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Abstract: *The Covid-19 pandemic is having a huge global impact, especially when we talk about* Internet of Things (IoT) and *market analysts to analyze the impact of the pandemic on smart cities and also to understand what are the new responses, challenges, opportunities which will arise in a post-pandemic scenario. Technology is a key which has turn a city into smart city which is well connected, sustainable and resilient, where information is not just available but also findable. Therefore, the emerging technologies have created new interest in smart cities' solutions. It is one of the most promising, prominent, and challenging applications of the Internet of Things (IoT). The main goal of is to optimize city functions and promote economic growth and also improving the quality of life for citizens especially by using smart technologies and data analysis that leads to smart outcomes. The progress and advancement of the smart cities' are the results of the successful utilization of emerging technologies. With the advancement of COVID-19 pandemic, people realized how important digital connectivity. We, as a society should learn how to be ready for a crisis and the best way to be ready for the crisis is really influenced all this innovation in the digital world.*

This paper thoroughly studies the value of how emerging technology is used and what are the challenges and responses of technology used in smart cities for the planet earth during and post COVID pandemic.

Keywords: Internet of Things(IoT), Emerging Technology, Smart City

Introduction

Technology could be a key which has turn a city into smart city which is well connected, sustainable and resilient, where information isn't just available but also findable. Therefore The emerging technologies have created new interest in smart cities' solutions. It's one amongst the foremost promising, prominent, and challenging applications of the web of Things (IoT). The progress and advancement of the smart cities' are the results of

the successful utilization of emerging technologies. No doubt, COVID definitely delayed down the progress of smart cities which has impacted many of the projects, particularly those focused on transportation and traffic. COVID actually prompted new smart city initiatives.

The smart city vision combines emerging technologies like edge computing, computer science etc. to make sustainable ecosystem. As far as public health is concerned many cities across the world using technology to watch air and water quality. During the study of this paper we have thoroughly studied the value of how emerging technology is used and what are the challenges and responses of technology used in smart cities for the planet earth during and post COVID pandemic.

Objectives of the study

- To study the technical requirements to establish a sustainable smart city.
- To study the value of how emerging technology is used within a smart city environment..
- To study COVID-19 Smart Spaces –A Technology based responses
- To study the challenges of technology used in smart cities for the planet earth during and post COVID pandemic.

Emerging Technology and its roles within a smart city environment in the time of COVID -19

The COVID-19 outbreak will accelerate technology trends thar are already underway. AI, blockchain, analytics and virtualization offer tangible samples of emerging technologies. Smart cities are cites where everything is connected to every other and this is often highly relied on technologies. Using technology, the officials are able to gather city intelligence and this intelligence when integrated with the operations make the cities smarter and safer. Creating a two-way communicate on channel is incredibly important for a city to be smart. ICT helps the government to research the demand pattern of the state and thus create a pool of resources to handle the identical online. The Six technologies crucial for smart cities [2]

Internet of Things: Internet of things is like veins of town spread all across and connecting each dot. Every device that a part of a wise city has to be connected to every other so they will talk amongst and may take decisions for themselves which reciprocally allows managing resources of a megacity population. This can be where the IoT comes in, providing the proper template of a body of communicating devices that gives smart solutions to everyday problems. All smart solutions in smart cities are supported on Internet of things where they're connected and smart enough to come to a decision.

Sensors: Sensors are hidden but ubiquitous components of the urban landscape. Sensors are important components of any intelligent system. Sensors are like converters which convert parameters of a physical nature to a signal, which may be interpreted by humans

or often fed into an autonomous system. These signals for conventional sensors, amongst others, include light, pressure, temperature, humidity, moisture and a spread of other parameters.

