

Is India Future Ready?

Ms. Rajashree Rao

Head of Partnerships & Ecosystem (APAC)

R² Data Labs, Rolls Royce

rajashreerkao@gmail.com

Sharing my vision for India to become the Future-Ready and Future-Proof Nation in the world

History of Smart City or Smart Nation

The concept of a smart city dates back to 1960s and 1970s when the community analysis bureau started using computer databases, infrared aerial photography, and cluster analysis for data collection, issuance of reports and resource allocation to the areas that required them the most for fighting off potential devastations or reducing poverty. Since then, three different generations of 'Smart Cities' have emerged.

a. Smart City 1.0: In the smart city, 1.0, many cities enhanced their infrastructure using sensing technology and data analytics to efficiently manage the urban assets (public transit, water and waste systems, and roads). This connected infrastructure vision comprises the physical assets connected via sensor technology that will generate vast streams of valuable data from smart streetlights, parking meters, and even trash receptacles.

b. Smart City 2.0: The smart city 2.0, in contrast, is the dawn of the next-gen urban evolution. Some of the advanced forward-thinking cities begun to go beyond mere infrastructure by tapping the wisdom of their visitors and residents. Therefore, the smart cities of tomorrow will involve not only the Government but also the visitors, citizens, and business in an intelligent, connected ecosystem developed on a sensor-based physical infrastructure.

c. Smart City 3.0: In the third generation of smart city 3.0, it focusses on enhancing the citizen experience by functioning at the intersection of the 3Ds - Data, Digital, and Design (human-centred). The objective its to enable better decision-making through the use of data for the respective stakeholders - Citizens, Government, and Business. The focus of any smart city became its people and providing benefits such as - Better quality of life; Economic competitiveness for attracting talent and industry; Focus on environment and sustainability. This model embraced a citizen co-creation to address the issues of equality and for building a smart community with social inclusion.

In a nutshell, a 'Smart City' is a city that has developed specific technological infrastructure which enables the city to collect, aggregate, and analyze real-time data and has made a concerted effort to use the data for improving the lives of its residents. Smart City initiative comprises of three key components - Information and Communication Technologies (ICTs) for generation and aggregation of data; analytical tools which convert data into usable information, and organizational models which encourage innovation, collaboration, and application of that information to solve public problems.

According to Harrison "Smart City is an instrumented, interconnected, and intelligent city. Instrumented referred to the collection and integration of real data in real-time from the use of sensors, applications, personal devices, and other resources. Interconnected referred to the integration of all such data into a computing platform that provides a set of services. Finally, intelligent referred to the complex elements, such as analytical calculations, modelling, optimization, and visualization of services for better operational decisions."

Although there is a lack of globally accepted definition, it is possible to describe the characteristic features of a Smart City, which services could improve its level or degree of "intelligence", and its essential aspects. The three main elements of intelligence are defined as follows:

a. The effectiveness refers to the ability of a city to effectively provide private and public services, such as citizens (senior citizens, workers, and students), corporate, and non-profit organizations. Therefore, a smart city is not in itself 'intelligent', but by the public value, it creates for its people.

b. Environmental benefits refer to improving the quality of the environment in big cities. One of the critical pillars of the smart city is to prevent degradation of the environment. Hence, it is necessary to conduct major studies regarding energy consumption, water pollution, air or traffic regulations. Therefore, a smart city must focus on these solutions to preserve the quality of the environment.

c. Innovation refers that a smart city must apply cutting-edge or next-gen technologies to improve the quality of the main components so that better services are offered. Therefore, technology is the central aspect of a city's intelligence.

Thus, the intelligence of a city's component can improve if they are transformed into innovative and effective tools which are not harmful to the environment. This offers the public value. However, the above three factors are not good enough to

increase public value. Hence creating public value should be the ultimate goal of a 'Smart City,' which requires that all initiatives and projects be targeted to the citizen. The concept of "Public Value" is complex and includes several dimensions.

- a. Creating both social and economic values that are different to unite at times, enter into conflict with each other.
- b. Creating value for different stakeholders, that might have various expectations that are not always compatible with each other.
- c. Building value regarding various dimensions of life in the city, which might also imply understanding what the priorities and real needs are?

According to the World Economic Forum, "India's economy will overtake the US by 2030 with a GDP of 46.3 trillion next only to China and also will be the world's youngest major economy. In just twelve years, India will undergo a startling transformation. By 2030, around 77% of Indians will be under the age group of 44, and most of those will be under 25. The country will also have more than 1 billion internet users. Every second, three more Indian go online for the first time. Consumer spending will quadruple, rising to nearly \$5.7 trillion in 2030."

However, the economy still faces significant challenges. By 2022, Due to its young demographic, there is a huge demand for massive employment. About 100 million new jobs must be created in the manufacturing and services sectors by 2030. To achieve this, more than half of Indian workers will need reskilling to close a widening skills gap and raise the participation of women in the workforce. India still has some of the most polluted cities in the world. India will need to boost spending on infrastructure and reduce growing economic inequality and ensure its fast-growing economy is inclusive.

Why and what is the need for building a Smart City?

Today, the centuries-old model of cities are reaching their limits since the city growth is skyrocketing inequality. We are in a situation wherein the Economic, Political, and Social Environment is fractured. Many citizens distrust the official elected to act on their behalf, and the government red-tape is seemingly unable to provide effective and efficient services. Therefore, the crux of the problem; we continue to build and develop cities that are net contributors to the very issues we are seeking to solve. Our cities are getting bigger; the commute times are getting unreasonably longer; the impact on the environment is getting worse. So, what do we do? We build bigger roads and provide services further away from where people habitat and do not take cogent environmental action. This is a 'Global' challenge. Countries like India, China, and Africa vividly illustrate the need for 'Smarter Solutions' to deal with the massive population growth; rural to urban migration, and resource depletion. Therefore, there is an urgent need to transform our cities not just once, but continuously rapidly.

What does it take for India to be a future-ready city?

We think being future-ready means embracing technology. It is the most powerful tool we have to improve infrastructure, help meet sustainability goals, enhance economic opportunities and raise the bar for the quality of life. However, India will have to lay down the plans for building a Digital Nation involving governments, the private sector and civic community to forge new partnerships; that means every Government, business, and industry should come forward to accelerate its digitalization efforts for developing solutions and capabilities that will propel the cities and nation forward.

