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*by W1 Soham1*

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# Landscape Study on Industry 4.0 - Smart Manufacturing in India

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## **ABSTRACT**

This report presents a comprehensive landscape study on Industry 4.0 and Smart Manufacturing in India. The study delves into the current state of digital transformation and technological adoption within the Indian manufacturing sector. It analyzes the key trends, challenges, and opportunities presented by Industry 4.0, focusing on the integration of advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), robotics, data analytics and many more. Furthermore, the study provides insights into specific case studies and success stories of companies that have embraced Industry 4.0 principles and reaped the benefits of increased efficiency, productivity, and competitiveness. It also explores the challenges faced by manufacturers during the implementation of smart manufacturing practices and offers potential strategies to overcome these obstacles.

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## 1. Introduction to Industry 4.0: Revolutionizing the Future of Manufacturing

In an era of rapidly evolving technology<sup>36</sup>, the world of manufacturing is undergoing a profound transformation. Welcome to Industry 4.0, the next industrial revolution that is reshaping the very foundation of how products are made, systems are managed, and businesses operate. With its innovative blend of cutting-edge technologies and interconnected systems, Industry 4.0 holds the potential to propel industries into an era of efficiency, productivity, and competitiveness.

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Industry 4.0 represents a paradigm shift in manufacturing<sup>141</sup>, characterized by the convergence of physical and digital realms. It leverages advanced technologies such as artificial intelligence, robotics, the Internet of Things (IoT), data analytics, and automation to create intelligent and interconnected production environments. This transformation transcends traditional manufacturing boundaries, unlocking a new era of opportunities for businesses worldwide.

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At the heart of Industry 4.0 lies the ability to collect, analyze, and leverage vast amounts of data from<sup>2</sup> every corner of the production process. Cyber-Physical Systems (CPS) work in harmony with IoT devices, sensors, and machines to generate a constant stream of real-time data. This data becomes the lifeblood that fuels smart decision-making, predictive maintenance, and optimization of manufacturing operations.

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Connectivity plays a pivotal role in the Industry 4.0 landscape. With interconnected systems and seamless information exchange, a cohesive ecosystem emerges, enabling end-to-end visibility and control across the entire value chain. Suppliers, manufacturers, distributors, and customers can now collaborate seamlessly, making informed decisions with a shared understanding of the production process.

Automation takes center stage in Industry 4.0, revolutionizing traditional manufacturing practices. From autonomous robots working alongside human operators to AI-powered systems making real-time decisions, the integration of automation technologies reshapes workflows, eliminates inefficiencies, and enhances productivity. By automating routine and repetitive tasks, human workers are liberated to focus on higher-value activities, fostering innovation and creativity.

Industry 4.0 doesn't merely boost efficiency and productivity; it also paves the way for unparalleled quality control and customization. With real-time data analytics, manufacturing processes can be continuously monitored, anomalies can be detected

and addressed promptly, and product quality can be ensured at every step. Moreover, the flexibility of Industry 4.0 allows for on-demand customization, enabling businesses to adapt swiftly to evolving customer demands <sup>2</sup> and gain a competitive edge in an increasingly dynamic market.

As the world grapples with challenges such as globalization, rising labor costs, and stricter environmental regulations, Industry 4.0 emerges as a beacon of hope and resilience. By embracing this transformative wave, businesses can unlock a multitude of benefits, including increased productivity, reduced costs, improved sustainability, enhanced operational agility, and accelerated innovation.

Industry 4.0 is not a distant dream; it is here and is revolutionizing the manufacturing landscape. The journey has already begun, with forward-thinking organizations across the globe harnessing the power of advanced technologies to shape a future of unprecedented possibilities.

<sup>239</sup> Industry 4.0 i.e the fourth industrial revolution that has the motive to fully automate the current manufacturing industries with the help of Smart Manufacturing Technologies

## <sup>84</sup> 1.1 Industrial Revolution:

INDUSTRY 1.0	INDUSTRY 2.0	INDUSTRY 3.0	INDUSTRY 4.0
Use of Steam Power + Mechanisation	<sup>52</sup> Use of Electricity + Assembly Line + Mass Production	Use of Partial Automation + Electronics & Computers (IT) + Telecommunication & Internet	Fully Automated + Smart Manufacturing Technologies such as CPS, IOT etc

