

Industry 5.0 And Smart Cities: A Futuristic Approach

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Abstract

Smart cities aim at a sustainable lifestyle with greener and safer urban environment. The futurists have already started discussing about Industry 5.0 with the theme of adding a human touch or personalization based on collaboration and co-working of a human and robot. We discuss how the concept of Industry 5.0 can impact smart cities and what kind of changes are expected – how it will create a diverse set of opportunities. This is a short article which discusses about the technological developments, shortcomings of industry 4.0, underlining structure of smart cities and what modifications can be expected under Industry 5.0.

Keywords—Industry 5.0, Smart cities, Industry 4.0, IoT, Big data

1. Concept of Industry 5.0

In generic terms, industrialization is economic and social process of discovering efficient and effective ways of creating values [1]. In the continuous process of finding innovative ways of adding values, brief discussion about the various stages of industrialization and their characteristics is important which is as follows [2][3]. Figure 1 also depicts the journey from Industry 1.0 to Industry 5.0.

- Industry 1.0: In addition to the human and animal powers, steam, coal and water engines were introduced in the early 1700s.
- Industry 2.0: Invention of telephone, telegraph, introduction of assembly lines, mass production, and mechanization are few characteristics of industry 2.0. It started in 1870s.
- Industry 3.0: A higher level of automation was achieved with the use of robots, information technology, and microprocessors.
- Industry 4.0: It is also known as “information revolution”. The industrial scale production was revolutionized by the integration of Internet of Things (IoT), automation, cyber physical systems, advanced analytics, cognitive computing and artificial intelligence (AI). It has atomized the factories and helped achieving cost savings. It is characterized by efficient and effective use of resources and amalgamation of business partners and customers into the business process [4]. The three key aspects of Industry 4.0 are integration of horizontal and vertical value chains, innovative and digital business models, and digitized service and product offerings [5].

The industry 4.0 has been a talk of the hour for more than a decade. It consists of four basic design principles namely interoperability, information transparency, technical assistance, and decentralized decisions. With the merger of machines, tools and vehicles to IoT framework, the ability of making virtual copies of machines and objects using artificial intelligence equipped computerized systems has increased. The humans are now been assisted in both physical work and decision making. To implement Industry 4.0 effectively, the integration of Computer Aided

Drafting (CAD), Enterprise Resource Planning (ERP), Manufacturing Executive Systems (MES), Computer Aided Manufacturing (CAM), and Product Lifecycle Management (PLM) is a crucial step. Industry 4.0 is therefore, a combination of technologies like Cloud services, Data Analytics, Simulation, IoT, Cyber Security, 3-D printing, Augmented Reality (AR) and Robots [6][7].

The benefits of Industry 4.0 are:

- Scalability: Automation has given a competitive advantage of faster production and the manufacturers are now able to concentrate on their strengths, leaving aside the other jobs to AI. Cloud computing is beneficial to smaller firms with less resources and budget for specific hardware or software. They can now carry on their works remotely using third party servers.
- Security: The companies do not have to fear the technical glitches anymore as the cognitive and cyber-physical management of IoT now happens through cloud computing.
- Visibility and Control: Industry 4.0 has ensured improved collaborations between people across the globe within a fraction of seconds.
- Satisfied customers: The customer is updated at every step, right from booking of the order till the delivery of final product including research and development, recycling the products, and manufacturing commissioning [9]. It focusses on individualized requirements [7].
- Customization: With the advent of commercial 3-D printers – modifications, production of improved parts and repair of faulty designs can be done in a jiffy [10] [11].

But there is an underlining assumption that more automation means more standardization which will lead to less human involvement. The velocity of change in technology is lightning fast e.g. the shift from 3G to 4G has already asked for a lot of investments and now the talks of 5G have already begun, which would lead to change in systems, reevaluating the business processes, and reskilling the staff. The data management costs would also be gigantic. A customer always prefers customized products, which calls for a human intervention to Industry 4.0 and that's where Industry 5.0 comes in. It focuses on the comeback of humans into the industrial framework [2] [13]. The machines and humans would be working together in collaboration to improve the efficiency of production [14]. For this purpose, collaborative robots or cobots and bots are used [8] [15]. The interaction of cognitive computing and human intelligence would be a normal phenomenon. The companies are also expected to focus and develop sustainable methods of using renewable energy and eliminating waste [10]. Bioeconomy is another concept which constitutes Industry 5.0, which demonstrates the use of biological resources in such a manner that the balance between the ecology, industry and economy is maintained [13]. Industry 5.0 is still a visionary but a convincing concept which will have a deep impact on the society, governance and human identity along with economic ramifications [15]. It is considered as a transformation from information society to super genius society [16]. The aim of Industry 5.0 is to allow humans to spend more time on planning and strategizing tasks, by providing a blend of human craftsmanship and automation [8] [14]. Industry 3.0 was all about mass production; Industry 4.0 was about mass customization and Industry 5.0 will be about mass personalization [17].

Figure 2 summarizes how Industry 5.0 will help in overcoming the shortages of Industry 4.0. It will be able to provide orthogonal safe exits when the digital networks fail. The fault in the hyperconnected network will not impact the orthogonal exit pathways. Industry 5.0 will be a systematic and symmetric approach to innovate the ecosystem design [18]. Data is considered as the new oil of 21st century [19]. Therefore, whosoever will have control over the data platforms will be a political dominant power. Industry 5.0 aims to find solutions to such issues by designing robust, responsible and sustainable innovations which are in harmony with societal values [18].

2. Understanding Smart Cities

The rapidly increasing shortage of resources and energy, deteriorating infrastructure, environmental crisis and demand for social benefits has led to the development of the concept of Smart city/ Intelligent city or Digital city which deals in applying the smart technologies to infrastructural services and components. This includes application of computing technologies to stream line city administration, education, healthcare, public safety, real-estate, transportation and other utilities [20]. A smart city also works towards optimizing its resources by planning its preventive maintenance and security activities [21]. The main aim is to integrate the physical, IT, social, and business infrastructure [22]. The characteristics and factors of smart cities are [23]:

A. Smart Economy:

- Entrepreneurship
- Productivity
- Flexible labor market

B. Smart People:

- Qualification level
- Creativity
- Open-mindedness
- Flexibility

C. Smart Governance:

- Part of decision-making process
- Social services
- Transparency

D. Smart Mobility:

- Availability of ICT
- Sustainable transport services
- Accessibility

E. Smart Environment:

- Level of pollution
- Protection of environment
- Resource management

F. Smart Living:

- Quality of housing
- Education facilities
- Tourism
- Social cohesiveness

The architecture of smart cities can be divided into two parts: external and internal. The external architecture is used for monitoring streets, parks, leisure areas, etc. The complete city is monitored through long ranged communication protocols e.g. use of sensors in public lighting. The internal architecture is comparatively cheaper to implement and makes use of short-range protocols like Wi-Fi, Bluetooth, RFID etc e.g. understanding the geometric shape of buildings, ownership of property etc [24].

The smart cities are completely dependent on IoT. The various sensors, devices and applications are used for collecting the data which is later analysed to make technology solutions more effective. There are 3 important layers which should be considered while transforming the city infrastructure to smart infrastructure – First, the tech based layer which makes use of

interconnected devices and sensors to collect the data; second is the processing layer which makes use of smart applications to analyze the data and convert it into meaningful insights; third is the adoption layer which deals in adoption of smart systems by the residents [25]. Getting a relevant insight on smart cities require handling contextual information from interconnected ICTs and physical spaces [26]. The analysis of data has to be fast, reliable and real-time otherwise it becomes useless e.g. traffic signals, health etc. All the smart city applications are required to maintain decent levels of privacy and security as the data is from various sources and in various formats, it poses a threat to the safety, privacy and well-being of the residents [27].

3. Outlook

Smart cities are considered to be an investment that use technological advances as a tool to support and improve the quality of living. Data serves as the heart while designing and implementing the concept of smart cities. The citizens of a smart city are expected to be fully aware of its applications and follow privacy, safety and security practices which can be achieved through appropriate training and awareness campaigns [27]. The government should be well coordinated with the data and must have proper documentation and codebooks as the onus of designing data policies lies on the government [28]. We have to design a road map that covers various stages like: deciding the vision, mission, policies, strategic objectives and operational values of the smart city; building ICT based smart infrastructure; integrating smart infrastructure into the applications to capture and analyze data in order to optimize the operations; and exploring new opportunities in terms of current developments and their impact, issues and future requirements. During this entire process of automation and developing a smart city, there will cases where machines will gain more control while monitoring the citizens. It is important that we have a realistic view of the technology which fits into the societal context and values like transparency, personal, social, economic, digital and professional development, [29]. In this complex set of functions, expectations, data and finding insights, a human touch will be of paramount importance and this has been shown by [30] in Figure 3.

Industry 5.0 or Society 5.0 is considered as an evolution over the previous industrial revolutions and aims to make a super smart society. The smart cities under Society 5.0 will design strategies and policies over hand IoT systems; commitment to research and development at various levels and taking care of educational reforms including technology literacy. The society 5.0 will further support dynamic, diversified and flexible working conditions leading to creation of a new category of jobs.

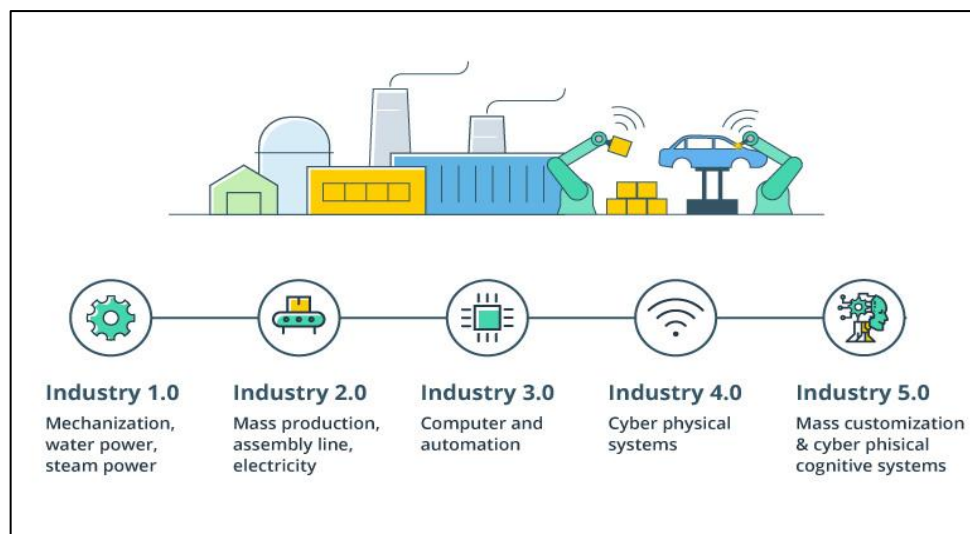


Figure 1 Journey from Industry 1.0 to Industry 5.0 [8]

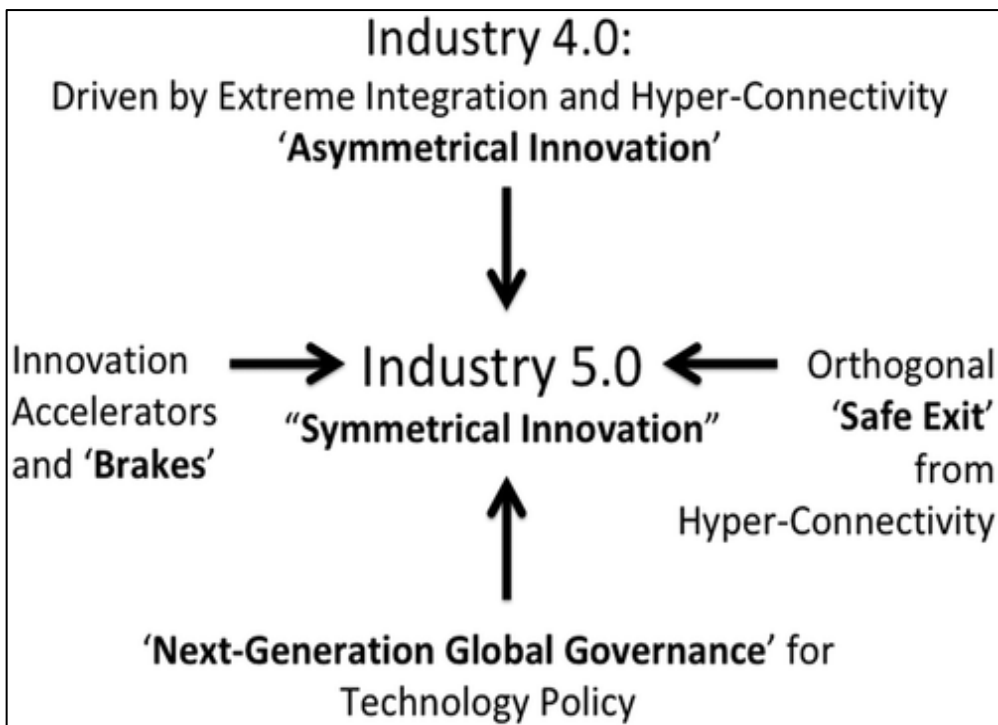


Figure 2: Industry 5.0 addressing the challenges of Industry 4.0 [18]

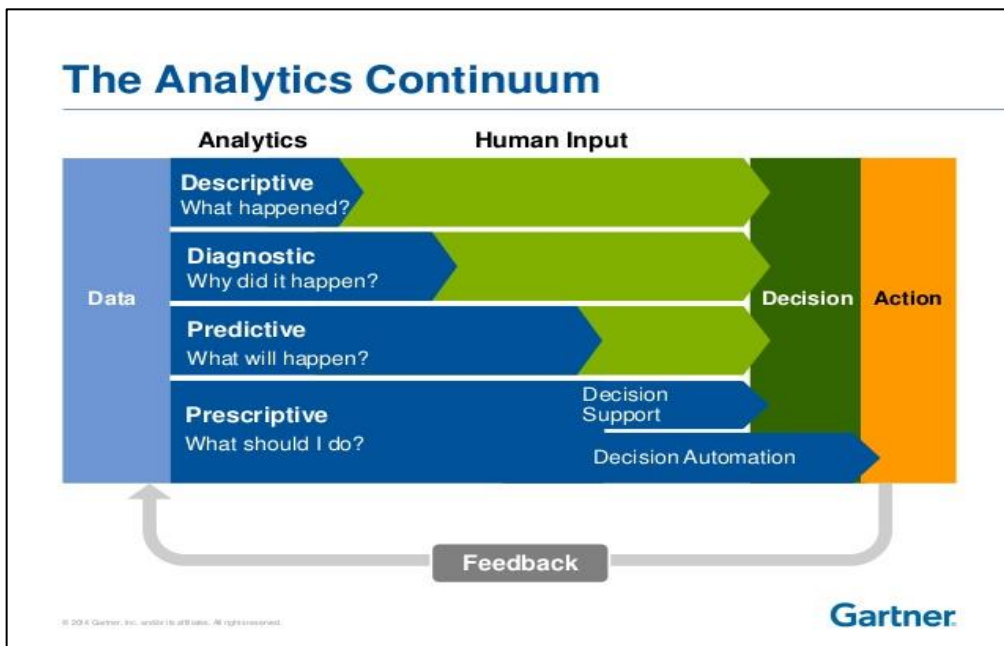


Figure 3: Involvement of Humans in analytics [30]

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