The key domains required for building a Smart and Digital City are as follows:

1. Smart Infrastructure: Digital Management of Infrastructure: According to Cambridge Centre, "In a world where infrastructure is truly smart, sensing technologies are embedded in infrastructure, and the equipment or device interacts with it. These sensors are connected to a communication backbone which enables real-time data acquisition and analysis. The information gathered is analyzed, interpreted, and delivered as reliable, robust, and meaningful information to the infrastructure providers, who can then make better-informed decisions about the structural health and maintenance of their assets." The smart infrastructures comprise of several operators from different domains of activity, such as energy, public transport, public safety and security. They deploy and operate "Cyber-Physical Systems", that are data controlled equipment which interacts with the physical world. The usage of cyber-physical devices (software-controlled devices that interact with the physical world). Therefore, a Smart Infrastructure is a lens through which the future is seen. It is about the self-driving cars that recognize one another, bridges that can detect their own weaknesses, power grids that exchange data with home appliances, in a nutshell, all cyber-physical infrastructure system that makes cities smart through digital transformation. Smart infrastructure is the backbone of a city, driven by a wireless sensor network. Similarly, studies on power grids describe smart infrastructure as the backbone of the distribution grid made of an intelligent energy subsystem, a smart information subsystem and a smart communication subsystem that all work together to deliver desirable results such improved longevity, adaptability, and efficiency of services provided to the businesses and consumers. In short, Smart Infrastructure is a transitioning process from a state of stillness to a state of 'intelligence' which refers to the ability to improve the performance by responding purposefully to the changes in its environment.

Even though the industry is working towards building the smart infrastructure, there are potential barriers which require to be addressed:

- a. Government:** No overarching governmental structure exists currently to manage multimodal, multi-agency changes that are currently proposed or underway.
- b. Investment:** Greater smartness inevitably involves greater integration, which requires huge investments for changing or retrofitting the infrastructure
- c. Data quality and Management:** With the increasing need to share information, it is important to come up with standards to assess data quality and privacy concerns.
- d. Privacy:** There many different ways in which people provide information to get some value back.
- e. Vulnerability:** The price of connectedness may be vulnerable to new kinds of attacks. Hence, security and resilience need to be built into the systems.
- f. Lifetime:** Electronic sensors embedded into the physical environment can start to limit the lifetime of the infrastructure.

2. Smart and Green Buildings: Smart A smart building is any structure that uses automated processes to automatically control the building's operations, including heating, ventilation, air conditioning, lighting, security and other systems. A smart building uses sensors, actuators and microchips, to collect data and manage it according to a business' functions and services. This infrastructure helps owners, operators and facility managers improve asset reliability and performance, which reduces energy use, optimizes how space is used and minimizes the environmental impact of buildings. Green building (also known as **green construction** or **sustainable building**) refers to both a structure and the application of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from planning to design, construction, operation, maintenance, renovation, and demolition. This requires close cooperation of the contractor, the architects, the engineers, and the client at all project stages. The Green Building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. In India, the percentage of respondents doing the majority of their projects green is expected to nearly double by 2021, from 28% to 55%. New green buildings in India is being driven mostly by environmental regulations and healthier buildings. The need for more public awareness about green is the top challenge faced and also the lack of educated green building professionals.

3. Smart Farming: Agro-Economy is critical for India's success of becoming a trillion-dollar economy. According to WEF, India is salient because, unlike its East and Southeast Asian neighbours, rapid economic growth has not been inclusive enough to reduce the numbers of Indians living in poverty. India contains the largest number of poor people in the world: 270 million, [according to the World Bank](#).⁽¹⁾ Employment growth is critical in low-productivity agriculture, which accounts for nearly three-quarters of the sparse population. However, automation threatens to create more unemployment. Public policy must be directed toward increasing the productivity of poor people rather than just offering handouts. As more young men are migrating from rural poverty to urban areas to seek employment, they are contributing to a rapid feminization of agriculture. Women, primarily dependent on agriculture, perform most of the backbreaking labour. Their low productivity in agriculture, itself increasingly affected by climate change, demands action by policymakers. Any transformation of agriculture requires removing the constraints on women. Digital India's strategic cornerstones, the Common Services Centres, are meant to provide access points for delivery of various electronic services to villages, to promote digital and financial inclusion, encourage rural entrepreneurship, and build rural capacities and livelihoods, offering a bottom-up approach to social change, particularly among India's rural citizens. New technologies enable small farmers to shift from input-intensive to knowledge-intensive agriculture. Precision agriculture can improve the timeliness of planting, secure the best market prices through market information and e-market reforms, provide fertilizer subsidies via direct bank transfers that eliminate or reduce the cost of financial intermediaries and improve agricultural extension.

Here is a case study of New Zealand on the "Futuristic Farms that will feed the World" which India desperately needs to adopt. If you need to feed the world in 2050 the next 40 years the world needs to produce the same amount of food as it did over the last 8,000 years which indicates the pressure on the food system. We are facing a considerable challenge. With the growing population, the change in consumption behaviour, the climate crisis; how do can we secure our food production? The real secret is sustainable production. It should be with fewer inputs, fertilizer, water, and pesticides. Otherwise, we will destroy our planet. The security of food systems is one of the world's most pressing challenges. The story of how a small country became an unexpected food superpower, and number two world's food exporter could be the solution to adapt to build a sustainable and greenhouse farming in India. [Link here](#) (2)

4. Smart or Digital Education: According to the Planning Commission of India, "Education is the most important lever for economic, social, and political transformation. A well-educated population, equipped with relevant knowledge, skills, and attitudes is essential for social and economic development in the 21st century. Education is the most potent tool for socio-economic mobility and a key instrument for building an equitable and just society. Education provides skills and competencies for economic well-being. Education strengthens democracy by imparting to citizens the tools needed to participate fully in the governance process. Education also acts as an integrative force in society, imparting values that foster social cohesion and national identity. Recognizing the importance of education in national development, the Twelfth Plan places an unprecedented focus on the expansion of education on significantly improving the quality of education imparted and on ensuring that educational opportunities are available to all segments of the society."