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Figure 1: The Smart Cities

5G Networking: Mobile technology is taking a big discovery. 5th – generation networks (5G) are transforming the ways we use wireless devices in ways in a rare ways. Combined with artificial intelligence (AI) and also the Internet of Things will dramatically the way citizens live, work and find round the city of the longer term. With 5G smart cities achieve massive device connectivity, higher data rates, reduce latency, higher system capacity, energy savings and price reduction. It can enable wireless connectivity in exceptional locations and enable IoT sensors to watch everything.

Figure 2: Emerging Technology in Smart Cities

Geospatial Technology: Whatever is made in a smart city has to be right and to make it

right, a right plan is that the need which is sustainable and this needs accurate, concise and detail data. Here comes the role of Geospatial technologies which provide the underlying foundation and ultimately the material upon which offer may be built. It provides location which allows pinpointing exactly on the necessity so better solution is applied to that. Geospatial technology provides a necessary framework for collecting data and remodeling observation in these collections to facilitate software-based solution around smart infrastructure

Artificial Intelligence: Smart city may be a digital revolution generating an enormous amount of information. This massive amount of knowledge generation brings the role of computer science which will be out of these data. to grasp the interesting aspect of AI within the terms of smart cities, allow us to take an example. during a system where energy spikes tend to happen, AI can learn where they typically occur and under which circumstances and this information is used for better management of the facility grid. Likewise, AI also plays a job in intelligent traffic management and healthcare facilities.

Block chain: Block chain application is an unaccustomed smart city concept. Blockchain technology secures data flow. Its integration into smart cities could better connect all city services while boosting security and transparency. In some ways, block chain is expected to influence cities through smart contracts, which help with billing, processing transactions and handling facilities management.[2] Block chain may be utilized in smart grids to facilitate energy sharing, an idea which is trending nowadays.

The United Nations has predicted that the traffic situation would further deteriorate, as by 2030 two-thirds of the world's population will live in megacities with high population density. This draws our immediate attention towards the need to mitigate overcrowding and congestion through smart urban planning.[3]

Philips Lighting, along with Smart Cities World, published a report that compiled a list of top smart cities after thorough research on more than 150 parameters that impact urban planning across the world. The report mentions Singapore, London, and Barcelona as the world's best smart cities, demonstrating that management, government policies, and leadership would play a key role in smart city programs.[2]

COVID-19 Smart Spaces –A Technology Based Responses

Digital technologies are playing a key role to remain our societies functional during now of lockdowns and quarantines. The COVID-19 pandemic has compelled everyone to wish a digital approach to being an employee, friend, or friend. Mobile and web technology is helpful for spreading awareness about COVID-19, facilitating contact tracing, notifying individuals who have are available close proximity to suspected carriers, tracking COVID-19 suspects in quarantine, real time tracking of crowds, remote monitoring of COVID-19 patients and far more. Drones are being employed for enforcing strict quarantine and social distancing and for disinfection purposes.

Robots are helping treat COVID-19 patients and sanitizing COVID-19 wards. Telemedicine is providing solutions for e-health checkups. Big data and AI is getting used for Research

and Development (R&D) purposes.[7]

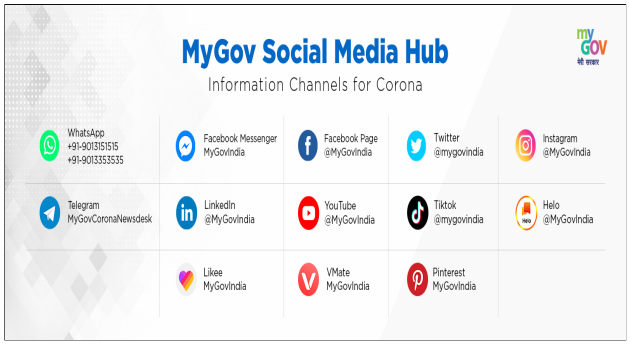

Figure 3: MyGov Social Media Hub

Source: National Informatics Centre, Ministry of Electronics & Information Technology, Government of India. 2020b. "#IndiaFightsCorona COVID-19." #India Fights Corona COVID-19 in India, Corona Virus Tracker. May 12, 2020. https://www.mygov.in/covid-19/.

