Preface

Dr. Santhosh Babu, I.A.S.
Principal Secretary, Information Technology Department,
Government of Tamil Nadu

Among the many functions of any Government, evolving policies on various fronts, moving files and taking decisions in pursuance of those policies, delivering services, providing employment opportunities, enabling businesses to thrive, maintaining law and order, etc., would be the top priorities. With the large-scale use of Information and Communication Technologies (ICT) in every aspect of governance, starting a couple of decades back, these functions have leap-frogged to hitherto unimaginable levels of efficiency in governance and concomitant citizen satisfaction. Expectations of better and better governance have also increased among our Citizens, as is evidenced by their aspirations frequently aired through the social media. Tamil Nadu has been in the forefront in using and consuming ICT for the larger benefit of its Citizens. Every Department/Agency of the Government of Tamil Nadu have taken proactive steps in this direction and the results are there for all to see. We recently issued a Government Order for making all Government offices in Tamil Nadu to be ERP driven. No wonder then, that Tamil Nadu is considered a State to look up to, insofar as ICT and its use cases are concerned. Hence, this is a good time to look back at the achievements and look forward to furthering this cause, using the Emerging Technologies.

Tamil Nadu has been a pioneer in e-Governance and the Information Technology Department, through the Tamil Nadu e-Governance Agency (TNeGA), ELCOT and the National Informatics Centre (NIC) have been spearheading this movement. Citizens are benefitting from end-to-end computerization of Government processes that has enabled them to receive services through Arasu e-Sevai Centres or on their desktops. Now, TNeGA by establishing a Centre of Excellence in Emerging Technologies (CEET), has taken a huge step forward by taking advantage of the Emerging Technologies like blockchain, artificial intelligence, machine learning, Internet of things, drones, augmented reality, virtual reality, additive manufacturing, analytics, geographic information system (GIS), etc. for solving pressing governance issues that were hitherto unsolved. Innovation is the key to using these technologies and young minds running startups revel in them to create products, processes and patents for the private sector. We deem it fit to use their innovative mind set and entrepreneurial skills, to come out with solutions for governance related problems also. The power of these technologies and the innovative thought processes in garnering its benefits will be unleashed in the near future. A State Family Database (SFDB) that is being created will ensure correct targeting of individual beneficiaries and households while extending Government welfare schemes. ERP driven Offices, predictive and data driven governance will become the order of the day. The right data is key to taking the right decisions, so that scarce resources are put to optimum use. Tamil Computing will also get a fillip through the Tamil Virtual Academy (TVA) as they exploit emerging technologies.

While, the tools of ICT bring huge benefits to governance and society, it also has its own pitfalls. Hence, e-Governance and e-Security should go together. The Government of Tamil Nadu has taken a huge step towards ensuring e-security of Government transactions by creating a Cyber Security Architecture for Tamil Nadu (CSA-TN). This will culminate in the creation of CERT-TN (Computer Emergency Response Team – Tamil Nadu), SOC-TN (Security Operations Centre – Tamil Nadu), CCMP-TN (Cyber Crisis Management Plan – Tamil Nadu) and SAF-TN (Security Architecture Framework – Tamil Nadu).

For any e-Governance activity, the backbone is the IT infrastructure which includes the State Data Centre, State Disaster Recovery Centre, Cloud Infrastructure, State Wide Area Network, State Portal, etc., with bandwidth being the critical component. While huge investments have been made in this area, it is imperative that we move forward subsuming latest trends and technologies in this sector. A Special Purpose Vehicle called the Tamil Nadu FibreNet Corporation (TANFINET) has been established to implement a 55,000 km optical fibre network under the BharatNet and TamilNet projects which will ensure atleast 1 Gbps connectivity to each of the 12,524 Village Panchayats, 528 Town Panchayats, 121 Municipalities and 15 Corporations. This will be a game changer for the larger benefit of our enabling them to transact with Government from the comfort of their homes.

Thus, we are seeing a paradigm shift in the way Government has been using the tools of Information Communication Technology for bringing in efficiency in the Government process as also for providing efficient services to our Citizens at their doorsteps. The Information Technology Department, will, with the support of all Government Departments/Agencies, MeitY, our numerous partners and stakeholders in the public sector, like NIC, CDAC, STPI, SETS, STQC, IITMRP, partners in the private sector like NASSCOM, CII, FICCI, MCC, ELCINA, MAIT, consultancies, startups and software companies etc. will lead this paradigm shift and give necessary fillip to all Government Departments/Agencies, right from the Village Office to the Secretariat, to be future ready, with the ultimate objective of creating an ecosystem that will engender a Knowledge Driven Governance System and a Knowledge Driven Society.

I strongly believe that an e-Governance conference like ECZITe will go a long way in furthering the above sentiment. My best wishes for an exciting ECZITe!

Foreword

V. Kavitha Dutt
Chairperson
FICCI Tamil Nadu State Council

I am delighted that this report on "Emerging Technologies in e-Governance" is being released at ECZITE 2019, the flagship e-Governance event organized by the Department of Information Technology, Government of Tamil Nadu and FICCI.

Established in 1927, FICCI is the largest and oldest apex business organisation in India. Over these years, we have been close witness to the growth of business in India. Through our member organizations, we know first-hand how technology and digitization have transformed our businesses.

Experts use different terms to describe this phenomenon – digitization, digitalisation, digital transformation or digital disruption. They represent a range of changes that emerging technologies have brought upon businesses – from a simple process of moving from analog to digital i.e. moving from paper to digital forms to more complex transformations of business models, of workplaces and of skills required to run these digital businesses. In many cases, we see consumers or society embracing digitization first in their digital social interactions (think of mobile, social media) before industries begin adopting these technologies, a trend that experts call "consumerisation of business".

While Government is different that a business organization in many fundamental ways, the "business" of governance is not immune to the changes unleashed by such emerging technologies. The aim of eGovernance is to make governments accessible, accountable, transparent and more engaged with citizens. As the United Nations e-Government Survey notes that while e-Government began with bringing services online, the future will be about the power of digital government to leverage societal innovation and resilience and to transform governance to better achieve the Sustainable Development Goals.

I wish all success to the Department of Information Technology, Government of Tamil Nadu as it embarks on ambitious e-Governance initiatives leveraging emerging technologies. I am thankful to itihaasa Research and Digital for being our Knowledge Partner in this event and helping produce this report.

Foreword

We are delighted to author this important report on “Emerging Technologies in e-Governance”. We set-up itihaasa Research and Digital (www.itihaasa.com) as a not-for-profit research organization that studies the history and evolution of technology domains in India. We study domains like Information Technology (see our chronicle on the history of Indian IT), Artificial Intelligence and Brain Sciences (see our landscape studies of research in India in these domains).

When we got the opportunity to apply our thoughts on the topic of E-Governance, we took it up with enthusiasm. We are thankful to Thiru Dr. Santhosh Babu, IAS, Principal Secretary IT, Government of Tamil Nadu, Thiru Mr. Santosh K. Misra, IAS, Commissioner of e-Governance Tamil Nadu e-governance Agency, Ms. V. Kavitha Dutt, Chairman FICCI TNSC and Mr. Rajaram V, Convener and Head of FICCI TNSC Technology Panel for having us as the knowledge partner of ECZITE 2019.

Why are Emerging Technologies important to us? Let us look at the evolution of world from the economic lens. Robin Hanson, a researcher at the Future of Humanity Institute in Oxford University, modeled the step change in economic activity. If humans continued as a hunter – gatherer society, then the world’s economy will double every 224,000 years. If we continued as a purely farming society, then the world economy doubles every 909 years. And if we continue as an industrial society - the first three industrial revolutions - then the world economy will double every 6.3 years. We can imagine the next economic shift powered by the science and technological advances of the fourth industrial revolution.

Governments are in a unique position to promote and adopt Emerging Technologies – not only are they consumers of such technologies, they are also the policy makers which nurture these technologies. As consumers, governments want to leverage the emerging technologies to deliver effective, efficient and even predictive citizen-services. As policy makers, while they want to encourage these emerging technologies, they also need to carefully consider their implications on the State’s / citizen’s well-being.

In this report, we explore the concept of e-Government, delve into initiatives and insights thereof from examples of emerging technologies like AI & Analytics, IoT & Smart City, Blockchain, Cloud Computing on e-Governance. We also examine initiatives of emerging technologies in India, Tamil Nadu and across the world and suggest 14 ideas for the way forward.

We sincerely hope that these ideas add to the existing discussions in the Government on the role of emerging technologies in e-Governance.

Krishnan Narayanan
Cofounder and President
itihaasa Research and Digital

N Dayasindhu PhD
Cofounder and CEO
itihaasa Research and Digital

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1. Introduction

According to a report by Barclays analysts, if human productivity was 100 units in 1765 it is increased to 3000 units today. In fact, the last five decades have seen an increase in human productivity from about 1500 units to 3000 units[1]. And this steep increase coincides with the adoption of Information Technology. The next phase, the fourth industrial revolution, is powered by advances in emerging technologies like Artificial Intelligence (AI) / Machine Learning (ML), analytics, cloud computing, Internet of Things (IoT), blockchain and brain science and is blurring the lines between the physical, digital, and biological domains[2].