India's education system needs a quantum shift. The quality of education has a direct bearing on any economy. With some 240 million students or nearly 20% of the Indian population in school, their quality of learning or lack of it assumes significance for the competitiveness of the country. The ASER report shows that Indian children have a vast learning deficit. This poor learning outcome in India is despite the Right to Education (RTE) Act. Besides, India has the [third-largest](#) (3) higher education system in the world, after the US and China, according to the World Bank. However, in terms of expenditure per student as well as per teacher, India falls behind. In the last decade, access to higher education has improved as more IITs, IIMs and central and state-level universities have been established. However, this proliferation has also raised concerns about an imbalance between excellence and inclusion.

Today's students are exposed to digital technology right from birth and do best in an interactive environment – where learning is experiential and involves high levels of sensory stimulation. We need to build this as standard into India's curriculum. Rote learning, worksheets, and lecture-based teaching are no longer appropriate. At the same time, administrative tasks and processes have increased the burden on teachers. We must ease this burden, freeing our educators to focus on what they do best. We need our education systems to teach the skills Indians need for a 'Digital Economy'. Globalization and technology advancements are rapidly changing skills requirements. Tomorrow's graduates will primarily be employed as knowledge workers in our services-based economy. We need to give them the skills to succeed in this very different work environment. Moreover, we need to make the most of our dwindling talent pool, by offering world-class education to every Indian child – regardless of socio-economic status.

Smart and digital learning aims to provide a holistic learning methodology to students using modern technology to enable them for a rapid and fast-changing world where adaptability is critical. Smart education offers a paradigm shift in the way students access education. It is not just a change in the delivery of education; it is much more than that. With radical transformations in technology, the teachers of today can have a hard time processing what the future will be in the next 20 years from now. Smart Education solves this conundrum by using state-of-art technology, helping both teachers and students prepare themselves for tomorrow. A smart or digital education can be done in a physical or virtual environment or both. It can also be summarised as the use of smart devices to augment the learning outcome of the traditional education system.

A Smart/Digital, multi-disciplinary student-centric education system – linked across schools, tertiary institutions and workforce training, using:

- Adaptive learning programs and learning portfolios for students
- Collaborative technologies and digital learning resources for teachers and students
- Computerized administration, monitoring and reporting to keep teachers in the classroom
- Better information on our learners
- Online learning resources for students everywhere.

Therefore, Smart Education provides an opportunity to transform India's education system to - Empower teachers and administrators; Engage effectively with students, and build a workforce with high-value global skills to become future-ready.

5. Smart Healthcare: India's healthcare sectors has become the largest verticals both in terms of employment and revenue. Healthcare comprises Hospitals, Clinical trials, Medical devices, Telemedicine, Outsourcing, Medical Equipment and Health Insurance. The healthcare market in India is expected to reach US\$ 372 billion by 2022, driven by a rising income level, greater health awareness, increased precedence to lifestyle diseases, and better access to Insurance has created a strong demand in the market. The hospital industry in India is expected to grow at CARG for 16-17 per cent to reach Rs 8.6 trillion, which has created attractive opportunities.

The number of doctors has increased from 8,27,006 to 8,41,104 in 2017, enabling the rising Manpower. Last but not least, the world's largest Government-funded healthcare schedule - Ayushman Bharat the National Health Protection Scheme to support healthcare policies. The private sector has emerged as a vibrant force behind India's healthcare industry. Bringing in the blend of both international and national repute accounting for 74% of India's total healthcare expenditure. Telemedicine is also fast-emerging in India. Major hospitals such as Narayana Hrudayalaya, AIIMS, Apollo have adopted telemedicine service and have signed for many public-private partnerships (PPP). Further, the presence of world-class hospitals and skilled medical professionals has strengthened India's position as a preferred destination for 'Medical Tourism' globally as the cost of surgery in India is about one-tenth of that is in the US or Europe. India's competitive advantage also lies in the increased success rate of Indian companies in getting the Abbreviated New Drug Application (ANDA) approvals.

Smart healthcare should cover the following:

- a. Right treatments to be provided at the right time, in the right place, and for the right patient.
- b. Clinicians use technology to diagnose more accurately and treat the illness and deliver care.
- c. The ecosystem care delivery stakeholders communicate effectively and efficiently and use information.
- d. Patient data is centralized and accessible to the relevant stakeholders within the industry
- e. Patients are actively engaged and are informed in their treatment plan.
- f. New cost-effective treatment models make healthcare available for everyone, including those who can't afford.
- g. Improvement in efficiency reduces waste.

The emerging technologies that could reshape healthcare are as follows:

According to McKinsey report, "Healthcare innovation is occurring at an unprecedented pace. The Center for Drug Evaluation and Research in the Food and Drug Administration (FDA) approves double the average annual number of novel drugs as it did a decade ago. 11 Among the therapies approved in 2017, 15 were first-in-class, indicating that they had a unique mechanism of action; another 18 address rare or orphan diseases. Some could dramatically improve the precision of diagnostics and the ability to personalize treatments (for example, through biomarkers), which could help reduce the significant variability in outcomes achieved by standard therapies. In the past two years, genuinely individualized treatments have been approved, ones that genetically modify patients' immune cells to battle leukaemia and lymphoma. 12 Curative therapies could substantially alter the nature and length of the delivery system demands from patients with chronic illnesses, potentially creating downstream savings. Furthermore, the care delivery requirements of some novel treatments could make possible, more convenient and affordable care in or closer to patients' homes.

Novel drugs are just one of nine emerging technologies that are reshaping healthcare in multiple ways—how consumers access it, how and which providers deliver it, and what health outcomes are achieved. Some of these innovations are specific to healthcare; others are more advanced in nonhealthcare sectors but hold tremendous potential in healthcare.

1. Connected and cognitive devices: Portable, wearable, ingestible, and implantable devices can monitor health information, engage patients and their community of caregivers, and deliver therapies autonomously.

2. Electroceuticals: Small implantable devices can alter the nervous system's electrical impulses to treat a variety of diseases.

3. Targeted and personalized medicine: Novel drug therapies that use a patient's own cells or deliver targeted genetic material can often treat disease more successfully than small-molecule or protein-effector drugs can.

4. Robotics: Next-generation robots could enable minimally invasive approaches and ease the physical burden of surgeries. Advanced robotics could also expand automation beyond specimen and material transport within the hospital to facilitate instrument handling and other tasks within the operating room.