- **AI-powered tools for screening**

An AI based voice tool has been developed and designed by a professor and her students in Mumbai (Press Trust of India 2020b). This tool is able to detect COVID-19 through voice-based diagnosis using a Smartphone app. The tool will detect COVID-19 based on the fact that the voice of COVID-19 patients is different from healthy people due to damage to the lungs and airways. Artificial Intelligence is able to detect these differences, which a normal ear cannot.

The Defence Institute of Advanced Technology (DIAT) in Pune, Maharashtra has also developed an AI based COVID-19 detection tool (Press Trust of India 2020h). The tool uses the chest x-rays of patients to identify COVID-19 infection.

- **Aarogya Setu App**

The Aarogya Setu App has been developed by National Informatics Centre (NIC), Ministry of Electronics and knowledge Technology, Government of India (Wikipedia 2020; National Informatics Centre, Ministry of Electronics & Information Technology, Government of India 2020a; Mitter 2020). it's a contact tracing app available in 11 languages. The app uses Bluetooth and site data to trace movement of the user. An alert is generated whenever a user has been within six feet of a COVID-19 patient by cross-referencing the pan-India government database of COVID-19 patients.

The app's programme displays current status of user locality (the zone: red, orange, green), risk of the user getting infected with COVID-19 and updates on COVID-19. The app is somewhat kind of like the community tracing app "Trace Together" utilized by

Singapore. Not only 'Aarogya Setu' but all other apps that track real-time movement of individuals raise privacy concerns.

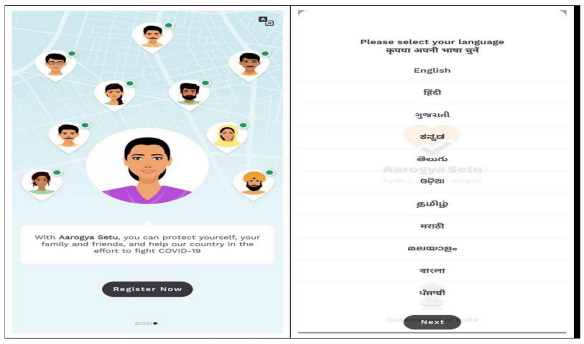

Figure 4 : Aarogya Setu App

Source: Mitter, Sohini. 2020. "Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India." Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India. April 2020. https://yourstory.com/2020/04/coronavirus-contact-tracing-patient-monitoring-apps-india.

- **Robots for treatment**

The use of robots is also being explored in various states in India to minimize the contact of healthcare teams with COVID-19 patients in hospitals and to address the shortage of Personal Protective Equipment (PPE).[7]

- **Nightingale-19 Robot**

The Nightingale-19 Robot is being used in hospitals in Kannur and Thalassery districts in Kerala (Thomas 2020; Zachariah 2020). Nightingale-19 can deliver food, medicines and other essential items. It also provides video conferencing facility to interact with the patient.[7]

Figure 5: Nightingale-19 Robot

Source: Zachariah, Serene Sarah. 2020. "Kerala's 'Nightingale-19' Robot Serves Meals, Helps Doctors Treat COVID-19 Patients." Kerala's 'Nightingale-19' Robot Serves Meals, Helps Doctors Treat COVID-19 Patients. April 2020. https://www.thebetterindia.com/224546/covid-19-kerala-robot-nightingale-19-innovation-protect-health-

workers-india-ser106/

Smart cities will enhance the standard of lifetime of citizens in multiple ways and reduce the taken time to commute between home and workplace because the problem of traffic jam is prohibited. the crucial developments in smart cities that might expectedly save time like mobility, Health care and Public safety.

