

Opportunities for IoT in Building Smarter e-governance Systems

B. Sathish Babu^{1*}, Brinda¹

¹*Dept. of Computer Science & Engineering, RV College of Engineering[®], Bengaluru*

Abstract

Technological advancements have provided a great opportunity in making transparent decisions in various fields of civilization, especially in e-governance. E-governance systems are expanding their range of applications for the citizens and businesses by adopting the Internet of Things (IoT). The coordination among various IoT devices and systems are the key to build smarter E-governance. Smarter e-governance systems have variety of use cases which includes public health sectors, banking sectors, and life sciences mainly in agriculture, farming, and forestry. It has also increased the intelligence of security, transport, and utility services. Despite various developments in IoT technology, there are still a number of research challenges in this domain of smarter e-governance with IoT. This paper identifies impacts of IoT to form a smarter e-governance application, followed by a review on IoT initiatives taken by e-governance across the globe. It is understandable that IoT will have a dominant impact on e-government services in the future, and the smarter e-governance can leverage IoT devices to offer service which will be efficient, shareable, on-time and transparent to the citizens.

Keywords: *Internet of Things, Internet of Things, Smarter e-governance*

1.0 Introduction

Governance is understood as a “manner of governing a state” which means the ability of the government to ensure effective and transparent administration and when it comes to e-governance, it emphasis more on Information and Communication Technologies (ICT) and it creates a new avenues for communications for the expansion of the appropriate e-government structures [1].

E-governance has become a solution, providing better communication between the government and the citizens. Today, technologies such as Big Data, Internet of Things (IoT), Artificial Intelligence (AI) and Cloud Computing (CC) are leading us to develop smart e-governance applications for core governmental sectors like Agriculture, Forestry, the Environment and Food Technologies, Health Care, etc. For a country like India with a vivid culture, diversified languages and large population, deploying a trustworthy, secure, efficient and

**Mail address: B Sathish Babu, Professor, Department of Computer Science and Engineering, RV College of Engineering[®], Bengaluru – 59, e-mail: bsbabu@rvce.edu.in Ph.: 9844488329*

smart e-government systems is challenging, yet always been encouraged by national governmental agencies.

National Informatics Centre (NIC) was established in the year 1976 with the financial support of the United Nations Development Program (UNDP) and this act was a major step in the execution of e-governance in India [2]. After this event many e-governance initiatives were set in motion at national and state levels. The government flagship initiatives such as Digital India, Make in India and Smart Cities, are playing a role of key enablers for these public services.

1.1 Internet of Things (IoT) and its expansion

The Internet of Things (IoT) is the advancement of the internet services over a network of interconnected computers and all other nodes which can access internet. IoT increases the presence of Internet by providing coordination among every device for the exchange of information and making devices to respond to the desired situation via embedded systems. The interconnected objects in IoT are assigned with IP address which collects and transfer the data without manual assistance. These objects contain embedded electronic system collaborated with some technologies like the radio frequency identification (RFID), wireless sensors with existing LAN / WAN networks [3]. The embedded technology in the objects helps them to interact with the external environment and to take effective decisions to become smart.

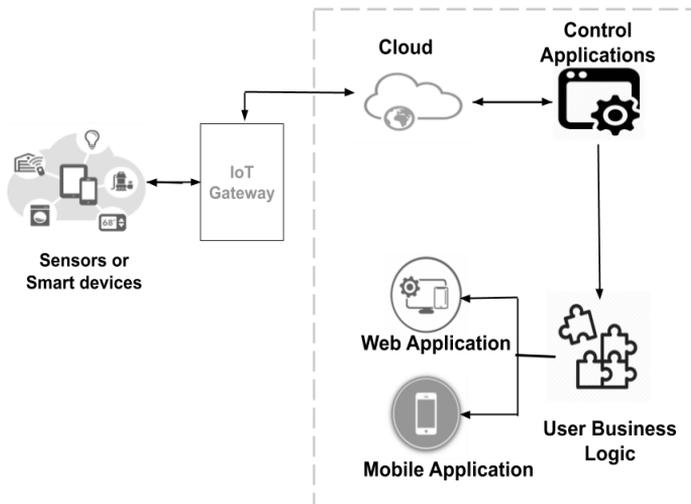


Fig. 1. Overview of IoT Architecture

The ‘thing’ in IoT could be an automobile with built-in-sensors or a person with a heart monitor. Data collected from the things are passed to the cloud services and vice versa where data is stored through the gateways. IoT gateways provide filtering and data pre-processing to reduce the amount of data and also impart control commands going from the cloud to the things (Fig. 1).