5. 3D printing: This technology can produce customized, 3-dimensional structures composed of biological and industrial materials, in the process of creating organ replacements, personalized prosthetics, and precision medication dosages.

6. Big data and analytics: Platforms and applications that store, transmit, and analyze continuously expanding medical data sets can be used to identify patients who are candidates for highly targeted therapies. In the future, physiological data recorded by robots during procedures could be leveraged to improve both medical education and surgical planning. As more data becomes readily available—some sources suggest an annual growth rate in available data of 48 % —the opportunity to better collect data and translate it into actionable insights is increasing.

7. Artificial intelligence (AI): Technologies that convert analytical insights into cognitive engagement solutions can enhance diagnosis, improve predictive interventions, and optimize clinical productivity.

8. Blockchain: This decentralized digital ledger technology holds the potential (with clear and simple use cases 15) to enable more secure transactions, more confidential patient data sharing, and more democratized data access, which could allow other technologies to better leverage data (for example, provider directories that can be rapidly updated with new network structures).

9. Robotic process automation (RPA): The automation of repetitive tasks (including the majority of claims processing) via simple rules or heuristics has the potential to enhance productivity rapidly.

While we cannot predict precisely how quickly each technology will emerge and scale in healthcare, each has the potential to have a significant impact over the next five to seven years. Among the factors that will influence the speed of change are the pace of innovators, the appetite of incumbents for change, and the rate at which regulations adapt to technology."

One of the significant challenges in Health care is the workforce challenges that are being felt across more and more countries. Staffing shortages are evident in several hospital specialties (emergency medicine and geriatrics) and general practice; there are also growing nursing shortages across both health and social care. Compounding the problem is a scarcity of leaders with strategic, next-generation skills to guide and support the transformation to becoming patient-centric, insight-driven, and value-focused organizations.

What stands in the way of more rapid progress in the move toward augmenting today's workforce? One factor may be that many leaders of health care provider organizations anticipate that the scale and pace of change will overwhelm their workforce and complex current talent issues. What these executives may not be considering is that technology-fueled shifts

in the nature of work represent a tremendous opportunity to help resolve today's challenges and build tomorrow's capabilities and element the red-tapes and make "Healthcare affordable and available for everyone."

6. Smart Mobility: Smart mobility is a revolutionary and emerging concept in the way of thinking how we get around; that is Safer, Cleaner, and Efficient which refers to "zero carbon emissions, no accidents, and zero ownership." What is smart about sitting in traffic or missing the train? Smart urban mobility, however, can be smart, and increasingly it is the individual on the street who makes the difference. People fed-up with congested cities with carbon foot-prints are innovating smart mobility with next-gen mobile technologies and intuitive apps which integrate enhanced infrastructure, public transportation, and car-pooling services. Smart mobility's primary focus is also on the green environment - be it electric cars or more bike lanes. In a nutshell, smart mobility solutions cause less congestion, improved access to public transportation, and clean-air.

One of the pillars of economic development for any country is the 'State-of-art Transportation Network', is critical to the national infrastructure. However, it has been a significant cause of greenhouse gases and efforts are ongoing to reduce the carbon foot-print to address environmental issues and decrease their dependence on fossil fuels. India is still following BS-IV as against EURO 6 implemented in European countries, which is equivalent to BS-VI.

Government across the world is battling to tackle issues traffic congestion and the rising levels in pollution. They recognize that these factors are leading to a negative impact on society. With people spending an enormous amount of time in commuting, there is a need for developing a "Smart Transportation Network" powered by real-time traffic updates, forecast, automatic asset monitoring, and best route planning based on weather conditions. All this is combined under the umbrella of Smart Mobility. The focus has shifted from merely building new capacity to using the existing capacity intelligently by using the next-gen technology to optimise the current asset performance. In India, over 30% of the population lives in the cities, and this number is expected to rise to 87% by 2031. To support this phenomenal growing urbanization, it has become essential to have smart transportation systems. The study by NITI Aayog along with Rocky mountain institute found that with the help of an electrically powered, connected mobility system, India can save up to 37% of carbon emissions by 2030.

The Government of India (GOI) has an ambitious target to make India 100% 'Electric Vehicle' (EV) nation by 2030. Its various programs, including FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles), are the steps towards achieving this goal. The Government is allowing the adoption of smart mobility options by cutting down taxes on the lithium-ion batteries which are used in the EVs. Under the 'Smart India Mission', the GOI is committed to make more investments in public transportation systems and initiate transit-oriented development across 100 cities. This will make the transport network well-connected, energy-efficient, and also substantially reduce the pollutions levels. Nagpur, with its 200 EVs, including buses, taxis, e-rickshaw, and autos, has earned the tag of India's first city with electric mass mobility system. India's quest for smart mobility has made the country a hot spot for international companies to offer their latest technologies such as pod taxis, hyperloop, electric vehicles, cable cars and ropeways.

Advanced data analytics, autonomous vehicles, and smart systems are the critical technology/solutions for the future development of transport and operations. The roads and transportation system will be optimized, making the traffic smoother, public transport more reliable and comfortable — the air cleaner with less need for private cars. Three main elements characterize most new urban public transportation solutions: more on-demand transport, the highly-effective use of digital innovation, and more electric-powered options. Moreover, all of these solutions need a well-rounded concept that covers the "last-mile" to exploit every level of the urban environment. The best approach to effective urban public transportation will be a mix that offers plenty of choices to commuters. Cities are, therefore, exploring urban public transportation on all levels: at ground level, underground, and above ground. Often referred to as a "3D" transport concept, the idea is to utilize and harmonize all options to cut down on congestion.

E.g., - Singapore Driverless Mass Rapid Transit (MRT)

A growing number of residents (over [5.6 million people](#)) (4) and vehicle population (almost [1 million](#)) (5) motor vehicles) have brought Singapore's [Land Transportation Authority](#) (LTA) (6) and the Intelligent Transportation Society Singapore (ITSS) together to create an intelligent transport system to improve commuters' travel.

Singapore's Smart Mobility 2030 strategic plan is an example of a smart plan that focuses mainly on transportation. The project aims to be informative, interactive, assistive, and to use green mobility. The LTA and ITSS have outlined three key strategies to achieve their goals:

1. To implement innovative and sustainable smart mobility solutions.
2. To develop and adopt intelligent transport system standards.
3. To establish close partnerships and co-creation.

