ICDL 2019

DIGITAL TRANSFORMATION FOR SDGs

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Background Paper

teri | The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

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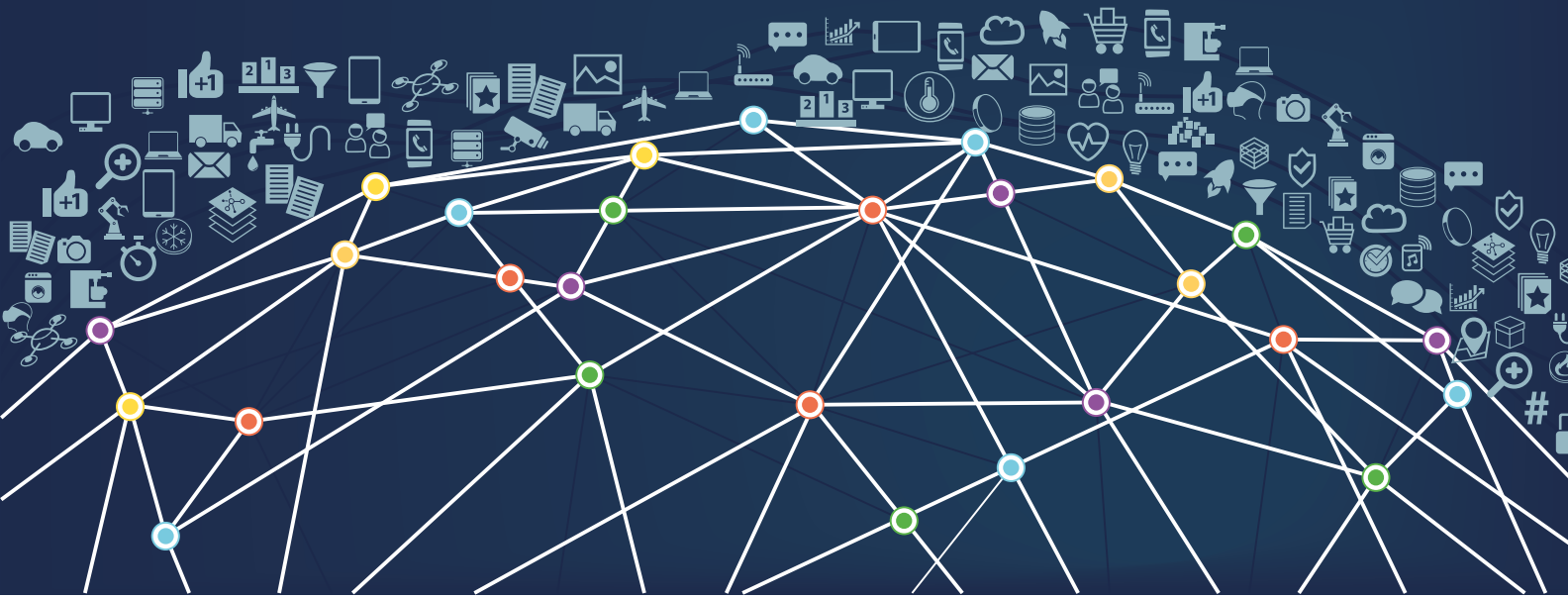
Digital Transformation in SDGs



Background

In the past few years, digital technologies have spread more and more into manufacturing and production processes. Rapid developments in the fields of Internet of Things, Big Data, Robotics, Block chain Technology, Sensors, Artificial Intelligence, Augmented Reality and Rapid Prototyping technologies have noticeably transcended into the manufacturing industry. This unprecedented occurrence, often referred to as "the fourth industrial revolution" or "Industry 4.0", has gained considerable momentum. Digitization is therefore the transformative power, fundamentally transforming the way goods are developed, produced and consumed, and galvanize the development of new business models, services, and behaviours.

Digitization promises many opportunities for economic development, its further reaching impacts are largely uncertain, however its potential can be realized only in the presence of "digital inclusion". The tremendous potential of digitization is evident from the studies that indicate that realization of "Industry 4.0" could deliver around $100 trillion to business and society in the next decade. Emerging against the backdrop of pressing global challenges such as climate change, food insecurity, lack of energy access, water scarcity, environmental degradation, loss of biodiversity

and megatrends like population growth, urbanization and mass migration, as well as the new and ongoing conflicts and crises worldwide, the question arising is: if – and how – Industry 4.0 could contribute to finding new ways of dealing with some of these major social, economic, and environmental challenges.

The United Nations Industrial Development Organization (UNIDO) is the specialized agency of the United Nations whose mission is to promote and accelerate Inclusive and Sustainable Industrial Development. UNIDO's mandate is fully recognized in the Sustainable Development Goal 9 (SDG 9), which demands to "build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation". Consistent with this mandate, UNIDO's programmatic approach is guided by three interrelated thematic priorities: creating shared prosperity, advancing economic competitiveness and safeguarding the environment.

In September 2015, the UN Sustainable Development Summit adopted the 2030 agenda which is the key document guiding international efforts for sustainable development until 2030. The agenda spells out 17 goals – the so-called Sustainable Development Goals (SDGs, see Figure 2) – and 169 more specific targets in key development areas such as poverty, water, energy, education, gender equality, economy, biodiversity, climate action, and many more.

In the context of this report, the SDGs 7 and 9 are of particular relevance:

- SDG 7 promotes affordable and clean energy. Its aim is to ensure access to affordable, reliable, sustainable and modern energy for all by 2030. This includes substantially increasing the share of renewable energies in the global energy mix as well as doubling the global rate of improvement in energy efficiency. SDG 7 especially aims at developing infrastructures and sustainable energy services for all in developing countries, with a particular focus on least developed countries, small island developing states, and land-locked developing countries.
- SDG 9 relates to industry, innovation and infrastructure. It aims at building resilient infrastructures and promoting inclusive and sustainable industrialization as well as fostering innovation. One of the targets of SDG 9 specifically highlights the promotion of inclusive and sustainable industrialization and to raise the share of employment in manufacturing and the proportion of manufacturing value added to gross domestic product. Besides, SDG 9 sets increased access to information and communications technology and universal and affordable access to the Internet in least developed countries by 2020 as a specific target.

This report aims to start a conversation on how these priorities can be achieved, focusing particularly on the potential of digitization of SGDs to help achieve the UN Sustainable Development

Goals (SDGs) related to affordable and clean energy (SDG 7), and industry and infrastructure (SDG 9), along with the implementation of the Paris Agreement.

Based on a review of the current literature and on interviews with experts, the report explores potential opportunities and also the challenges that digitization may pose to countries at varying levels.

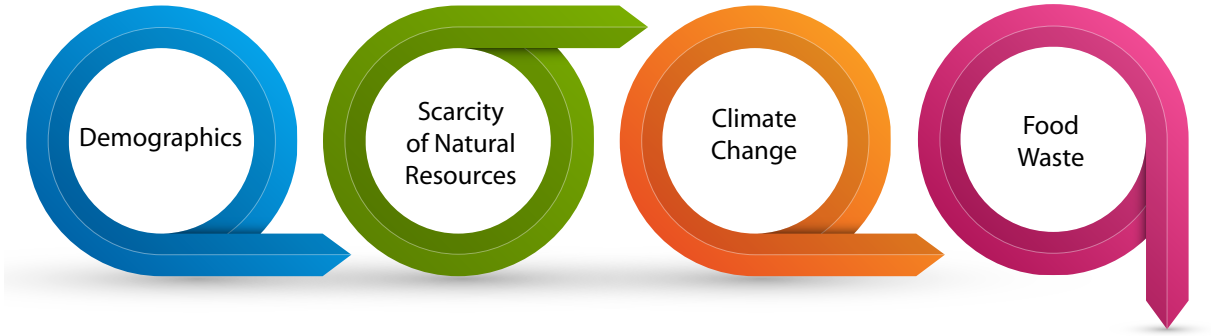
Sustainable Agriculture 4.0

Introduction

- In 2015, the UN 2030 sustainable development agenda and international community committed itself to ending hunger (Transforming Our World: The 2030 Agenda for Sustainable Development). How close are we to reaching the objective? The short answer: Not close at all—roughly 800 million people worldwide suffer from hunger. And under a business as - usual scenario, 8 percent of the world's population (or 650 million) will still be undernourished by 2030.
- Although demand is continuously growing, by 2050 we will need to produce 70 percent more food. Meanwhile, agriculture's share of global GDP has shrunk to just 3 percent, one-third its contribution just decades ago. The reality is that very little innovation has taken place in the industry of late—in any case, nothing to indicate that food scarcity and hunger will not be an issue in the coming decades. The world needs drastic change: following the current path will not solve the problem.
- Four main developments are placing pressure on the legacy agriculture model in meeting the demands of the future: demographics, scarcity of natural resources, climate change, and food waste are all intensifying the hunger and food scarcity problem. To meet these challenges will require a concerted effort by governments, investors, and innovative agricultural technologies. It can be done, but we need to disrupt the system.
- Agriculture 4.0 will no longer depend on applying water, fertilizers, and pesticides uniformly across entire fields. Instead, farmers will use the minimum quantities required and target very specific areas. It will be possible to grow crops in arid areas, making use of abundant and clean resources such as the sun and seawater. Other innovations—3D printing of foods, cultured meat, genetic modification, and seawater agriculture—are still in the early stages but could all be game changers in the next decade.
- Farms and agricultural operations will have to be run very differently, primarily due to advancements in technology such as sensors, devices, machines, and information technology. Future agriculture will use sophisticated technologies such as robots, temperature and moisture sensors, aerial images, and GPS technology. These advanced devices and precision agriculture and robotic systems will allow farms to be more profitable, efficient, safe, and environmentally friendly.
- These efforts will not come cheap: To end hunger by 2030 and accommodate the demographic pressure will amount to annual investments of US$265 billion, according to an FAO report.
- Governments can play a key part in solving the food scarcity issue. They need to take on a broader and more prominent role than their traditional regulatory and facilitating function. Our view is that in today's age of disruption, no one can act alone. A broader and international collaboration needs to be structured, while preserving the required agility to drive innovation. Governments can drive the setup of goal-oriented programs aimed at solving the food security dilemma. Those programs, however, cannot only follow the typical ecosystem and cluster approach in which governments enable the ecosystem and provide an environment for players to compete in. The culture of such programs (think: the Apollo moonshot program) require the setting up of international collaboration, building on public/private/ R&D partnerships where funding is measured on problem-solving outcomes and based on attracting the best talent. The programs must be focused on creating new products, solutions, and market leaders.

Challenges in Agriculture Industry

A number of global trends are influencing food security, poverty, and the overall sustainability of food and agricultural systems. The four main developments placing pressure on agriculture to meeting the demands of the future:



Increase in Demographics Increases Demand for Food

- **Population is growing**: In the coming decades, world population is expected to grow to by 33 percent, to almost 10 billion by 2050, up from 7.6 billion (as of October 20171). By 2100, the global population is expected to reach 11.2 billion. That figure may understate actual fertility rates—under other scenarios, population could hit 16.5 billion.
- **Urbanization is increasing**: Global urbanization between now and 2050 could lead to a net addition of 2.4 billion people to towns and cities. Urbanization stimulates improvements in infrastructure, such as cold chains, which permit trade in perishable goods.

Produce differently using New Techniques

1. **Hydroponics**: Hydroponics, a subset of hydroculture, is the method of growing plants without soil, using mineral nutrient solutions in a water solvent. Sundrop, for example, a company based in Australia, has developed a hydroponics seawater technology that combines solar, desalination, and agriculture to grow vegetables in any region. This system is sustainable, doesn't rely on fossil fuels (drawing its energy from the sun instead), and doesn't require land. Instead, its technologies integrate solar power, electricity generation, freshwater production, and hydroponics
2. **Algae Feedstock**: Algae farmed in aquaculture sites can become a substitute for feedstock and fishmeal. The cost of farming algae in most locations is between $400 and $600 per metric ton, a 60 percent to 70 percent savings compared to fishmeal, which costs $1,700 per ton.
3. **Desert Agriculture and Sea Water Farming**: Most of the world's surface is covered in water, in the form of oceans. The remaining landmass of the Earth amounts to approximately 29 percent of the surface. Of this remaining 29 percent, one-third consists of deserts of all types. To tackle the food crisis, the world must turn the world's desert and sea into food production facilities, an effort that will need the combined brainpower of the brightest minds, universities, and research facilities.

4. **Sustainable Packaging**: BIOPLASTICS

   New technologies and solutions are disrupting not only the production side of the value chain but also food packaging. And it's long overdue, what with 100 million tons of debris drifting in the oceans, much of it disposable plastic food packaging containers and bags. Consumers increasingly are urging companies to develop food containers that can be recycled and are biodegradable or compostable too. Bioplastics have been around for more than 20 years. However, they haven't managed to deliver on the promise of bringing the same packaging usefulness as plastic and returning 100 percent back to nature, with no harmful impact. The startup TIPA, however, wants to change all that. TIPA was founded to create viable plastic packaging solutions. Its vision is to create a compostable, recyclable package that is the equivalent to a fruit or vegetable: something that when discarded, would decompose and leave no toxic residue.

