REVIEW OF RESEARCH
ISSN: 2249-894X
IMPACT FACTOR : 5.2331(UIF)
VOLUME - 7 | ISSUE - 6 | MARCH - 2018

# INDUSTY 4.0 IN INDIA: A CONCEPTUAL OVERVIEW

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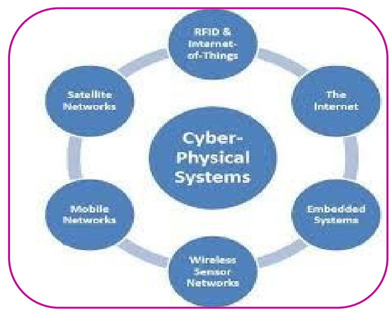
**ABSTRACT**

*Industry 4.0 is a strategic initiative introduced by the German government. The goal of the initiative is transformation of industrial manufacturing through digitalization and exploitation of potentials of new technologies. Industry 4.0 is driven by an amalgamation of emerging technologies like data volumes, computational power, Internet of Things (IoT), business analytics, augmented reality, artificial intelligence, elemental design, simulation, advanced robotics, additive manufacturing, sensor-based technologies and cyber-physical systems. Industry 4.0 would mean the convergence of real and virtual worlds - the next phase in bringing together conventional and modern technologies in manufacturing. In India, the adoption of Industry 4.0 is at a nascent stage. Widespread implementation still looks to be some years away due to challenges such as the need for high investment outlay, inadequate knowhow, lack of infrastructure and lack of adequate cybersecurity norms. However, with benefits such as cost reduction, higher efficiencies, safer factories and faster speed to market, Industry 4.0 can provide the country's manufacturing sector the much-needed platform to stay competitive in the global market. This paper makes an attempt to overview of industry 4.0 in Indian perspective. It also focuses on the major problems faced by industry especially in the sector of automotive.*




**KEY WORDS:** *Cloud Computing, Cyber Physical System, Industry 4.0, Internet of Things.*

## INTRODUCTION :

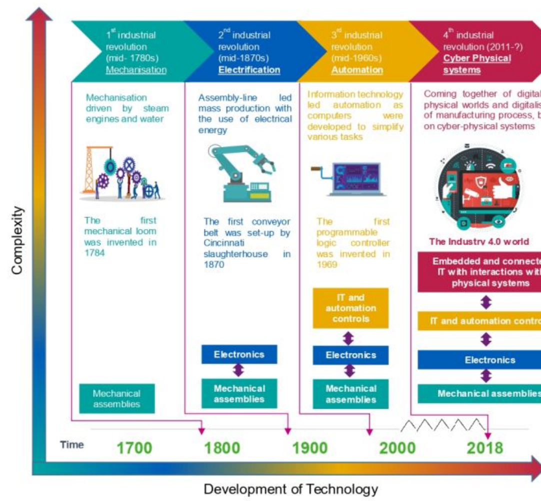
Industrial production is nowadays driven by global competition and the need for fast adaptation of production to the ever-changing market requests. These requirements can be met only by radical advances in current manufacturing technology. Industry 4.0 is a promising approach based on integration of the business and manufacturing processes, as well as integration of all actors in the company's value chain (suppliers and customers). Technical aspects of these requirements are addressed by the application of the generic concepts of Cyber-Physical Systems (CPS) and industrial Internet of Things (IoT) to the industrial production systems. The Industry 4.0 'execution system' is therefore based on the connections of CPS building blocks. These blocks are embedded systems with decentralized control and advanced connectivity that are collecting and exchanging real-time information with the goal of identifying, locating, tracking, monitoring and optimizing the production processes. Furthermore, an extensive software support based on decentralized and adapted versions of Manufacturing Execution Systems (MES) and Enterprise Resource

Planning (ERP) is needed for a seamless integration of manufacturing and business processes. The third important aspect is handling of a big amount of data collected from the processes, machines and products. Typically, the data is stored in a cloud storage. This data requires extensive analytics that lead from the 'raw' data to the useful information and, finally to the concrete actions that support an adaptive and continuously self optimizing industrial production process.