Therefore, the road to the future of smart urban mobility:

Whatever solutions a city will choose to solve its unique urban mobility challenges, the approach will be holistic, shared, and deeply embedded in digital technology. Only when planners embrace diverse ways of getting around, whether on e-scooter, above ground, or in an on-demand shuttle, will commuters feel free and enjoy moving through their city. Based on the innovation trends and disruptive forces in urban mobility, it is realistic to envision a future scenario when smart city residents and visitors enjoy a wider range of affordable, -multimodal, on-demand mobility options; and conventional cars and ownership practices are replaced by shared electric and autonomous vehicles.

7. Smart Manufacturing: Making India an intelligent and smart manufacturing hub through the, "Make in India" to "Make Digitally in India." The vision behind Mr Modi's flagship program "Make in India" launched in 2014 was a progressive step towards positioning India as the hub of manufacturing in the world. India's demographic advantage vs increased labour cost in China has presented India with a golden opportunity to demonstrate our strength in the manufacturing sector. However, in the roadmap of this initiative, there are underlying areas where the Government's attention is required to be diverted aggressively. Digital transformation of the manufacturing unit is one of the most critical aspects of it. In the pursuit of achieving operational excellence, the decision-makers of the manufacturing firms must have real-time data of their assets and processes. Manufacturing units are flooding existing systems with a plethora of data, and the process of converting this data into meaningful information through cutting-edge digital technologies is the fundamental goal of digital transformation. In 2012 General Electrics (GE) introduced the "Industrial IoT" (IIoT). IIoT applies IoT to manufacturing by integrating big data analytics, machine learning, harnessing sensor data and automation.

India has to move from manufacturing hubs of Industry 1.0 and 2.0 to Industry 4.0 or beyond. Smart Advanced Manufacturing and Rapid Transformation Hub (SAMARTH) - Udyog Bharat 4.0 is an Industry 4.0 initiative of the Department of Heavy Industry, Government of India under its scheme on the enhancement of competitiveness in Indian Capital Goods sector. The initiative aims to raise awareness about the Industry 4.0 amongst the Indian manufacturing industry through demonstration centres. Currently, there are four centres which include IITD-AIA Foundation for Smart Manufacturing; Center for Industry 4.0 (C4i4) Lab at Pune; Smart Manufacturing Demo & Development Cell at CMTI; and IISc Factory R&D Platform in Bangalore.

Indian Engineering Exports have been growing at 10% variation, but the Engineering Exports as a percentage of ASEAN and World Exports is stagnating at 0.8-1% over the last 15 years. This is because the majority of engineering goods originated from low or middle-level products. Department of Commerce, Ministry of Commerce and Industry has given to the apex engineering body, a mandate to set-up a technology centre to enable MSMEs to benefit from the various next-gen technologies. India also requires to close a quality gap faced with the best-in-class and leapfrogging to emerging technologies; which will enable export quality products. Hence EEPC India technology centre gains ground.

Smart manufacturing has been defined as the fully-integrated, collaborative manufacturing systems that respond in real-time to meet the changing conditions and demands in the factory, in the supply-chain network, and customer needs. Smart Industry is a synonym for Industrial transformation in the fourth industrial revolution within which smart manufacturing de-facto fits. Industry, the manufacturing business, manufacturing companies and even manufacturing processes are in full transformation. This is mainly due to increasing automation, [digital transformation](#), (7) the bridging of digital and physical environments (*as enabled by IoT or the Internet of Things*), evolving industrial and [manufacturing technologies](#), (8) the intensive usage of data/analytics, industry and manufacturing challenges, human, economic and societal evolutions and demands and the integration of information technology and operational technology (*IT and OT*).

The IISc is building India's first smart factory in Bangalore with a seed funding from Boeing Company. Bosch, a German auto component manufacturer, will begin implementation of intelligent manufacturing at its 15 centres in India which I assume is already launched. Digital literacy of India has shown significant pace in the last decade. Therefore, it is important to understand the Career

- ***Integration Between Data and Process*** - The most crucial aspect of digitalizing any unit is to define the complex process of machines through simple algorithms. The algorithms which not only explains the basics of the process but equipped decision-makers to apply cutting edge technologies like predictive analysis and digital twinning to improve the overall efficiency of operation.
- ***Interoperability*** - Interoperability and the IoT are prominent enablers for data collection and its better use by manufacturers. Many are investing heavily in tools for leveraging and analyzing this newfound asset. At the core of interoperability is the ability for users to access information from multiple sources in one seamless application.
- ***Faster time-to-value*** – The term coined by General electric endorses digital transformation by defining a standardized way to connect machines, data, and people with a consistent interface for superior user experience, dynamic scalability, and extensibility to grow functionality as business needs evolve

Proposed Framework for Smart manufacturing Unit: Researchers and industry leaders around the world have been trying to integrate Cloud technology with manufacturing field. The impact is visible in additive manufacturing level but not so on

subtractive manufacturing. In the manufacturing field, different organizations use different software for their work. To sort this issue, a generic Cloud-based system approach can be understood from the below framework. The resistance towards new technology is an eventuality, and thought leaders in this industry need to penetrate this education through simple but effective frameworks.

Conclusion and Future Direction: Smart Manufacturing is in its early stage of development. Even though a good amount of research and development has been going on; its principal focus remained to the additive manufacturing sector and seldom in other industries like subtractive manufacturing. Also, the amount of research work happening in India in this area is far lesser as compared to other countries like China or the USA. Hence its widespread application is not made available yet. Since in Cloud technology everything is treated as a service, even small manufacturers or those who want to focus on core work only can use it by taking Cloud or Infrastructure as a service from third-party service providers. The system architecture proposed here is generic in nature and can be customized or modified.

There is an excellent future available in this field; many of the Smart Manufacturing platforms developed are still in the embryonic stages. With the use of IoT technologies, AI/ML, proposed for Cloud-based manufacturing systems can be further improved. One may integrate new technologies like IoT, along with predictive and preventive analytics, to make it more automated as the future variations, and possible applications are enormous.