We are already living in such a world, where digital technologies are rapidly transforming our everyday lives – the way we work, live, interact, govern and create value. Governments around the world are focused on creating digital-friendly policies, applications in citizen-centric and socially relevant sectors, digital infrastructure (data eco-systems, high speed computing infrastructure including 5G networks) and enabling eco-systems (Government, funding, partnerships etc.). While the opportunity for digital technologies to transform is immense, they are also raising fundamental questions about ethics, privacy, security and trust in business, society, and governance.

The concept of e-Government was first formally proposed in 1997 by the US government[3]. e-Government refers to the application of ICT to the public sector, with the aim of improving the efficiency, effectiveness, governance and innovation of public services design and delivery through digitization. The aim is to make Governments accessible, accountable, transparent and more engaged with citizens[4,5,6]. While e-Government began with bringing services online, the future will be about the power of digital government to leverage societal innovation and resilience and to transform governance to better achieve the Sustainable Development Goals[7].

In this report, we shall explore the concept of e-Government, delve into initiatives of emerging technologies like AI & Analytics, IoT & Smart City, Blockchain, Cloud Computing on e-Governance. We will examine initiatives of emerging technologies in India, Tamil Nadu and across the world and suggest ideas for the way forward.

1 Macroeconomics of the machines, Christian Keller et al, Barclays, 10 Apr 2018,
http://www.fullertreacymoney.com/system/data/files/PDFs/2018/April/27th/Barclays_Macroeconomics_of_the_machines.pdf Pg 2
2 Landscape of Artificial Intelligence and Machine Learning Research in India, N Dayasindhu and Krishnan Narayanan, itihaasa Research and Digital, 2019
http://www.itihaasa.com/pdf/itihaasa_AI_Research_Report.pdf
3 US Federal Government, Access America: Reengineering Through Information Technology, February 1997
http://govinfo.library.unt.edu/npr/library/announc/access/acessrpt.html
4 OECD (2016) Digital government strategies for transforming public Services in the Welfare Areas. OECD Comparative Study.
http://www.oecd.org/gov/digital-government/Digital-Government-Strategies-Welfare-Service.pdf
5 Sánchez-Torres, J.M. & Miles, I. Eur J Futures Res (2017) 5: 15. https://doi.org/10.1007/s40309-017-0131-7
6 IndEA Framework, (India Enterprise Architecture Framework) https://www.negd.gov.in/sites/default/files/Part1IndEAFrameworkv10Public_0.pdf
7 UN E-Government Survey 2018,
https://publicadministration.un.org/egovkb/Portals/egovkb/Documents/un/2018-Survey/E-Government%20Survey%202018_FINAL%20for%20web.pdf

2. e-Governance

Current Context

1997
The term 'e-Government' was formally proposed first

The concept of e-Government was first formally proposed in 1997 by the US government[8]. e-Government refers to the application of ICT to the public sector, with the aim of improving the efficiency, effectiveness, governance and innovation of public services design and delivery through digitization. The aim is to make Governments accessible, accountable, transparent and more engaged with citizens[9,10,11].

The 2018 United Nations e-Government Survey[12] suggests that e-Government can

- Advance the implementation of the Sustainable Development Goals including basic services such as health, education, water and sanitation.
- Also respond to shocks emanating from natural or man-made disasters and various types of other crises thus building resilient societies.

While e-Government began with bringing services online, the future will be about the power of digital government to leverage societal innovation and resilience and to transform governance to better achieve the SDGs.

In India & the state of Tamil Nadu

e-Government initiatives of India

While digital divide tends to focus on the access available to individuals, digital inclusion is meant to signal a focus on a practical, policy-driven approach that addresses the needs of communities as a whole[13,14].

- The importance of the Internet today poses challenges and opportunities for one billion Indians – called the next billion who can get excluded from development since they are unable to access the Internet.
- Thus, India should focus on (1) Access: availability, affordability, design for inclusion, and public access (2) Adoption: Relevance, digital literacy, and consumer safety and (3) Application: Including healthcare, financial inclusion and e-governance.
  - Technology enabled innovations, digital healthcare solutions and models have the potential to transform healthcare in India. For instance; telemedicine is playing a key role in bridging the rural-urban divide by providing affordable consultation and diagnostic facilities in the hinterlands via. telecommunication and 3G/4G internet services. Further, telemedicine-based models have the capability to handle up to half of in-person outpatient consultations.
  - India has taken massive strides towards financial inclusion by implementing relevant policy and regulation, and leveraging innovative digital technologies. The number of adult Indians having bank accounts doubled in 7 years and stands at 80%, according to the Global Findex Database published in April 2018. A Reserve Bank of India (RBI) study found a positive and statistically significant impact of financial outreach on per capita income growth. Global research has already linked poverty alleviation to financial inclusion brought about through financial awareness.
- While the potential benefits of Digital India initiative are unquestionable, challenges remain, including delayed infrastructure development, bandwidth availability, personal computer penetration, the capacity to scale and the digital gender divide.

8 US Federal Government, Access America: Reengineering Through Information Technology, February 1997
http://govinfo.library.unt.edu/npr/library/announc/access/acessrpt.html
9 OECD (2016) Digital government strategies for transforming public Services in the Welfare Areas. OECD Comparative Study.
http://www.oecd.org/gov/digital-government/Digital-Government-Strategies-Welfare-Service.pdf
10 Sánchez-Torres, J.M. & Miles, I. Eur J Futures Res (2017) 5: 15. https://doi.org/10.1007/s40309-017-0131-7
11 IndEA Framework, (India Enterprise Architecture Framework) https://www.negd.gov.in/sites/default/files/Part1IndEAFrameworkv10Public_0.pdf
12 UN E-Government Survey 2018,
https://publicadministration.un.org/egovkb/Portals/egovkb/Documents/un/2018-Survey/E-Government%20Survey%202018_FINAL%20for%20web.pdf 13
https://digitalinclusion.umd.edu/content/what-digital-inclusion
14 IITMAA Sangam 2019 Report "Reimagining India in 2030", https://iitmaa.org/f/Report-IITMAA-Sangam-2019---Reimagining-India-in-2030-2888 pg 51

India is making progress in the field of e-Governance, from making use of ICT for elections, census, computerizing all the government offices, to digital lockers, e-kranthi portals, e-panchaayat, Jeevan Praman programme and e-seva kendras, and the new India is making its mark in the world of e-Governance[15].

- This can be illustrated by the 100% benefit transfer that has been achieved by the successful implementation of Direct Benefit Transfer (DBT). Models like JAM involving integration of Jan Dhan Yojana, Aadhar and mobile technology, enable the Government in implementation of DBT on a large scale.
- Additionally, to engage citizens, My Gov and UMANG platform have been established to exchange ideas and suggestions with the government. Through this initiative, the government receives feedback, inputs and ideas from people regarding policy decisions and new initiatives like Digital India, Swachh Bharat, Make in India, among others[16].
- The key challenges in e-governance projects in India include the sheer scale of operations, the resistance to new technologies, the need for seamless, transparent operations at all levels and change management for both Indian citizens and government officials.

96
India's rank at the UN e-Government Survey 2018

According to the UN e-Government Survey 2018, India is ranked at 96 on e-Government Development Index (EGDI) published by United Nations for the year 2018 (although India ranking is improving from 107 (in 2016) and 118 (in 2014)).

Internet readiness index is a composite index on components like e-infrastructure index, e-participation index, IT-services and e-governance index, according to the report, Index of Internet Readiness of Indian States', published by the Internet and Mobile Association of India (IAMAI) and Indicus Analytics[17].

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- Maharashtra has emerged as the top-ranking state in terms of overall Internet readiness index in India
- Followed by Karnataka, Gujarat, Telangana and Tamil Nadu

Public Affairs Index 2018 released by the think tank Public Affairs Centre (PAC) considers Indian states across 10 themes such as essential infrastructure, support to human development, social protection, women and children as well as law and order[18].

- Tamil Nadu, Telangana, Karnataka and Gujarat followed Kerala among the top five states delivering good governance.

e-Government Initiatives of Tamil Nadu

2006
Commissionerate of e-Governance created in Tamil Nadu

The Commissionerate of e-Governance was created in 2006 to lead all e-Governance initiatives of Government of Tamil Nadu[19].

- Vision: To fulfil the vision of Good Governance using the tools that information technology provides, such that working within Government becomes transparent and efficient, with concomitant transparency and efficiency in delivery of services to our Citizens.
- Mission: The mission of TNeGA is to improve the quality of life of our Citizens through efficient delivery of Government Services using the tools of Information Technology, and to create cost effective, scalable solutions for Governance, making full use of Emerging Technologies like Blockchain, AI/ML, IoT, Drones, Data Analytics, AR/VR, etc.