Due to the importance of this transition for the position of a country in a global market, some government-led initiatives were introduced all-around the world to support the transition. Industry 4.0, as the first such initiative and inspiration for other initiatives, comes from Germany.

## EVOLUTION OF INDUSTRY 4.0

The first industrial revolution was triggered by water and steam power to move from human labor to mechanical manufacturing. The second industrial revolution built on electric power to create mass production. After seeing constant progress on the back of mechanization, electrification and the advent of the assembly line over two centuries, the global manufacturing industry adopted information technology in the 1960s, when computers came into the forefront of development, simplifying human effort. The third industrial revolution used electronics and information technology to automate manufacturing. The fourth is the current trend of automation and data exchange in manufacturing technologies. From then to now, both operational technology and information technology have come a long way, unleashing a vast plethora of possibilities on the factory floor through I4.0.

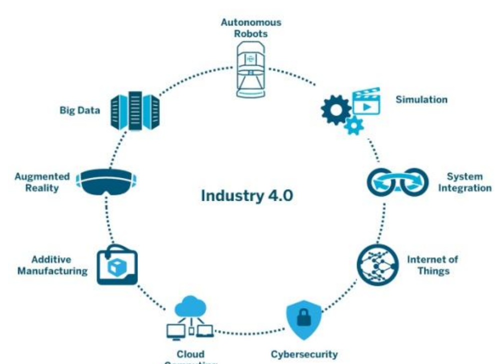



**1st Industrial Revolution (mid- 1780s) Mechanisation:** Mechanisation driven by steam engines and water. The first mechanical loom was invented in 1784.

**2nd Industrial Revolution (mid 1870s) Electrification:** Assembly line led mass production with the use of electrical energy. The first conveyor belt was set-up by Cincinnati slaughterhouse in 1870.

**3rd Industrial Revolution (mid 1960s) Automation:** Information technology led automation as computers were developed to simplify various tasks. The first programmable logic controller was invented in 1969.

**4th Industrial Revolution (2011) Cyber Physical Systems:** While Industry 3.0 focused on the automation of single machines and processes, Industry 4.0 focuses on the end-to-end digitization of all physical assets and integration into digital ecosystems with value chain partners. Generating, Analysing and communicating data seamlessly underpins the gains promised by Industry 4.0, which networks a wide range of new technologies to create value.



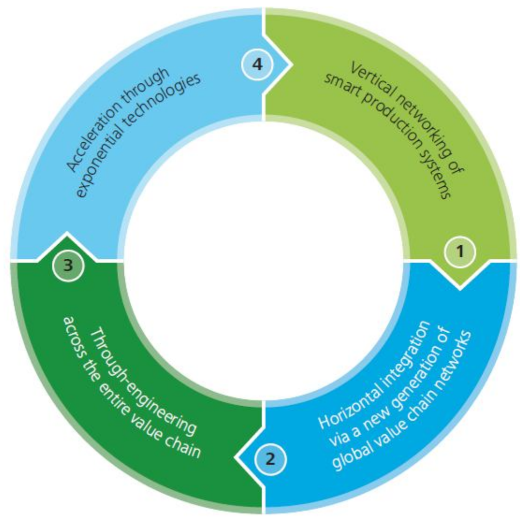

## COMPONENTS OF INDUSTRY 4.0

The vision of Industry 4.0 is likely to be adopted worldwide and it might influence other initiatives and cooperative efforts. In general, there are nine key technological components that progressively make up the foundation of Industry 4.0: Autonomous robots, big data, augmented reality (AR), additive manufacturing, cloud computing, cyber security, IoT, system integration, and simulation.