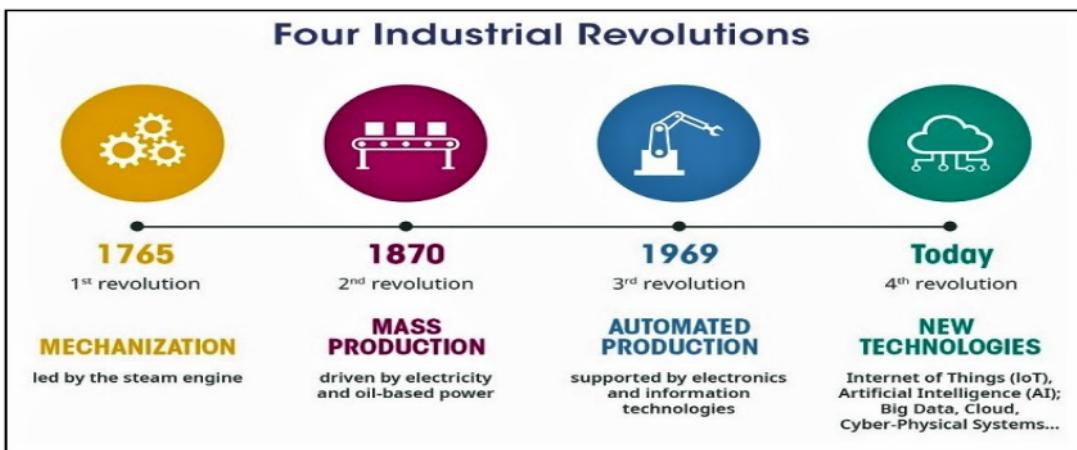


Image Source:

<https://www.iasparliament.com/current-affairs/fourth-industrial-revolution-4ir>

## 1.2 FEATURES OF INDUSTRY 4.0

Following are the key features of Industry 4.0:

**1. Automated:** Industry 4.0 emphasizes the automation of manufacturing processes through the use of advanced technologies such as robotics and artificial intelligence. Automation reduces reliance on human intervention, improving efficiency and productivity.

**2. Digitization:** Industry 4.0 focuses on the digitization of manufacturing operations, converting physical processes and data into digital formats. This enables better data collection, analysis, and utilization for improved decision-making and optimization.

**3. Interoperability:** Interoperability refers to the seamless exchange of information and data across different systems and devices. In Industry 4.0, interconnected machines, sensors, and systems can communicate and collaborate, enabling end-to-end visibility and control across the entire value chain.

**4. Robustness:** Industry 4.0 systems are designed to be robust and self-sustaining. They can self-organize, self-maintain, self-repair, and make autonomous decisions based on real-time data. Remote diagnosis capabilities allow for quick identification and resolution of issues.

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**5. Real-time control:** Industry 4.0 emphasizes real-time control and monitoring of manufacturing processes. By collecting and analyzing data in real-time, adjustments and optimizations can be made promptly, leading to improved efficiency and quality.

**6. Sustainability:** Industry 4.0 promotes sustainable manufacturing practices by optimizing resource utilization, reducing waste, and minimizing environmental impact. It leverages data and automation to improve energy efficiency and enable more sustainable production processes.

**7. Data autonomy:** Industry 4.0 gives importance to data autonomy, where organizations have control over their own data. This allows businesses to leverage data for decision-making, innovation, and competitive advantage while ensuring data privacy and security.

**8. Resilience:** Industry 4.0 systems are designed to be resilient and adaptable to changing conditions and disruptions. They can quickly respond to unforeseen events, recover from failures, and continue operations with minimal downtime.

**9. Transparency:** Industry 4.0 promotes transparency by providing visibility into the manufacturing process and supply chain. This transparency enhances trust and collaboration among stakeholders, enabling informed decision-making and efficient coordination.

2

**10. Predictability:** Industry 4.0 leverages data analytics and predictive algorithms to forecast and anticipate manufacturing outcomes. This enables proactive decision-making, optimized planning, and improved production predictability.

**11. Efficiency:** Industry 4.0 aims to improve overall operational efficiency by eliminating inefficiencies, optimizing processes, and reducing costs. Automation and data-driven insights enable streamlined workflows, reduced lead times, and improved resource utilization.

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**12. Vertical interconnection of intelligent manufacturing systems:** Industry 4.0 emphasizes the integration and interconnection of intelligent manufacturing systems vertically across different levels of the value chain. This integration enables seamless data flow and coordination between different stages of production.

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### 13. Horizontal integration through a new generation of global value chain

**networks:** Industry 4.0 enables horizontal integration by connecting different organizations and partners across the global value chain. This integration facilitates collaboration, information sharing, and efficient coordination of activities.

**14. Through-engineering throughout the value chain:** Industry 4.0 promotes through-engineering, which involves integrating and optimizing processes, systems, and data throughout the entire value chain. This approach ensures seamless flow, efficiency, and quality from raw materials to end products.