Smart Agriculture 4.0: Disruption with New Technologies

Digital technologies—including the Internet, mobile technologies and devices, data analytics, artificial intelligence, digitally-delivered services and apps—are changing agriculture and the food system. Examples abound at different stages of the agri-food value chain: farm machinery automation allows fine-tuning of inputs and reduces demand for manual labour; remote satellite data and in-situ sensors improve the accuracy and reduce the cost of monitoring crop growth and quality of land or water; and traceability technologies and digital logistics services offer the potential to streamline agri-food supply chains, while also providing trusted information for consumers.

Digital technologies can also help governments improve the efficiency and effectiveness of existing policies and programmes, and to design better ones. For instance, freely available and high-quality satellite imagery dramatically reduces the cost of monitoring many agricultural activities. This could allow governments to move towards more targeted policies which pay (or penalise) farmers based on observed environmental outcomes. In addition to monitoring compliance with environmental policies, digital technologies enable automation of administrative processes for agriculture and the development of expanded government services, such as in relation to extension or advisory services.

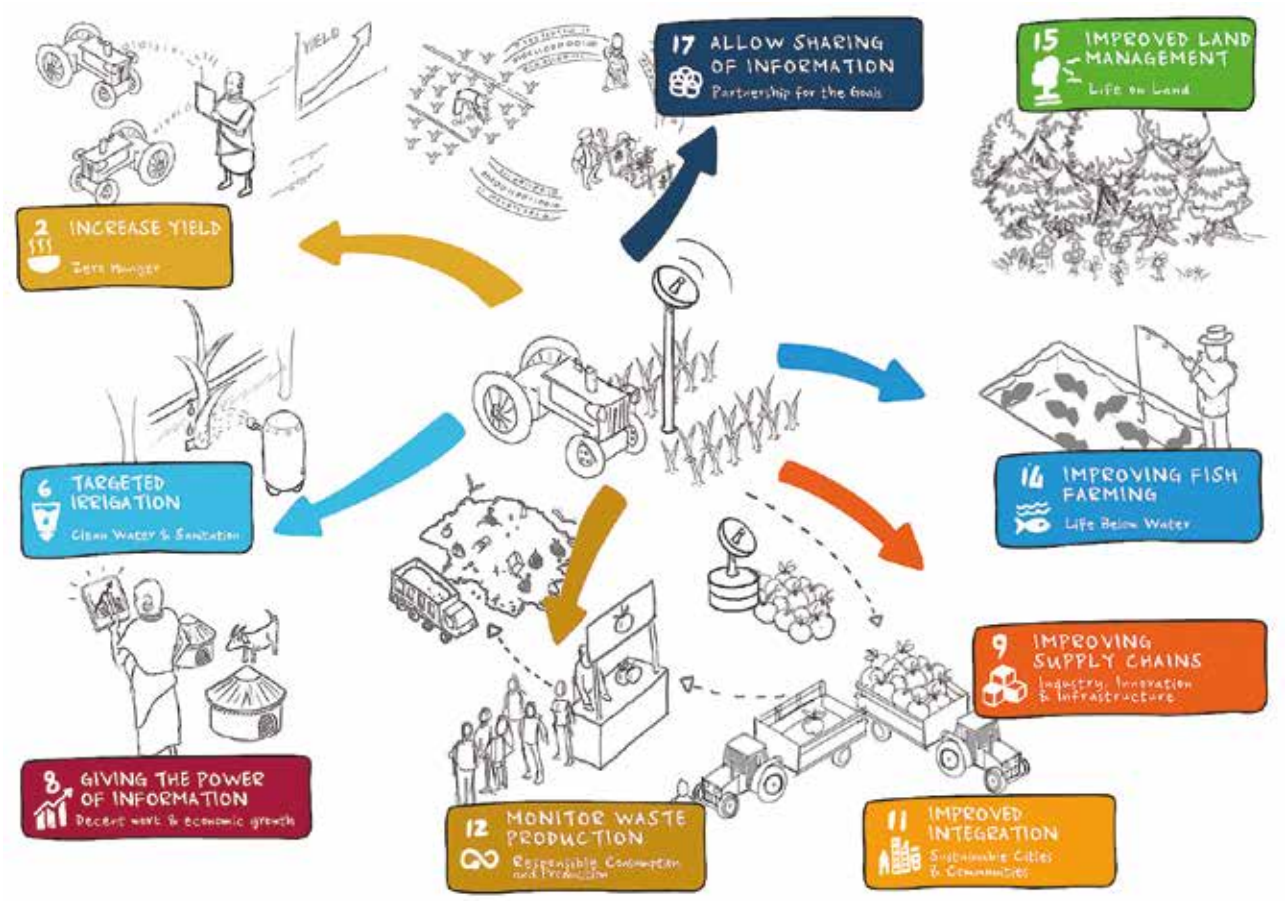
Finally, digital technologies can support trade in agriculture and food products, by connecting private sector suppliers to new markets, and enabling new ways for governments to monitor and ensure compliance with standards and to provide faster and more efficient border procedures that are essential for perishable products.

Disruptive Technology

Technologies used include sensors, communication networks, Unmanned Aviation Systems (UAS), Artificial Intelligence (AI), robotics and other advanced machinery and often draws on the principles of the Internet of Things. Each one of these brings something valuable to farming from data collection, through to management and processing, as well as guidance and direction. This integrated system offers new insights that enhance the ability to make decisions and subsequently implement them.

Advancing the Sustainable Development Goals (SDGs)

Digital agriculture has the potential to advance many of the SDGs. Below are some examples of areas of application across a wide variety of sectors.



(Source: FAO http://breakthrough.unglobalcompact.org/disruptive-technologies/digital-agriculture/)

Barriers to adoption

As digital agriculture develops, it will be critical to make the technology available to as many farmers as possible and to implement it in ways that minimises negative impacts on those who work in the sector:

Technical Considerations

As digital agriculture is a complex system of technologies, it is essential to clearly define the design and manage the integration of the disruptive technologies that underpin it.

- User centric design
- Technology integration
- Connectivity

Enabling new business models

Digital agriculture will enable a number of the disruptive business model levers identified, specifically:

- Product or service
- Closed-loop process
- Collaborative and Networked ecosystem

Application 3D Printing Technology to Food

Application of 3D printing, which is becoming important in manufacturing industries, is now being applied food production. 3D printing (also known as additive manufacturing) is a process whereby layers of material are formed to create objects—and in this case, familiar dishes. Experts believe printers using hydrocolloids (substances that form gels with water) could be used to replace the base ingredients of foods with renewables like algae, duckweed, and grass.

Netherlands Organization for Applied Scientific Research has developed a printing method for microalgae, a natural source of protein, carbohydrates, pigments, and antioxidants, and is turning those ingredients into edible foods like carrots. The technology essentially turns "mush" into meals. In one study, researchers added milled mealworm to a shortbread cookie recipe.

Incorporate Cross-Industry Technologies and Applications

Efficiency and productivity will increase in the coming years as "precision agriculture" becomes bigger and farms become more connected. It's estimated that y 2020, over 75 million agricultural IoT devices will be in use: The average farm will generate 4.1 million data points daily in 2050, up from 190,000 in 2014.

But while the growing number of connected devices represents a big opportunity for food producers, it also adds complexity. The solution lies in making use of cognitive technologies that help understand, learn, reason, interact, and increase efficiency. Some technologies are further along than others. But the innovations hold great promise. Here are some key game changers:

- **Internet of Things (IoT):** Digital transformation is disrupting the agricultural world. IoT technologies allow correlations of structured and unstructured data to provide insights into food production. IoT platforms such as IBM's Watson are applying machine learning to sensor or drone data, transforming management systems into real AI systems.
- **Automation of skills and workforce:** By the 2050, the UN projects that two-thirds of the world's population will live in urban areas, reducing the rural workforce. New technologies will be needed to ease the workload

on farmers: Operations will be done remotely, processes will be automated, risks will be identified, and issues solved. In the future, a farmer's skills will increasingly be a mix of technology and biology skills rather than pure agricultural.

- **Data-driven farming:** By analyzing and correlating information about weather, types of seeds, soil quality, probability of diseases, historical data, marketplace trends, and prices, farmers will make more informed decisions.
- **Chatbots:** Currently, AI-powered chatbots (virtual assistants) are used in retail, travel, media, and insurance sectors. But agriculture could also leverage this technology by assisting farmers with answers and recommendations on specific problems.

Drone Technology

Drones aren't a new technology. But thanks to investment and a relaxed regulatory environment, their time may have arrived:

The value of drone-powered solutions in all applicable industries could be more than $127 billion, according to reports. And one of the most promising areas is agriculture, where drones have the potential to address major challenges.

Drone technology is giving agriculture a high-tech makeover. Here are six ways drones will be used throughout the crop cycle:

- **Soil and field analysis:** By producing precise 3-D maps for early soil analysis, drones can play a role in planning seed planting and gathering data for managing irrigation and nitrogen levels.
- **Planting:** Startups have created drone-planting systems that decrease planting costs by 85 percent. These systems shoot pods with seeds and nutrients into the soil, providing all the nutrients necessary for growing crops.
- **Crop spraying:** Drones can scan the ground, spraying in real time for even coverage. The result: aerial spraying is five times faster with drones than traditional machinery.
- **Crop monitoring:** Inefficient crop monitoring is a huge obstacle. With drones, time-series animations can show the development of a crop and reveal production inefficiencies, enabling better management.
- **Irrigation:** Sensor drones can identify which parts of a field are dry or need improvement.
- **Health assessment:** By scanning a crop using both visible and near-infrared light, drone-carried devices can help track changes in plants and indicate their health—and alert farmers to disease.

UAVs may one day consist of autonomous swarms of drones, collecting data and performing tasks. The biggest obstacle to that becoming a reality is sensors capable of collecting high-quality data and number crunching software that can make that high-tech dream a reality.

Block Chain and Agriculture Value Chain

Blockchain, the distributed ledger technology behind Bitcoin and other cryptocurrencies, allows for highly secure digital transactions and recordkeeping. While blockchain has mainly been used in virtual currencies, it can also be applied to other types of transactions, including agricultural ones.

Blockchain can reduce inefficiencies and fraud and improve food safety, farmer pay, and transaction times. By improving traceability in supply chains, it can enable regulators to quickly identify the source of contaminated foods and determine the scope of affected products during contamination incidents. The transparency of blockchain can also help fight food fraud. As consumer demand for organic, GMO-and antibiotic-free food soars, the news is rife with cases of fraudulent labeling. The smallest transactions— whether at the farm, warehouse, or factory—can be monitored efficiently and communicated across the entire supply chain when paired with IoT technologies, such as sensors and RFID tags.

Blockchain technologies can prevent price extortion and delayed payments while simultaneously eliminating middlemen and lowering transaction fees, leading to fairer pricing and helping smallholder farmers capture a larger part of their crop value.

Nano Technology and Precision Agriculture

The Green Revolution of the 20th century was driven by a blind use of pesticides and chemical fertilizers, resulting in a loss of soil biodiversity and a rise in resistance against pathogens and pests. The new revolution will be precision agriculture, driven by nanotechnology. This revolution will see nanoparticles delivered to plants and advanced biosensors for precision farming. Nanoencapsulated conventional fertilizers, pesticides, and herbicides will release of nutrients and agrochemicals in a slow and sustained manner, resulting in precise dosage to the plants.

Among the benefits of nanotechnology precision farming are:

- Roughly 60 percent of applied fertilizers are lost to the environment, causing pollution
- Nano-fertilizers helps in the slow, sustained release of agrochemicals, resulting in precise dosages
- Greater plant protection and treatment of diseases
- Biosensors can detect pesticides in crops, leading to more-informed decisions

Food Sharing and Crowd Farming

Finally the sharing economy and crowdsourcing also have a place in preventing food waste.

Technology has enabled communities to share their goods and services. This first became popular in ride sharing and house sharing, and now it is being applied to every industry, including food.

Olio, founded by social entrepreneurs, has built an app connecting people with their neighbors and local shops so that surplus food can be shared, rather than be discarded.

Another social entrepreneurial project, Naranjas del Carmen, has developed the concept of Crowdfarming. Naranjas del Carmen has created a system in which the person has ownership over the trees and land that the farmer cultivates. In this way, the fruit of those trees goes to their owners, creating a direct link between production and consumption and avoiding overproduction and waste along the value chain.

What can governments do to reap the benefits of digital technologies for the agriculture sector?

Three key questions highlight the actions needed from governments to ensure the opportunities offered by digital technologies are realised:

- First, how can government policies and programmes appropriately facilitate the adoption of digital technologies by the agriculture and food sectors? Policymakers will need to consider potential benefits, costs and risks, and to understand the factors affecting technology uptake so that interventions can be targeted to where there is a market failure, or a public interest.
- How can governments make use of digital technologies to design and deliver better agricultural policies? This requires understanding how technology can help in different components of the policy cycle, and may require government bodies to expand their skillsets, invest in technology and training, or partner with other actors (both government and non-government).
- How might digital technologies change the roles of government? On the one hand, digital technologies may create new roles or responsibilities for governments, including to enable the digital infrastructure (is there a case

for governments to be a provider or a rule maker of new digital infrastructure, and under what circumstances); but on the other hand, if technology can reduce information asymmetries and transactions costs, less government intervention may be needed.