Cloud facilitates secure data transmission and also assures compatibility with all the protocols supported by IoT gateway. Control applications send commands and alerts the sensors or devices, like, if the result from sensor show that soil is dry then the watering devices or system will get commands to water the plants. These control applications can be designed on a rule-based or machine learning-based, which depends on the business requirement of the IoT application [4]. A user application connects users with IoT devices and also gives the benefits to the users to regulate or monitor their smart devices.

1.2 Need for IoT and its implications

Today, industries require a great revenue management system to reduce waste, loss, and cost. If there exists a device that can communicate and gather data without any human involvement then many things can be tracked and controlled. This is precisely what the IoT platform does. It enables the devices to identify, observe and understand the situations or surroundings. IoT connects its users with the application having on and off switch functions via internet and serves a much better way to the people to control their environment. This makes the communication and remote manual control as the two ultimate goals of the IoT devices.

There are hundreds of IoT applications which are being recognized by different industries, they can be logically divided into two categories [5].

Category 1: This category is about averaging the data that gets collected by different sensors and smart devices. Data mining for patterns and trends is done on this data for useful marketing information. For example, store/website tracking which includes the path from where you visited the store, at which division of the store you spent the most time and even what type of materials you searched at the store and picked.

Category 2: In this, IoT plays the role of remote tracking, routing, and commanding device. This means IoT applications of this category are not about data mining of user practices but relatively they extend the automation and communications between IoT devices as well as between devices and nature. For example, IoT enabled weather updating device can inform about the forthcoming weather conditions and can change users room temperature accordingly.

Dynamic interactions between internet enabled nodes created through IoT devices leads to a better resource utilization and optimization. Energy utilization and responding to the information to minimize the resource allocation can be achieved effectively by making use of IoT. Item tracking, which is done with barcode and manual steps can be replaced in the future by IoT enabled smart tags, near-field communication (NFC) and RFID to globally track all kinds of items.

IoT system strengthens the device to device communication resulting in a long-term efficiency for both the IoT companies and the users. More information

flow will lead to the analysis of large trends in the data to improve the features of the device which further reduces the cost of implementation and time. When devices can represent themselves digitally, they can be controlled from anywhere and this greatly reduces human efforts.

2.0 Smarter e-governance

Presently, governments around the world have realized the potential benefits of providing integrated services to their citizens using internet as their tool. Furthermore, they are also fully aware of the need for transforming themselves to smarter government as the emergence of newer technologies are allowing the citizens to connect with their government at very ease and decision-making procedures can be effectively improved by processing the data generated by these newer technologies.

2.1 e-governance versus smarter e-governance

Nevertheless, the concept of e-governance is fizzing from last few decades, there are many works going on to forecast the benefits of smarter e-governance in modern service delivery to the citizens and for the public administration by the government. This section provides the major difference between e-governance and smarter e-governance.

E-governance is an automation and technology-driven relationship between citizens and their government with respect to interaction and deployment of various policies using internet [6]. On contrast to e-governance, “smarter e-governance” refers to the deployment of different business processes with corresponding technologies so that information can seamlessly flow across various sectors of government to provide best services to the citizens [7]. To understand it more clearly it can be stated that smarter e-governance is an expansion of e-governance which involves applying information and smart technologies across multiple governmental domains to generate meaningful value to the governmental services. As people are relying mostly on technologies these days, smarter e-governance involves expansion and collaboration of various technologies to gain maximum advantages out of it.

The aim of e-governance is to enhance the use of information technologies to provide efficient interface with the citizens and businesses. In turn, to achieve transparency, accessibility and finally growth of revenue [8]. E-governance model focuses on eCitizens, eServices and eSociety. eCitizens and eServices involves usage of innovative technologies by the government to interact with their citizens and eSociety is to build external relationships with governmental agencies, public agents and so on. Contrary to e-governance model, smarter e-governance model focuses on citizen participation, information transparency and collaboration of newer technologies. This involves formal circulation of information and ensuring that citizens participate in governmental decisions and feel free to give feedbacks. Smarter e-governance is citizen directed which aims at providing personalized information [9]. Fig. 2, manifests that the smarter e-

governance extends the concepts of e-governance for better resource utilization to provide greater services to the citizens.