8. Smart Energy: Digital transformation is transforming companies across diverse sectors, societies, and lives. All this is taking place thanks to the connected era of devices, intelligent systems, human-machine interface, and products. The same is true for the power sector as well, which was traditionally asset focused and utility-driven.

In recent years, the terms "Smart Energy" and "Systems" is used to express the approach that is broader than the term "Smart Grid." The Smart Grids primarily focus on the electricity sector; Smart Energy Systems take an integrated, holistic approach on the inclusion of more sectors (Electricity, Buildings, Heating, Cooling, Industry and Transportation) and enables for the identification of more affordable and achievable solutions for the transformation into future renewable and sustainable energy solutions.

India is the second most populated country in the world, contributing to 6% of the world's primary energy consumption. Due to rapid urbanisation and burgeoning urban population, there will be serious implications on energy consumption and subsequent carbon emissions. Cities face a series of complex interconnected challenges across different sectors (Mobility, built environment, waste & water management, and public services) and it is critical to re-look at these challenges by integrating the principles of 'smart energy management' for achieving sustainable and low-carbon urban development.

Managing the energy footprint of cities is one of the most challenging goals, and with the evolution and transformation of existing cities into smart cities, smart energy management thus becomes an integral component of urban transformation. India's urban population growing from 31.6% to 57.7% by 2050, there will be further implications on energy consumption patterns and subsequent GHGs emissions (UN, Dept of Economic and Social Affairs). Therefore, the task of managing and reducing energy-related carbon emissions is often challenging for urban developers and needs to be addressed in various sectors to ensure an integrated approach to energy management.

"Smart energy management (SEM) is a component of smart city development aiming at a site-specific continuous transition towards sustainability, self-sufficiency, and resilience of energy systems, while ensuring accessibility, affordability, and adequacy of energy services, through optimised integration of energy conservation, energy efficiency, and local renewable energy sources. It is characterised by a combination of technologies with information and communication technologies that enables the integration of multiple domains and enforces collaboration of multiple stakeholders while ensuring the sustainability of its measures."

The Government of India (GoI) has been developing policies and programs to guide the mainstreaming of SEM in urban planning. To meet the energy needs of citizens and reduce carbon emissions, the Indian Government has adopted a two-pronged approach, i.e., focusing on supply and demand. On the generation side, greater use of renewable energy, mainly solar and wind, is being promoted. On the demand side, efforts are being made to improve energy efficiency through a variety of innovative policy measures that fall within the umbrella of the 2001 Energy Conservation Law.

An uninterrupted power supply is a crucial element for the development of the Smart City. The smart cities mission focuses on reliable power quality, climate protection, and economic efficiency. Utilities have been analysing the existing network and planning for the modernisation of the distributed infrastructure. However, several other measures such as the replacement of conventional substations, quick-to-install, reliable, maintenance-free, and compact substations or e-houses; the replacement of overhead networks with underground cables; the use of intelligent switching devices, smart metering and billing, and smart electrical storage systems are required. The Government has launched several initiatives such as the National Smart Grid Mission (NSGM), the Ujwal Discom Assurance Yojana (UDAY) and the Integrated Power Development Scheme (IPDS).

India plans to implement the smart grid projects, promotion of electric vehicles, development of microgrids, the installation of grid-connected solar rooftop systems, training and capacity building, along with enhancing consumer engagement. Further, there is a pressing need for advances in geographic information system (GIS), mobile, and information technologies such as cloud computing and data analytics which could transform the utility industry. The Government also needs to formulate regulations for decentralised power and provide incentives for producing renewable energy to implement smart energy initiatives.

The way forward for achieving the integrated 'Smart Energy Management' is to a) Integrate policy governance and effective decision making. b) Government to provide better infrastructure and resources for technological advancements. c) Develop information, education, and communication (IEC) strategies for stakeholder engagement and management. d) Establish performance goals for effective implementation and monitoring. The conclusion is that the Smart Energy System concept represents a scientific shift in paradigms away from single-sector thinking to a coherent energy systems understanding on how to benefit from the integration of all sectors and infrastructures.

9. Smart Banking: Powerful forces are reshaping the Banking Industry - Customer expectations, regulatory requirements, technological advancements, economics and demographics are together creating an imperative to change. Banks today need to get ahead of these challenges and reinvent to win in the next era of 'Digitization.' Banks must not only execute on the imperatives of today but also radically transform to innovate themselves for the future. Today's challenges are that nearly most of the bankers view attracting a new customer as one of their top challenges over the next couple of years. Banks are hungry for growth and finding a new customer base. However, banks also recognise the need to deepen their customer relationships and focus on more specific customer outcomes. Therefore enhancing customer service is the number one investment priority for the banks globally. However, in the rapidly developing emerging and Asian markets, where big and established banks have less dominance. Bankers report that retaining existing customers and attracting talent in the face fierce competition and new market entrants are also the top challenges. R&D, Innovation and New product developments are the top investment priorities in these regions.

The Bank of Hindustan and the General Bank of India were established in the late 18th century but did not survive for very long. The British presidency government then established the Bank of Calcutta, Bank of Bombay, and Bank of Madras which were merged in 1921 to form the Imperial Bank of India. In 1955 it became the State Bank of India and is the oldest surviving bank in India. Several banks have been established pre and post-independence. In 1935 the Reserve Bank of India was established, and it was nationalized in 1949. That same year the Banking Regulation Act was passed, which authorized the Reserve Bank of India to regulate, control and inspect all banks in India. It also stipulated that RBI will have to authorize the establishment of any new banks.

Technological innovation began in the Banking sector back in the 1980s. Since the establishment of the ICICI Bank, digitization in the banking industry has been commendably fast. Banks offering many services over the internet has resulted in the growth of banking sector in India. Banks have been able to expand their customer base, provide additional services, and ensure that customers can handle a number of banking tasks over the internet in the comfort of their homes or offices. If you are a banker, online shopper, tech-savvy person or even a regular bank customer, you must have heard the word "digital banking". Interestingly, most people have a different take on digital banking. There is a lot more to digital banking than just a few features that we can see on the surface. Digital banking is converting the brick and mortar banks into more greener and efficient places to operate. There are a plethora of options that people can opt for when it comes to banking. Now people can check their bank account details, pay their bills online, transfer money to other accounts, and all of this can be done from the very comfort of their home. All that the people need for banking these days is an internet connection.