Figure 6: Smart Spaces Technology Based Responses

- **Smart Spaces**

We spend 90% of our time indoors, in order to maintain safety in shared spaces like offices, schools, universities, etc. we need a kind of systems in places so that we can protect people from infectious diseases. Common sense guidelines are already being implemented. Technology based options also exist. It is critical to consider high-tech Internet of Things based solutions that are available as valuable tools to prevent sick from entering a building, maintaining the appropriate social practices inside the space,

relying upon robotics to maintain a sanitized environment [3]

- **Digital City Services**

With many municipal offices closed and staff working remotely, most cities have been forced to deliver more citizen services digitally. Some city government conduct meetings virtually,
e-learning, training and virtual whiteboards were imparted through technology-based responses by educational institutions They may find that there certain efficiencies to continue to work this way.

- **Delivery of Cooked Food to Slums**

Agra, referred to as the "City of the Taj," among one of the most common international tourism destinations of India, had registered its first case of COVID-19 on March 02, 2020. Since then till May 22, 2020, a total of 840 cases were reported in the city, with 28 deaths and 707 recoveries. It is one of the worst affected cities in the State of Uttar Pradesh accounting for about 20% of total cases reported in the State. The key highlights of Agra's containment plan include: [5]

- ✔ Converting Integrated Control and Command Centre (ICCC) into WAR room, with more than 25 people working 24x7 helping city authorities and operating the helpdesk to respond to citizen grievances [5]
- ✔ Launch of Lockdown monitoring app to track crowd gathering and social distancing violations using real-time alerts and messaging systems across all city police stations.[5]

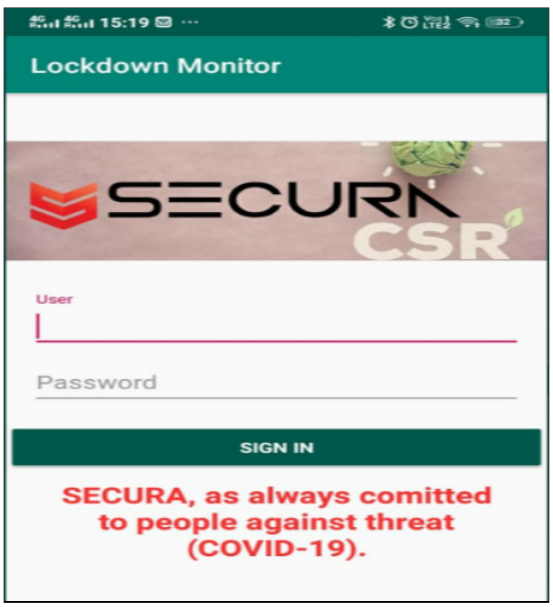

Figure 7: Lockdown Monitor SECURA

- Launch of a **GIS-based COVID-Tracker dashboard** showing various corona virus

hotspots, disease heat map, and providing information on the number of positive cases, patients recovered, daily case count, trends, age groups affected, etc. to help in data-driven decision making.[5]

- Web-Portal for online **Door to door delivery of essentials** (including groceries, vegetables, fruits, and medicines)

Agra District Administration and Agra Smart City Limited have collaborated in ensuring doorstep delivery of daily need items Based on a survey done for the entire 100 wards of Agra city, specific kirana shops and fruit/vegetable vendors were identified in each ward for participating in the initiative. About 6-10 vendors per ward were identified to distribute fruits, vegetables, and essentials at the citizens' doorstep in that ward. [5]

Figure 8: Distribution of food among street dwellers and poor families [5]

AWebPortalhttp://agrasmartcity.in/EssentialItemSupplier. aspx) was launched, which can be accessed by mobile (app) and computer (web portal) to allow the general public to select the nearest available vendors of groceries, fruits, and vegetables. [5]

The web link also provides the contact details (mobile number and address) of the registered vendor (which were collected during the GIS property survey and SWM RFID tag installation), where the public can directly call and place their order. The E-Pass facility is provided to the registered vendors to facilitate the movement of essential service goods.[5]