The ICDL 2019 Conference will provide a forum to discuss the opportunities offered by disruptive digital technologies to increase productivity, and access to services and markets in the agricultural sector. Several promising digital technology innovators in agriculture shared their innovation and business plans. Leaders of public and private institutions, technology companies, incubators, researchers, the business community, policymakers, financial institutions, and the donor community will gather together to learn from and network with each other.

Themes:

1. **Advisory and Information for Agricultural Productivity:** This theme covers extension services and Climate Smart Agriculture advisory, as well as the delivery of credible and actionable information in real-time directly to Indian farmers to increase productivity. This will help them transition from time, labor, input and resource-intensive practices to more efficient and sustainable planning, production, and management systems.
2. **Market Linkages:** This theme will look at tools to help Indian farmers produce high quality, high yield crops as well as help link them to markets, including digital platforms to sell farm produce.
3. **Farmer Financial Inclusion:** It will focus on innovators, organizations and businesses that link Indian farmers to credit and savings products, insurance, and other innovative financial services, enabling them to invest in their farms.
4. **Data Analytics and Agricultural Intelligence:** This challenge is open to solutions that have leveraged data infrastructure, remote sensing and mapping technologies, precision agriculture tools, and computing power to enable data-driven decision-making by policymakers, public agencies, and private service providers in the agriculture sector.

Digitalization of Water: Move towards Next Generation

From big data solutions to advanced management of the distribution network to digital customer engagement programs, nearly all utilities we talked to have begun the digital transformation journey. While the transformation is not always easy, with aging infrastructure, inadequate investment, changing climate and demographics, digital water is now seen not as an 'option' but as an 'imperative.' The major elements of water services to be addressed in national and global context, are – resource sustainability, infrastructure management, and financial stability.

A more sustainable and secure water future means moving to the next generation of water systems, which includes embracing digital solutions and the enabling conditions that can support their effective implementation.

How will digital technologies transform our relationship with water – not just the water and wastewater utility sector but how all stakeholders connect to and manage water?

Why Digitalization Water?

The great water challenges of our time, namely climate change, population growth and increasing urbanization, and ageing and overly stressed infrastructure, inflict significant pressure on water networks. The water industry, and in particular water utilities, needs to adapt to meet the emerging demands of a dynamic, highly deregulated and competitive environment within the context of a changing climate. In such an environment, water utilities need to continue to deliver essential services including safe and secure drinking water, storm-water management and wastewater management.

Addressing these on-going and growing challenges requires a transformation to optimize its processes and operational efficiency. In fact, these challenges and their increasing complexity necessitate a paradigm shift to the next generation of water systems beyond traditional water and sewerage infrastructure. The development of new systems is against the background of cyber-physical systems, digitalization and big data where software, sensors, processors, communication and control technologies are increasingly integrated, to enable informed decisions in an increasingly changing, complex and uncertain world.

A paradigm shift for the water industry

The paradigm shift for the water industry is to move towards:

i. offering new services ranging from resource recovery to newer digital approaches as a consequence of integrating organizational siloes to offer a dynamic and sustainable real-time decision-making;

ii. considering a systems approach which recognizes the interconnectedness of water across sectors and how decision-making can improve benefit sharing and

iii. decentralisation or distributed systems to maximize resource recovery, deal with rapid growing cities, and dampen the propagation of failures.

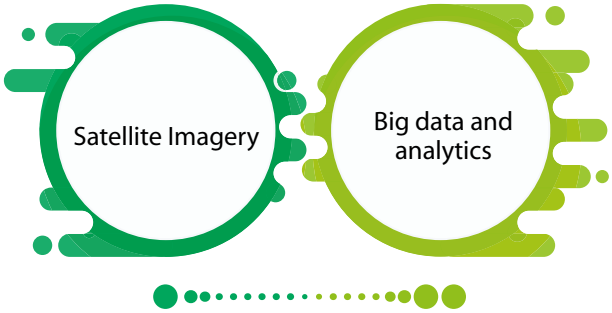
To support these shifts in how water services are operated, water utilities will be expected to invest in appropriate measures, which include the digitalization of the way water is managed, distributed and regulated.

Technologies driven in Water Industry

A growing number of asset management systems include:

- Artificial intelligence (AI) applications to manage infrastructure assets.
- Virtual and augmented reality (AR) technologies can provide utility workforces with apps and dashboards to provide more efficient asset management repair and replacement.

Utilities also can better understand resource availability through:



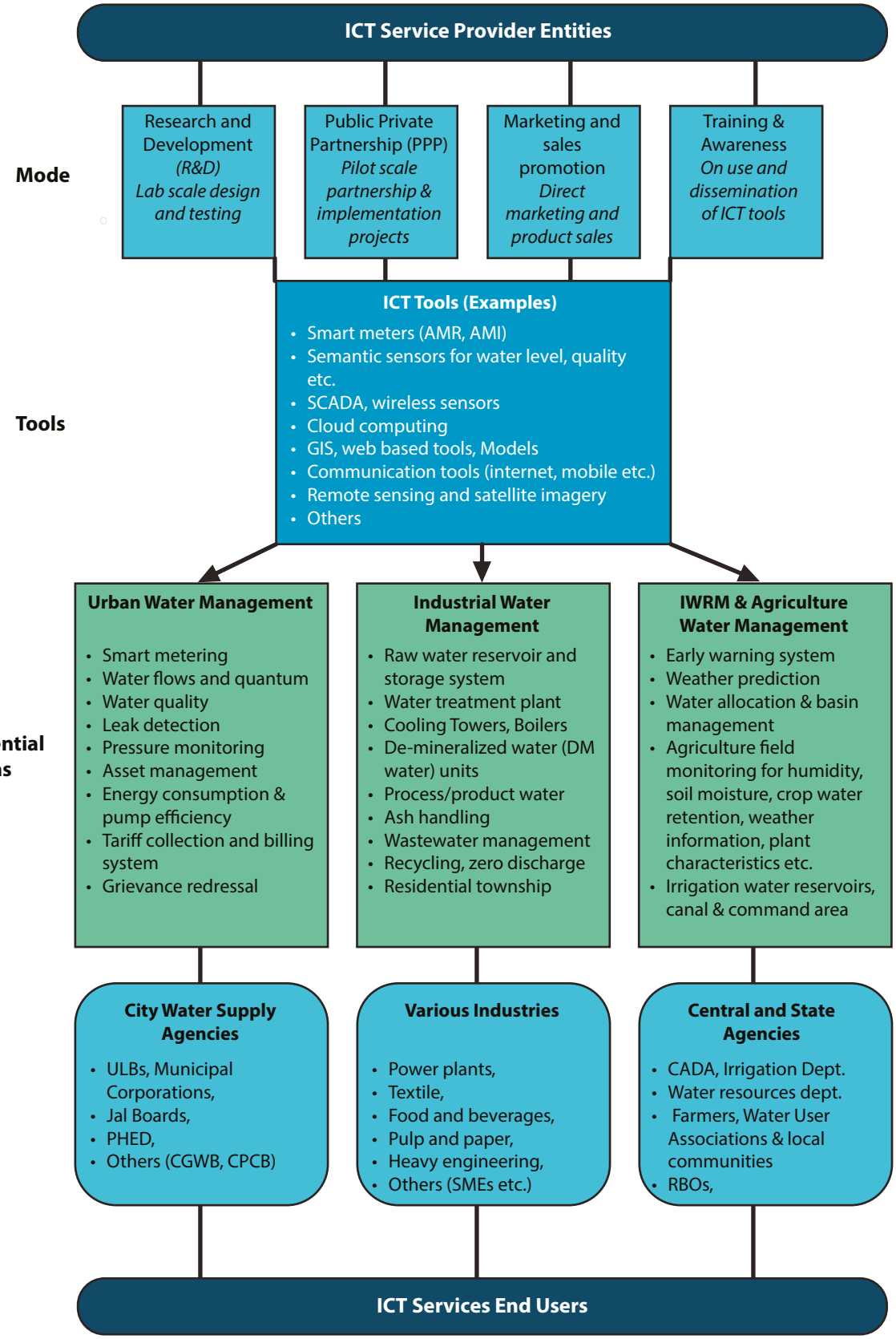
Potential of ICT in Water Sector

Use of ICT (information & communication technology) in water sector has a significant role in improving the water use efficiency in agriculture sector, urban water supply and industrial sector, and can help in addressing the challenges of water scarcity and vulnerabilities in water sector. Efficient water resources management calls for a comprehensive & reliable information/data with their timely access and dissemination for effective decision making. Lack of timely information on water quantity and quality has since long been the limitation in water management decision making. Use of IT based technologies (e.g. softwares and sensors) can automate monitoring and database sharing for improving water services with nationwide coverage. This would help in improving the performance benchmarks of the water use and would promote accountability and transparency in the water sector as well. Some of the potential areas of ICT interventions in water sector are as follows:

i. **Water Supply & Wastewater Management:** Implementation of various ICT based solution/tools such as sensors, smart meters, SCADA & advanced communication tools can bring about real-time data base and information management and thus improving the performance of Urban Local Bodies (ULBs) and water utilities. Following areas can be targeted

   - Urban & rural water supply and distribution network; real-time monitoring of flows/quantum and water quality; leak detection & water pressure monitoring; Asset management with use of GIS, sensor and web tools; monitoring of energy consumption & pump efficiency; Smart billing system and tariff collection with online support; Online grievance redressal system

- Smart Meters and ICT tools are much likely to benefit both, the water utilities and final consumers, thus promoting efficient use of water both at the supply and demand side. Besides, it shall improve the credibility of the utilities thus improving revenue collection and reducing non-revenue water (NRW).


ICT Service Provider Entities
Mode
Research and Development (R&D) Lab scale design and testing
Public Private Partnership (PPP) Pilot scale partnership & implementation projects
Marketing and sales promotion Direct marketing and product sales
Training & Awareness On use and dissemination of ICT tools
Tools
ICT Tools (Examples)
• Smart meters (AMR, AMI)
• Semantic sensors for water level, quality etc.
• SCADA, wireless sensors
• Cloud computing
• GIS, web based tools, Models
• Communication tools (internet, mobile etc.)
• Remote sensing and satellite imagery
• Others
Potential Areas
Urban Water Management
• Smart metering
• Water flows and quantum
• Water quality
• Leak detection
• Pressure monitoring
• Asset management
• Energy consumption & pump efficiency
• Tariff collection and billing system
• Grievance redressal
Industrial Water Management
• Raw water reservoir and storage system
• Water treatment plant
• Cooling Towers, Boilers
• De-mineralized water (DM water) units
• Process/product water
• Ash handling
• Wastewater management
• Recycling, zero discharge
• Residential township
IWRM & Agriculture Water Management
• Early warning system
• Weather prediction
• Water allocation & basin management
• Agriculture field monitoring for humidity, soil moisture, crop water retention, weather information, plant characteristics etc.
• Irrigation water reservoirs, canal & command area
City Water Supply Agencies
• ULBs, Municipal Corporations,
• Jal Boards,
• PHED,
• Others (CGWB, CPCB)
Various Industries
• Power plants,
• Textile,
• Food and beverages,
• Pulp and paper,
• Heavy engineering,
• Others (SMEs etc.)
Central and State Agencies
• CADA, Irrigation Dept.
• Water resources dept.
• Farmers, Water User Associations & local communities
• RBOs,
ICT Services End Users

- The ability to monitor water supply & distribution system on a real-time basis shall enable quick identification, prediction and prevention of potential problems such as a burst water main, a slow leak, a clogged drain or a hazardous sewage overflow/contamination. It shall thus ultimately ensure water conservation and reduction in losses and UFWs. Such systems can improve the efficacy of **water and wastewater treatment system**.

ii. **Industrial water management:** IT industry can target water intensive industries (such as power plant, textile, pulp and paper industries etc.) to provide automation, advanced monitoring & control system in their processes/ units on a real time basis. Sensor and SCADA or cloud computing based automation with real time water flows & water quality monitoring can provide substantial opportunities for reducing leakages/losses and specific water consumption while also optimizing water conservation, recycle and reuse. Some of the processes/units that can be focused for ICT tools application include

  - Raw water reservoir, storage & treatment system; Cooling Towers, Boilers, DM water units, ash handling units; Process/product water use; GIS based asset management system; Wastewater generation and discharge system; Residential township water supply

iii. **Agricultural water management:** IT industry has potentially largest opportunity in the agriculture sector for data generation, real-time monitoring and decision making to bring about significant changes in agricultural water use by focusing on some of the following areas

  - Agriculture field monitoring for humidity, soil moisture, crop water retention, weather information, plant characteristics etc.
  - Irrigation water reservoirs, canal & command area

- ICT can help in scheduling the optimal time of irrigation along with optimal water use for agriculture, which helps in preventing damage due to drought stress or over irrigational practices.
- Use of ICT tools and communication network like the internet, mobiles, GPS, etc. can help in remote management of irrigation activities, fertilizer usage, groundwater extraction pumps.
- Use of ICT tools in irrigation management system can help water authorities in regulating allocation of irrigation water from reservoirs and minimizing the distribution losses in command areas.

iv. **IWRM and River basin management**

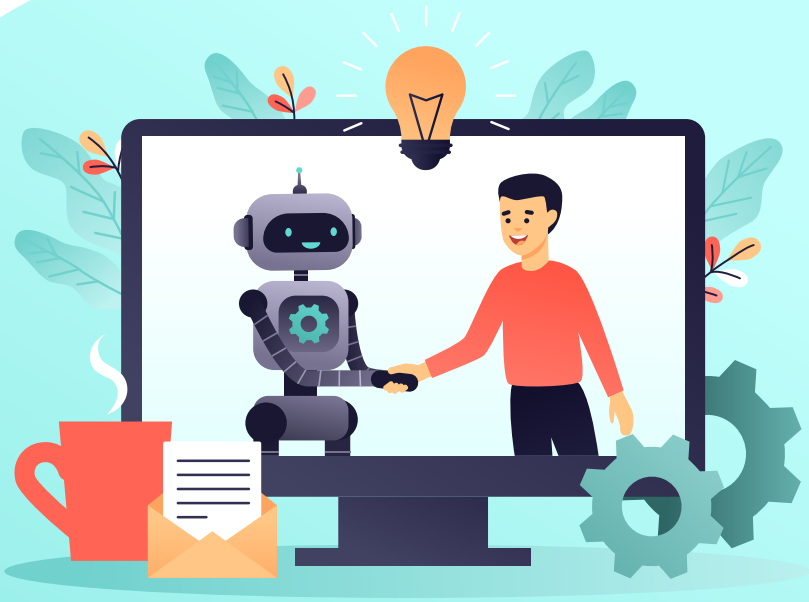
IT tools can also be used at basin level to provide early warning system, weather prediction as well as decision making for water allocation & river basin management. This includes

- Use of smart sensors and associated data to enhance the early warning system during extreme events such as flash flooding etc. besides also managing infrastructure and reservoir systems.
- Use of integrated monitoring and sensing system & data at river & canals to help in profiling the water flow and quality on a real-time basis and help undertake immediate interventions to curb water pollution; maintain flows and help address the upstream and downstream issues thus providing opportunity for optimizing water allocation on a dynamic basis.
- Interlinking the real-time data on river and groundwater with a GIS platform can help identify several interventions in a synchronous way to effectively implement IWRM (integrated water resources management) at basin & watershed level.

- Groundwater: Collating and disseminating the information/data on groundwater level, aquifer status, and groundwater contamination for enhancing decision making for improved groundwater management.

v. ICT tools can help in information/data dissemination at different level viz. community, policy makers, field level water managers, centre and state. ICT assisted interface between various government agencies can foster effective decision support system for wider use of database and timely decision making thus improving the coordination between the institutions.

vi. The ICT industries can invest in the R&D with lab scale design and development of specialized tools for water sector and later develop full scale products for implementation in the abovementioned areas.



Education 4.0 and Learning Analytics

The educational sector is set for a major and likely disruptive makeover. A decade ago the possibility of unlimited unfettered access to education appeared farfetched. Driven by the forces of globalisation, advances in information and communication technologies, and the next generation of tech-savvy learners, education is fast evolving toward an open, always available and personalised model, possibly breaking the stranglehold of traditional universities.

The enticing promise of digitisation in transforming education and learning is now uncontested by both educationists and policy makers. Expectations that digital innovations would make education both affordable and accessible has been a dominant theme driving these discussions. While there has been some progress on these fronts, the overall impact on the ground has been rather muted. Prior research and anecdotal evidence indicates that the impact of digital technologies in transforming education may be muted due to a variety of reasons. These include, lack of supporting infrastructure, financial constraints faced by the targeted beneficiaries, technology barriers lack of appropriate technologies, and a diffusion of effort due to the emergence of multiple competing platforms and business models or simply lack of interest.

India is a good case in point. Despite the emphasis on a digital transformation of the economy, the rural-urban divide is on internet penetration is huge, with the internet penetration in urban and rural areas pegged at 65 percent and 20 percent respectively leaving nearly ….. % of India's population unserved or underserved with regards to educational services. The situation in much of South Asia is similar.

- What accounts for these gaps in technology, policy and practice?
- How can these gaps be bridged?
- How can technological advancements be leveraged to make high quality education affordable, accessible and empowering for the vast majority of the unserved population.

Education systems have evolved over the centuries in response to social, economic and technological innovations, which in turn are impacted by the evolution in education system itself.

Education is evolving in response to the changes in the society — the changes that are in turn driven by the evolving education system. Changing social paradigms and environment have transformed students' motivation and career expectations, emphasising the need for comprehensive education ecosystems. Today, there is a widespread need for improved skills and human capital, which form the backbone of effective education systems.

Education has gradually transformed from a person-to-person learning system to a formal system of education that focused on one-to-many education to, today, providing various broad learning opportunities to the masses with increased use of technology.

Education 1.0

During ancient to Middle Ages, education was imparted on a person-to-person basis, thus limited in scale and informal in nature Education in the ancient and Middle Ages comprised of personalized education confined to few students, skilling for the masses, low literacy rates and informal methods of education, which gradually developed into formal schools in later centuries.

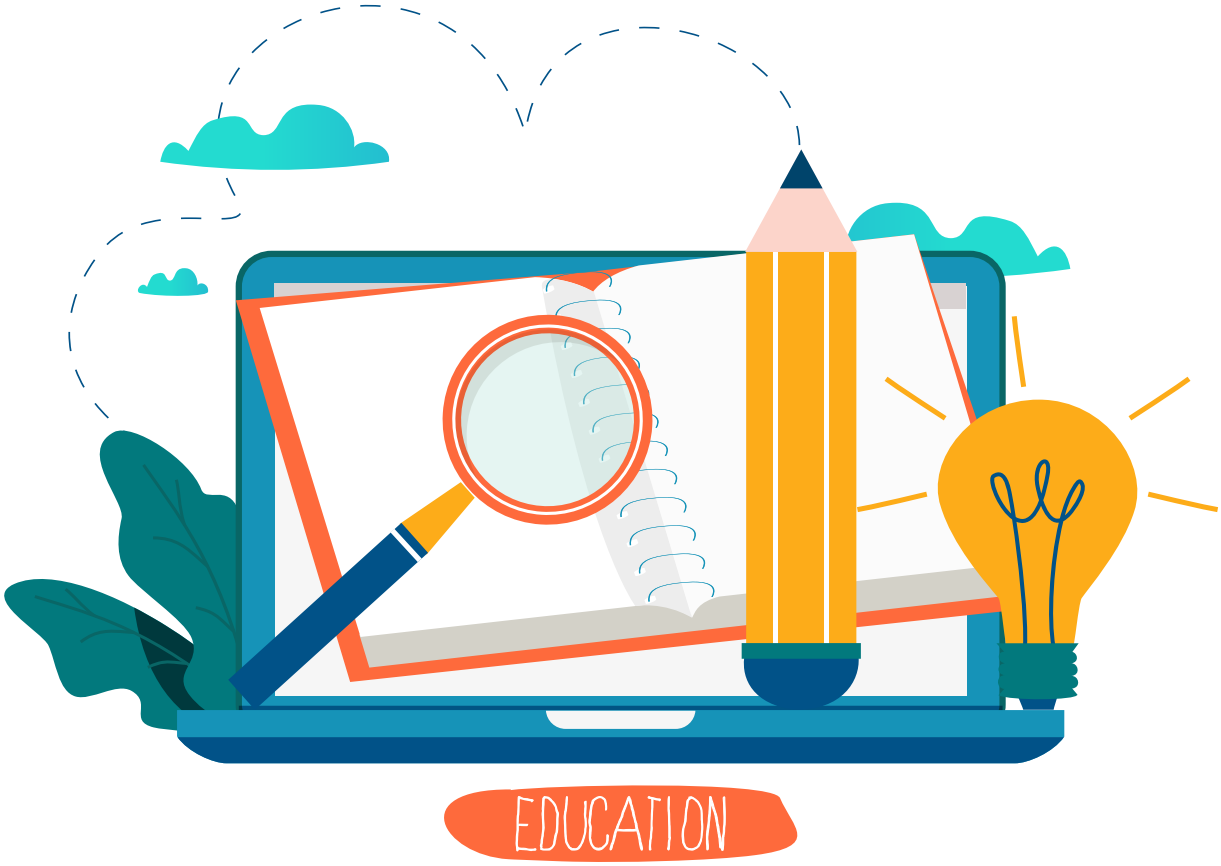
Ancient education gained popularity with the advent of informal education in India, China, Israel, Rome and Greece and was focused on teaching only elite classes and educating boys. With increasing awareness and importance of education, education of girls gained prominence and the concept of formal education governed by priests developed. In the Middle Ages, education transformed with the dominance of religion in Western Europe and India, along with a focus on scientific research in Rome.

Several priests from churches were appointed to provide quality education and the period saw the emergence of various scholars. A formal system of HE started developing with countries such as Japan, China, India, the UK, Korea and France starting to build universities and colleges.

Education 2.0

The invention of the printing press allowed the masses to get access to basic education, and brought in a culture of scientific inquiry

The invention of the printing press in the mid-15th century completely transformed the education sector and helped increase literacy levels as it enabled rapid dissemination of ideas through books. Socio-economic advances in this period led to Education 2.0, which took several thousand years to transform from traditional Education 1.0.



With the invention of the printing press, knowledge dissemination was no longer person dependent and could be done to the masses through printed books. Printing press technology had a profound effect on literacy levels in France, England, Germany, Russia and the Asia in the 15th and 16th centuries. The period witnessed a shift from manuscript to printing, which was further supported by the scientific revolution, Renaissance and Reformation, leading to the development of a society where inquires, new ideas and innovations were encouraged.

The spread of educational institutes as centers of discussion, science and experimentation further helped with social, philosophical and scientific innovations. Vocational education gained popularity in India, Japan, Europe and South Korea through apprenticeships and monasteries. New age scholars developed practical learning to prepare students to manage their social, economic, and political affairs efficiently rather than focus on religious aspects of Greek and Latin classics.

India showed a remarkable transformation in its HE landscape during the 17th till 19th centuries. Major developments were made during the Mughal period when Islamic universities and colleges influenced by Madrasas emerged. After the Mughals, the British Empire helped in establishing more HEIs and improving the number of students and teachers. Also, to reduce drug imports during the 18th century, the British encouraged scientific research in Indian medicinal plants.

After independence, the Government initiated a planned development of HE in the country particularly focused toward growth of grant-in-aid institutions. University Grants Commission was established in 1953 to enable it. Efforts of the Government encouraged research in Indian universities and improved the gross enrolment ratios across states. Female enrolment rates also improved significantly from 11.3% in 1950 to 36.9% in 2000.(13) Till 1980, the HE sector was controlled by the Government; however, after the economic reforms of 1991, the number of private universities also grew rapidly.

Education 3.0

The emergence of internet and IT changed the mode of delivery, providing a technology platform to learn. The transition from Education 2.0 to 3.0 took a couple of decades and the period saw a significant increase in enrolments due to increased accessibility of HE.

HE has evolved across the centuries in response to external forces. Today, in Education 3.0, there has been a massive increase in global demand for education, the role of a teacher has changed from that of an instructor to a facilitator, and technology has become omnipresent for content delivery in various online and distance learning programs. Initially, this period saw huge public investments; however, now the funding has moved toward private investment and donations.

The transition toward platform-enabled learning drove exponential growth in the education technology (edtech) market, but the core learning methods have remained unchanged.

Increasing adoption of new technologies in the HE sector, possibility of learning on devices and disassociation of education and learning are changing the overall dynamics in education and leading to the rise of the edtech market globally.

The global edtech market is growing rapidly with the growing need for skills and changing workforce in the 21st century. With growth of smart classrooms, increasing mobile penetration and increase in online education qualifications, the market is expected to reach US$94 billion in 2020 from US$43 billion in 2015, growing at a CAGR of 17%. Until now, the US is the fastest growing market for online learning, followed by Asia and Europe, but the trend could change. According to a report by KPMG Consulting, the online

learning market in India is estimated to grow 8 times from US$247 Million in 2015 to US$1,960 million by 2021. The growth will be driven by engaging course materials, innovative ways of delivering courses and extensive reach out to distant locations having limited education infrastructure. India is the third largest online market for education in the world after the US and China. The online HE market in India was valued at US$33 million in 2015 and is expected to reach US$184 million by 2020, growing at a CAGR of 41%.

While the speed and space of teaching have changed, the core philosophy of teaching with the teacher at the center has remained unchanged

A 14th century illustration by Laurentius de Voltolina depicts a university lecture in medieval Italy. The scene, sans the dresses of the teacher and the students, could as well be of a lecture in a modern day Indian college. The teacher lectures from a podium at the front of the room while the students sit in rows and listen. Some of the students have books open in front of them and appear to be following along. This constant picture of the classroom well underlines the need to critically look at whether learning has kept pace with the changing needs of the society and the learner.

While education delivery has evolved over the ages — through Education 1.0 to Education 3.0 — the core process of teaching has remained almost constant. A teacher-instructed classroom has been the way knowledge is disseminated. Content is prepared in a fixed curriculum structure, delivered at a point of time to the learner cohort and standardized in terms of the content and its delivery. The "innovations" of respective ages such as the post, radio or television have done little to change the core concept of this teaching philosophy. It is only the speed and space that have changed.

The needs of Industry and Society are Rapidly Evolving

Highly dynamic socio-economic markets (especially across emerging countries), coupled with technological innovations, have led to disruptions across not just individual lives, but also industries and economies.

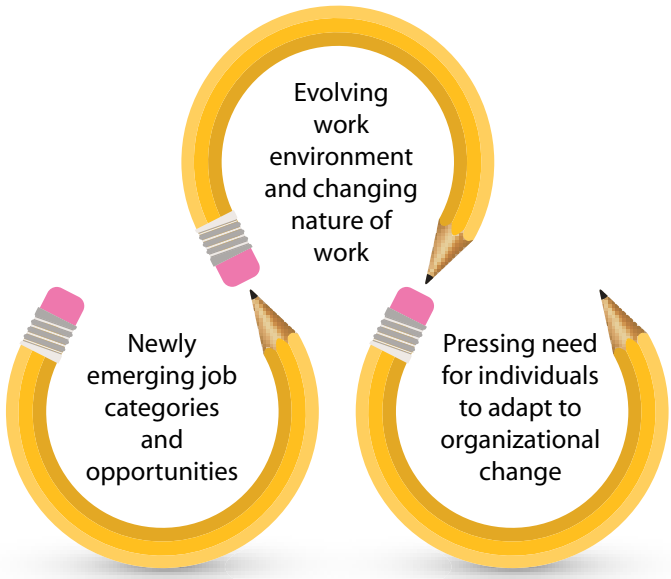
Some of these social and technological disruption drivers have already made an impact, while several others are expected to make a significant impact in the years to come.

The changing skill requirements from the industry demands a competency-based learning model than a fixed learning structure

- Competency-based learning models are gaining popularity worldwide, as individuals look for ways to improve college affordability and more accurately measure student learning.
- Competency-based learning is aimed at mastering skills/knowledge regardless of the time it takes. It promotes self-paced learning and caters to students across various levels of learning.

There exists a mismatch between what traditional HE provides and what employers need. As per a recent study by Gallup Consulting, only 11% business leaders agree that graduates have the skills and competencies that their business needs.

The three factors below reinitiate the need for programs to be aligned to industry demands and the need for alternation of the traditional HE model:



The changing job scenario — where the nature of future jobs is ever evolving — has led to the growth of the "non-traditional" student. A student ready for college right after high school and enrolled in full-time classes to complete

a degree is no longer the norm. Over the years, this "traditional" profile of the learner has been changing. The learner of today does not necessarily fall within a defined age bracket. There has been a transformation from the traditional setting of the lecture hall to integration of new tools and technologies in teaching along with growth of online learning and simulated learning opportunities. The sector is moving toward democratization of content with broad access to useful qualifications and more opportunities for self-study programs. To this end, MOOCs have significantly contributed by providing wider access to education irrespective of economic or social status, gender or geography. These programs have given flexibility to the students and have provided them the necessary skills to perform better.

Dynamic technological advancement has provided the platform to reach the new generation of learners through various channels

Introducing Education 4.0

Education 4.0 puts the learner at the center of the ecosystem and empowers him or her to structure individual paths keeping in mind the final outcome. HE has been evolving continuously in response to the internal and external forces. Evolution today is taking place at an accelerated pace as change is now measured in years and not centuries. A privilege to a few is now an expectation for all.

In Education 4.0, learning is connected to the learner, focused on the learner, demonstrated by the learner and led by the learner. It is the learner who is responsible for defining the various dimension of his education path — the what, where, when, how and why while moving up the learning ladder.

Education 4.0 – The HE ecosystem

The focus of Education 4.0 is around "experiential learning" by the individual – the instructional theory and foundations are delivered across technology-enabled platforms – and a tighter integration with the Industry and society provide a robust platform for learning from the peers, social interactions and real-world issues.

Rapid changes in the Student Lifecycle

The advent of Education 4.0 has the potential to revolutionize the way we look at HE providers today. The way the various stakeholders interact with the providers — for learning, knowledge creation and research — and the way they utilize the end product of the HE system need to change and some of these changes are evident today in their small yet finite ways. The university's transactions with stakeholders have undergone a sea change due to the innovations

Key stakeholders	Mediums of delivery
Learner: Demands greater flexibility and looks out for affordable alternatives that can be customized as per his or her individual aspirations	Dynamic technology: Dynamic technology envelops the learner and provides options for the learner's core decisions of what, where, when, how and why to study. The technology layer could deliver the cognitive learning parts – instructional delivery, content and remote learning.
University: Aims to be the prime education provider at the forefront of knowledge creation and dissemination with a sustainable business model	Experiential learning: Interactions with all the stakeholders – either in person, across groups through peers or social learning – supported by technology only to an extent. The real world experiences and the life skills that prepare the learner for the future of jobs would be learned through social interactions, physical world learning by doing and interpersonal experiences.
Industry: Looks out for industry-ready personal with problem-solving skills, creativity and analytical thinking capabilities; also looks to the HE ecosystem for collaborative research opportunities and solution development	
Society: Expects the ecosystem to create individuals with high emotional quotient (EQ) and who are empathetic and work toward solving community challenges collective	

in technology and communications and the need for more practical life skills among the learners. The appreciation of these changes would lead to the university being more agile and responsive to the changing times. The various functions of the university as we know today — the teaching lifecycle and the research — are being transformed in a big way. Enrolments in the university model are being limited by various infrastructure and design constraints HE has been the privilege of a few till now. Globally, less than 50% of the people coming out of the school education system get into the HE ecosystem. Many of the people out of the formal HE system could be attributed to the mismatch of the needs and expectations of these learners and the design of the HE system.

Flexible enrolments and technology-driven online programs could help universities overcome these constraints.

Technology-driven online education mechanisms can alleviate these drawbacks. They offer flexible anytime anywhere learning paradigms, at a fraction of the costs of a brick-and-mortar university, and allow universities to overcome the infrastructural constraints by leveraging their existing resources to a larger audience using technology channels. The drivers for the target student to enrol in a course are highly varied, and the advent of technology-driven learning tools can impact them in multiple ways. Students and employers are opening up to the idea of non-traditional means of learning. Alternate program offerings are being created that offer a learning blended with student experience – challenging the next level of education. This is clearly visible in the shift in the enrolment patterns across the variety of learning methods – where the traditional on-campus enrolments are decreasing in the US, while self-driven MOOCs and online courses see a strong growth.

education

Universities are using MOOCs to develop personalized learning paths in their program designs, while developing strong industry linkages for experiential learning and keeping costs subdued.

From being an inquisitive add-on program to broadening the understanding of the subject, MOOCs are changing into self-paced learning platforms with clearly defined program pathways. MOOCs are not competition by the universities but can instead can be used as a branding and student marketing tool. Universities can offer MOOCs to provide prospective students an experience of their offerings and market their best courses and best professors to attract students to their full-time courses.

With growing traction for online education, HEIs need to create environments where learners can both learn and apply concepts.

Universities have practiced a monopoly in knowledge creation and dissemination, creating an exclusivity for the people who passed through them. Classrooms were relatively isolated and collaboration usually happened within the confines of the classrooms. In their quest for pure knowledge, they have distanced research from the society around them and the industry, which was the consumer for the knowledge being generated. As a result, the curricula became more complex around the theoretical and foundational aspect without preparing a workforce for the industry or tangible research output that could be quickly commercialised by the industry. Students emerging from a rote learning system have great foundation and depth in the subjects of their study but lack real-world application knowledge or the creative skills that are sought by employers in rapidly changing industries today. With technology greatly impacting learning of these foundation concepts, universities need to augment their curriculum to address these life skills to remain relevant.

Top 10 skills sought by employers in 2020

HEIs need to respect complexities and variances in learner behavior and move away from cohort-based classes.

The lack of flexibility in the time and place of study was further exuberated by almost no changes in the instruction delivery. While this process of teaching ensured that HE became mainstream by reaching out to a large learner pool, it needed a complete overhaul due to the complexity of learning behaviors.

Degrees and other credentials have been one of the most visible and tangible outputs of the university system.

Education and work-related credentials are considered to be important milestones for multiple individual career pathways. Credentials have aspirational value as students wish to pursue courses from renowned institutions to enhance their educational status and face the cut throat competition in the form of entrance examinations and other assessments to "earn" the coveted credential that many eye for but only a few get.

At every level of education, students have the opportunity to earn credentials that verify their educational attainment, skill mastery and the authority to perform a task or operation — conveying real economic benefits in the labor market. They act as standardized communication by reflecting the position of the credential holder in the hierarchy of existing qualifications. In some ways, credentials are like currency – defined in value and equivalence along with interoperability.

Credentials are also valuable to employers, allowing them to determine the skill or education level of job applicants without having to perform an assessment for each one since they help determine the level of excellence a student possesses in the area he or she gets credential for. It further segregates students in various groups depending on the kind of credential a student possesses and gives them an identity in the society.

Education 4.0 Student-centric learning

At this juncture, universities have a critical decision to make: embrace new opportunities and succeed or make the wrong choice and perish. Thus, making the wrong choice is not an option. The following section explores how the current university model might evolve to keep pace with the changing paradigm and advent of Education 4.0 in the near future.

Smart Education	
Government	
MHRD	• Online learning software, e-learning tutorials, multimedia lessons, educational websites, online training, online two-way conversation, video chatting, and online classes • Smart desk, connected sports, smart content delivery, student tracking, attendance management, student and teacher safety, affordable education, smart workshops • Swayam Prabha-It is a group of 32 DTH channels devoted to telecasting of high-quality educational programmes on 24X7 basis using the GSAT-15 satellite. Every day, there will be new content for at least (4) hours which would be repeated 5 more times in a day, allowing the students to choose the time of their convenience. The channels are uplinked from BISAG, Gandhinagar. The contents are provided by NPTEL, IITs, UGC, CEC, IGNOU, NCERT and NIOS. The INFLIBNET Centre maintains the web portal.
AICTE	• SMART INDIA HACKATHON 2019- A unique initiative to identify new and disruptive digital solutions for solving the challenges faced by our country under the program of Smart India Hackathon 2017. • E- SHODH SINDHU(SUBSCRIPTION TO E-JOURNALS)- This scheme aims to provide e-resources on technical education to 126 AICTE supported technical Institutes. Rs. 8.72 crore are the subscription rates paid by AICTE in 2018. • The Ministry also launched a web portal named "SAKSHAT" a 'One Stop Education Portal'. The high quality e-content once developed will be uploaded on SAKSHAT in all disciplines and subjects. Several projects are in the completion stage and are expected to change the way teaching and learning is done in India.

Start-up	
Smartivity	Do-it-yourself science, art and craft kits for children designed to enhance creative, practical and analytical intelligence.
Unacademy	Learning platform
upGrad	upGrad's online courses to gain certification in data science, digital marketing, product management, machine learning, software development etc
Leverage Edu	Started off as a college admission platform has grown to a full stack marketplace in the last one year. It uses an AI tool to help students in their careers through mentorship products, end-to-end college admissions guidance, programmes to help get first-job ready, as well as one-to-one virtual career advisory for multiple career streams.
NoPaperForms	It is a Software-As-A-Service (SAAS) based enrolment automation solution which aims to fundamentally transform the admission process in the educational institutions in India and abroad.

Digital Health 4.0

We are entering the Fourth Industrial Revolution where rapid technological advances are blurring the boundaries between the physical, digital and biological worlds. New technologies (e.g., robotics, block chain, 3D printing and artificial intelligence) and scientific breakthroughs such as gene editing have resulted in a hyper-connected world and the transformation of life sciences companies' business models.

For the last two decades life sciences companies have created value by developing premium priced products (either for primary care market or in more specialized areas such as oncology.) As reimbursement pressures have grown, there has been a shift toward outcomes driven business models. A multitude of technologies are reshaping this emerging health care ecosystem, including:

- **Electronic health records and cloud storage:** Allow quick access to and storage of individual's data enabling streamlined collaboration between different stakeholders in the ecosystem
- **Consumer-facing mobile apps:** Empower patients to be in charge of their own health
- **Wearable's / Remote monitoring tools:** Enable care providers to remotely monitor the key health parameters of the patient and allow real-time decision making
- **Augmented reality:** Technologies such as 3D medical imaging and vein visualization are being explored to further improve remote care and achieve improved patient outcomes

With this uninterrupted pace of technological evolution, we can soon expect an era of platforms providing end-to-end "medical solutions" by the end of the next decade. New entrants outside the traditional health space see a massive opportunity to improve health care as a result of changing customer expectations and technological advancements. Convergence between these non-traditional and traditional players, which blends health care expertise with network and platform capabilities, is resulting in a new health care ecosystem that ultimately will be more holistic.

Why Indian Health Care Should embrace ?

Rising Demand in Indian Health Care Infrastructure

The Indian health care system lacks sufficient infrastructure to meet the health care demands of the country. It is currently facing two major burdens: the rising prevalence of lifestyle - related diseases and an aging population. As per India Brand Equity Foundation (IBEF) estimates, the respective ten-year CAGR (Compound annual growth rate) of hospitalized cases from 2008 till 2018 for cardiac diseases, oncology and diabetes are 18%, 16% and 19%. These factors, along with a rising population, are all leading to rising demand of specialized health care in India.

Looking at the current health care trends and an increasing need for specialized care, the challenges pertaining to health care infrastructure in the country are further expected to escalate. It is expected that India will require 2.07 million more doctors by 2030 in order to achieve a doctor-to-population ratio of 1:1,000 and an additional three million beds to achieve the target of three beds per 1,000 people by 2025. Lack of sufficient health care infrastructure has led to a supply-demand imbalance in the country making health care less affordable and accessible for all.

Rising Patient Awareness Systems

Digital technologies hold the potential to improve quality, affordability and accessibility of health care solutions, thus reshaping health care delivery across the patient pathway. The Indian health care industry has already started showing early signs of disruption. As LS 4.0 is embraced by all health care stakeholders, it is critical that life sciences companies get ready to lead the change.

As the Indian health care industry has started responding to the changing environment, the life sciences industry also needs to speed up its activity in the area. Companies have started taking small, experimental steps on their 4.0 journey. Most of the current efforts are directed toward enhancing customer engagement by providing wrap-around services for key products. Some companies are also making headway toward achieving operational efficiency in their R&D, manufacturing, supply chain and marketing business functions. Below are some of the key areas where Indian life sciences companies have started adopting digital technologies:

- **Patient engagement:** Tools / services for increasing patient awareness about disease / health, inducing behavioral changes, encouraging medication adherence, enabling self-management; digital campaigns (including multi-channel marketing)
- **Physician engagement:** Tools / services for sharing educational material; interactive portals to connect, learn and share with peer fraternity; tools / data to enable informed decision making
- **Field force effectiveness:** Technology interfaces such as tabs for e-detailing and easy day-to-day reporting; smart mobile apps for appointment bookings and work day planning; mobile learning solutions
- **R&D efficiency:** Clinical trial data management solutions to improve clinical trial efficiency; technology and data to improve R&D productivity /efficiency
- **Supply chain management:** Use of software to streamline supply and demand and connect buyers to sellers quickly; serialization

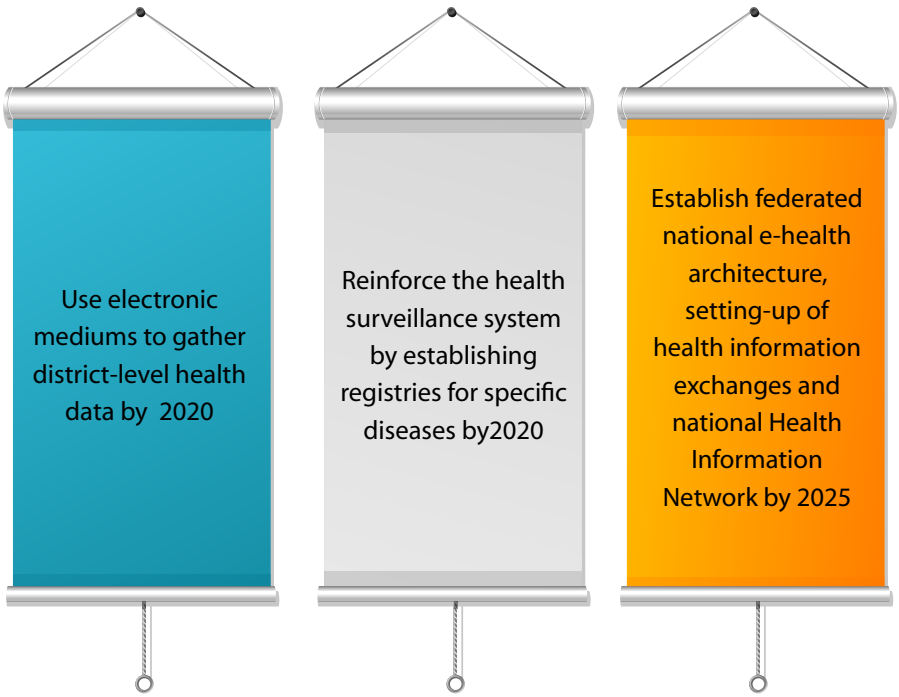
While Indian pharma players are making multiple investments, the activity is fragmented across the value chain. As such, the efforts don't go far enough to fully leverage the potential benefits of the new technologies and the abundance of data now available. The pharma industry is in urgent need of holistic platforms that connect the entire product value chain, with patients being an integral part of the process. These connected platforms can help pharma companies deliver the desired outcomes to all stakeholders, while also capturing value for themselves in the form of access to useful data and trusted relationships.

As companies respond to evolving customer demands, how these companies create value in the future and the capabilities they need will shift in ways that depend on their chosen business models, for instance:

Efficient producers will create value by delivering high quality drugs at low cost. They will need capabilities (e.g., predictive analytics, blockchain, automation, etc.) that bring efficiency and transparency to their manufacturing and supply chains.

Breakthrough innovators will create value by launching innovative drugs and potentially services, to cure diseases. They will need capabilities (e.g., artificial intelligence, remote monitoring systems, etc.) to improve efficiency in drug discovery and the clinical trial process, and also to generate real world data to demonstrate improved outcomes.

The National Health Policy (2017) has three distinct goals:



To achieve these goals, the government is establishing regulatory bodies (e.g., National eHealth Authority, National Digital Health Authority, etc.) and launching new legislations and policies (e.g., Digital Information Security in health care Act to regulate digital health data and ensure privacy, etc.).

The **"Ayushman Bharat"** program was launched in 2018 to address holistic health care delivery:

- **Primary health care:** 150,000 health and wellness centres will be created to provide comprehensive primary health care services
- **Secondary and tertiary care:** Pradhan Mantri Jan Arogya Yojana (National Health Protection Scheme) is the world's largest government funded health care insurance program that provides ~100 million families support worth INR 0.5 million per family per year.

This program will be driven by the usage of digital technologies and telemedicine services to improve quality, affordability and accessibility of health care.

- India is the third largest start-up ecosystem in the world, only behind the US and the UK, according to NASSCOM. India has a strong start-up base of >7500 companies, with 1200 new start-ups added in 2018. Tech start-ups received more than US$4 billion in the first three quarters of 2018 (+108% vs. same period last year).
- Health tech start-ups, comprising 8% (~600 start-ups) of total start-ups in India, rank fourth on the list behind start-ups developing enterprise (16%), FinTech (14%), or marketplace (12%) solutions.
- Indian entrepreneurs have created novel, locally relevant digital solutions that address health care affordability and accessibility challenges. These start-ups are slowly becoming an integral part of the health care system.

In recognition of the importance of a healthy start-up ecosystem, the government launched its Start-up India program in 2016. The number of health care and life sciences start-ups recognized by the government under the program is the second highest, behind only the IT services industry.

Indian life sciences companies, irrespective of the business model, need to focus on building capabilities in three key areas:

- **Customer engagement:** Super consumers today demand the same level of engagement in health care that they have experienced in other industries. Companies must develop capabilities that help them establish trusted and strong relationship with their customers (patients, physicians, providers, insurers, etc.). They should invest in:
  - **Platform capabilities:** to deliver seamless experience to the customers by providing relevant information at the desired time, via desired channel/s, and aligned to their values, preferences, and behaviors
  - **Talent - Specialist roles**: behavioral scientists; user interface / experience designers who understand customer journeys, profiles and preferences; regulatory experts to guide customer interactions in different geographies, etc.
  - **Soft skills:** customer first culture, patience, empathy, etc.
- **Personalization:** It is no longer restricted to cancer treatment; it is now desired in all products and services. This is a key opportunity that is emerging from the wealth of data generated via direct customer engagement and other channels. Personalization can not only help companies establish trusted relationships with their customers, but also bring greater efficiencies in how the products and services are delivered and the outcomes they produce. Companies must invest in:
  - **Platform capabilities:** based on new technologies (e.g., artificial intelligence, machine learning, etc.) that can provide predictive insights to guide superior preventive, diagnostic, and curative decision making
  - **Talent - Specialist roles:** geneticists, technology experts, etc.
  - **Soft skills:** cognition, design thinking, etc.
- **Data literacy:** Immense amounts of data are being generated across the product value chain and patient journey. Insights from the data can enable achievement of stakeholder satisfaction (by delivering improved products and services) and operational excellence • Companies must invest in:
  - **Platform capabilities:** That enable companies to collect and integrate data from various sources and produce business relevant insights
  - **Talent:** Specialist roles: Data experts, cyber security experts, experts in data privacy regulations
  - **Soft skills:** Critical thinking, logical reasoning, curiosity, etc.

National Health Programmes	
Govt of India Digital Health	
Digital Information Security in Health Care Act.(DISHA)	An Act to provide for establishment of National and State eHealth Authorities and Health Information Exchanges; to standardize and regulate the processes related to collection, storing, transmission and use of digital health data; and to ensure reliability, data privacy, confidentiality and security of digital health data and such other matters related and incidental thereto.

Research	
Survey reveals the digital health of Indian healthcare sector	D Yellow Elephant (DYE), a digital and social media firm, has revealed the digital health of leading India healthcare companies in a survey that scrutinises the digital performance of 160 firms spread across four primary segments of healthcare "pharmaceuticals, diagnostics, medical devices and equipment, and hospitals. ❖ The survey judged four crucial digital parameters: online presence, content, listening and engagement.
India Digital Health Report 2017	Investments & Government Initiatives: ❖ The Indian healthcare industry has been witnessing some stupendous growth in terms of investments. ❖ Private equity and venture capital funding in healthcare sector has gone up by 13 times, from US$ 94 million in 2011 to US$1,275 in 2016. ❖ Increase in overall health budget, where healthcare has been allocated 2.27% of the total budget, against the 1.97% previously. Other important initiatives include: ❖ Landmark agreements and reforms at the state level ❖ E-health initiative ❖ Ministry of AYUSH ❖ Sehat (Social Endeavour for Health and Telemedicine) among others.

Digitalization in Sector	
Types of Digital Health Tools	Data firm IQVIA lists 11 specific categories of digital health tools in their report 1. Consumer Mobile Apps 2. Consumer Wearables 3. Connected Biometric Sensors 4. Smartphone Cameras 5. Clinical Trial Patient Information Collection Tools 6. In-Home Connected Virtual Assistants 7. Telemedicine and Virtual Physician Visits 8. Personal Health Records 9. Web-based Interactive Programs 10. Text Messaging or Email 11. Health System Disease Management Apps
mHealth	• **CareMessage technology** allows for automated appointment reminders for some of the most at-risk patient populations. The technology takes three critical factors into account: the patient's precondition symptoms, their language preferences, and how they want to receive messages. • **Purple Binder Designed** to help hospital social workers find the resources their clients need, Purple Binder seeks to bridge the gap between social and economic services and healthcare services.
Tools to Track Digital Health	• **Health Coaching via the Cloud:** Beyou is a digital wellness-coaching application. The program helps individuals with dietary, exercise and heart health planning with live coaching as well as a daily healthcare plan. The program synchronizes with users' digital devices via a cloud account and automatically counts calories and incorporates users' exercise history and diet into wellness diagnostics. • **Encouraging Little Patients:** BravePotions is a digital application that helps parents and physicians reduce children's anxiety about visits to the doctor. The program is a simple tool to help children develop confidence when visiting physicians and dentists. The application offers interactive stories where children play the role of a superhero visiting the doctor's office. Parents can give the game to children before visits for encouragement and after visits to provide positive reinforcement. • **Clinical Level Heart Support in an Application:** Cardiosecur helps people manage their heart health and provides immediate recommendations during emergencies. The service uses electrocardiogram (ECG) technology to produce clinical grade readings and allows individuals to share information with their primary caregivers. The service provides an attachment that takes vital readings with users' smart devices. Cardiosecur has won several awards from the medical community and provides physicians with software for patient monitoring through their application.

Start ups	
Lybrate – providing instant support from doctors using phone	The Delhi-based startup helps patients find doctors near their location,and connect with them instantly. Lybrate has over 1,00,000 doctors across different specialisations connected with its service, providing instant support to patients over phone or through appointments.
Niramai – using Artificial Intelligence to fight breast cancer	The Bengaluru-based startup uses Artificial Intelligence for pain-free breast cancer screening. Detecting breast cancer in its early stage, Niramai's screening device can detect tumours five times smaller than what a clinical exam can catch. The startup uses machine learning and big data analytics over thermography images to develop reliable and low-cost diagnostic methods.
Practo – building a one-stop healthcare platform	SaaS platform for doctors has, over the past 10 years, evolved into a one-stop destination for appointments, consultations, health records, insurance, and ordering medicines online.
MUrgency – bringing medical emergency services under one app	Mumbai-based MUrgency is a healthcare mobile app that connects people who need emergency responses with qualified medical, safety, rescue, and assistance professionals.
Portea – bringing doctors and medical professionals at the patient's doorstep	The Bengaluru-based startup offers home visits from doctors, nurses, physiotherapists, and technicians for patients. Using remote diagnostics, point-of-care devices, and remote monitoring equipments; doctors and medical professionals can monitor patients who can't travel to hospitals. The patient data is uploaded using smartphones to an EMR platform, which uses predictive analytics to understand health trends in the patient.
Advancells – making stem cell therapy affordable	Startup provides stem cell therapies in India. Stem cell therapy, also known as regenerative medicine, is considered the next big thing in potential in organ transplantation. The technology has been found capable of treating various diseases such as diabetes, Parkinson's, Alzheimer's, arthritis, stroke and heart diseases.
Forus Health – fighting blindness with tech	Forus Health is using technology to fight the skewed ophthalmologist-to-patient ratio in India. With its portable innovative product 3nethra, screening of common eye problems which can lead to blindness is just a few minutes affair..
AddressHealth – making pediatrics affordable and holistic	AddressHealth makes use of tech at each step to make healthcare holistic and affordable for children. The startup has also designed curriculums for students to instill healthy behaviours, both mental and physical, in their formative years.
Mitra Biotech - developing low-cost personalised cancer care and drugs	Originally conceived as an academic project between Massachusetts Institute of Technology and Harvard University, Mitra Biotech was established in India in 2009 by Dr Mallik Sunderram and Dr Pradip K. Majumdar.

Embrace Digital in Ayurveda (Holistic Medicine)

India is one of the largest smartphone markets in the world and approximately one-third of the population is connected digitally. This connectivity can be leveraged to create the awareness and effectively respond to demand for Ayurveda products and services.

- **AyurTeleMed:** Telemedicine (over smartphones/laptops/mobile health vans) will enable to extend quality Ayurveda clinical expertise to Tier 2 and 3 cities, in addition to rural areas, and address the burgeoning demand for chronic diseases/non-communicable disease care across the country. This can be a breakthrough initiative from the Government of India and generate considerable employment for Ayurveda doctors.
- **AyurClinCloud:** Develop a cloud-based large-scale clinical information system that can host lakhs of Ayurveda clinical services providers across government and private sectors.
- **AyurNET:** Leverage digital technologies across the value chain of Ayurveda products and services from farms/forests to factory, and from factory to store and then to hospitals to home to enhance quality and efficiency for benefit of all stakeholders.
- E-commerce is the future of Digital India. Adoption of mobile technologies provides "product manufacturers" a massive platform to operate "GloRural."

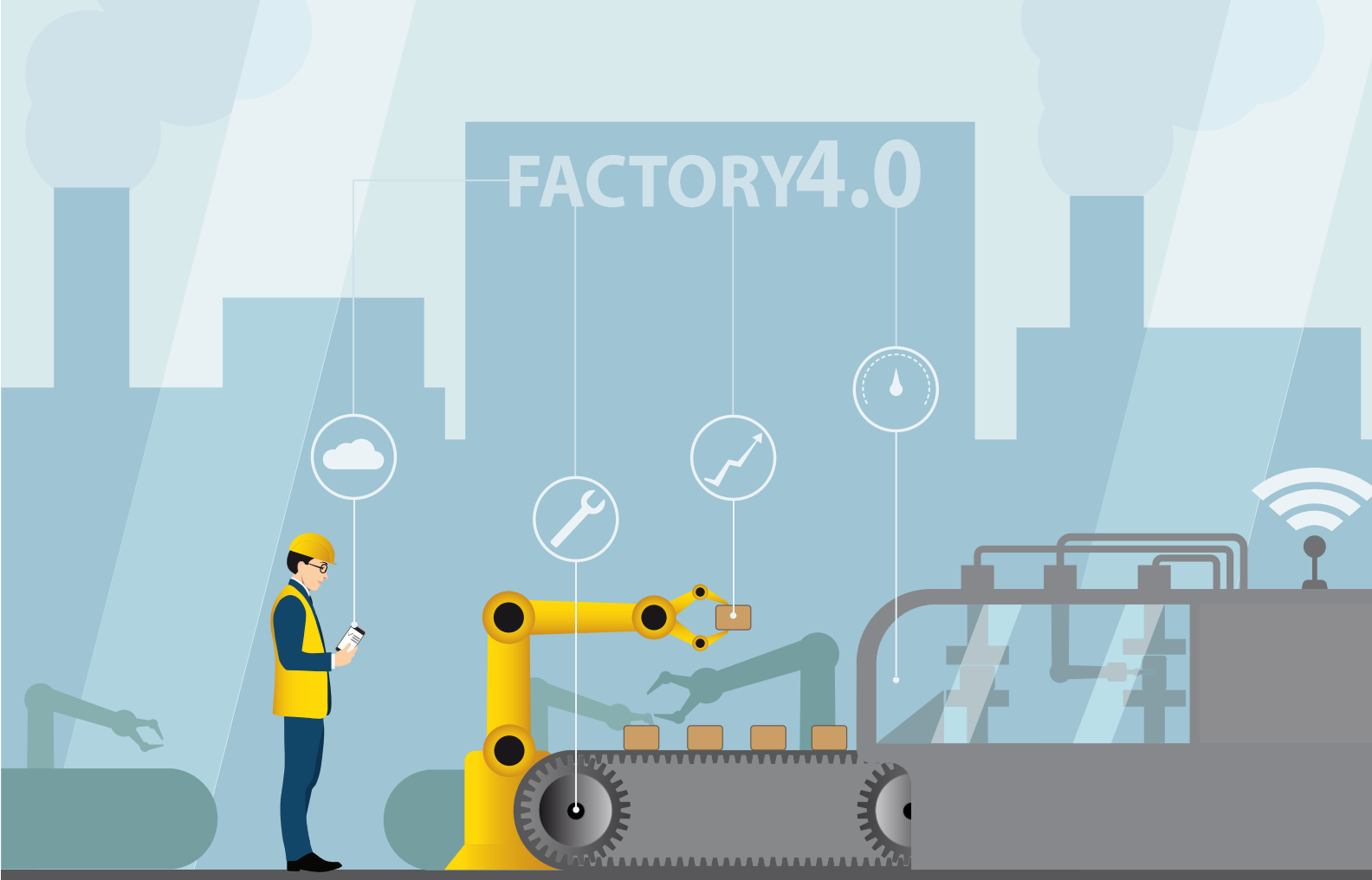
- Big Data Analytics will play a crucial role in the transition to "high-value innovative (bio prospecting) products" and support decision making to choose "combination therapy" (Allopathic medicine + Ayurveda).

Policy Initiatives

- Formulate a comprehensive Ayurveda Industry Policy
- Leverage Information Technology (IT) and Biotechnology (BT) sector policy frameworks and initiatives to attract big ticket (more than100 crore) investments from Indian and global MNCs. Draw upon enabling inputs (monetary and non-monetary) for the Ayurveda sector, like successful precedents in IT/BT sectors.
- Establishment of National Ayush Mission (NAM) would support the cultivation of increased number of medicinal plants on farmer's lands.
- Ayush Ministry to spearhead Public Private Partnerships by opening the Ayurveda public health infrastructure to the private sector.
- Operationalize MOUs between academic institutions and practicing hospitals/government research institutes.
- Establishing standard guidelines for evaluation of clinical trials and pharmacovigilance centers for data collection and assessment of Ayurveda medicines.

Popularizing Ayurveda

- The Ayurveda brand should be systematically and scientifically studied by a team of experts in the area (branding and domain) constituted by the Ministry of AYUSH, Government of India and experts from industry and academia leading to a clear articulation of brand dimensions, followed by laying out a strategic roadmap to achieving this.
- An Ayurveda brand development action plan should be centrally conceived and regulated by the Ministry of AYUSH with appropriate participation by industry stakeholders. By consensus, industry stakeholders from industry, government, and NGO sectors will be urged to comply with the recommended brand communication guidelines.
- Geographical indication protection is to be obtained for Ayurveda as originating from India. Furthermore, a team of legal experts should systematically evaluate copyright protection and intellectual property protection of Ayurvedic ideas and concepts.

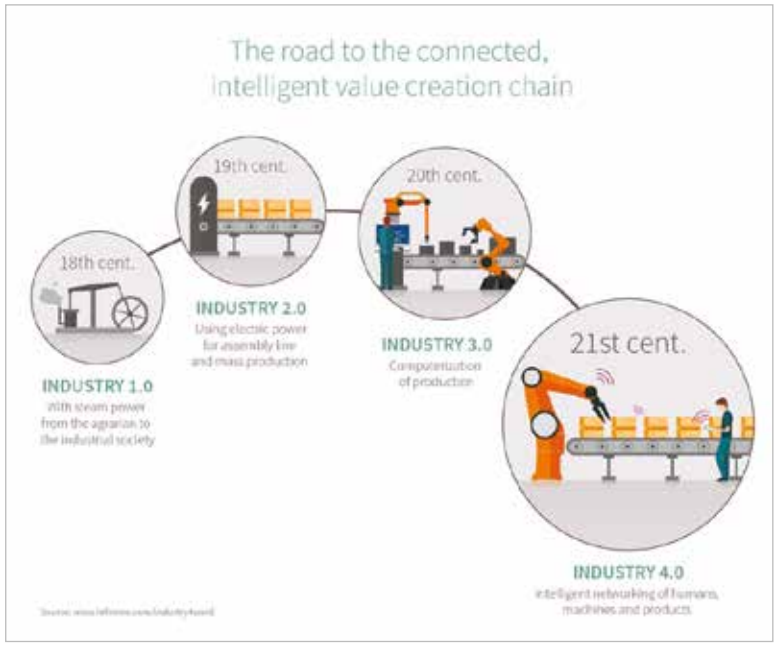


Smart Industry Management

The transformation of the energy sector through the deployment of more sustainable energy systems and digital transformation of the industry will substantially alter the way people live, consume, produce and trade. These two major transformations are concurrent and interconnected, but are pursued in different political arenas and with different paces and priorities across the globe.

The sustainable energy transition and Industry 4.0 share important characteristics: both are highly influenced by technological innovations, dependent on the development of new suitable infrastructures and regulations as well as are potential enablers for new business models.

Background



Automation has always been a part of the Industry to some degree, and even high levels of automation are nothing new. Through the application of artificial intelligence (AI) and increasing sophistication of cyber physical systems that can combine physical machines and business processes, automation increasingly includes complex optimization decisions that humans typically make.

The smart Industry is a flexible system that can self-optimize performance across a broader network, self-adapt to and learn from new conditions in real or near-real time, and autonomously run entire production processes. Smart factories can operate within the four walls of the Industry, but they can also connect to a global network of similar production systems and even to the digital supply network more broadly. It is important to note, that on-going evolution, a continuous journey toward building and maintaining a flexible learning system—rather than the "one and done" Industry modernization approach of the past.

The true power of the smart Industry lies in its ability to evolve and grow along with the changing needs of the organization—whether they be shifting customer demand, expansion into new markets, development of new products or services, more predictive and responsive approaches to operations and maintenance, incorporation of new processes or technologies, or near-real-time changes to production. Because of more powerful computing and analytical capabilities—along with broader ecosystems of smart, connected assets—smart factories can enable organizations to adapt to changes in ways that would have been difficult, if not impossible, to do so before.

Features of the smart Industry: What makes it different?

As many manufacturers grapple with the myriad organizational and ecosystem-wide changes exerting pressure on their operations, the smart Industry offers ways that can successfully address some of those issues.

i. The ability to adjust to and learn from data in real time can make the smart Industry more responsive, proactive, and predictive, and enables the organization to avoid operational downtime and other productivity challenges.

ii. The benefits of this automation included lower lead times for customers and lower overall costs, along with production capacity improvement of 25 percent and 50 percent fewer defective products.

iii. Some of its major features: **connectivity, optimization, transparency, proactivity, and agility.** Each of these features can play a role in enabling more informed decisions and can help organizations improve the production process.

It is important to note that no two smart factories will likely look the same, and manufacturers can prioritize the various areas and features most relevant to their specific needs. Perhaps the most important feature of the smart Industry, its connected nature, is also one of its most crucial sources of value. Smart factories require the underlying processes and materials to be connected to generate the data necessary to make real-time decisions.

In a truly smart Industry, assets are fitted with smart sensors so systems can continuously pull data sets from both new and traditional sources, ensuring data are constantly updated and reflect current conditions.

- **Integration of data** from operations and business systems, as well as from suppliers and customers, enables a holistic view of upstream and downstream supply chain processes, driving greater overall supply network efficiency.
- An optimized smart Industry allows operations to be executed with **minimal manual intervention and high reliability.** The automated workflows, synchronization of assets, improved tracking and scheduling, and optimized energy consumption inherent in the smart Industry can increase yield, uptime, and quality, as well as reduce costs and waste.
- **Data captured are transparent**: Real-time data visualizations can transform data captured from processes and fielded or still-in-production products and convert them into actionable insights, either for humans or autonomous decision making. A transparent network can enable greater visibility across the facility and ensure that the organization can make more accurate decisions by providing tools such as role-based views, real-time alerts and notifications, and real-time tracking and monitoring.

The Smart Industry: Why Now?

While automation and controls have existed for decades, the fully smart Industry has only recently gained traction as a viable pursuit for manufacturers. Five overarching trends seem to be accelerating the drive toward smart factories:

- Rapidly evolving technological capabilities
- Increased supply chain complexity and global fragmentation of production and demand
- Growing competitive pressures from unexpected sources
- Organizational realignments resulting from the marriage of IT and OT
- On-going talent challenges

Until recently, the realization of the smart Industry remained elusive due to limitations in digital technology capabilities, as well as prohibitive computing, storage, and bandwidth costs. Such obstacles, however, have diminished dramatically in recent years, making it possible to do more with less cost across a broader network. Further, the capabilities of technologies themselves have grown more sophisticated: AI, cognitive computing, and machine learning have enabled systems to interpret, adjust to, and learn from the data gathered from connected machines.

"Smart Industries" will leverage industrial equipment that communicates with users and with other machines, automated processes, and mechanisms to facilitate real-time communication between the factory and the market to support dynamic adaptation and maximize efficiency.

Digitization of the Energy Sector

Over the past few years, the digitization of energy systems has received wide attention. Developments in information and communication technologies, the spread of internet access and mobile devices such as smartphones, and the development of the block chain technology open opportunities for new approaches and business models that could significantly impact the energy sector.

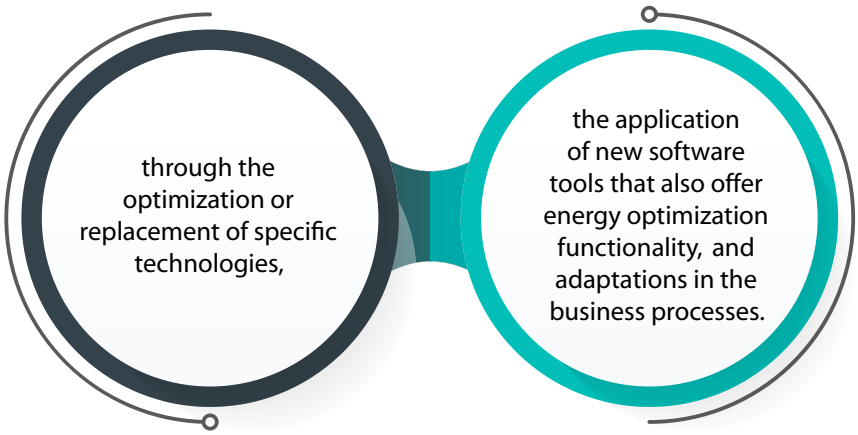
Digital technologies could offer solutions to the challenges of integrating renewable energy sources into small and large power grids which require new approaches to grid management. The term refers to grids that draw on the potentials of information and communication technologies in order to monitor and efficiently manage the generation, delivery, and consumption of electricity from different – potentially decentralized – sources of electricity to meet the varying electricity demands of end-users (OECD/IEA 2011). Such grids could provide the flexibility necessary to integrated renewable energies such as wind and solar into electricity networks on a large scale. However, there are still many technical and regulatory barriers to smart grids and the complexity of electrical systems makes it rather unlikely that the implementation of smart grids will be provided by the market alone (OECD/IEA 2011).

Another digital approach related to distributed energy generation is Virtual Power Plants (VPP). VPP are heterogeneous coalitions of distributed energy resources, generally composed of intermittent renewable sources, storage systems, flexible loads, and small conventional power plants that need to negotiate some bilateral contracts in advance prior to participating in the day ahead market (Shabanzadeh et al. 2015). VPP usually have a cloud-based central or distributed control centre and make use of the Internet of Things devices and other digital technologies.

An analysis and simulation conducted by German scientists show that combining virtual power plants with renewable energy will allow for the exclusive use of renewable energy sources in the future (Knorr et al. 2014). Big industry players have already taken up the development of solutions for virtual power plants, such as the cloud-based energy management system DEMS of Siemens' Smart Grid division.

Can Digitization Save Energy in the Manufacturing Sector

One of the key characteristics of Industry 4.0 is the digitization of manufacturing processes. This transformation can offer opportunities for energy saving – for example,



The following paragraphs will elaborate how these approaches can support energy savings. An example for the optimization of a specific technology can be found in the control of the behavior of a large number of interconnected robots by an algorithm that reduces their energy consumption. Several innovative digital technologies also offer the chance for the replacement of conventional, often more energy-intensive manufacturing procedures. For the production of prototypes or products with low lot sizes, Rapid Prototyping technologies can be a much cheaper, quicker and more energy-efficient alternative compared to the sequence of conventional ablative procedures which would conventionally be used to manufacture them.

A more disruptive approach is to transform a range of business processes. The digitization of the entire value creation network also opens the way to directly connect to the customer and integrate their user experience e. g. in the development of future products or additional services. On-demand customized products become technologically feasible, providing the opportunity for eliminating unnecessary functionality (e. g. omit a gearshift for people who only want to cycle through flat terrain). The physical realization of every function requires resources (material for physical or energy for digital solutions), the reduction to customer-requested functionalities will help save resources compared to "all-inclusive" default solutions.

THEME 1: Industry 4.0

Session 1.1 – Industrial Internet of Things

We are in front of a new digital revolution that will transform the way we understand and use services and infrastructures. One of the key factors of this revolution is related to the evolution of the Internet of Things (IoT). Connected sensors will be installed in cities and homes affecting the daily life of people and providing them new ways of performing their daily activities. However, this revolution will also affect business and industry bringing the IoT to the production processes in what is called Industry 4.0.

Session 1.2 – Big Data

Big Data makes it possible to analyze the data at a more advanced level than traditional tools allowed. With this technology, even data which has been collected in various mutually incompatible systems, databases and websites is processed and combined to give a clear picture of the situation in which there is a specific company or person.

Session 1.3 – Mobile and Cloud Computing

Big Data Cloud computing is considered as a new paradigm shift in information technology industry. Many of the authors consider it as the fifth utility service. That means the information technology service will be consumed and paid as electricity and water services. It is not just technical concept but it is new business approach of selling IT services.

THEME 2: Applications of Industry 4.0

Session 2.1 – Smart Industry and manufacturing

Industry 4.0 makes factories more intelligent, flexible, and dynamic by equipping manufacturing with sensors, actors, and autonomous systems. Accordingly, machines and equipment will achieve high levels of self-optimization

and automation. In addition, the manufacturing process has the capacity of fulfilling more complex and qualified standards and requirements of products, as expected.

Session 2.2 – Smart Product

The architecture of Industry 4.0, including ICT, IoT, CPS, cloud-formed data integration, standardized intelligent control, and visualized monitoring, allows human beings to communicate with products. The existing production systems need to be integrated to cooperate with Industry 4.0.

IoT in Industries	
L&T set to float new industrial IoT initiative	L&T-Nxt: will focus on artificial intelligence, IoT, virtual reality, augmented reality, geospatial solutions and cyber. security.
NASSCOM Initiatives	Failure analysis for predictive maintenance Automation of shop floor material transportation along with logging for analytics

Government Draft policies in IoT	
Smart Supply, Chain and Logistics	• To setup a project for enabling universal ambulance service at any place using any kind of device. • To enable logistics chain managed by government for essential food items to ensuring need-based re-filling and reduction in wastage of food items. • To create tools which could enable faster fulfillment of ecommerce purchases.
Smart Manufacturing / Industrial Iot	• To setup projects using IoT for planning preventive and in-time maintenance for equipment's in various manufacturing verticals. The sensors for early defect detection will help in reducing equipment malfunction and hence downtime. • To setup projects for process improvement in manufacturing leading to optimal utilization of resources(fuel, power, as the case may be). • To setup projects for monitoring operations and creating warning/alerts for deviation/damages. For example fire, gas leakage sensors together with alerts.
IoT Development Center	The IoT developmental center can be set-up anywhere in India. And the Internet and space would be made available at subsidized rates.

Government Draft policies in IoT	
Support to Participate in International Global Trade Fairs:	The government will support the participation of India-based IoT companies in international global trade fairs to showcase Indian industries' capabilities in IoT. It will also fund (up to 100%) IoT specific study tours by the industry associations and supporting government organizations.
IoT Curriculum Introduced in Academics:	For developing skillsets for IoT, there is an introduction of IoT curriculum at M. Tech, B. Tech, and Ph.D levels. The government sponsors 150 students every year for the fellowship program. Certification courses in IoT, workshops for working level executives from industry and faculty, introducing cross country pacts for IoT education exchange programs, and introducing bilateral cooperation programs between Indian premier institutions and institutes of other countries are part of the various initiatives taken by the government.
Setting up Incubation Centers:	The government will set-up incubation centers (National Center of Excellence) under the PPP mode with NASSCOM and other industry associations. It is aimed at setting up of five IoT centers in the next five years. A budget of Rs 100 crore has been benchmarked for the set-up, wherein the latest gadgets and instruments would be provided for researchers to come up with ideas pertaining to IoT implementation.

Start ups	
Zenatix	The Gurugram-based IoT startup's offerings include WattMan that aims to help retail and BFSI businesses save up to 30% of their energy bills. The solution ensures governance, quality of service, and risk mitigation across the distributed infrastructure through automated and intelligent controls claims the company.
Ecolibrium Energy	Ecolibrium Energy provides energy intelligence to commercial and industrial consumers and utilities. The startup's big data analytics platform intends to improve operational efficiency by optimising energy usage and asset utilisation. The startup helps power distribution companies meet their demand-side management goals. SmartSense connects with their high power consuming consumers and helps them optimise the way they consume power.
Smartron	Smartron India provides an intelligent connected platform TronX, offering highly customised and personalised experiences, services and care through the next generation of smart devices across various IoT verticals.
Covacsis Technologies	The startup offers tailor-made analytics suite for manufacturing operations. Using machine learning and big data technologies, it offers highly dynamic decision-making capabilities in real time. The Intelligent Plant Framework from Covacsis provides a 360° visibility of the manufacturing floor in real time.
TerraBlue XT	The Bengaluru-based startup has come up with solutions called TJay and Xaant. While TJay, an innovative solution for the prediction and management of epilepsy, is more about unravelling the mysteries of the brain, Xaant is a therapeutic wearable device that traces the inner realm of a mind's pathways to generate real-time data when one is trying out any method to calm his/her senses.
Bharati Robotic Systems	Bharati Robotics aims to accelerate the application of IoT-based robotic solutions in cleaning and material handling equipment such as scrubber-driers and sweepers.

Start ups	
Saviant	Saviant is the preferred Data Analytics & Intelligent Solutions partner for leading Asset-intensive and Field-force driven Enterprises across industries like Energy, Utilities, Logistics & Construction. Saviant is a Microsoft Gold Partner for Cloud Platform, Data Analytics, Application Development & Xamarin Premier Consulting Partner.
Stellapps Technologies	Stellapps' innovative applications and state-of-the-art mechanization tools leverage Internet of Things (IoT), Big Data, Cloud, Mobility, and Data Analytics to improve Agri- Dairy supply chain parameters, including milk production, milk procurement, cold chain, animal insurance and farmer payments. Their SmartMoo™ IoT router and in-premise IoT Controller acquire data via sensors that are embedded in Milking Systems, Animal Wearables, Milk Chilling Equipment & Milk Procurement Peripherals, and transmit the same to the Stellapps SmartMoo™ Big Data Cloud Service Delivery Platform (SDP) where the SmartMoo™ suite of applications analyse and crunch the received data before disseminating the Analytics & Data Science outcome to various stakeholders over low-end and smart mobile devices.
Infosys	Their solutions span platforms, consulting services, system integration offerings, embedded and hardware solutions, and requirements definition.
HCL Technologies	At HCL, they have a dedicated IoT team with end-to-end planning to delivery functions, dedicated labs for IoT solution development and mature relationships with IoT partners. HCL's 36 years of complex engineering heritage, rich experience of working with top R&D companies in smart mobile analytics & cloud technologies, experience centric digital services, thought leading propositions in infrastructure management, distinguished intellectual properties and futuristic solutions across product intelligence, augmented reality, artificial intelligence reinforced by global partnerships help their customers ideate & deploy turnkey IoT solutions faster in an outcome centric smart ecosystem.
Tata Communications	Tata Communications offers end-to-end IoT solutions for digital transformation needs through its rapidly growing pan-India presence and strong partner ecosystem across the entire IoT value chain, including: • Smart Metering • Personal Safety • Environmental Monitoring • Employee Health & Safety • Smart Lighting • Asset Management • Smart Feedback
TVS Infotech	Our Smart iT OutSourcing (SiTOS) provides companies the flexibility to use us as their extended IT arm, with services ranging from program management, enterprise solutions, infrastructure management, IT applications to website and portal management.
CarIQ	CarIQ's robust platform is capable of handling and analyzing tens of thousands of vehicles simultaneously. It uses the latest in cloud technologies and has been put together after over a year of R&D.

About TERI

We are an independent, multi-dimensional organization, with capabilities in research, policy, consultancy, and implementation. We are innovators and agents of change in the energy, environment, climate change, and sustainability space, having pioneered conversations and action in these areas for over four decades.

We believe that resource efficiency and waste management are the keys to smart, sustainable, and inclusive development. Our work across sectors is focused on:

- Promoting efficient use of resources
- Increasing access and uptake of sustainable inputs and practices
- Reducing the impact on environment and climate

Established in 1974, TERI is headquartered in New Delhi. We have regional centres and campuses in Gurugram, Bengaluru, Guwahati, Mumbai, Panaji, and Nainital. Our 1000-plus team of scientists, sociologists, economists, and engineers, delivers insightful, high quality action-oriented research and transformative solutions supported by state-of-the-art infrastructure.

Knowledge Resource Centre of TERI

The Knowledge Resource Centre (KRC) caters to the rising knowledge needs of both TERI researchers and external professionals by collecting, collating, and disseminating knowledge-based products and proactive online and digital value-added services. KRC subscribes to a wide array of resources, including books, reports, periodicals, and e-resources. Besides providing research assistance to users, the core competency of KRC professionals includes providing innovative knowledge-based services; capacity building for research and knowledge and information professionals; web content development: contributions to publications: and setting up specialized information centres on contemporary themes such as transport, renewable energy and environment, mycorrhiza, and climate change.

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