When wearables become implants used for real-time payments, will the credit unions and banks still be consumer's primary financial institutions? To thrive in a dynamic environment, they should do this following:

- a. Tune into the changing expectations and preferences of consumers.
- b. Embrace the full potential of Artificial Intelligence (AI) in personalisation and other financial applications.
- c. Keep up the pace with what the major brands are doing in and out of banking, relating to the consumer experience.

Tomorrow's banking consumers are the segment born between 1979 - 1995 called 'Millennials' who will become the largest age-based demographics, and retail banking providers should carefully note their preferences, and behaviour as they approach middle-age and their spending power would grow exponentially. Millennials have had access to smartphones for most of their adult lives. Generation Z can't remember life without these pocket-size digital tools since younger consumers are so comfortable with mobile technology. Hundreds of mobile financial applications such as Mint or Venmo have gained traction disrupting the status-quo in banking and have challenged the financial institution to keep pace.

Research has shown that the younger generation does seem to be brand loyal and tend to be even more faithful to "Convenience." Millennials or young consumers embrace a do-it-for-me culture - hence the label - "lazy"). Even older generations have adopted — and come to expect — “do-it-for-me” digital solutions across many aspects of their lives, from one-click purchases to ordering rideshares through Uber or Lyft.

AI has the potential for a multitude of practical applications in the banking industry. Already it is being used to reduce payments fraud, improve service through personalization, and assist consumers with financial decisions (e.g., investments). Banks and credit unions must embrace the AI-driven “do-it-for-me” revolution and take their place along with other consumer industries that have firmly embraced AI-related technologies.

Many large banking institutions are well along this road already. They recognize that financial institutions have a massive advantage in this emerging new world of AI. Banks and credit unions have a wealth of valuable consumer data drawn from account records and transaction histories. This data is the essential “raw material” that fuels artificial intelligence engines; it’s how AI creates more personalized, streamlined experiences across a range of devices and banking services.

Facebook recently said that it would allow users to transfer money through its messenger service. This is further proof that boundaries between banking and technology products are fast dissolving. Payment providers such as PayPal and Square have already made a mark abroad. The more popular payment firms in India reportedly have more users than the entire market of active credit card users. The marriage of technology with financial services can be seen in recent joint ventures between telecom companies and Indian banks to pitch for payments banks.

Indian banking regulators have been partial to traditional banks that they can control with reasonable ease. Moreover, they have been suspicious of other financial intermediaries because of fears that these shadow banks could threaten the stability of the financial system. Fintech or ‘Financial Technology’ has become a buzzword in financial circles through Fintech Partnerships. Fintech players the world over are challenging the status quo of the financial services industry by bringing in a fresh take on problems faced by customers, as seen through the lens of technology. The unprecedented growth in the fintech sector in India is a direct result of rapidly changing demographics and consumer behaviour, underpinned by the need for convenience. India is fast becoming a digital economy with over a billion mobile phones, 330 million internet users (c.94% on wireless devices), and 240 million smartphones.

The future generations might not have ever to visit a bank, and even if they have to, they might visit a small consumer-friendly digital bank cafe that runs on cutting edge technology. It is exciting to wonder what the future of banking might be. As of now, smart banking is making banking for us easier and making traditional banks who are adapting with next-gen technology, more relevant with each passing day.

10. Smart Water and Waste Management: Water resources are under pressure from continuing population growth and urbanisation, rapid industrialisation, and expanding and intensifying food production, particularly in developing countries and in urban areas. Urban populations may nearly double from current 3.4 billion to 6.4 billion by 2050. Growing population and climate changes sweeping across the globe have put untold pressure on water networks. According to UN, as of March 1st 2018, there were 7.6 billion human beings on the planet, and this number will rise to around 10 billion by 2035 – all increasing demand on precious water resources. An ageing infrastructure that is overly stressed by a rapidly increasing population, torrential rains and flooding is the root cause of leaks and bursts in pipes. Many Indian cities, including Bangalore, Mumbai, Delhi and parts of Haryana are already facing these issues. Not only does this water loss and contamination affect an organisation by increasing operational costs and failing to provide 24x7 water, but, it also has a significant impact on the environment. The solutions for putting an end to this water loss are furiously sought.

Smart technology in the water sector consists of four components: a) Digital output instruments (sensors and meters), which collect and transmit data in real-time; b) Supervisory Control and Data Acquisition (SCADA) systems, which process information, and remotely operate and optimise systems; c) Geographic Information System (GIS) which store, analyse, and manage spatial information and d) Software application, which support modelling infrastructure and environmental systems by managing and reporting data to improve design, risk management, and decision-making. Today almost three-quarters of the world's waste ends up in landfill, imposing enormous environmental costs and squandering opportunities to extract value through recycling and reuse.

The improvement of the urban waste collection service and, in general, the achievement of more efficient management of the waste, is one of the main challenges that the cities face, mainly due to the population growth. Thus, smart waste management is a critical factor in smart cities.

Within the public services – priority element of a smart city – waste management, is a fundamental pillar. To understand its importance, we must take into account that the management of urban waste is composed of different stages, from the collection and transport to its treatment. Being the collection the critical factor to achieve this efficient management of municipal waste for two reasons, its costs and its logistic component. Mainly, we must focus on reducing costs, as it is [exceptionally costly](#), since it involves many workers and vehicles as well as improving the planning of waste collection, since having a high logistical component, allows a wide margin of improvement through solutions that business intelligence can bring.

According to Swachh Bharat Mission (Urban) data for 2018, 43% of the total urban wards in India are now segregating their waste at the source (Sambyal & Agarwal, 2018). In 2017, door-to-door collection coverage increased from 53% to

80% (ibid.). In cities such as Panaji, Indore, Mysore and Muzaffarpur, there is a waste separation system, wherein separated waste is brought to the processing centre. Then, compost is made from wet waste, while only inert waste goes to the landfill. Sambyal (2016) elaborates that Alappuzha in Kerala prioritises segregation and reuse of waste at the household level, making it one of the cleanest cities in India. It has accomplished decentralised waste management; 80% of the households now own biogas plants and pipe composting systems. As part of the Clean Home Clean City programme, Alappuzha launched Thumburmuzhi in 2013, a model aerobic composting plant that composts animal carcasses (Sambyal, 2016).

A key challenge facing the waste sector in India is the need to increase the workforce at the collection level. Waste segregation is a significant obstacle and remains a daunting task. Despite the existing intelligent mapping and routing technologies, the segregation of waste, especially at the household level, is still limited. The sector requires a higher utilisation of economical and user-friendly technical solutions. Another core issue in the sector is the lack of accountability and transparency resulting from the monopoly and control of a small number of private companies. Due to the limited knowledge of stakeholders (sometimes corruption) and the lack of innovative solutions, the methods used are not the optimal for effective waste management. Therefore, it is important to develop capacity building and awareness programs for responsible authorities and relevant citizens to respond to behavioural changes and incorporate smart practices into the waste management sector.

11. Smart Governance: Smart governance or good governance are two sides of the same coin. The use of the internet and digital technology is creating a progressive government- public partnership, strengthening government institutions and integrating all sections of society. Information and Communication Technology (ICT) has become an integral part of our lifestyle. Without the internet and digital technology, modern lifestyle is unimaginable. Whether it is transportation, telecommunications, healthcare, security, education, almost every segment of society is dependent on ICT. E-governance and involvement of the public in decision-making process is the most important aspect of smart governance.

'Smart city governance' contributes to developing a framework for building new, smart governance models addressing the challenges of the digital society, collaborative governance, information sharing, citizen engagement, transparency and openness. The diverse ecosystem of stakeholders requires smart cities to define governance clearly. City leaders, regional governments, transportation districts, corporate and non-profit partners and, depending on the funding model, state and federal agencies may all participate in establishing and executing a smart city vision. Stakeholders should be able to articulate their responsibilities and ensure that appropriate information flows to the right decision-makers. Establishing accountability upfront and creating mechanisms to drive timely decisions are also critical. Therefore SMART refers to :- S = Standardizing, M = Monitoring, A = Accounting, R = Rethinking, T = Transforming.

According to the Smart City Guideline, The strategic components of area-based development in the Smart Cities Mission are city improvements (retrofitting), city renewal (redevelopment) and city extension (greenfield development) plus a Pan-city initiative in which Smart Solutions are applied covering larger parts of the city.

a. Retrofit: Retrofitting will introduce planning in an existing built-up area to achieve Smart City objectives, along with other objectives, to make the existing area more efficient and liveable. In retrofitting, an area consisting of more than 500 acres will be identified by the city in consultation with citizens. Depending on the existing level of infrastructure services in the identified area and the vision of the residents, the cities will prepare a strategy to become smart. Since existing structures are largely to remain intact in this model, it is expected that more intensive infrastructure service levels and a large number of smart applications will be packed into the retrofitted Smart City. This strategy may also be completed in a shorter time frame, leading to its replication in another part of the city.

b. Redevelop: The redevelopment will effect a replacement of the existing built-up environment and enable co-creation of a new layout with enhanced infrastructure using mixed land use and increased density. Redevelopment envisages an area of more than 50 acres, identified by Urban Local Bodies (ULBs) in consultation with citizens. For instance, a new layout plan of the identified area will be prepared with mixed land-use, higher FSI and high ground coverage. Two examples of the redevelopment model are the Saifee Burhani Upliftment Project in Mumbai (also called the Bhandi Bazaar Project), and the National Building Construction Corporation is undertaking the redevelopment of East Kidwai Nagar in New Delhi.

c. Greenfield: The greenfield development will introduce most of the Smart Solutions in a previously vacant area (more than 250 acres) using innovative planning, plan to finance and plan implementation tools (e.g. land pooling/ land reconstitution) with provision for affordable housing, especially for the poor. Greenfield developments are required around cities to address the needs of the expanding population. One well-known example is the GIFT City in Gujarat. Unlike retrofitting and redevelopment, greenfield developments could be located either within the limits of the ULB or within the boundaries of the local Urban Development Authority (UDA).

d. Pan-city: The pan-city development envisages application of selected Smart Solutions to the existing city-wide infrastructure. Implementation of Smart Solutions will involve the use of technology, information and data to make infrastructure and services better. For example, applying Smart Solutions in the transport sector (intelligent traffic

management system) and reducing average commute time or cost to citizens will have positive effects on productivity and quality of life of citizens. Another example can be waste water recycling and smart metering, which can make a substantial contribution to better water management in the city.

To summarise, for India to become "Digital India" the following framework needs to be followed - Digital Economy, Digital Government, Digital Industry, and Digital Society by Accelerating digitization of existing sectors; Competing by integrating the ecosystems to grow India's competitiveness and foster new ecosystem that is digitally enabled; Transforming by developing the next-gen digital industry as the growth engine.

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About the author



Rajashree Rao (Shree) is a globally acclaimed Industry Thought leader, visionary, advisor, principal consultant, and mentor in next-gen technologies - AI, Cloud Computing, Data Analytics, Robotics, Industry 4.0, IoT, IIoT, Blockchain, and Smart Cities/Nation across industry verticals. After working for 20 years in the corporate across the regions, she is back to her roots to venture onto the next biggest growth market in the world. Shree brings with her the diverse industry experience of working with IBM, Intel, and SAP, leading and influencing the technology adoption within the Singapore Government and Public Sector for building the Smart City and Smart Nation Initiatives in the APAC region. Shree has recently joined Rolls-Royce as the Head of Partnerships and Ecosystem (APAC) at R² Data Labs based out of Bangalore. Shree is a passionate technologist who challenges the industry and technology providers to innovate and think out of the box since she believes that Technology's principal goal is to enable an individual, organization, city, or a nation to retrofit their existing system/business model/solutions/infrastructure, which will empower and transform the way people live, and work in the era of digital transformation.

She also holds various awards for having built trusted Business Partner relationships. Shree is also an enthusiastic and fervent Speaker and Writer in the Next-Gen Technologies (<http://www.techtzpah.com/>) Leadership, Entrepreneurship, Life-lessons (<https://zenlighted.wordpress.com/>), and Self. Shree is a Graduate (Hons.) from Bangalore University in Business Management and has a diploma in Computer Science - Ecommerce. She enjoys international travel, cooking and is in the constant pursuit of the spiritual. She is also passionate about women's empowerment and spends her free time working with women and women's organizations.