15 https://digitalindia.gov.in/di-initiatives
16 https://mygov.in
17 https://www.financialexpress.com/industry/technology/internet-readiness-index-in-india-maharashtra-tops-telengana-4th-says-iamai-report/208772/
18 https://www.hindustantimes.com/india-news/kerala-tops-governance-index-tamil-nadu-ranks-second-report/story-z9w0JuypL16iaO8XUu9x5H.html
19 Tamil Nadu Government Information Technology Department, Policy Note, 2019 – 2020

- Some e-Government initiatives undertaken in Tamil Nadu include:
  - Arasu e-Sevai Centres: Arasu e-Sevai Centres are functioning with the objective of providing unified access to e-Services of different Government Departments on a common platform across the State.
  - Makkal Number: TNeGA has created a Makkal Portal in which for each resident of Tamil Nadu a unique number has been created called "Makkal Number". This Number will be the base for creating the State Family Database (SFDB)
  - Amma e-Gramam: Tele-medicine, tele-education, LED lighting, WiFi hotspot, Skill Development, Digital Knowledge Centre and Common Service Centres will be made available at the selected villages.
    FinBlue: India's first FinTech centre of excellence is set up in Chennai with an objective to provide resources in terms of mentoring, technology support and funding for FinTech startups.

In Jan 2019, the Honourable Chief Minister of Tamil Nadu announced the creation of a Centre of Excellence in Emerging Technologies (CEET) in TNeGA. Accordingly, the CEET has been established, with the vision to bridge the knowledge gap between development and application of emerging technologies in Government Departments. CEET conducts weekly seminars on emerging technologies and its application for governance.

The following projects have been undertaken in CEET:
- Detecting internal bleeding from CT scans
- Identification of pest, disease and nutrient deficiency of crop using AI.
- Computer-vision based attendance system
- Enablement using Blockchain.
- Blockchain for tamper proof preservation of Registration documents.
- Creating a State Family Database (SFDB)
- IoT based monitoring of drinking water supply in rural areas.
- Creating a Chatbot for facilitating delivery of Government services to citizens.
- Real time monitoring solution for Mudumalai Tiger reserve.

In other Governments across the world

E-government has been growing rapidly over the past 17 years since the first attempt of the United Nations to benchmark the state of e-Government in 2001.

40
Countries scored "Very High"on their e-Government Development Index

- In the 2018 Survey, 40 countries scored "Very-High", with e-Government Development Index (EGDI) values in the range of 0.75 to 1.00, as compared to only 10 countries in 2003.
- Since 2014, all 193 Member States have been delivering some form of online presence.
- The average world EGDI has been increasing from 0.47 in 2014 to 0.55 in 2018.
- The three most commonly used online services in 2018 are utilities payment, submission of income taxes, and registration of new businesses.

- Service availability through emails, feed updates, mobile apps and SMS has doubled globally, especially in the health and education sectors.
  - 176 countries provide online services in education via email alerts to citizens compared to 88 countries in 2016, and
  - 152 countries provided such services in the health sector this year compared to 75 in 2016.
  - A growing number of countries is also providing targeted online services to vulnerable groups
  - One hundred forty (140) Member States provide at least one transactional service online.

- Denmark, followed by Australia and the Republic of Korea, lead the world in providing government services and information through the Internet according to the 2018 e-Government Development Index (EGDI).
- The remaining countries in the top 10 are the United Kingdom, Sweden, Finland, Singapore, New Zealand, France and Japan.

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The remaining countries in the top 10 are the United Kingdom, Sweden, Finland, Singapore, New Zealand, France and Japan.

Country Name	Region	OSI*	HCI*	TII*	EGDI	2016 Rank	2018 Rank
Denmark	Europe	1.0000	0.9742	0.7978	0.9150	9	1
Australia	Oceania	0.9722	1.0000	0.7436	0.9053	2	2
Republic of Korea	Asia	0.9792	0.8743	0.8496	0.9010	3	3
United Kingdom of Great Britain and Northern Ireland	Europe	0.9792	0.9200	0.8004	0.8999	1	4
Sweden	Europe	0.9444	0.9366	0.7835	0.8882	6	5
Finland	Europe	0.9653	0.9509	0.7284	0.8815	5	6
Singapore	Asia	0.9861	0.8557	0.8019	0.8812	4	7
New Zealand	Oceania	0.9514	0.9450	0.7455	0.8806	8	8
France	Europe	0.9792	0.8598	0.7979	0.8790	10	9
Japan	Asia	0.9514	0.8428	0.8406	0.8783	11	10
Estonia	Europe	0.9028	0.8818	0.7613	0.8486	13	16
India	Asia	0.9514	0.5484	0.2009	0.5669	107	96

***OSI**-Online Service Component | **HCI**-Human Capital Component | **TII**-Telecomm. Infrastructure Component
Table 1: UN Survey 2018 e-Government Development Index scores of Top 10 countries, India and Estonia (partner country at ECZITE 2019)

Predictive Governance

There is an opportunity for India to leverage the emerging technologies and leapfrog in the e-Governance journey. The new digital environments provide opportunities for more collaborative, participatory and inclusive relationships across stakeholders in the governance process, facilitate digital inclusion and enable creation of a citizen-centric public service approach, thus empowering the citizens.

One important way in which the emerging technologies may impact is to make governance predictive. Thus, governments can make of use of past data, citizen responses and data on a host of macro and micro environmental factors and preempt problems rather than reacting to them.

An article by Deloitte on 'Anticipatory government' identifies some examples of such predictive governance:

- Law enforcement and crime reduction: Some police departments around the world are observing patterns in criminal activities to predict crime events. In some cases, these predictions are twice as accurate as those by trained human analysts. Predictive modeling may be applied to financial crimes such as tax evasion or to predict and prevent cyber-attacks.
  - As a FICCI-EY report on Predictive Policing indicates, there are some instances of predictive policing in the Indian context too in places like Delhi, Jharkhand, and Maharashtra.
- Fight human trafficking: Various governments around the world have developed systems that monitor suspicious online advertisements and infers a connection between them and child trafficking.
- Health and safety: Governments target which buildings and restaurants to inspect by predicting which of them have the greatest risk of fire or health safety violations.
- Prepare for natural disasters: Governments are using data to predict incidence of natural disasters like floods or to predict the spread of epidemics in their state or country.

Ideas for Way Forward

1. Strive to bring about digital inclusion for the next-billion in India.
We need a slew of measures to bring about digital inclusion. These include but are not limited to providing public access to devices that can help connect to the Internet, access to a range of digital services in multiple local Indian languages, and providing digital literacy services that assist individuals navigate, understand, evaluate, create digital content using a range of information and communications technologies, and creating digital public services in healthcare, governance etc.

Experts in the IIT Madras Robert Bosch Centre for Data Sciences and Artificial Intelligence (RBCDSAI) and itihaasa Research and Digital's 'AI Colloquium: A Priority of India' were unanimous that India has the opportunity to leapfrog and adopt emerging technologies like AI to serve the next billion users and bring about digital inclusion[20].

A 'digital citizenship' education should be offered at every school in Tamil Nadu. Also, there should be an army of trained intermediaries who should be provided digital training in Tamil / local language to citizens to become digitally savvy. The model of intermediaries to facilitate digital literacy can be borrowed and scaled-up from the Deshpande Foundation's model of training intermediaries in rural and semi-urban areas[21].

2. Augment sustainability and resilience in e-Government
Strengthening resilience entails ensuring that people, societies and institutions have the resources and capacities to anticipate, reduce, absorb and adapt to various shocks and risks. Online services should be sheltered from the impact of cyber-attacks. Governments should find ways to ensure high security standards in online public services such as digital health.

Digital technologies are used by governments to respond better to disasters and other crises and improve national / community resilience. Geographic Information Systems

(GIS), open data, eGovernment services, and emerging cutting-edge technologies such as AI or blockchain, can serve as a means for improving both resilience and emergency response[22].

3. Train future leaders from various walks of society on the relationships between science, innovation, society and governance.
Science and technology are transforming at an increasingly rapid pace. Subsequently, their impact on our business and society too is being felt in a significant way. The Government plays a crucial role in establishing trust between science and society.

The Government should look at creating a dialogue space for members of society, scientific community and the government to connect and engage. The objectives of such a forum / institution include:

- Be a forum for disseminating scientific and innovation culture to the society.
- Take into account citizen's expectations during such a dissemination process.
- Train future leaders from various walks of society (citizens, government employees, scientists and businesspersons) on the relationships between science, innovation, society and governance.

One reference model for such an initiative is the Institute of Higher Studies for Science and Technology (IHEST)[23]. The IHEST was created as a public institution in 2007 by the French Government. It runs a training program to which members from different walks of life are selected and invited. They are trained for a total of around 36 days, spread over a year through 12 thematic sessions, 8 workshops, and 1 field visit.

20 https://rbc-dsai.iitm.ac.in/2019/01/19/IIT-Madras-Colloquium-videos.html
21 IITMAA Sangam 2019 Report "Reimagining India in 2030", https://iitmaa.org/f/Report-IITMAA-Sangam-2019---Reimagining-India-in-2030-2888 pg 58
22 UN E-Government Survey 2018, pg 4
23 https://www.ihest.fr/

3. AI & Analytics and Governance

Current Context

Artificial Intelligence (AI) is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans and other animals[24]. Machine Learning (ML), a subset of AI, is a field of computer science that uses statistical techniques to give computer systems the ability to "learn" (e.g., progressively improve performance on a specific task) with data, without being explicitly programmed[25]. Analytics is the discovery, interpretation, and communication of meaningful patterns in data and entails applying data patterns towards effective decision making[26]. Predictive analytics analyze current and historical facts to make predictions about future or otherwise unknown events[27].