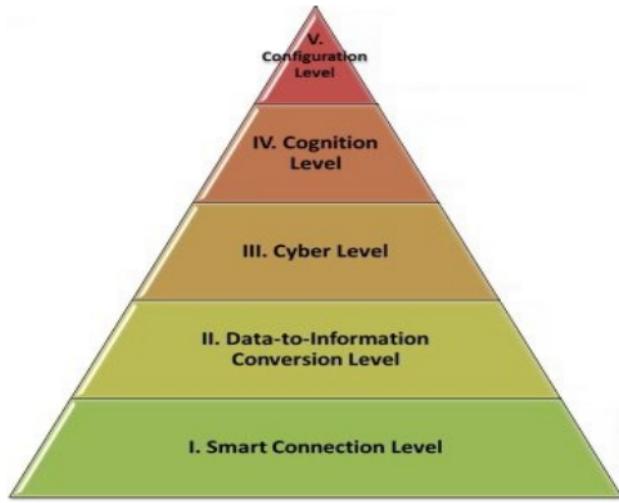
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**15. Acceleration using exponential technologies:** Industry 4.0 leverages exponential technologies such as AI, IoT, data analytics, and additive manufacturing to accelerate innovation, productivity, and competitiveness in manufacturing. These technologies enable rapid advancements and breakthroughs in various aspects of production.

## 1.3 Implementation of Technologies in Industry 4.0 Through CPS

### 1.3.1 Levels in CPS implementation in Industry 4.0:

Cyber Physical Systems (CPS) is the Key Technology for Industry 4.0, Through 5C Architecture of CPS the Industrial Output is Achieved in Industry 4.0



## 5C ARCHITECTURE OF CPS (Source-Wikipedia)

### 1. Smart Connection Level:

- The smart Connection Level<sup>277</sup> includes connection of machines with the Sensors and Controllers in order to acquire the real time data from the physical System i.e Machines

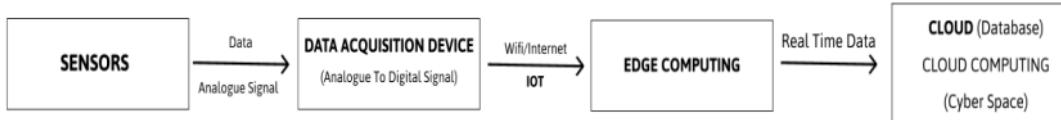


<sup>36</sup>

### 2. Data to Information Conversion Level:<sup>280</sup>

- From the data collected by the sensors or Controllers, meaningful information needs to be Extracted. So the Data in form of Analogue signal from sensor is then passed through Data Acquisition Device where the Analog signal from the sensors gets converted and processed to Digital Signal making the information computer readable,
- This Digital or Computer readable information is then passed to computers with the help of Network/Wifi leading to the need of **Internet of Things (IOT)**. By the help of IOT it Passes this Information to the Cloud with Internet/Wifi.

- 2
- At Cloud level , **Cloud computing** and **Edge computing** helps to process the data, thus creating a database.



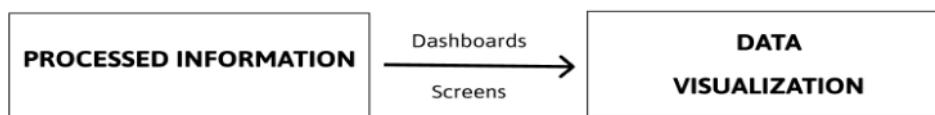
### 3. Cyber Level:

- At cyber level, The real time information enters the Computers i.e the cyber space from the database via internet/wifi, Making it a Central Information Hub, this forms the Machines Network
- Now By **Big Data Analytics** ,the processing of large and complex data sets into meaningful data such as patterns, correlations, market trends is done, thus by the help of **Machine Learning** the System Self-Identifies , self-trains and self-Adapts from the Information.
- Now the **Artificial Intelligence** will help to create the **Digital Twin** of The Required Product that needs to be Manufactured as well as the **Augmented Reality** will help visualize and analyse the system.



### 4. Cognition Level:

- At this level the Processed Information, will be displayed through dashboards/Screens and the Data Visualization and analysis will be done



### 5. Configuration Level:

- At this level, the system configures the further steps of manufacturing thus gives a feedback to physical space from the cyberspace, after the approval from the the Human Intelligence ,The AI i.e **robotics and automation** will help to manufacture the products

- This may include automation of assembly lines or machines, Robotic Arm Functionalities etc



At every stage the **Cyber security** plays a vital role so that it provides protection of system (Computers, servers, networks etc) from cyber attacks/threats

## 1.4 Differentiating between Current Industry and Industry 4.0:

### ➤ Data collection and analysis:

- In the current industry, data collection and analysis are often performed manually. This means that workers manually record data and analyze it using traditional methods. However, in Industry 4.0, data collection and analysis are automated using Cyber-Physical Systems (CPS) and Internet of Things (IoT) devices.
- These devices can collect data from various sources, such as sensors on machinery, production lines, or even wearable devices. The data is then analyzed using advanced analytics techniques, including artificial intelligence and machine learning algorithms. This automation allows for real-time monitoring, predictive maintenance, and optimization of processes, leading to better decision-making.