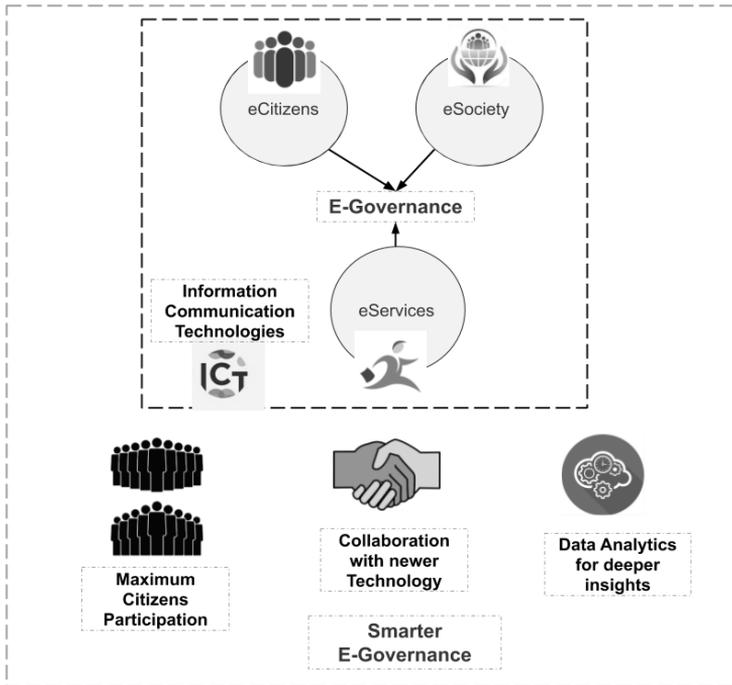


Fig. 2. e-governance and Smarter E-governance

It is understood that e-governance and smarter e-governance are related yet comparatively different terms of government. On its role, e-governance implies using digital tools and technologies for effective, transparent and efficient services for the citizens and private or public business and smarter e-governance involves leveraging innovative technologies and business models for making smarter decisions for the well-being of the citizens.

2.2 IoT in e-governance

E-governance initiatives towards different usage scenarios of IoT enabled solutions will make smarter e-governance for citizens. IoT enabled industry-agnostic can be deployed in the manufacturing, automobile, educational, healthcare, agriculture, banking & insurance, logistics sectors, etc. It will lead to identified citizen services, in turn, improving the efficiency and effectiveness in the communication between government and its citizens and other stakeholders involved.

There are several ways in which IoT enabled smart devices can impact the working of e-governance. Like in India, where agricultural land patterns are very different and global solutions do not typically work, IoT enabled automated systems can play a crucial role. It can be used in all aspects of agriculture from soil testing, tilling, seeding to post-processing. Coming to Safe

Water Networks which aims to provide safe drinking water, IoT solutions can be used to get real-time data to anticipate water shortages in rural areas. Further, IoT solutions can be used to track the cash levels in ATMs and also to track the banking agent's activities thus improving the banking infrastructure.

In the energy utility sector, millions of meters could be connected to form smart meters which can extend to utilities like water and gas, thereby reducing distribution and transmission losses. IoT can be used for monitoring the petrol/diesel generators for fuel usage, power output, and other parameters. IoT enabled mobile POS (Point-of-Sale) cards can be used in multiple cases like fair price shop payments or Aadhaar linked payments. IoT enabled wearable devices and sensors can give insights on medical effectiveness by monitoring pulse, heart, walking, and other health data. Remote monitoring of various medical equipment is also possible which will reduce the possible downtime. IoT could be used for fire detection in forests and rural areas. For instance, a set of sensors could be adopted to monitor a forest for identifying fire events. Mobile IoT devices, particularly unmanned vehicles, could also be extremely valuable tools for fire protection.

Mobile IoT devices are capable of generating fire alerts in case of fire detection in residential areas or in forests. These could assist emergency management authorities for taking proactive decisions. IoT based meteorological systems can give precise and frequent weather updates and in case of intense weather phenomena it can generate alerts. E-government services under environmental sector could also involve IoT devices for the auditing and follow up of waste management and also for the pollution converging from residential or industrial activities.