AI & Analytics
Offer citizens personalized public services and derive actionable insights of policies

As the nature of data collected for analysis dramatically increased in size and variety (structure data, unstructured data like pictures, videos, voice of citizens, healthcare information like MRI scans & genome data etc.) and the information technology related to data became more sophisticated (databases, data-warehouses, business intelligence, data mining, big data, cloud analytics etc.), data analysis has transformed too from simple statistical analysis to historical data analytics to predictive analytics leveraging AI and ML techniques.

Governments could harness data about citizens and their behaviours based on their interactions with various Government agencies and digital sites and leverage AI and analytic techniques to offer citizens personalized public services, derive actionable insights of policy decisions, help Governments make forecasts and predict future trends, and simulate adoption of various policy options and determine unintended consequences before policy implementation.

In India & the state of Tamil Nadu

Government of India AI & Analytics Initiatives

According to a report by the National Institution for Transforming India (NITI Aayog)[28], AI/ML has the potential to transform India's nucleus – healthcare, agriculture, education, smart cities and infrastructure, and smart mobility and transportation.
The Artificial Intelligence Task Force set up by the Ministry of Commerce and Industry, Govt. of India has identified 10 important domains of relevance to India including manufacturing, healthcare, fin-tech, agriculture, education, retail, accessibility, national security and public utility services[29].

Let's look at a few examples of applications of AI in India.

AI in Kumbh Mela
Monitoring 20 crore devotees, through 1000 CCTV cameras spread over 3200 hectares

- **Crowd Management:** AI & Analytics was used in the Kumbh Mela aimed at predicting crowd behavior and possibility of a stampede[30]. The Kumbh Mela was attended by about 20 crore devotees. AI & Analytics solutions helped with advance prediction and response management. AI & Analytics was used to analyse feeds from over 1,000 CCTV cameras and monitor various movements across the Kumbh Mela area spread across 3,200 hectares. AI & Analytics was used by the Uttar Pradesh State Government's integrated command and control centre of the police wherein the security personnel could see the visuals of crowd movement and assess the crowd size. At the same time, they could also monitor anything which is suspicious.

24 https://en.wikipedia.org/wiki/Artificial_intelligence
25 https://en.wikipedia.org/wiki/Machine_learning
26 https://en.wikipedia.org/wiki/Analytics
27 https://en.wikipedia.org/wiki/Predictive_analytics
28 Discussion Paper on National Strategy for Artificial Intelligence, https://niti.gov.in/content/national-strategy-ai-discussion-paper pg 24 - 46
29 Report of the Artificial Intelligence Task Force, http://dipp.nic.in/sites/default/files/Report_of_Task_Force_on_ArtificialIntelligence_20March2018_2.pdf pg 9-30
30 https://www.theweek.in/news/sci-tech/2019/01/14/AI-to-ensure-efficient-crowd-control-during-Kumbh-Mela.html

- **Agriculture:** There is potential to create wealth and jobs in the rural India with the adoption of appropriate AI & Analytics technologies. Specific areas where AI & Analytics technologies can be put into use are weather prediction, intelligent environment control, intelligent driverless tractors and drones, etc. Enhancing farmer's awareness on these technologies will help is better adoption. AI & Analytics technologies can transform agriculture in India to raise farm productivity and create new opportunity for farmers. These technologies can also be used to advise farmers on which crops to grow and the right amount of fertilizer to use and enable farmers to engage in precision agriculture.

- **Machine Translation – Indian Natural Language Processing:** The Government of India has already realized the importance of machine translation[31]. It has announced a project that creates a machine learning system based on AI & Analytics that is a conceptual dictionary to help decipher correct meaning of words in 18 Indian languages. The objective is to help in translation, dialogue generation, question-answering and information retrieval.
  - Another important aspect of e-governance where AI & Analytics & machine translation can make a huge difference in Indian governance is in quickening the pace of the judicial process many-fold. In order to achieve this, courts, prisons and police stations would need to be interconnected. This would necessitate computerisation and real time updating of all citizen/court/police records as well as proceedings. Once online databases of such sensitive information have been created, guaranteed security, safety and integrity of all national databases will be mandated. India also needs to AI & Analytics leverage technologies that help translating judicial documents from regional languages to English and vice-versa.

- **Smart Cities:** One of the potential use cases for AI & Analytics according to NITI Aayog in in the governance of smart cities. Some use cases of governance using AI & Analytics in smart cities are[32].
  - **Smart public spaces and facilities:** Public spaces facilities and other spaces contribute substantially to a city's liveability. Use of AI & Analytics to monitor patronage and accordingly control associated systems such as lighting, maintenance and other operational conditions could lead better safety and accessibility and also cost savings.
  - **AI & Analytics driven service delivery:** Implementation of AI & Analytics to leverage data on service delivery could see application such as predictive service delivery from Government Departments on the basis of citizen data, rationalisation of administrative personnel on the basis of predicted service demand and migration trend analysis, and AI based grievance redressal through chat-bots.
  - **Cyber-attacks:** Cyber-attacks seem to pose a great threat to our online public systems, today. AI& Analytics technologies possess the capability to detect vulnerabilities and take remedial measures to minimise exposure of secure online platforms containing highly sensitive data from being targeted by unscrupulous social elements.

Tamil Nadu Government AI & Analytics Initiatives

Let's look at a few examples of applications of AI in Tamil Nadu[33].

99.5% accuracy
Facial Recognition based attendance system

- Facial Recognition based attendance system: TNeGA has recently launched an AI & Analytics based Face Recognition based Attendance System (FRAS)[34]. This system is running in two Chennai corporation schools to mark daily attendance since August 2019. FRAS was optimised to Indian conditions and is a robust system that will work on extremely low frame rates and delivers accuracy of over 99.5%. It doesn't require any internet connection and a high computing platform. This is a friendly system to use and doesn't require anyone in a box or an enclosure. It is designed to save time on an average of 45 minutes per day spent on taking attendance. As a step forward, TNeGA is planning to package FRAS into one compact stand-alone device with edge computing features, and a battery backup.

31 https://economictimes.indiatimes.com/tech/software/niti-aayog-iit-developing-indian-language-bot/articleshow/67031593.cms
32 Discussion Paper on National Strategy for Artificial Intelligence, https://niti.gov.in/content/national-strategy-ai-discussion-paper
33 https://www.ai4bharat.org/articles/tn-egovernance
34 http://tnega.tn.gov.in/face_system.html

- AI based detection of pests and diseases in crops: TNeGA, along with the Department of Agriculture of Tami Nadu, is developing an AI-based solution that equips farmers with a mobile app, through which they can send in photos of diseases or pests. The AI engine will detect the pest or disease and prescribe suitable treatments/interventions in real-time.

- AI based assistive detection of internal bleeding in brain from CT scans: TNeGA, in collaboration with the Health Department, is working on developing an AI-based solution to assist doctors in detecting internal bleeding in the brain from CT scan images. Quite a few District Hospitals in Tamil Nadu do not have radiologist round the clock. Scans from such hospitals are sent to hospitals in metros and larger cities for diagnosis in such cases. As a result, radiologists become overloaded with scans from their hospitals as well as those from neighbouring districts. The AI-based solution will assist in prioritizing scans that require immediate attention and help in better queue management of scans. Such a solution will help in reducing the load on the radiologists interpreting the scans, and they will be able to devote their time and skills to scans that require urgent intervention.

In other Governments across the world

China

- China along with the USA is in the forefront of AI & Analytics[35]. In 2019, the Beijing AI Principles were released by a multi-stakeholder coalition including the Beijing Academy of Artificial Intelligence (BAAI), Peking University, Tsinghua University, Institute of Automation and Institute of Computing Technology in Chinese Academy of Sciences, and an AI industrial league involving firms like Baidu, Alibaba and Tencent. The 15 Principles call for “the construction of a human community with a shared future, and the realization of beneficial AI for humankind and nature.”

- The Principles are separated into three sections: Research and Development, Use, and Governance. They include focus on benefitting all of humanity and the environment; serving human values such as privacy, dignity, freedom, autonomy, and rights; continuous focus on AI safety and security; inclusivity; openness; supporting international cooperation and avoiding a “malicious AI race”; and long-term planning for more advanced AI systems, among others.

- There are also local government AI policy initiatives throughout China. For example, the Shanghai government issued its own implementation plan for new generation AI, A major new AI-focused industrial park is under construction in Beijing, Guangzhou launched an International Institute of AI, and many other districts have promised funds for AI research.

European Union

- The EU’s EU General Data Protection Regulation (GDPR), which came into effect in 2018, established sweeping privacy rules as well as requirements for how EU residents’ data can be used with AI & Analytics. It specifically addresses how business should provide transparency around automated decision-making.

- 25 European countries signed an agreement of cooperation on AI, resolving to collectively deal with “social, economic, ethical and legal questions” of AI[36]. The European Commission released a call for a coordinated approach on AI, setting out the idea that the EU should “be the champion of an approach to AI that benefits people and society as a whole” by taking into account ethical principles[37].

- The European Commission has set up a group with more than 50 business, academic, and civil society experts on AI to advise the Commission on AI, including ethical and legal frameworks. The group released a draft of its ethics guidelines in 2018[38].