### ➤ Connectivity:

- In the current industry, different systems within a manufacturing environment are often isolated and disconnected from each other. This means that data is not shared between systems, limiting the ability to gain insights and make informed decisions. However, in Industry 4.0, there is a strong emphasis on connectivity and interoperability.
- Through the use of technologies like the Industrial Internet of Things (IIoT), systems, machines, and devices can communicate and share data in real time. This enables a seamless flow of information across the entire manufacturing value chain, from suppliers to customers. The connectivity provided by Industry 4.0 enables better coordination, synchronization, and

optimization of processes, leading to increased efficiency and improved decision-making.

➤ **Autonomation (Automation + Automation):**

- In the current industry, many tasks are still performed manually by human workers. However, Industry 4.0 introduces a higher degree of automation through technologies such as robotics, artificial intelligence, and advanced control systems. This shift toward <sup>143</sup>autonomation, also known as "smart automation," aims to automate repetitive and mundane tasks, allowing human workers to focus on more strategic and creative activities.
- Industrial robots can perform complex operations with precision, speed, and consistency, improving productivity and reducing errors. Automation also enables the integration of production processes, optimizing the flow of materials and reducing downtime. Additionally, with the use of AI and machine learning, autonomous systems can learn from data, adapt to changing conditions, and make autonomous decisions, further enhancing efficiency and productivity.
- These are some of the key differentiators between the current industry and Industry 4.0. By leveraging data, connectivity, and automation, Industry 4.0 aims to transform manufacturing processes and drive significant improvements in productivity, cost-efficiency, quality, flexibility, and sustainability.

The current industrial landscape is characterized by a number of challenges, including:

- Increasing competition from globalized markets
- Rising labor costs
- The need to comply with stricter environmental regulations
- Economic Volatility
- Changing Workforce Dynamics
- Resource Scarcity
- Intellectual Property Protection
- Customer Demands, Expectations and Experience
- Sustainable Supply Chain Management

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Industry 4.0 technologies offer the potential to address these challenges by:

- Increasing productivity and efficiency
- Reducing costs

- Increasing flexibility
- Reducing environmental impact
- Operational Complexity
- Inventory Management
- Demand Forecasting and Planning
- Maintenance and Asset Management
- Data Security and Privacy
- Adaptability to Market Changes

## 1.5 Industry 4.0 Providers In India

### 1.5.1 SERVICE PROVIDERS FOR INDUSTRY 4.0:

COMPANY DETAILS	SERVICES PROVIDED	CLIENTS
<p><b>1. ELDE Info Solutions Pvt. Ltd.</b></p> <p>We are a consulting company that helps businesses improve their efficiency using advanced technology. Our team focuses on achieving operational excellence for organizations. We understand how to make large IT projects successful and profitable. We create solutions that work well with your existing systems, providing a smooth experience for users and valuable information for decision-makers.</p> <p><b>Address</b></p> <p>59 359 A to Z Industrial Premises, G. K. Marg, Lower Parel, Mumbai - 400 013 India</p> <p><b>Contact Details:</b></p> <p>Name: Nishant Desai Phone No.: +91 9820068892</p>	<ul style="list-style-type: none"> <li>• IIoT - Industrie 4.0 standard</li> <li>• Smart Manufacturing Execution Systems</li> <li>• Simplified Business Process Management with Low Code/No Code</li> <li>• AI and ML-powered Data Analytics for insightful reporting</li> <li>• Integration of operational technology with MODBUS, OPC, MQTT, etc.</li> <li>• Integration of software technologies with Web Service, API, SFTP, etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Cummins India Ltd.</li> <li>• Berger Becker Pvt. Ltd.</li> <li>• Chowgule Group</li> <li>• Angre Port Pvt. Ltd.</li> <li>• Fossil India Pvt. Ltd.</li> </ul>