The advancing connectivity via IoT enables changes in every sector of the country and IoT enabled e-governance services will lead to better access to public services. Reduction of congestion and queues due to traffic, improved and affordable healthcare, lesser environmental impact, improved safety and security for citizens, etc can be acquired with IoT adoption in e-governance.

2.3 Impact of IoT on smarter e-governance

IoT systems can bring varieties of benefits including real-time measurements and analyses of historical data over time collected from different sensors. IoT devices and the interaction between them can benefit e-governance by providing on-time, required data to the citizens and at the same time required information could help government to take right decisions at the regular time intervals [10].

There are at least four ways in which IoT will impact government bodies. First, it will enable government employees to be more productive since the technology can be used to automate many tasks. IoT devices can take significantly more complex tasks and interact with people, machines and the physical environment to discover new insights that will improve the quality of internal local government operations. Second, the IoT will make a more responsive and agile government. IoT solutions can answer citizen's questions

on a timely basis and also improve the delivery of services to the citizens. IoT will allow people to interact more naturally with digital government services, increasing citizen participation.

Third, IoT solutions will provide a new vision for managing the public and private infrastructure which will lead to the reduction of labour cost. In case of infrastructure maintenance, embedded wireless sensors can provide data required for the event and load managements [11]. It will lead to better access to the public services for the citizens. Fourth, it will promote government transparency. Sharing and collaboration of sensor generated data between various divisions of government will make the working of e-governance more transparent to the citizens. From the government point of view, IoT will lead to a quality of life, economic growth, health and safety, sustainability of energy and mobility for its citizens. The smarter e-governance means best engagement of all the shareholders across the country; therefore, government must focus on adapting IoT solutions at the greater extent in both private and public sectors.

3.0 Proposed IoT-Based Models for E-governance

IoT enabled government always extends the quality of services to their citizens by providing inventive smart provisions in various domains such as health, transportation, energy, energy, defence, smart cities and so on. This section reviews some of the IoT initiatives taken by e-governance across the globe.

3.1 Road and Water management in Netherlands

“Rijkswaterstaat” (RWS) is a member of the Netherlands Ministry of Infrastructure, responsible for the design, construction, and maintenance of infrastructure facilities. Over the years, RWS has placed several sensors on the road for many purposes. Embedded loops of sensors in the road surface detect the movement of vehicles which is used for optimizing traffic signal timings accordingly [12]. “Weigh in Motion” facility of RWS acts as a monitoring point on the roads to weigh the heavy vehicles. It helps the government to take proper actions against overloaded vehicles.

National Water Management Network of Netherlands comprises of more than 400 sensors to collect data for measuring a wide variety of hydrological data for water levels, water flow levels, water temperature, water velocity, etc. These sensors give more detailed weather forecasts and helps for long term analysis for rising sea levels detections, etc. The Netherlands has deployed smart levees [13] for detection and warning system to prevent the overflow of a river. Benefits of IoT in smarter e-governance in the Netherlands can be summarised with improved effectiveness of services, health and safety measures, and tactical improvements of services to the citizens.

3.2 Transport and Traffic Management in Spain

In the city of Madrid, Spain [14], a control centre called Emesa has been built to monitor the underground traffic of a busy highway with extended tunnel, M30. According to M30, an average of 1.5 million motor vehicles passes the highway

on a daily basis. To manage this significant number of vehicles, incidents and maintenance works, the Control Centre features the most advanced IT systems, which guarantee a safe and smooth traffic flow. The control is conducted from different posts in the Primary Control Centre, as well as from the Backup Control Centre.

Some systems that stand out among others in this project are the Automatic Incident Detection system, the energy remote control, CCTV and several Supervisory Control and Data Acquisition (SCADA) systems. The SCADA systems allow the control centre to supervise and run all the facilities, including signals coming from security systems, electromechanical installations and traffic. Multi-lane speed cameras are also installed at various spots of the highway which can observe 6 lanes of both directions at the same time. Exit tunnel of M30 highway have emergency exist at every 200 metres and Emesa keeps on checking the status of these exits at regular time interval.

3.3 Crime prevention in United State

In United State, Police Department of Chicago has combined its forces with the University of Chicago Crime Lab to bring out the data analysis at real-time [15]. This project aims to increase the effectiveness of police work across the city and to reduce the crime rates at the same time. Under this project, areas with ShotSpotter are monitored with license plate recognition systems. These systems are very carefully built to locate the exact location and time when gunshots were fired. The police squads are using a web-based patrol management system called Hunchlab that can predict where and when crimes could happen and also can suggest the best way to respond to such crimes.

Canadian Border Service Agency (CBSA) tested An Automated Virtual Agent for Truth Assessments in Real Time (AVATAR) to help border security police. This will help the police to verify if the travellers are legally entering the country's border or not. Motion and sensor technology along with eye detection software are being used by the police department to detect psychological and physical behaviour of the suspects to explain if suspects are telling the lie or not. Use of analytic tools helps to identify, classify and match stored surveillance data. This project has built a trustworthy environment between the citizens and the government.

3.4 Agriculture in China

In the Internet-based agriculture park of Shishan Town, Haikou City of China, IoT based company named Sun's has deployed IoT based devices and sensors which runs on specialized algorithms to detect the moisture level in the soil and environment. These sensors work by considering the cool and humid environment of the local areas. Smart irrigation systems are also installed in this park to water the soil and plants according to their requirements. This project has led to a dramatic reduction in irrigation problem in this area. Furthermore, it has been stated by the company that earlier at least 10 workers were required to

irrigate an area of 100 mu (1 mu = 0.0667 hectares) of vineyard but after the implementation of this project the same work can be done by one person [16].

It has been recorded that by using the drip irrigation system citizens can save up-to 70 percent of the water required for watering the crops or plants. Furthermore, 60 percentage of fertilizers can be saved by just placing the fertilizers to the root areas of the crops. The company, Sun has expanded its business over to 10 more provinces in China, providing IoT based technologies for saving water and fertilizers. This project has given a new way to test, alert and make adjustments for the best of plant development environment.

3.5 Health management in Singapore

KK Women's and Children's Hospital (KKH), in Singapore collaborated with UnaBiz, which is a company aimed to provide end-to-end Internet of Things (IoT) solutions. The main project of this company is to deploy low-powered IoT sensors for temperature monitoring and checking humidity of the environment [17]. Under this project more than 100 temperature and humidity sensors were placed in KKH at different locations within the hospital premises, especially in intensive care units and patient wards. After the deployment of this projects, hospital staff no longer have to maintain daily temperature logs manually and they can use that time for the well-being of their patients.

4.0 Smart e-governance in India

In India, industrialisation and urbanisation is expanding very rapidly and it is estimated that in the upcoming 15 years, around 200 million people of the country will shift to the urban areas [18]. Over the years many governmental plans have been proposed and many projects have been implemented to achieve smarter e-governance in India. According to the United Nation's E-government Survey 2018 [19], India was ranked 96 whereas in 2014, India ranked 118. This hop of 22 place shows that digital technologies have already started impacting the governmental sector of the country.

4.1 Recently deployed e-governance initiatives

During the 5th Digital India Summit on 28th June 2019, many technologies were discussed which are influencing the government at bigger extent. Very first, Cochin police claimed about usage of facial recognition cameras for predicting suspicious activities based on the previous facial records of criminals in their database. These cameras are placed at many public places in the city. Furthermore, Cochin traffic police is using AI devices called ITMS (Intelligent Traffic Management Systems) for keeping the track of the traffic, and also to manage the traffic lights according to the traffic congestion [20]. Applications of technologies has also started its rooting in the department of fertilizers with the use of bio metric verification to track the fertilizer's sale rate. This facility will track that which fertilizers, and how much of that fertilizers are purchased by individual farmer. In the healthcare sector, smarter technologies like Artificial Intelligence is used to detect the early stage of diseases like

Tuberculosis. Adaptation to this technology has filled the gap with radiology and image-based detection systems.

To empower farmers and to increase the agricultural productivity, GIS (Geographic Information Systems) are being deployed to understand and operate crop yield estimates. These systems use remote sensing and geospatial technologies to make the estimations. In 2017, GIS platform was awarded as one of the best projects by the government of Gujarat [21]. The government of Andhra Pradesh, working in partnership with Hitachi, claims its real time governance initiative that has benefitted over 50 million citizens by mainly resolving citizen grievances. This project aims at providing data about climate changing events in real time across the state and monitoring of infrastructural projects undertaken by the private and government agencies. This has created more efficient way of carrying out the governmental operations and has led to sustainable society in the state.

4.2 Scope for IoT based smarter e-governance

IoT for smarter e-governance encourages enhancements in almost every infrastructure like agriculture, transportation, healthcare, education, power, environment and so on. Smarter IoT based cities will lead to real-time interactions between each entities of cities including sensors, citizens, business processes and governmental agencies. Apart from providing automation of different processes, IoT will gather and analyse information for making efficient town planning and control. Traffic is one of the growing problems in India and IoT based vehicles or smart highways can extend the e-governance services to assist the users to provide facilities associated with traffic management. Along with saving time and cost, it will also take care of emergency management as better flow of traffic will reduce the accidental cases.

Environment monitoring is another key challenge in India and IoT based smarter governance can involve applications for air pollution level detection, monitoring soil quality for agriculture, observing water quality for drinking and waste management. Energy based provisions like electricity or gas fields, where there are always life risks, IoT based e-government systems will lead greater managerial support. It will respond quickly in case of emergency situations. Security and safety are another important concern for the Indian society. IoT based sensors like environmental sensors can be used for efficient surveillance and also can report early signs of any crime to the police in case of dangerous situations. IoT devices can be used by government to monitor boarder security and also to for public security at highly populated places like, airports, metro stations, popular road junctions, malls etc. Smarter e-governance can surpass human limitations and can offer increased safety to the citizens.

The lack of real-time medical data has always limited the work towards healthcare applications and IoT based devices can produce far superior data for performing much advanced research on medical field. In a country like India where the most of the population have diagnosed with some or other health

problems, IoT solutions can lead to accurate and large location specific data generation, in turn providing better healthcare services to the citizen. Patient centric information can be analysed from far distance, bringing better secure environment to the country people. Another area which needs to embrace IoT solutions is agriculture sector. IoT based e-governance services can effectively guild framers about extreme weather conditions and enhance productivity by measuring the quality of soil or fertilizers. IoT based agricultural drones can be further used for soil analysis, irrigation and also for crop health assessment. The IoT based sensor systems can also be used in greenhouse for measuring temperature, pressure and light levels which will help the farmers for better yield production.

The power of Internet of Things has let many initiatives by many IoT based Indian companies. One such company is IoTrek which aims at developing low powered tracking devices. These devices are embedded with sensors which connects assets and people in real time and works over wireless infrastructure. This project has saved millions of dollars under infrastructural operational costs [22]. DeTect Technologies is another such IoT based company which has built a pipeline condition monitoring ultrasonic sensor for temperature about 350 degree Celsius. The company provides many IoT based sensors for boilers, chimneys, vessels etc. Deployment of these devices have given a deeper insight of automation and control.

The government of India has already in the path towards productive implementation of innovative technologies for smarter e-governance. Despite of the larger population and lesser literacy rate at rural areas, many governmental services have reached remote areas of villages in most user-friendly and reliable manners. More accurate and precise citizen centric information will increase the citizens faith towards government. Scope of mining the data generated by IoT sensors and using the data science in every sectors of e-governance is very vast and yet to be researched at deeper level.

5.0 Conclusions

Internet of Things is growing as a connected device and the future of IoT in making users life much easier is very promising with underlying support from the government. Collaboration and sharing of data collected with sensors and various IoT enabled devices from various governmental domain, enables effective knowledge management. Use of IoT enabled devices has already brought many benefits in various sectors of e-governance in many countries. The objective of this paper was to highlight the possible benefits of IoT for smarter e-governance. IoT enabled devices can collect remote sensor data so that physical world or devices can be monitored and controlled from a distance without human involvement. In addition, combining different sensor data and analysing these collected data can bring out the insights of many solutions which in turn can help the government to develop, deploy and improve services to its citizens. Despite the fact that there has been a very precise work done so far on the ground level of IoT based smarter e-governance, there are many

potential benefits of IoT ranging from operational to a political level. The benefits of smarter e-governance can be attributed to effective and flexible services, governmental transparency, improved efficiency in policies, forecasting of events and improved health and safety measures to the citizens.

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