- **Big data:** One of the major challenges with data has been its quantum. Too much data makes it difficult to identify the relevant information and trends that can lead to some intelligent analysis. This is where "Big data" and analytics come in. They make it possible to identify the performance of an individual component and its operating restrictions in order to prevent future production issues and take preventative action.
- **Cloud computing:** The industry has seen a large shift in utilising cloud solutions, and this will continue to grow. The cloud is being used for applications such as remote services, colour management, and performance benchmarking and its role in other business areas will continue to expand. With continuous advancements in technology, machine data and functionality will only continue to shift towards cloud solutions. The cloud allows for a much faster roll out of updates, performance models, and delivery options than standalone systems.
- **Internet of things (IoT):** The IoT is a key functionality in Industry 4.0 driven solutions. IoT is a system of interrelated computing devices, mechanical and digital machines, objects and people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. For instance, smart watches in the market have turned our wrists into smartphone holsters by enabling text messaging, phone calls, and more. Devices such as Fitbit and Jawbone have helped revolutionize the fitness world. With the proper connections and data, the IoT can solve traffic congestion issues, reduce noise and pollution.
- **Simulation:** The simulations of systems allow assessment of various scenarios. Once the scenarios are assessed, cost effective solutions can be developed, tested and implemented much quicker leading to reduced cost and time to market.
- **Autonomous robots:** They are used to automate production methods across the various sectors and are powered by the concept of Internet of Things (IoT). This connects devices and computer machines to communicate with each other. Materials can be transported across the factory floor via autonomous mobile robots (AMRs), avoiding obstacles, coordinating with fleet mates, and identifying where pickups and drop offs are needed in real-time. By connecting to a central server or database, the actions of robots can be coordinated and automated to a greater extent than ever before. They can complete tasks intelligently, with minimal human input.
- **Augmented reality (AR):** Augmented reality grows in use by providing real-time information in an effective manner to allow humans to better integrate and interact with electronic systems. Examples can include the transmission of information on repairs for a part that can be viewed through different devices or the training of personnel using simulations and 3D views of the facility or equipment.
- **Cyber security:** The security of information becomes paramount as we move away from closed systems towards increased connectivity from the IoT and cloud. Security and reliability enable the successful implementation of a truly modern and digitized production work flow, leveraging all of the benefits of a connected environment.
- **System Integration:** Mostly systems are highly automated within their own operations and struggle to communicate with other systems. Standards and open architecture support the easy transfer of information both to the business and to the customer/end user. This can involve defining common languages for data exchange such as JDF for job information, CxF for colour information etc.
- **Additive manufacturing:** This continues to become increasingly important for small-batch applications or for the production of individual parts or personalised products. This will be used either directly with the customer or by suppliers to improve designs with increased performance, flexibility, and cost effectiveness.

## CHARACTERISTICS OF INDUSTRY 4.0

The following four main characteristics of industry 4.0 demonstrate the huge capacity that industry and traditional manufacturing have for change: vertical networking of smart production systems, horizontal integration via a new generation of global value chain networks, through-engineering across value chain and the impact of exponential technologies.




### ➢ Vertical networking of smart production systems

The first main characteristic of industry 4.0 is the vertical networking of smart production systems in the factories of the future. This vertical networking uses cyber-physical production systems (CPPSs) to enable plants to react rapidly to changes in demand or stock levels and to faults. Smart factories organised themselves and enable production that is customer-specific and individualized. This requires data to be extensively integrated. Smart sensor technology is also needed to help with monitoring and autonomous organisation. CPPSs enable not only autonomous organisation of production management but also maintenance management. Resources and products are networked, and materials and parts can be located anywhere and at any time. All processing stages in the production process are logged, with discrepancies registered automatically. Amendments to orders, fluctuations in quality or machinery breakdowns can be dealt with more rapidly. Such processes also enable wear and tear on materials to be monitored more effectively or pre-empted. All in all, waste is reduced. Significant emphasis is attached to resource efficiency and in particular, the efficient use of materials, energy and human resources. The demands on workers engaged in operational tasks such as production, warehousing, logistics and maintenance are also changing, meaning that new skills in efficient working with CPPSs are required.

### ➢ Horizontal integration via a new generation of global value chain networks

The second main characteristic of industry 4.0 is horizontal integration via a new generation of global value chain networks. These new value-creation networks are real-time optimized networks that enable integrated transparency, offer a high level of flexibility to respond more rapidly to problems and faults, and facilitate better global optimization.Similar to networked production systems, these (local and global) networks provide networking via CPPSs, from inbound logistics through warehousing, production, marketing and sales to outbound logistics and downstream services. The history of any part or product is logged and can be accessed at any time, ensuring constant traceability (a concept known as ’product memory’). This creates transparency and flexibility across entire process chains – from purchasing through production to sales, for example, or from the supplier through the company to the customer. Customer-specific adaptations can be made not only in the production but also in the development, ordering, planning, composition and distribution of products, enabling factors such as quality, time, risk, price and environmental sustainability to be handled dynamically, in real time and at all stages of the value chain. This kind of horizontal integration of both customers and business partners can generate completely new business models and new models for cooperation, representing a challenge for all those involved. Legal issues and questions of liability and protection of intellectual property are becoming increasingly important.

### ➢ Through-engineering across the entire value chain

The third main characteristic of industry 4.0 is cross-disciplinary through-engineering across the entire value chain and across the full life cycle of both products and customers. This engineering occurs seamlessly during the design, development and manufacture of new products and services. New products need new and/or modified production systems. The development and manufacture of new products and production systems is integrated and coordinated with product life cycles, enabling new synergies to be created between product development and production systems. Characteristic of this through-engineering is that data and information are also available at all stages of a product's life cycle, enabling new, more flexible processes to be defined from data via modelling to prototypes and the product stage.

- **Acceleration through exponential technologies**

The fourth main characteristic of industry 4.0 is the impact of exponential technologies as an accelerant or catalyst that allows individualized solutions, flexibility and cost savings in industrial processes. Industry 4.0 already requires automation solutions to be highly cognitive and highly autonomous. Artificial intelligence (AI), advanced robotics and sensor technology have the potential to increase autonomy further still and to speed up individualization and flexibilization. AI cannot only help to plan driverless vehicle routes in factories and warehouses more flexibly, save time and cost in Supply Chain Management (SCM), increase reliability in production or analyse big data, but can also help to find new construction and design solutions or enhance the cooperation between humans and machines to the point of services. Functional nanomaterials and Nano sensors can also be used in production control functions to make quality management more efficient or allow the production of next generation robots that work 'hand in hand' and safely with humans.

Flying maintenance robots in production halls and using drones to make inventories of warehouse stock levels and deliver spare parts, at any time of day or night and in any terrain and weather, are further applications that will become simply routines in the autonomous and smart factories of the future. A prime example here of an exponential technology that is accelerating industry 4.0 and making it more flexible is 3D printing (additive manufacturing). 3D printing allows new production solutions (e.g. functionality, higher complexity without additional cost) or new supply chain solutions (e.g. inventory reduction, faster delivery times), or a combination of both that lead to disruptive new business models (e.g. disintermediation of supply chain members, customer integration). More important will be the scanning for quality assurance or changes in SCM and warehousing through on-location printing of spare parts. Significant questions still need to be answered regarding intellectual property, product liability, customs duty and value-added tax. While 3D printing already exists for all materials (metal, plastic, ceramic, living cells etc.), not all materials fulfil industry requirements with regards to porosity and other characteristics. In the cases where the required quality has already been achieved, long lasting material qualification processes are under way, comparable with the processes for any other new material.

## CURRENT STATUS OF INDUSTRY 4.0 IN INDIA

Globally, the I4.0 market is expected to reach INR 13,90,647 crore by 2023.1 Countries such as the U.S., China, Japan and European nations like U.K., Ireland, Sweden and Austria all have started adopting I4.0. In India, the sixth-largest manufacturing country, the manufacturing sector forms an integral part of the country's long-term vision as seen by the government's strong focus on the 'Make in India' campaign. The government aims to augment the share of manufacturing in GDP to 25 per cent from the current 17 per cent, by 2022. A number of initiatives and policy reforms, such as implementation of the GST (Goods and Services Tax) and easing FDI policy have been taken by the government.

At present, India lags its global peers in I4.0 adoption. A significant portion of the Indian manufacturing sector is still in the post-electrification phase with use of technology limited to systems that function independently of each other. The integration of physical systems on cyber platforms, the basic premise of I4.0, is still at its infancy. Furthermore, the Micro, Small & Medium Enterprises (MSME) segment has very little access to automation technology due to the high cost barrier. The current scenario of I4.0 implication in India can be summoned by following way:

1. Non-awareness of the technology
2. Systematic approach towards modernization.

3. Non-Willingness to adopt the new technologies
4. Availability of Cheap labor initiates reluctance to adopt automation
5. Volume of products is not very high so as to adopt the automation increases ROI for the investments.
6. Non-availability of skill set to adopt the Automation.

**importance of Industry 4.0 for indian automotive sectors**

According to International Yearbook of Industrial Statistics 2016- published by UNIDO with its ranking going up by three places, India has now been ranked sixth among the world's 10 largest manufacturing countries. India is no exception to this global trend and is steadily increasing its share of Global Manufacturing GDP. All leading countries are embarking on major initiatives to promote manufacturing by adopting the advancements

in Internet and Information Technology arenas. German government announced "Industry 4.0" while governments in China and India have their own focused programs, "Made in China 2025" and "Make in India" respectively. Idea is to encourage multi-national, as well as national companies to manufacture their products in India. With a plethora of crippling regulations and under-developed infrastructure, the Government is focusing more on enabling policies and improving infrastructure for certain key sectors.

According to IBEF, the Government of India has set an ambitious target of increasing the contribution of manufacturing output to 25 per cent of Gross Domestic Product (GDP) by 2025, from 16 per cent currently. There is no escape from integrating principles of Industry 4.0 with the "Make in India" initiative, if Indian Manufacturing has to win against global competition. India has a unique opportunity to innovatively pave its own road to Smart Manufacturing. It can skip several steps that other countries adopted in their evolution from an agrarian society to their current stage of development. Industry 4.0 is expected to transform manufacturing in India by bringing operational efficiencies to manufacturing industries like automotive, electrical and electronics. The major area of focus shall be the technological advancement across various industries. IIOT (Industrial Internet of Things), 3DP (3-dimensional printing) 3D sensors, social software, augmented reality, location awareness are considered to usher in the next era of smart production. These automation technologies collectively are moving the manufacturing industry towards the next phase of technological advancement.

Industry 4.0 is a holistic automation, business information, and manufacturing execution architecture to improve industry with the integration of all aspects of production and commerce across company boundaries for greater efficiency. Internet of Things, being one of the most important aspects of Industry 4.0 for India is expected to capture close to 20 per cent share in global Internet of Things (IoT) market in the next five years. The global market is expected to touch US$ 300 bn by 2020. The IoT industry is a proposed development of the Internet in which everyday objects are likely to have network connectivity, allowing them to send and receive data. According to IBEF forecast, the IoT market in India is projected to grow at a CAGR more than 28 per cent during 2015-2020.

Major Indian states are taking initiatives to adapt to Industry 4.0. Andhra Pradesh has taken an initiative to capitalize on the IoT potential in the country. The state government has approved the first-of-its-kind IoT policy with an aim to turn the state into an IoT hub by 2020 and tap close to 10 per cent market share in the country. The Indian government has created Green Energy Corridors to bring in more renewable energies, to make smart grids that will support the variable input of renewable energies and create storage. India has committed over US$ 1 bn in this initiative and has started projects in many states, such as Andhra Pradesh, Rajasthan, Tamil Nadu, Gujarat, and Himachal Pradesh.

India's first smart factory, moving from automation to autonomy, where machines speak with each other, is being set up in Bengaluru. It is making progress at the Indian Institute of Science's (IISc) Centre for Product Design and Manufacturing (CPDM) with an investment from The Boeing Company. A smart factory, armed with data exchange in manufacturing and the Internet of Things (IoT) is the future and experts are calling it revolution Industry 4.0. Reports peg the smart factory industry to touch US$ 215 bn by 2025 and all major economies are likely to accept it. Various Indian companies are increasing their focus and partnering with other companies for developing new IoT and M2M solutions, the Digital India initiative from the Government of India is expected to enhance the focus on IoT in tackling the domestic challenges.

## CHALLENGES OF Industry 4.0 IN INDIA

Industry 4.0 is a critical area as it offers esteem expansion to the manufacturing yields and frameworks by integrating emerging technologies in manufacturing sector and services. However, enterprises still have a mountain to cross for the fruitful and auspicious execution of the digital concepts. The primary explanations behind the vulnerabilities lie in the high capital investment levels and the unclear financial benefits for the industry 4.0 implementation areas. Further, there is lack of adequate knowledge and skills in the employees which is required to cope up with the upcoming emerging technologies and automation and here is an absence of clearness in the guidelines for the implementation of industry 4.0 which has made vagueness in many organizations. This digital revolution will need to cross many barriers before being successfully implemented by all organizations. The list of challenges for implementation of Industry 4.0 with a brief description is presented before:

- **Employment Disruptions:** Employment Disruptions is characterized as the interruptions brought in the employment because of the development of the emerging technologies and automation. Current employments in the industrial sectors are inclined to be robotized bringing about human employment misfortunes. The remaining manufacturing jobs will consist of more data and learning work as well as increasing short-term and hard-to-plan tasks.
- **High Implementation Cost:** High implementation cost refers to the capital cost that the organizations must incur for developing the industry 4.0 framework in their organizations. It is difficult for small and medium industries to adopt Industry 4.0, as there is a lack of capital for appropriate emerging technologies. Emerging and promising technologies such as IoT, always carry a significant threat for investments to organizations as there can be potential capital losses and no recovery of investments.
- **Organizational and Process Changes:** Organizational and Process Changes alludes to the procedure changes which will be provoked because of the coming of cyber physical systems and smart factories. There will be change in organization functions after adoption of Industry 4.0 and this will give rise to decentralized organizational structure. Decision making can be done at the shop floor level. With the enormous IoT applications and solutions, which are being beneficial across industries also carry significant challenges which apply to the integration of both internal and external, vertical, heterogeneous, and closed systems. These are perceived as huge worries for many ventures.
- **Need for Enhanced Skills:** With the adoption of the Industry 4.0 by the organization, the knowledge, qualification and skills of the employees will be the key to success of a highly innovative organization. The organizations must be focused on the development of skilled workforce by the effective Human Resources Management. Effective design and deployment of IoT solutions require a lot of primary knowledge which lacks across various technical and non- technical programs.
- **Lack of Data management system:** Data management systems allude to data innovation frameworks refer to information technology systems that store and recover information, improve coordinated effort, find information sources, dig archives for hidden information, capture and use information, and improve the data management process. Knowledge management systems can be benefited by embedding the IoT and processing the collected big data from IoT devices however; the real time data may not be handled by existing systems. Extensive technical skills are required to switch from operational to more strategic and specific tasks. There will be a significant demand for data analysts who will analyze the big data and create value through optimization and forecasting.
- **Lack of clear comprehension about IoT:** Internet of things may be defined as the system of physical gadgets implanted with sensors, electronics, software, sensors, actuators, and connectivity for sending and getting information. No doubt in the fact that the adoption of IoT in new venture is related to potential monetary profits. On the contradictory side, organization must have a clear and precise knowledge regarding the nuances of deployment of IoT, i.e., of value creation, delivery, and abduction. If

the organizations are considering the business model with IoT application, then they should evaluate the variances accordingly. Several IoT applications and associated technologies are still in the initial development stages. Because of this, there lies an uncertainty in the potential monetary profits expectations that may be derived from the IoT deployment. Hence, deployment of IoT is believed as a crucial confrontation faced by most of the organizations.

- **Lack of Standards and Reference Architecture:** With wireless sensory network, it has been a significant challenge to design and select an Industry 4.0 architecture for different applications. There is a lack of standards and reference architecture since the concept of industry 4.0 is new. For example, the design of efficient and effective IoT architecture throughout value chains involving objects, network, information services, and applications layers is seen as a considerable barrier to successful adoption of IoT.
- **Lack of Internet coverage and IT facilities:** Lack of IT facilities refers to the IT framework that is required to support implementation of Industry 4.0. Refers to the lack of IT infrastructure that is required to support the Industry 4.0 implementation. IoT plays a important role in Industry 4.0 infrastructure. Lack of IT solutions for effective communication and internet coverage may act as a significant barrier for many products/ services. Weak signal causes the problem of signal attenuation in certain manufacturing premises.
- **Security and Privacy Issues:** There is an enormous quantity of data flow that happens on the industry 4.0 platform creating cybersecurity threat and information privacy problems. Virtual work on servers or stages commits representatives to know about digital security. An important aspect of the cyber physical system (CPS) is cybersecurity. CPS is more affected to cyber- assaults with the recent advancements in IT technologies. Digital security risks related to verification, approval, privacy protection, system access, applications, network, and information remain significant barrier for the organizations.
- **Seamless integration and compatibility issues:** These are the issues which may emerge while updating the current machines and equipment for the industry 4.0. Building up consistent incorporation and interoperability between different emerging technologies and network systems is one of the considerable barriers associated with the implementation of IoT solutions to create a cyber physical system of IoT ecosystems.
- **Regulatory Compliance issues:** Regulatory compliance refers to the objectives that the enterprise seek to accomplish in their endeavors to guarantee that they know about and find a way to conform to material laws, arrangements, and guidelines. Organizations need to have strict standards set up for IT security, working with the machine, or working hours.
- **Legal and Contractual Uncertainty:** Digitalization poses a challenge for the law because the competition gets wild. Laws for data protection, liability for AI, standardization should be thought of whereas deploying a digital strategy. Without a lawful identity, the virtual association does not legitimately exist thus can't be distinguished as a lawfully autonomous element. Each virtual association that utilizes ICT needs to ensure that by exchanging information online they do as such in a protected way, and they don't encroach security guidelines or that the agreements finished up are legitimate and enforceable

## CONCLUSIONS

In a nutshell, Industry 4.0 is the future of global manufacturing which aggregates existing ideas to a new value chain which plays a crucial role to transform whole value chains of life cycle of goods while developing innovative services and products in the manufacturing industry which involves the connection of systems to things that creates self-organizing and dynamic control within an organization. Industry 4.0 describes a future scenario of industrial production that is characterized by the aspects of a new level of controlling, organizing and transforming the entire value chain with the life cycle of products, resulting in higher productivity and flexibility through three types of effective integration which are horizontal, vertical and end-to-end engineering integration.

Industry 4.0 will revolutionize manufacturing around the globe, as did the first three industrial revolutions. With global supply chains and highly interactive markets, this revolution will be vastly different from the previous ones: being much faster and generating results that were heretofore unexpected. It will highlight the fact that small changes in one area of the manufacturing ecosystem will create significant ripples throughout the ecosystem, due to connectivity throughout the supply chain and the speed at which information propagates. Furthermore, Industry 4.0 will enable information to flow not only from manufacturer to product, but between producers, products and, most importantly, customers. The ability to embrace Industry 4.0 and use the opportunities that will rapidly (and, in many instances, unexpectedly) present themselves will be a key to success in the new global market. Enabling that innovation to proceed from a concept to a mass-produced product will be critical for success; and ensuring a talent pool in the manufacturing workforce that can move those innovations rapidly forward will be equally important.

India has a number of programs to enable innovation and ensure the talent pipeline for manufacturing. Some are well established, and others are quite new and very innovative. It is clear that Industry 4.0 presents tremendous opportunities, and this fact highlights the need for a highly trained and flexible workforce and production capacity that can answer the needs of tomorrow as well as those of today.

## BIBLIOGRAPHY


1. Rojko, Andreja (2017), Industry 4.0 Concept: Background and Overview, International Journal of Interactive Mobile Technologies, Vol.11, No. 5
2. Grant Thornton (2017), India’s Readiness for Industry 4.0: A focus on Automotive Sector- https://www.gita.org.in/Attachments/Reports/India%E2%80%99s%20Readiness%20for%20Industry%20 4.0.pdf
3. AIMA-KPMG Report Industry 4.0 (2018), Industry 4.0 India Inc. Gearing Up for Change- http://resources.aima.in/presentations/AIMA-KPMG-industry-4-0-report.pdf
4. J. Yan, S. Xin, Q. Liu, W. Xu, L. Yang, L. Fan, Q. Wang (2014) Intelligent supply chain integration and management based on cloud of things, Int. J. Distrib. Sens. Netw. Vol. 10, No. 3
5. Tay, S. I et. al (2018), An Overview of Industry 4.0: definition, Components, and Government Initiatives, Journal of Advance Research in Dynamical & Control Systems, Vol. 10, No.14
6. M.I. Hussain (2017), Internet of things: challenges and research opportunities, CSI Trans. ICT, Vol. 5, No.1