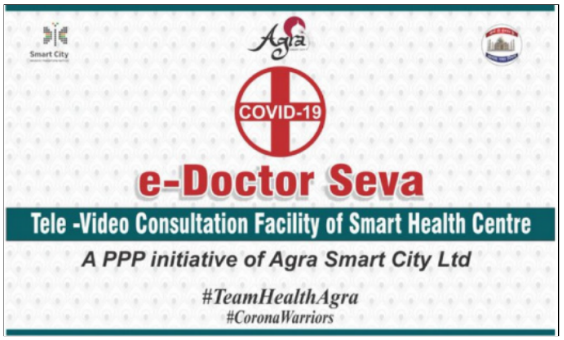

Figure 9 : e-Doctor Seva -Tele Medicine facility provided to citizen [5]

- **e-Doctor Seva**, a PPP initiative to provide tele-video consultation

Further, Secretary, Food & Supplies is distributing wheat flour and pulses to the registered beneficiaries under Pradhan Mantri Garib Kalyan Anna Yojana (PMGKAY) using a coupon system (having distribution time slots) to ensure social distancing.[7]

Talking about the best practices from other countries Technology has always been the top priority of the South Korean government, and South Korea has also proven to be the global leader in using ICT to fight against COVID-19. With the help of Artificial Intelligence (AI), South Korea was able to develop a COVID-19 testing kit in just three weeks time which normally would have taken around 2-3 months to develop (ITU News 2020). South Korea has had a 'Smart quarantine Information System' in place since the MERS outbreak in 2015(ITU News 2020). South Korea has leveraged Artificial Intelligence (AI) for the development of various tools to aid in quick diagnosis and classification of case severity (ITU News 2020). The AI based Chest X-Ray Image Support Decision Tool developed by VUNO helps in identifying abnormal findings on chest x-rays within few seconds and is able to classify if the patient needs intensive care. AiHub is a medical platform which utilizes AI to examine lung diseases within few seconds. AI based Hand-held chest X-ray camera can scan the chest in just three seconds and gives a heatmap visualization of abnormal lesion. For instance, voice robots based on AI automatically calls people who seek information or need attention.[7]

Hong Kong has showcased the best example in the world of caseload mapping. It has published building-by-building map which illustrates the number of COVID-19 cases at every single address in the whole city without any additional identifiable information.[6]

Countries like Germany and Italy are strict in terms of data protection laws and are using anonymised location data to identify public places where people are defying lockdowns by gathering in groups.[7]

Aarogya Setu contact tracing app, launched by Government of India, and Israel's "HaMagen"(or "TheShield") app are few such examples.[7]

Challenges of technology used in smart cities for the planet earth during and post COVID pandemic.

ICT enables new ways of managing the COVID-19 crisis and will be considered as a sovereign remedy to deadly diseases. ICT plays the role of a catalyst so on to facilitate the processes involved in fighting against COVID-19. Various new mobile apps have been launched by the central and state governments of India to help and fight against the COVID-19 situation within the country. Most of those mobile apps are designed for smart phones and poor are less likely to afford them while elderly are less likely to use them. Therefore, efforts should be taken towards scaling up those ICT interventions which

enables inclusion of these vulnerable groups.

Post-COVID-19, IoT plays a major role in smart cities. Thanks to the increasing specialize in building security and connected buildings, similarly as city operation. In post-COVID-19 smart cities, IoT together with digital twin and artificial intelligence (AI) techniques will provide valuable predictive modeling that's critical to enable cities to work out the security, effectiveness and economic implications of policy measures. To hire inure future public health emergencies, smart cities must embrace IoT and other emerging technologies for such things as social distance measurement, viral testing and infection case.

Conclusion

According to the study the conclusion which has been derived is that COVID-19 has led to the changes in how smart cities are using the applications IoT. The worth comes from not just use, but effective use of the technologies combined with evidence-based policies and practices. There is no denying the pandemic has created changes within the built environment and across cities that are here to remain. The progress and advancement of the smart cities' are the results of the successful utilization of emerging technologies.

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