35 https://futureoflife.org/ai-policy-china/
36 https://ec.europa.eu/digital-single-market/en/news/eu-member-states-sign-cooperate-artificial-intelligence
37 https://ec.europa.eu/digital-single-market/en/news/communication-artificial-intelligence-europe
38 https://ec.europa.eu/digital-single-market/en/news/have-your-say-european-expert-group-seeks-feedback-draft-ethics-guidelines-trustworthy

Singapore

- Singapore Government has incorporated AI & Analytics in different domains. Some of these innovative uses of AI & Analytics are[39]:
  - Smart Homes: Smart devices available in some homes include an AI & Analytics system for utility management system that helps with household utilities usage.
  - Preventing Corruption in Government Procurement: AI & Analytics algorithms analyze HR and finance data, procurement requests, tender approvals, and workflows to pick up patterns to identify and prevent potential corruption in government.
  - Matching Job Seekers with Positions: Machine learning and text analysis identify skills required for jobs and prioritize search results according to the relevance of the job seeker's skills.
  - Traffic Management: An expressway monitoring and advisory system uses AI & Analytics to detect accidents, vehicle breakdowns, and other incidents, and provides real-time travel time information from the expressway's entry point to selected exits.
  - Lamppost-as-a-Platform: Sensors on lampposts monitor air quality and water levels, count electric scooters in public places, and collect footfall data to support urban and transport planning using AI & Analytics.

- Singapore has also released Asia's first Model AI Governance Framework in 2019[40]. The two high-level guiding principles underpinning this Model Framework are to help organisations ensure that: 1) Decisions made by or with the assistance of AI are explainable, transparent and fair to consumers; and 2) Their AI solutions are human-centric. This in turn enhances trust in and understanding of AI, as well as acceptance of how AI & Analytics related decisions are made for the benefit of users.

USA

- President Trump signed the Executive Order on Maintaining American Leadership in AI in 2019[41]. This is a concerted effort to promote and protect national AI technology and innovation. The Initiative implements a whole-of-government strategy in collaboration and engagement with the private sector, academia, the public, and like-minded international partners.
- It directs Federal agencies to pursue a multipronged approach to advance AI, including:
  - Promoting sustained AI R&D investment
  - Enhancing access to high-quality cyber infrastructure and data,
  - Removing regulatory barriers, ensuring that America leads in the development of technical standards for AI,
  - Providing education and training opportunities to prepare the American workforce for AI, and
  - Developing and implementing an action plan to protect its technological advantage in AI.

Governments have been typically cautious with adoption of new technologies. AI is in many ways different from the usual automation and information technology solutions that the Governments have encountered so far. The policy makers and administrators in the Government need to familiarize themselves with what AI entails and how it works. They need to consider multiple factors and questions before a wide-spread adoption of AI in Governments. They need to consider multiple factors and questions before a wide-spread adoption of AI in Governments: 1) In what Government scenarios is AI apt? 2)Which AI solution / technique is appropriate? 3) How can AI results be made transparent and fair? 4) How to verify the quality of the outcomes? 5) How to ensure that the data powering the AI is valid and free of bias? 6) How can one control and secure the AI tools[42].

39 https://www.bcg.com/publications/2019/citizen-perspective-use-artificial-intelligence-Government-digital-benchmarking.aspx
40.https://www.gov.sg/~/sgpcmedia/media_releases/imda/press_release/P-20190123-1/attachment/SINGAPORE%20RELEASES%20ASIAS%20FIRST%20MODEL%20AI%20GOVERNANCE%20FRAMEWORK.pdf
41 https://www.whitehouse.gov/ai/executive-order-ai/
42 'Destination unknown: Exploring the impact of Artificial Intelligence on Government', Centre for Public Impact, 2017

Ideas for Way Forward

1. Launch an 'AI for Good' initiative
The Government should consider launching an 'AI for Good' initiative and conducting an AI for Good Summit in Tamil Nadu.

It could be modeled on the UN initiative[43] which includes

- AI for Earth, referring specifically to environmental applications
- Humanitarian AI, referring to applications for humanitarian ends and
- AI for Healthcare

As we increasingly adopt AI for good, 1) India should take up initiatives to create India-specific data-sets on a war-footing. Take the case of genomics – while India accounts for more than one-sixth of the world's population, the DNA sequences of its people contribute a meagre 0.2% of the global genetic databases. Hence the need for initiatives by the Centre for Brain Research at IISc which is collecting one-of-a-kind Indian data related to healthcare and DNA sequencing, and which would be used to develop, say unique markers for early detection of Alzheimer's in Indians[44].

2. Keep 'Ethics' central to AI & Analytics initiatives
Citizens of a democratic country are entitled to three key aspects of governance – accountability, transparency and efficacy. In order to achieve these, Information and Communication Technology (ICT) including AI & Analytics is being globally recognized for promoting effective governance. Appropriate applications of AI & Analytics can help in promoting accountable plus open governance.

While India will benefit from AI & Analytics systems, care should be taken to ensure the ethical basis of these systems. AI & Analytics systems may increasingly be making important decisions that will fundamentally affect the lives of Indians.

- A multi-disciplinary approach with experts from the domain, humanities, public policy, and law will be required to implement AI & Analytics systems in the Indian context.
- Training data sets should include a sample of all segments of Indians.
- The decision made by an AI system should be explained clearly so that a digital illiterate Indian can understand the context, implications, and options clearly.

Such an approach will lead to the adoption of better AI that will benefit all Indians.

3. Enhance capability and capacity in AI & Analytics
While there is huge potential for AI & Analytics in governance, there is a shortage of AI & Analytics capacity at the Indian central and state governments. There is a lack of targeted training programs for building AI & Analytics capacity.

- Combating resistance to change initiatives, such training programs can help the government to build capability and capacity to successfully implement smart, AI & Analytics based e-governance projects.
- The next-billion people in India cannot absorb emerging technologies like AI directly. Not until digital natives are born among the next-billion people. Till such time, the AI capacity should be built in digital-intermediaries who will play the role of training of the next-billion users.

Additionally, there is insufficient impetus towards collaboration in AI & Analytics interventions across the country. This leads to inefficiencies and siloed digital infrastructure over time.

- All Indian states and the central government should push for utilizing their AI & Analytics capabilities in combination for maximum impact. Only then can we successfully tap these technologies effectively for governance and societal well-being.

43 https://aiforgood.itu.int/
44 https://factordaily.com/longform/indias-big-data-huntfor-cures-mental-ageing-related-diseases/

4. Blockchain and Governance

Current Context

Blockchain as a technology gained prominence in the wake of the Bitcoin tech-storm. The underlying technology of Blockchain has enormous significance in non-financial industries too including governance. Let's first understand what Blockchain technology means.

Blockchain 3.0
Allows for very high transaction throughput & speed

- Blockchain is "an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way"[45].
- "Blockchain technology offers a way for untrusted parties to reach agreement (consensus) on a common digital history. Digital assets and transactions could be faked and/or duplicated and Blockchain technology solves this problem without using a trusted intermediary"[46].
- Blockchain 3.0 platform, which is based on the principle of Directed Acyclic Graph (DAG), allows for large scale implementation due to its ability to overcome the challenges (of transaction throughput and speed) posed by Blockchain 1.0 and 2.0 platforms[47].

Blockchain is thus good at creating trust in information and processes in situations where there are large, heterogeneous sets of stakeholders or users. Blockchain is also good at creating trusted information audit trails, and helping keep data both private and shareable. In the context of governance, some of the scenarios that Blockchains can be deployed include[48,49].

- Secure and share important data and records like citizen-identity
- Create asset registries, in case of land title (helps property buy-sell process), patient health records or educational certifications
- Develop digital versions of national currencies, new payment systems
- Enhance food traceability
- Help benefit claimants to manage their money
- Voting systems
- State-run blockchain based lottery
- Anti-counterfeiting blockchain
- Formally verifiable, security system for the Government

In India & the state of Tamil Nadu

Government of India Blockchain Initiatives

Nearly half the states in India have initiated blockchain projects to address different elements of citizen service delivery.

40+
Blockchain initiatives in Indian states

- Currently, 40+ Blockchain initiatives are being executed by the public sector in India, with ~92% in pilot/POC phase and ~8% projects in the production phase.
- NITI Aayog along with the Government of Telegana and the Government of Goa co-hosted the International Blockchain Congress 2018[50].

45 Iansiti, Marco; Lakhani, Karim R. (January 2017). "The Truth About Blockchain". Harvard Business Review.
46 https://www.cbinsights.com/research/what-is-blockchain-technology/#blockchain
47 https://cryptoresearch.report/crypto-research/blockchain-3-0-future-dlt/
48 Blockchain for Government and Public Services, The European Union Blockchain Observatory and Forum
49 https://www.computerworld.com/article/3412304/how-governments-around-the-world-are-using-blockchain.html
50 https://www.enbloc.media/

- Telegana Government in its draft Blockchain Policy plans to create a Blockchain 'district' which will house all major Blockchain technology companies, a huge incubator and a world-class facility for promoting research[51].
- The Maharashtra government has put together a plan to implement blockchain technology in agriculture marketing, supply chain, registration of vehicles and document management system[52].