<p>Email Id: nd@elde.tech</p> <p><b>Website:</b></p> <p><a href="https://www.elde.tech/">https://www.elde.tech/</a></p>		
<p><b>2.M/s Phooltas Transrail Limited</b></p> <p>We are a prominent company in the world that specializes in manufacturing, leasing, and contracting equipment for railway track and overhead equipment (OHE) construction, maintenance, and inspection. Our company is certified with ISO 9001:2015 and CE, ensuring that all our products meet international standards. We offer a comprehensive product support program that includes installation, commissioning, training, and warranty. If requested, we can also provide operation and maintenance services. Phooltas equipment has been successfully used on Indian Railways (IR) and metro systems for the past three decades..</p> <p><b>Address</b></p> <p>'Layak Enclave' East Sahay Nagar, Phulwari Sharif, Patna, Bihar, India. 801506</p> <p><b>Contact Details:</b></p> <p>Name: VN Singh</p> <p>Phone No.: +91-9334126311</p> <p>Email Id: vns@phooltas.org</p> <p><b>Website:</b><a href="https://phooltas.org/">https://phooltas.org/</a></p>	<ul style="list-style-type: none"> <li>● DB - Overhead Equipment (OHE) measurement systems</li> <li>● DMA - Non-contact OHE measurement systems and measurement systems for track, turnouts, and crossings geometry</li> <li>● Transurb - Integration, training, and certification for ERTMS/ETCS</li> <li>● ERTM Solutions - Tools for commissioning, maintenance, and health checks of ETCS Level I and II systems.</li> </ul>	<ul style="list-style-type: none"> <li>• L&amp;T</li> <li>• AFCONS</li> <li>• RVNL</li> <li>• KEC</li> <li>• Indian Railways</li> <li>• All Metro Railways</li> </ul>
<p><b>3.TÜV Rheinland India Pvt Ltd</b></p> <p>TÜV Rheinland is a trusted and respected company that focuses on safety and</p>	<ul style="list-style-type: none"> <li>● Pressure equipment</li> <li>● Lifting equipment and machinery</li> </ul>	

<p><sup>25</sup> quality in various industries and aspects of life. With a history of nearly 150 years, the company has become a global leader in testing services. It has a team of over 21,400 highly skilled professionals and generates annual revenues of 2.1 billion euros. TÜV Rheinland's experts conduct rigorous tests on technical systems and products worldwide. They also support technological and business innovations, provide training in various professions, and certify management systems according to international standards. Their independent expertise builds trust in products and processes across global value chains and trade.</p> <p><b>Address:</b></p> <p><sup>147</sup> TÜV Rheinland India Pvt Ltd. 27/B, 2nd Cross Road, Electronic City Phase I, Bangalore 560100, India</p> <p><b>Contact Details:</b></p> <p>Phone No.: +91-8046498074</p> <p>Website: <a href="https://www.tuv.com/india/en/">https://www.tuv.com/india/en/</a></p>	<p><sup>97</sup></p> <ul style="list-style-type: none"> <li>● Electrical engineering and automation</li> <li>● Industrial inspection</li> <li>● Infrastructure and civil engineering</li> <li>● Energy and environmental project management</li> <li>● Material testing and non-destructive testing (NDT)</li> <li>● Cybersecurity and functional safety</li> </ul>	
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### 1.5.2 Technology Provider for Industry 4.0:

COMPANY DETAILS	TECHNOLOGIES PROVIDED	CLIENTS
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<p><b>1.AceMicromatic Manufacturing Intelligence Technologies Pvt. Ltd. (AmiT)</b></p> <p>Ace Micromatic MIT (AmiT) is a pioneering and leading company in India that specializes in Industry 4.0 and Smart Manufacturing Industrial IoT solutions. Our solutions, developed by experienced industry experts, have helped businesses significantly increase their productivity and profits.<sup>18</sup> We offer a comprehensive range of Industry 4.0 solutions, including real-time data acquisition from various production assets, TPM-Trak Advanced Analytics and Intelligence, eSHOPx Digital Factory, traceability and genealogy systems, online quality control with automated corrections, MachineConnect for predictive maintenance, visual factory solutions, advanced workflows, and seamless integration with enterprise systems like ERP. With our extensive domain expertise and widespread presence, we deliver products that are specifically designed and perfected through practical implementation on shop-floors. Our solutions have been successfully deployed by over 100 organizations across multiple industries, with more than 15,000 licenses in use. Guided by strong ethical principles and values, we form reliable partnerships with our customers, acting as a trusted technology leader to support their growth and digital transformation journey.</p> <p><b>Address:</b></p> <p><sup>87</sup> 7th Floor, 'Brigade Rubix'   20, HMT Watch Factory Road  </p>	<ul style="list-style-type: none"> <li>•Factory Digitisation / Digital Factory</li> <li>• Industry 4.0</li> <li>• Cloud</li> <li>• Production Analytics over Web</li> <li>• AI</li> <li>• ML</li> </ul>	<p>L &amp; T</p> <ul style="list-style-type: none"> <li>• Triveni Turbines</li> <li>• Trelleborg</li> <li>• SONA BLW</li> <li>• TAFE</li> </ul>
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Email:[AMITSales@academicromatic.com](mailto:AMITSales@academicromatic.com)

Website  
<http://www.amitpl.com/>

**2.Amplio Global Inc.**

Amplio Global Inc. is a company that uses AI technology to help organizations navigate the fast-paced digital world. Their unique platform, which is based in the cloud and driven by data and design, empowers businesses to take charge of their future. It allows them to set and measure their own strategies, improve connections, increase transparency, rethink their value chain, enhance relationships with customers and suppliers, and revitalize their company culture. Established in 2018, Amplio Global Inc. is based in New Jersey and has offices worldwide, including in India, Europe, Singapore, and Israel.

**Address:**

121  
Address 62,63,64, Unit 5, Lakshmi Towers, Nobel Residency, Begur Road Off Bannerghatta Road, Bangalore, India 560076

**Contact Details:**

Name: Sonya P Banerjee Email

- Cloud
- AI/ML
- Data Lake
- Microservices
- UX/UI Design
- AmpMarking
- Capability Modeling
- Performance Measuring
- Design Thinking
- Roadmapping

- YPO
- Scripps
- Harley Davidson
- Tiffany
- Delphi

<p>Email Id: sonyap.banerjee@amploglobal.com</p> <p><b>Website:</b> <a href="https://www.amploglobal.com/">https://www.amploglobal.com/</a></p>		
<p style="text-align: right;">79</p> <p><b>3. Chipster Technologies Pvt Ltd</b></p> <p>Chipster is a product development company specializing in Industrial IoT, located in Bangalore, India. We have created a platform called Crunch™, a cloud-based solution that enables manufacturing companies to digitize their operations. By using this platform, companies can eliminate paper-based processes and achieve improved Overall Equipment Effectiveness (OEE) through effective monitoring of machines and assets. Additionally, Chipster collaborates with machine manufacturers to make<sup>80</sup> their machines "smart" by offering Industry 4.0 solutions to their customers. These solutions provide valuable insights to original equipment manufacturers (OEMs) regarding the performance of their machines in the field. Our product is designed to address the specific challenges faced by both customers and OEMs, ensuring it meets their needs effectively.</p> <p><b>Address:</b></p> <p>#328, 3rd Main, 1st Cross, RT Nagar, Bangalore – 560032</p> <p><b>Contact Details:</b></p>	<p>IoT Hardware Solutions</p> <ul style="list-style-type: none"> <li>• Edge Computing Solutions</li> <li>• Cloud Application</li> <li>• Industrial Data Analytics</li> </ul>	<ul style="list-style-type: none"> <li>• Ashirvad Pipes</li> <li>• Vignesh Polymers</li> <li>• United Industries</li> <li>• Lumax Industries</li> </ul>

<p><b>Name:</b> Nachiketh G Rao  <span style="background-color: #0070C0; color: white; padding: 2px 5px;">112</span>  <b>Phone No.:</b> +91 – 9886408090  <b>Email Id:</b> <a href="mailto:nachiketh@chipster.in">nachiketh@chipster.in</a>  <b>Website:</b> <a href="http://www.chipster.in/">http://www.chipster.in/</a></p>		
<p><span style="background-color: #C0A080; color: black; padding: 2px 5px; font-size: small;">79</span></p> <p><b>4.Cosmos Impex (India) Pvt. Ltd.</b></p> <p>Founded in 1987, COSMOS Group is a leading company in the Machine Tools industry. They specialize in:</p> <ul style="list-style-type: none"> <li>• Industry 4.0 solutions, including IoT</li> <li>• Manufacturing and marketing of CNC Machine Tools</li> <li>• Production of Machine Tool Accessories</li> <li>• Manufacturing of High Precision Components</li> </ul> <p>With a Group Turnover of over USD 52 million and exports exceeding USD 9.5 million, COSMOS Group aims to become a USD 100+ million company within the next 3 years.</p> <p><b>Address:</b> 85/2, COSMOS HOUSE, Atladra, Padra Road, Vadodara – 390012</p> <p><b>Contact Details:</b></p> <p><span style="background-color: #0070C0; color: white; padding: 2px 5px;">112</span>me: Mr. Aditya Shah  <b>Phone No.:</b> +91 9099027084  <b>Email Id:</b> <a href="mailto:aditya@cosmos.in">aditya@cosmos.in</a></p> <p><b>Website:</b> <a href="http://www.cosmos.in/">http://www.cosmos.in/</a></p>	<p>Machine Monitoring – CNC / PLC / Conventional</p> <ul style="list-style-type: none"> <li>• IOT solutions</li> <li>• Industry 4.0 Software's</li> <li>• Productivity Improvement</li> </ul>	<ul style="list-style-type: none"> <li>• Aequus Aerospace (SEZ)</li> <li>• Lohia Corp</li> <li>• Rochling Engineering Plastics</li> <li>• Mitsubishi Heavy IndustriesVST Diesel Engines Pvt. Ltd.</li> <li>• Weatherford Drilling &amp; Production Services</li> </ul>
<p><b>5.Deepti Electronics &amp; Electro-Optics Private Limited.</b></p>	<ul style="list-style-type: none"> <li>• Sensing</li> <li>• Electro-Optics</li> <li>• Laser</li> </ul>	<ul style="list-style-type: none"> <li>• IGI Airport</li> <li>• L&amp;T</li> <li>• Mahindra</li> </ul>

<p>DELOPT, a part of the JK Organisation, is a highly reputable company with certifications such as AS9100D, ISO9001<sup>267</sup> and CEMILAC. They specialize in Defence Electronics, Avionics, and Electro-Optics products and solutions.</p> <p>With a strong expertise of over 20 years in Military Avionics and various advanced technologies, DELOPT has developed exceptional products like Thermal Sights, Stabilized Electro-Optic Sight Payloads, On-Board Computers, and more for underwater systems and naval operations.</p> <p>In addition to their military contributions, DELOPT is expanding its focus to other sectors including Industrial Automation &amp; Robotics, Mobility &amp; Transportation, Public Safety/Security/Surveillance, Smart Cities, Healthcare, and Space. They are well-positioned to provide solutions in these domains and are actively involved in the emerging fields of Sensors, IoT, Analytics, and C4ISR.</p> <p>DELOPT collaborates with leading platform integrators in Industrial Automation, Transportation, Building Management, and Communication to deliver optimal solutions with agility and customer-centricity. Their aim is to grow globally and make significant contributions in these innovative areas.</p> <p><b>Address:</b></p> <p>76  #3&amp;4, 1st Cross, 7th Main, J C Industrial Area, Off. Kanakapura Main Road, Bengaluru – 560062, Karnataka</p>	<ul style="list-style-type: none"> <li>• Thermal Imaging</li> <li>• Video Analytics</li> <li>• IoT</li> <li>• Application Interface</li> <li>• Analytics</li> <li>• People Counting</li> <li>• Sensors / Electronics / Software / IoT / Network &amp; Communication/ Situational Awareness &amp; Cognitive UI</li> <li>• Analytics &amp; BI</li> <li>• Cyber Security &amp; UAV / Remote Platforms</li> </ul>	<ul style="list-style-type: none"> <li>• TASL</li> <li>• Reliance</li> </ul>
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<p><b>Contact Details:</b></p> <p>Name: Mr. Naivedhya Suryawanshi Email Id: naivedhya@delopt.co.in</p> <p><b>Website</b> <a href="http://www.delopt.co.in/">http://www.delopt.co.in/</a></p>		
<p><b>6. Entrib Analytics Technology Pvt. Ltd. (ShopWorx)</b></p> <p>Entrib Analytics Technology is a startup based in Pune that has quickly expanded its operations in India, China, Thailand, and Singapore. With their flagship product called "ShopWorx," Entrib is revolutionizing the manufacturing industry.</p> <p>ShopWorx is a comprehensive set of smart factory applications designed to enhance visibility and efficiency on the manufacturing shop floor. It has successfully digitized and transformed more than 3000 assets, and in just the past 4 years, it has monitored over 8 billion parts.</p> <p>Entrib's innovative approach and the success of ShopWorx have made them a prominent player in the industry, enabling manufacturers to optimize their operations and achieve higher levels of productivity and performance.</p> <p><b>Address:</b></p> <p>Office no. 6, Revati Arcade II, Opposite Kapil Malhar, Baner Road, Pune – 411045</p> <p><b>Contact Details:</b></p> <p>Name: Kiran Nataraj Email Id: <a href="mailto:kiran@entrib.com">kiran@entrib.com</a></p>	<ul style="list-style-type: none"> <li>● Production Insights: This includes monitoring and analyzing manufacturing processes in various industries such as discrete manufacturing, continuous manufacturing, assembly lines, and machining shops.</li> <li>● Process Monitoring and Insights: This involves tracking critical-to-quality (CTQ) parameters in specific processes like paint shops and pharmaceuticals to ensure quality control and optimization.</li> <li>● Maintenance Management: This encompasses scheduling and tracking of predictive and preventive maintenance activities to minimize downtime and ensure equipment reliability.</li> <li>● Quality Inspection: This covers inspections of parts and batches, adherence to standard operating procedures (SOPs) for quality checks, and verification of raw material receipts and packaging integrity.</li> <li>● Utility Insights: This focuses on monitoring and</li> </ul>	<ul style="list-style-type: none"> <li>• Hero</li> <li>• Bajaj</li> <li>• Tata</li> <li>• Carrier</li> <li>• Prince Pipes</li> <li>• Automat</li> <li>• DLJM</li> <li>• ITC</li> <li>• Kangaro</li> </ul>

<p><b>Website:</b>  <a href="https://shopworx.io/">https://shopworx.io/</a></p>	<p>analyzing the consumption and performance of utility systems such as chillers, generators, compressors, and parameters like water, air, gas, electricity, and steam (W.A.G.E.S), as well as environmental factors like temperature and moisture.</p> <ul style="list-style-type: none"> <li>● Traceability: This involves tracking the history and lineage of child parts and batches, along with recording process steps and parameters to ensure product traceability and compliance.</li> <li>● Analytics and Insights: This refers to the use of advanced analytics techniques to analyze data collected from various sources, providing valuable insights for decision-making and process optimization</li> </ul>	
<p><b>7.Festo<sup>58</sup> India Private Limited</b>  Festo is a global leader in automation technology and technical training. With a strong emphasis on maintaining local presence, we have established our own companies worldwide, forming a network of over 21,000 experts who contribute their expertise every day. This makes us a key player in our industry and enables us to keep the world moving. Through our connection between industry and education, we assist customers globally in enhancing their productivity. Festo Didactic, specifically, is a world market leader in industrial education, providing equipment for technical</p>	<ul style="list-style-type: none"> <li>• Pneumatic Automation</li> <li>• Electric Automation</li> <li>• Digital Automation</li> <li>• Industry 4.0</li> </ul>	<ul style="list-style-type: none"> <li>• BHEL</li> <li>• TEAL</li> <li>• CONTINENTAL.</li> <li>• MARUTI SUZUKI</li> <li>• BOSCH</li> </ul>

<p>training institutes and offering training and consultancy services to manufacturing companies.</p> <p><b>Address:</b></p> <p>237B, Hosur Road, Bommasandra Indl.area, Bengaluru – 560099</p> <p><b>Contact Details:</b></p> <p>Name: Karthik V Designation: Sr.Officer Marketing</p> <p><b>Website:</b> <a href="http://www.festo.in/">http://www.festo.in/</a></p>		
<p><b>8.Fluke Networks</b></p> <p>Fluke Networks is the global leader in providing certification, troubleshooting, and installation tools for professionals involved in maintaining and installing network cabling infrastructure. Our solutions cater to a wide range of environments, from cutting-edge data centers to challenging manufacturing settings. With a reputation for reliability and superior performance, our products enable efficient completion of tasks. Our flagship offering, LinkWare™ Live, is an innovative cloud-connected cable certification solution that has already recorded over twenty million results</p> <p><b>Address:</b></p> <p>Fluke Networks Indique – Brigade Opus 4th Floor, Office “B” 2286, Kodigehalli Main Road, Sanjeevini Nagar, Bengaluru – 560 092, Karnataka India</p> <p><b>Contact Details:</b></p>	<p>Market leader in Physical Media Testing / Troubleshooting / Certification &amp; Compliance testing as per latest International standards.</p> <ul style="list-style-type: none"> <li>• BEL</li> <li>• Rockwell</li> <li>• L &amp; T.</li> <li>• BHEL</li> <li>• ABB</li> </ul>	

<p>Name: Sachin Sehgal Phone No.: 9871398733</p> <p><b>Website:</b> <a href="http://www.flukenetworks.com/">http://www.flukenetworks.com/</a></p>	
<p><b>9.Happy Visitor eSolutions Private limited</b></p> <p>Happy Visitor is a cloud-based Front Office Automation Suite that offers comprehensive process automation, bringing improved control, tracking, safety, and monitoring to various processes. It covers a wide range of functions, including Visitor Management, Gate pass Management for material movement, Work permit management, Delivery vehicle management, Contractor Movement tracking, Employee Day Pass, Courier/mail room management, Registers Digitisation, and Consumable inventory management. The platform is hardware agnostic and holds certifications such as ISO 27001, GDPR compliance, and Infosec validation by renowned Fortune 500 brands. Happy Visitor has a proven track record with over 800 successful installations, processing over 50 million visitors, issuing 3 million Material Gate passes and 100,000 work permits. Additionally, it has successfully digitized over 5,000 registers and contributed to saving 10,000+ trees. Trusted by leading Fortune 500 brands across various industries globally.</p> <p><b>Address:</b></p>	<ul style="list-style-type: none"> <li>• Visitor Management</li> <li>• Material movement Gate pass Management</li> <li>• Work permit management • Delivery vehicle management</li> <li>• