when visiting a gunshot area, officers would be able to access data in form of 3D version and model of the building, learn about the past arrests at same address, and prior police reports about hazardous conditions.

Citizen engagement and e-services: Imagine a world where government form and applications can be accessed, viewed and completed through a variety of AR devices, like smart phones, smart glasses, in-office displays and readers, with help of full range of accessibility aids such as sound, language translations, visual and graphic instructions, etc. Imagine a world where policy, legal, regulatory documents and frameworks as part of governance processes are transformed into “living” documents that could interact with citizens and officials via AR enabled devices. And imagine a world where citizens and businesses can actually “see” and even ‘interact’ with help of augmented reality as to what planned public works projects like highways, water and energy facilities, public parks, transit lines and stations, etc would look like.

Emergency Management: AR can improve resident’s knowledge of his/ her surroundings in order to rescue residents in need, during emergency situations. Residents in this case can plot their locations on the interactive map distributed to responders, which would highlight the safest rescue routes possible and identify particularly hazardous areas.

Digital Services: In case where residents need to fill static digital forms in order to receive services, AR and VR could provide an interactive experience that helps aids users through the application process. Deployment of this technology would reduce errors by residents, ensure speedy delivery of services and further create more pleasant government-citizen interactions.

Culture and Tourism: By providing additional historical and/ or cultural details, AR has the ability to transform visitor experiences with city landmarks. Cities can utilize this technology of AR & VR to highlight their historic pasts for interest and attraction of the tourists and other interested group of people.

Education: One of the most interesting and an immediate application is sector of training and education. Several studies have proven that students who learn and train in VR retain information for longer durations of time as compared to those who simply use books, videos and other traditional methods. Here, both augmented and virtual reality has the potential to attract more students to the classroom and create more engaging and exciting classroom experiences. Using VR, student’s belonging to the

rural areas could participate in the virtual classroom in a more fulfilling and rich way than in traditional online classes. Using AR and VR, teachers can also create an immersive learning environment. By funding these technologies in public schools, cities can make schools more inclusive and engaging.

Urban Planning: By creating AR and VR models of new construction projects, cities can get a better sense of how the new work fits within existing urban landscape and potentially increase interest from investors. By making these models available to residents and local businesses, cities can also gain feedback on their plans.

Culture, heritage and tourism: Across the globe, protection of one's own heritage and culture is of a high priority. One of the richest uses of AR is to enhance places, such as historic buildings, castles, monuments and heritage sites and battlefields. Museums and culturally significant buildings are perfect candidates for AR information and rich content around artwork, artefacts, publications, etc. Natural resources like national parks, coastlines, forest and wetlands, when combined with AR can provide a powerful educational experience and all these factor when tied together including things to do, art and culture, history and heritage shall create interesting AR experiences for cultural tourists and citizens alike.

Transportation and urban mobility: Imagine being able to 'see' and visually "connect" the various transportation systems, ranging from traditional highway, roadway and fixed-rail infrastructure, to modern mobility services and active transit (walking and biking). Operators of trains, buses, shuttles, car/vans, will have AR windshield displays providing real-time information such as traffic incidents, scheduling and route changes, customer needs, vehicle maintenance and health, etc. And imagine augmenting physical maps of transit systems so that users, visitors and residents alike are able to visually and/ or audibly access that portion of the transit network which they actually use and need.

Training: With the capacity to recreate real-world experiences in a high level of detail, augmented and virtual reality could revolutionize training for employees. Stimulating those situations which are too dangerous or difficult to recreate in real life would be the added attraction and worthwhile. AR and VR training programs have the ability to expose employees to realistic and diverse situations, preparing them for any future exigency.

Public Safety & Emergency Services: Imagine fire-fighter and disaster management people being able to navigate to and through their environments with emergency vehicles equipped with AR windshield displays providing route guidance and real-time sensor data on environmental and hazardous conditions; and with helmet-mounted AR devices which would allow them to see and hear through smoke, fire, rubble, poor weather and other conditions. Imagine AR disaster applications that provide visual and audio guidance for citizens seeking refuge, evacuation routes, or emergency assistance in a disaster situation. Imagine real-time data-driven AR applications that allow law enforcement officers to access location specific information and data on dangerous situations via smart glasses, in-vehicle displays and other wearable. Citizens and businesses can access authorized geo-specific data on crime statistics and other environmental factors just by pointing their mobile devices at a building, down a street, or for an entire community.

Courtroom: Once upon a time, lawyers used to use photos, demonstrative exhibits, visual aids, witness statements and boards to 'transport a jury to an accident scene'. With the technology of Virtual reality, lawyers are now able to transport the decision-makers directly into the scene. As lawyers, one of the biggest challenges faced in a case is showing the decision makers or jury what actually happened at a crime scene or at the precise moment of impact during a catastrophic injury. With help of VR, lawyers can transport jurors to the accident scene directly. The sense of 'presence' that technology of virtual reality has the potential to be a game changer in the practice of law.

XI. 3D PRINTING

Three-dimensional (3-D) printing is changing the face of traditional manufacturing. Today, 3-D printers not only make jewellery and toothbrushes but also football boots, racing-car parts, custom-designed cakes, human organs, houses, aeroplane parts and even more efficient lithium-ion batteries.

Globally, according to a report published by Markets and Markets, the world's largest revenue impact company, the 3-D printing market is expected to be worth \$32.78 billion by 2023, at a CAGR of 25.76% between 2017 and 2023. This growth is attributed to factors such as ease of development of customized products, ability to reduce overall manufacturing costs, and government investments in the 3D printing projects for the development and deployment of the technology. Also as per same report, sectors like aerospace and defence have been reported to hold the largest share of the global 3-D printing market in 2016.

According to 6Wresearch, India's 3-D printer market is projected to touch \$79 million by 2021. In India, 3-D printers have been used in wide range of sectors like medical, architecture, automotive, industrial, aerospace, military and other applications; with automotive application accounting for the largest revenue and volume share. Globally established companies like Stratasys and Optomec have footprints in India through partnerships and alliances, as per findings of 6Wresearch. Also, major companies active in the Indian 3D-printing market space are Altem Technologies, Imaginarium, Brahma 3, KCbots and JGroup Robotics. As an example of application of this technology, it is worthwhile to note that around 4 years ago in India, a team of Indian plastic surgeons at the Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER) in Puducherry restored the deformed skull of a three-year-old girl to its original shape with the help of a 3-D printer that was sourced from a Mumbai-based 3-D printer maker, Divide By Zero Technologies. JIPMER now has its own 3-D Printer.

XII. POTENTIAL CHALLENGES IN IMPLEMENTATION:

The emerging technologies have proved to be a boon in a lot of use cases across different countries, however, as these technologies are yet to be implemented in India, hence the effects are not yet observed. Some foreseeable challenges are :

- **Social - Data privacy** has been a matter of great discussion as at various forums. With the advent of Artificial Intelligence, data has become the key component of any advanced IT system. bouquet of benefits for the citizens by improving the government agility, ready availability of the government services to the remotest areas.

- Economic - It is largely perceived that with the proliferation of AI based applications in our ecosystem, there will be a loss of jobs due to automation of a lot of activities. However this can be managed by the concept of 'Jobs Lost – Jobs Changes – Jobs Gained'. Essentially by reskilling and retooling the workforce will get an opportunity to get in to newer roles and changed nature of work by reskilling programmes.
- Cyber Security – remains one of the major concerns as almost all the emerging technologies demand cleaner and huge volumes of data for processing and generating meaningful output.

XIII. OTHER INITIATIVES IN EMERGING TECHNOLOGIES UNDER DIGITAL INDIA:

A. Centres of Excellence for AI & IOT in India:

The Centre of Excellence for IoT was announced by the Prime Minister Narendra Modi in July 2015 as a part of Digital India Initiative to jump start the IOT ecosystem taking advantage of India's IT strengths and in the long run attain a leadership role in the convergent area of hardware and software. Main objective of the center is to create a deep technology innovative ecosystem in India by harnessing the innovative nature of start-up community and leveraging the experience of corporate players. Some of the leading COEs in India created to promote emerging technologies like Artificial Intelligence, Blockchain, Virtual Reality, Augmented Reality and Data Analytics, etc are:

- Fintech at Chennai
- IoT in Agriculture at Guwahati and Patna
- Virtual Reality at Bhubaneswar
- Block chain at Gurugram
- Medical Technology at Lucknow
- Electronics Products at Bengaluru
- R&D in Nanoelectronics at IIT Guwahati
- Proposed CoE on gaming, animation and computer vision at Software Technology Parks of India (STPI) facility in Hyderabad

B. Committees on Artificial Intelligence:

The Ministry of Electronics and Information Technology has embraced the technology of AI by forming four committees on different aspects of AI:

- Citizen centric usage
- Data Platform
- Skilling, re skilling and R&D
- Legal, regulatory, ethical and cyber security challenges

In the same lines, NITI Ayog, Government of India's premier policy think-tank will establish a National Strategy for Artificial Intelligence, #AIFORALL to conduct research and development in areas of emerging technologies like machine learning, artificial intelligence and others.

C. National Centre of Geo-informatics (NCoG):

This will be one of its kind 'GIS platform', for sharing & collaborating GIS data source, location based analytics and decision support system serving to the Central and State Government and departments across the country. More than 126 GIS based web/mobile applications under 23 Central and more than 14 State governments are at various stages of operationalization.

XIV. CONCLUSION

Globally, technology has been the greatest enabler in causing disruptive change and also for bringing about massive transformation in both public and private sectors. India's story is no different, and the use of digital technologies to educate and empower citizens is being seen as a game-changer. Given India's vast expanse and differences in demographics across the nation, there is also a vast difference in the level of adoption among the citizens. Given the complexity of implementation at such a large scale and unprecedented scope of the project, it is critical to choose disruptive and emerging technologies, which have mass reach, can be customized and are ubiquitous in nature. Considering the timelines involved, the implementation would need to be done in a lean and agile manner, apart from being cost effective and secure.

As digital technologies continue to evolve and become more sophisticated, the focus is shifting towards designing solutions which integrate these technologies to provide holistic solutions to long standing challenges facing the society. Going forward, it is anticipated that these emerging technologies, also known as key technology drivers would interconnect and integrate while significantly improving interoperability, towards creating an ecosystem which would be capable of adapting to the behaviour of users, anticipating their needs, providing solutions as well as implementing them with minimal human intervention.

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