Although the Reserve Bank of India has banned crypto-currency, it has proposed a regulatory sandbox in which blockchain technology applications will be tested[53].

- The RBI's research arm, the Institute for Development and Research in Banking Technology (IDRBT) is engaged in a research project entitled "Distributed Center of Excellence for Blockchain Technology", sponsored by the Ministry of Electronics and Information Technology (MeitY)[54].

Tamil Nadu Government Blockchain Initiatives

Let's look at a few examples of applications of AI in Tamil Nadu.

- Data Integration, Analytics and Blockchain: TNeGA has also explored the possibilities of blockchain technology in various applications that require maintaining the integrity of transactions.
  - It is vital to develop synergies and collaboration between the various Departments of the Government for delivering better values to society. The policymakers and analysts require ground data from various departments of the Government to make informed decisions.
  - A Data Integration and Exchange Platform will facilitate data exchange between all the departments of the Government, thus enabling evidence-driven policymaking, which in turn will result in better outcomes for the citizens.
  - For example, an upcoming industrial corridor can use development projections for planning required to support infrastructure such as schools and hospitals and their positioning.

- Tamil Nadu government is the first state government to sign and MoU and collaborate with a premier research institute like IIT Madras for harnessing the power of artificial intelligence and blockchain technology in areas of health, education and agriculture[55].

In other Governments across the world[56]

USA

- In September 2016, the US House of Representatives passed a resolution calling for a national technology innovation policy for digital currencies and blockchain technology. A blockchain working group "Blockchain@State" was formed in 2017 to formulate and improve regulatory policies related to blockchain technology.
- In 2019, different States in the US like Wyoming, Pennsylvania and Washington all enacted policies to encourage the development of distributed ledgers and blockchain technology[57].

Estonia

- Estonia began testing distributed ledger technology in 2008 (even before the Bitcoin paper was published). Their blockchain technology (called KSI) powers the backbone platform that connects all their government services like healthcare, judiciary etc. The technology protects them from corruption and misuse.
- Their blockchain technology provides a formally verifiable security system so that government can function even under a cyber-attack.

51 https://www.livemint.com/technology/tech-news/telangana-to-have-india-s-first-blockchain-district-woos-firms-with-incentives-1558862756949.html
52 https://www.dnaindia.com/mumbai/report-maharashtra-to-use-blockchain-technology-in-agriculture-marketing-vehicle-registration-2782991
53 Draft Enabling Framework for Regulatory Sandbox, Reserve Bank of India, https://www.rbi.org.in/scripts/PublicationReportDetails.aspx?UrlPage=&ID=920
54https://dea.gov.in/sites/default/files/Approved%20and%20Signed%20Report%20and%20Bill%20of%20IMC%20on%20VCs%2028%20Feb%202019.pdf
55https://economictimes.indiatimes.com/industry/services/education/iit-madras-collaborates-with-state-Government-to-improve-e-governance/articleshow/66134542.cms
56 https://www.computerworld.com/article/3412304/how-governments-around-the-world-are-using-blockchain.html
57 https://medium.com/@support_34903/an-introduction-to-global-blockchain-policies-part-i-e28c6164d11

China

- China, while banning crypto-currency, is putting its weight behind blockchain technology through public-private partnerships such as Alibaba and the city of Changzhou for healthcare data on blockchain; Tencent and China Federation of Logistics and Purchasing for a blockchain logistics platform.
- Cities of Shanghai, Henan, Guangzhou etc. have announced blockchain related programs and the Xiongan New Area is being developed into a blockchain innovation hub.

Switzerland

- Switzerland has one of the most blockchain-friendly regulatory regime in the world. The Swiss city of Zug accepts cryptocurrency, has digitized citizen ID registrations, and conducted e-voting on a blockchain.
- A software company Luxoft, the city of Zug, and Lucerne University of Applied Sciences are establishing a Blockchain for Government Alliance.

We are at early stages of implementing blockchain technologies for governance applications. The experiments should continue and test the technological feasibility of the blockchain solutions and also their economic impact.

Ideas for Way Forward

1. Set-up the right infrastructure and policies to promote Blockchain

Set up the right infrastructure (like the Tamil Nadu Govt.'s Data Integration and Exchange Platform) as a Blockchain Platform as a Service model (BPaaS). This is a flexible, cloud-based shared infrastructure that hosts different Blockchain protocols, developer tools, an integrated development and operations environment.

Most applied Blockchain use cases are land registry, farm insurance, securing digital certificates on blockchain and governance[58]. This shared sandbox approach would allow different government agencies to build proofs of concept and test the results faster.
The government may consider releasing a draft policy on Blockchain in order to encourage research, startups and an innovation hub in the state in the blockchain and distributed ledger domains.

2. Encourage public-private collaboration on research and development into Blockchain

Just like one saw with the case studies of Governments of China or Switzerland, one may encourage public-private partnerships to develop blockchain based solutions of importance at the Tamil Nadu state level.

With respect to research in Blockchain, two areas emerge at the intersection of Blockchain and AI[59].

- Blockchain as an enabler of AI – especially with respect to provenance of data i.e. to determine which data has come from where in the 'supply chain' that creates an AI model.
- AI in the service of blockchain – various business objects collect onto a blockchain and data typically belongs to multiple owners. How does one do secure, confidentiality preserving AI?

58 https://community.nasscom.in/download.php?file=wp-content/uploads/attachment/15216-executive-summary-avasant-nasscom-blockchain-report-final.pdf
59 Landscape of Artificial Intelligence / Machine Learning in India, itihaasa Research and Digital, 2019
http://www.itihaasa.com/pdf/itihaasa_AI_Research_Report.pdf

5. IoT and Governance of a Smart City

Current Context

The Internet of Things (IoT) involves a system of interrelated computing devices or sensors which collect and transfer data over a network. An application then collects and analyses this data and makes a decision based on the analysis. A simple example is that of a temperature sensor (IoT device) that measures the ambient temperature (data) in a place and keeps sending this data to a back-end server. When the ambient temperature crosses a set threshold (data analysis), an alarm is sounded (action).

Smart City
A significant IoT application in government

One of the significant applications of IoT in government is under the category of Smart City. Such solutions require a wide-spread deployment of IoT sensors across the city, which provide real-time data on the happenings in the city; and a centralized system analyzes the data and helps in governing cities by improved decision making.

Some of the key aspects of a smart city as articulated in India's IoT Policy include Smart parking, Intelligent transport system, Tele-care, Woman Safety, Smart grids, Smart urban lighting, Waste management, Smart city maintenance, Digital-signage, and Water Management[60].

Possible benefits of the IoT in the government context are[61]:
1. Political and Strategic - improved forecasting and trend analysis, promoting government transparency, improved citizen empowerment;
2. Tactical - improved planning with regards to management and maintenance, more efficient enforcement of regulations, improved health and safety measures, cost reduction;
3. Operational - improved efficiency of services, improved effectiveness of services, and improved flexibility of services.

In India & the state of Tamil Nadu

Government of India IoT – Smart City Initiatives

The Government of India (GoI) has taken the following key initiatives on IoT[62]:

- In line with the GoI's vision of a Digital India, the Ministry of Electronics and Information Technology (MEITY) launched India's first draft IoT Policy Document in 2016.
- National Digital Communications Policy (NDCP) in 2018 addresses the problem of communications and access of digital services in India.

100
Smart Cities in India identified for development

- Smart Cities Mission (SCM) in 2015 aims at developing 100 Smart Cities with a total proposed investment of nearly US$31 bn.
- IoT Centre of Excellence is a Digital India initiative (by NASSCOM, MEITY and ERNET).

Some IoT – Smart City initiatives undertaken by other states in India include:

- The State of Andhra Pradesh and its technology partner Vassar Labs have implemented a Smart City Geoportal[63]. The Geoportal provides a unified solution for various applications such as Property Tax, Water Charges, Grievances, Blackspots, Road quality, building deviation etc.
- Digital divide in India has been sought to be bridged by opening over 2.5 lakhs Common Service Centres in all 687 districts and the rural parts of India. One model of stepping up the delivery of Glocal (Global to Local) services from these CSCs is seen in Tumakuru Smart City Limited[64].

60 IoT Policy Document, Government of India, https://meity.gov.in/sites/upload_files/dit/files/Draft-IoT-Policy%20%281%29.pdf
61 Paul Brous, Marijn Janssen. Advancing e-Government Using the Internet of Things: A Systematic Review of Benefits. 14th International Conference on Electronic Government (EGOV), Aug 2015, Thessaloniki, Greece. pp.156-169, 10.1007/978-3-319-22479-4_12. hal-01412248
62 Future of IoT, FICCI – EY report 2019, http://ficci.in/spdocument/23092/Future-of-IoT.pdf
63 http://www.vassarlabs.com/smart-city-solution.html
64 Tumakuru Smart City, by public Trust Indian CST, http://tscl.indiancst.com

Tamil Nadu Government IoT – Smart City Initiatives

Let's look at a few IoT initiatives in Tamil Nadu.

11
Tamil Nadu cities in the Smart City Mission

- AI/IoT based system to monitor drinking water supply to villages: Drinking water supply in agricultural-community-dominant districts may suffer due to immitigable irrigation demand exacerbated by lack of reservoirs/dams for local water management. The first step in this regard is to monitor water collected in water tanks at a block (or village) level, which may be further classified into ``water-rich" and ``water-poor" localities, able to redistribute this precious resource through the use of mobile tankers. Such IoT-based reliable monitoring at a district level and redistribution via shortest distance algorithms can be a blessing for thirsty families in summer and a bonus in the form of fuel savings for the municipal corporation.

- The Tamil Nadu Startup & Innovation Policy 2018-2023 promises to establish support infrastructure and strengthen the existing mechanism in the thrust areas like IoT and AI[65].
- Eleven Tamil Nadu cities have been selected for development under the Smart City Mission. They are Chennai, Coimbatore, Tiruchirappalli, Erode, Madurai, Salem, Tirupur, Thanjavur, Thoothukudi, Tirunelveli and Vellore[66].

In other Governments / Smart Cities across the world[67]

USA & European Union

- The state of California in the US just passed the first IoT Cybersecurity law that holds IoT device manufacturers to higher security standards. The EU and the UK published guidelines and codes for IoT manufacturers[68].

Let's look at Smart City policies of a few major cities across the world[69].

Singapore

- The Smart Nation program in Singapore was launched on 24th November, 2014.
- It specifies three types of Internet of Things (IoT) Standards – sensor network standards (TR38 - for public areas & TR40 - for homes), IoT foundational standards (common set of guidelines for IoT requirements and architecture, information and service interoperability, security and data integrity) and domain-specific standards (healthcare, mobility, urban living, etc.).

Dubai, United Arab Emirates

- The Dubai Smart City strategy was launched in 2015 as part of the Dubai Plan 2021 vision with a focus on Smart Grid, Mobile Payment, Smart Water, Health applications, Public Wi-Fi, Municipality, E-Traffic solutions.
- They are collaborating with the International Telecommunications Union (ITU) to adopt the performance indicators by the ITU Focus Group on Smart Sustainable Cities.

New York City, United States of America

- The 'One New York Plan' announced in the year 2015 is a comprehensive plan for 'Building a Smart+Equitable City'.
- They follow the ANSI Network on Smart and Sustainable Cities (ANSSC) and ISO/ITU defined standards on smart cities.

65 https://www.investingintamilnadu.com/wp-content/uploads/2019/06/Tamil%20Nadu%20Startup%20&%20Innovation%20Policy%20(2018-2023).pdf
66 https://www.projectstoday.com/News/Tamil-Nadu-to-have-more-smart-cities-under-Smart-Cities-Mission
67 https://www.computerworld.com/article/3412304/how-governments-around-the-world-are-using-blockchain.html
68 https://www.thehindubusinessline.com/opinion/india-must-get-on-the-iot-highway-fast/article25783043.ece
69 https://cis-india.org/internet-governance/blog/policies-and-standards-overview-of-five-international-smart-cities

While costs of funding such IoT and required data storage infrastructure remains a challenge as with any other technology, IoT also poses certain unique challenges. Governments face greater cyber risk from hackers wanting to gain control of the State's smart-city infrastructure. Governments also face significant challenges with smart city governance, especially the data governance aspects[70].

Ideas for Way Forward

Government's involvement in smart city projects involves three roles: 1) as purchaser of services; 2) as co-creator of smart city solutions; and 3) as regulator and protector of the public interest[71].

1. Design and demonstrate a working model for PURA (Providing Urban amenities in Rural Areas)[72].
One of the models for India is to go for smaller cities with "human dimension" with a population of less than 100,000 by providing urban amenities in rural areas, as proposed by our former president Abdul Kalam. The basic objective should be to create intermediary cities as growth centers with excellent physical, electronic, technological and economic connectivity with the whole of India. Bigger villages should be developed as small towns with a population of less than 100,000 and smaller villages should be developed as interconnected cluster of villages.

The aim is to design and run a model sustainable town with a population of about 100,000 by 2025. This model should integrate, agriculture and agriculture-based SMEs, renewable energy generation, healthcare and education facilities, waste management, etc. with the use of appropriate technology. The Government should take the winning models and solutions and start implementing them across the country by the end of the decade.

2. Create Cities as Living Labs in Tamil Nadu
Urban Living Labs are a form of experimental governance, whereby urban stakeholders develop and test new technologies, products, services and ways of living to produce innovative solutions to the challenges of climate change, resilience and urban sustainability[73].

The Government of Tamil Nadu should explore creation of an open-innovation smart city ecosystem.

- It should make available data-sets collated from such Living Labs Smart Cities to the innovation ecosystem to develop solutions.
- It may also go beyond and create a public-private partnership to support the Living Labs. An example is the Amsterdam Smart City which considers itself an innovation platform that brings together proactive citizens, innovative companies, knowledge institutions and public authorities to shape the city of the future[74].
- They can crowdsource innovations through Hackathons.

At a recent ML Hackathon[75] conducted by the IIT Madras Alumni Association, participants were provided Time series data on air quality and pollution recorded by IoT (Internet of Things) devices from 'Project Kaatru (Air)', a research project of Prof. Raghunathan Rengaswamy, IIT Madras and supported by Robert Bosch Centre for Data Science and Artificial Intelligence, IIT Madras. Several innovative solutions emerged:

- The winning team proposed a solution for providing commuters with information about the cleanest route between two locations on a map. They combined their spatial AQI prediction method and route information from Google's mapping API, to arrive at the cleanest route.
- The data provided by the device also had gyroscope and accelerometer data in it. Although the main purpose of device is to calculate pollution data, one of the solutions developed accessed the road conditions using accelerometer data, combined it with a pothole-detection algorithm derived from a research done at Carnegie Melon University (CMU) to detect potholes on Indian roads.

70 Smart government – Smart city solutions for the public services landscape, Deloitte Insights, 2019, https://www2.deloitte.com/us/en/insights/industry/public-sector/government-trends/2020/data-driven-government.html
71 https://www.pwc.com/gx/en/sustainability/assets/creating-the-smart-cities-of-the-future.pdf
72 IITMAA Sangam 2019 Report "Reimagining India in 2030", https://iitmaa.org/f/Report-IITMAA-Sangam-2019---Reimagining-India-in-2030-2888
73 Cities as Living Labs – Increasing the impact of investment in the circular economy for sustainable cities, Directorate-General for Research and Innovation, European Commission, 2017
74 https://amsterdamsmartcity.com/network/amsterdam-smart-city
75 Sangam 2019 'Mood of the Nation' Survey, Hackathon Report, https://iitmaa.org/f/report-iitmaa-sangam-2019---reimagining-india-in-2030-2888

3. Put people at the center of the Smart City application[76]

The ultimate purpose of becoming a Smart City is only to be more responsive to its citizens and to serve their needs better. Smart City applications will work only if citizens use them regularly. But a balance needs to be struck in nudging citizens to use the smart-city apps (notifications, alerts etc.) while avoiding becoming irritating. Public-facing applications should be compelling and may even have a fun element. A user-centric, design-thinking approach should be adopted in creating Smart City applications.

- In Buenos Aires, the allGreenup app engages users by awarding them points for sharing a vehicle; these points can be exchanged for rewards and discounts from associated businesses.
- The Laboratorio para la Cuidad in Mexico City created an app that turned mapping the routes into a competitive game that engaged thousands of riders in the project of compiling data on their routes.

76 Smart Cities: Digital Solutions for a more livable future, McKinsey Global Institute, June 2018

6. Cloud Computing and Governance

Current Context

As per National Institute of Standards and Technology's (NIST), Cloud Computing model comprises five essential characteristics (viz. on-demand self-service, ubiquitous network access, metered use, elasticity and resource pooling), three service models (infrastructure as a service, platform as a service and software as a service), and four deployment models (public cloud, private cloud, community cloud and hybrid cloud).

Cloud computing has the potential to transform the way IT is consumed and managed, resulting in improved cost efficiencies, accelerated innovation, faster time to-market, and the ability to scale applications on demand. The relevance of the cloud infrastructure is even more in the context of emerging technologies like IoT and AI and the data deluge that these technologies both generate and demand.

In India & the state of Tamil Nadu

Government of India Cloud Initiatives

2013
India's Cloud initiative MeghRaj started

Government of India started its Cloud journey with publishing of two reports which announced the Cloud First policy of the Government of India. This was followed by setting up of NIC National Cloud and empanelment of Cloud Service Providers. Government of India has also made available Cloud Procurement Guidelines, indicative Service Level Agreements and Contractual Terms. The government is also setting up a Cloud Management Office (CMO) which will provide guidelines, policies and directions for cloud ecosystem in India.

Under the MeghRaj Initiative, Government of India embarked upon its Cloud initiative in 2013 with publishing of two reports – GI Cloud Strategic Direction Paper and GI Cloud Adoption and Implementation Roadmap. The focus of this initiative was to accelerate delivery of e-services in the country while optimizing ICT spending of the Government.

The first National Cloud was setup by National Informatics Centre in 2014[77]. The Digital India program came soon after with a vision to transform India into a digitally empowered society and knowledge economy. With the establishment of Cloud services and declaration of Cloud first Policy by the Government, there was a major shift in the Data Centre hosting patterns. New applications are now being hosted on cloud. Even existing applications are being moved to cloud. This has greatly impacted the time to go live.

Hosting support is being provided from National Cloud on 24x7 basis for various critical e-Governance projects viz. e-Procurement, Public Financial Monitoring System(CPSMS), eLekha, e-Panchayat, Aadhaar Enabled Biometric Attendance System (AEBAS), IVFRT, PDS, Swachh Bharat Mission, National Portal of India, Jeevan Pramaan, CCBS, NREGA, MyGOV, Digital Locker, JoSSA & NEET(Counselling), ORS(e-Hospital), National Scholarship, e-NAM, mFMS, GeM, Cyber Swachhta Kendra, Digital India Portal, National Transport Project, Shram Suvidha Portal, Prime Minister Office website, Govt. Websites.

77 NIC case study "National Informatics Centre Data Centre and Cloud Services"

Tamizh Megam
Tamil Nadu Government's Cloud initiative

Cloud Enabled State Data Centres
State Data Centres (SDCs) are one of the important elements of the core infrastructure for supporting e-Governance initiatives in States/UTs. Currently, 33 States/UTs have their SDCs either operational or under implementation. Out of these 33 SDCs, 14 SDCs are operational and Cloud enabled. The Cloud services offered by these SDCs are being consumed by government departments/agencies in their respective States/UTs.

Tamil Nadu Government Cloud Initiatives

Tamil Nadu has been in the forefront of cloud computing infrastructure initiatives. Its flagship "Tamizh Megam – TN Cloud" for rapidly provisioning e-Governance applications with minimal management have been established at Tamil Nadu State Data Centre (TNSDC)[78]

Tamil Nadu e Governance Agency (TNeGA) has developed a Cloud Based Asset Management System for Government Departments which helps to manage IT and non-IT assets, provide asset inventory & tagging services, maintain asset data, and provide standardized descriptions[79].

The Digital Archives of Tamil Nadu is an initiative of TNeGA. It provides a platform to aggregate and provide the archived artifacts that are available with the different Departments in the State in digital format, neatly organized as archives with customized categories, sorted by Year, with keywords to easily search and view / download the artifacts with secure access. The project is hosted on state-of-the-art infrastructure to support multi-tenancy for more Departments to publish their archives and for people to access them with ease[80].

In other Governments across the world

Various governments have published updated guidelines to their cloud policy since they were first published around 2010-11. The top concerns addressed in the cloud policies worldwide include topics like data ownership, privacy and security, contractual terms and change management issues.

The policies typically specify the following.

- Definition of cloud and technical requirements for the cloud
- Considerations for moving to the cloud including potential use-cases and successful case studies
- A decision framework and practical steps, guidelines and incentives for migrating to and adopting the cloud
- Framework for other considerations like security, privacy and other standards like interoperability, data ownership, records management, procurement &contracts, governance, SLAs and performance scorecard, skill development, etc.
- Provide tax breaks and other incentives to attract companies to set up their data centres

Canada

- The 2018 Canada cloud adoption strategy has 3 broad goals[81]:

a. to help balance the supply of IT services with the demand for those services
b. to manage the risks of cloud adoption consistently
c. prepare the IT workforce for cloud

78 https://it.tn.gov.in/en/IT_Infrastructure/Thamizh_Megam_TN_CLOUD
79 https://it.tn.gov.in/en/TNEGA/Other_Projects
80 http://tnega.tn.gov.in/digi.html
81Government of Canada Cloud Adoption Strategy: 2018 update,
https://www.canada.ca/en/treasury-board-secretariat/services/information-technology/cloud-computing/government-canada-cloud-adoption-strategy.html

China

- The development of the cloud industry in China is a major strategic priority for the central government and featured prominently in both the country's 12th and 13th Five-Year Plans. Cloud computing technology has been identified as one of the government's 11 supported priority technology sectors[82].
- China is aiming to increase the scale of its cloud computing industry by more than 2.5 times by 2019, from 2015 levels[83]. Other targets include making breakthroughs in core technologies, increasing cloud computing in manufacturing and government affairs, and strengthening the global influence of Chinese cloud computing companies.

European Cloud Initiative - European Open Science Cloud

- This initiative is an example specific to a particular user group, the scientific research community in Europe[84].
- A European Open Science Cloud (EOSC) will offer Europe's 1.7 million researchers and 70 million science and technology professionals a virtual environment to store, share and re-use the large volumes of information generated by the big data revolution.

South Korea

- South Korea implemented the Cloud Computing Act in September 2015. The government has incentivised public agencies to adopt cloud, including by providing them with bonus points on their evaluations, removing obstacles to adoption, opening a public cloud support centre and even appointing 48 "chief cloud first officers" (CCFOs) across the government.

United States of America

- The first step in this process was the 2010 Federal Risk and Authorization Management Program (FedRAMP). FedRAMP defined requirements for cloud computing security controls, including vulnerability scanning, incident monitoring, logging and reporting[85].
- Various states in USA have provided tax breaks to companies operating data centres[86]. For instance, Virginia utilized tax breaks and other financial incentive programs to establish itself as one of the premier locations for hosting data centre operations. In addition, the State law exempts qualified data centres and co-location tenants from paying sales or use tax on hardware, software and other equipment.[87].

Cloud computing, while enabling significant innovation, cost reduction and efficiencies, has also raised a number of regulatory concerns. Regulators and policy makers wish to harness the potential associated with cloud computing by implementing more 'cloud-ready' policies. At the same time, they are keen to address issues pertaining to cloud security and privacy through these policies.

Ideas for Way Forward

1. Define a conducive Data Centre policy

Due to increasing requirements of data hosting, India would need rapid establishment of Data Centres. Hence there is a need for a policy for setting up Cloud enabled data centres of a certain size in specific suitable locations.

Data centre investment decisions are based on complex models that take into account as many as a hundred decision attributes[88]. The State governments could consider creating Special Economic Zones for cloud companies to consider their States for investment. While considering Cloud Economic Zone, establishment of Green Data Centres using renewable energy should be encouraged thereby reducing the carbon footprints.

82 Cloud Computing Trends in China, http://alicloud-common.oss-ap-southeast-1.aliyuncs.com/Updated_Materials/Infopaper%20-%20Cloud%20Computing%20Trends%20in%20China%20-%20updated.pdf
83China sets ambitious goal in cloud computing, http://english.gov.cn/state_council/ministries/2017/04/11/content_281475623431686.htm
84 EOSC Strategic Implementation Roadmap 2018-2020, https://ec.europa.eu/research/openscience/pdf/eosc_strategic_implementation_roadmap_short.pdf#view=fit&pagemode=none
85 Federal Cloud Computing Strategy, https://www.dhs.gov/sites/default/files/publications/digital-strategy/federal-cloud-computing-strategy.pdf
86 Iskhakov, J. (2006, November 13). What Are Top States for Data Center Tax Breaks? http://www.datacenterknowledge.com/archives/2013/11/06/what-are-top-states-for-data-center-tax-breaks
87 State of Virginia. (2013, September 01). Senate Bill No. 1133. https://lis.virginia.gov/cgi-bin/legp604.exe?131+ful+SB1133+pdf
88 State of the Data Center Industry, Washington State, 2018 http://www.commerce.wa.gov/wp-content/uploads/2018/01/Commerce-Data-Center-Study-and-appendices-2017.pdf

84 per cent of India's data centre supply is concentrated in the country's five largest markets — Mumbai, Chennai, New Delhi, Bengaluru and Pune[89]. The TN government may conduct a follow-on study to identify and index 10 locations across Tamil Nadu to host data centres.

2. Increase the usage of cloud computing by Government
Cloud computing can be seen as an innovation in the policy making context. As the World Intellectual Property Organization indicates, when it comes to innovation policy making, attention should be paid to demand and the demand conditions for innovation.

The demand-side instruments available for the state are numerous[90] - 1) The state can act as buyer 2) The state action can apply so-called price-based measures like subsidies or tax allowances 3) There are numerous non-financial measures like awareness creation, demonstration projects to build up trust in innovations, and education programs 4) Conduct needs-based foresight activities 5) Support in generating or cogenerating innovation, including conducting social innovation initiatives. The Government can use a combination of these demand-side instruments to promote cloud adoption.

3. Set up sector-specific clouds for strategic sectors and support Cloud innovations
It is therefore necessary to establish shared visions and roadmaps between the public sector and the private sector firms to implement demand-side policy instruments successfully[91].

Japan created dedicated working groups for Cloud services in sectors like Medical Care, Education, Agriculture, and Tourism. Similarly, Europe created a Cloud specific to scientific research community.

The TN Government may set-up sector specific clouds for select domains. It may also set up a Cloud Innovation Lab to develop, test and implement new Cloud solutions in themes like Interoperability, 5G, Internet of Things, and Artificial Intelligence.

89 451 Research, 2017, https://www.thehindubusinessline.com/info-tech/data-centre-market-set-for-rapid-growth/article9926486.ece
90 Local Needs, Global Challenges: The Meaning of Demand-Side Policies for Innovation and Development, Jakob Edler, http://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2016-chapter5.pdf
91 Demand-Side Innovation Policies - OECD.org, http://www.oecd.org/science/inno/48081293.pdf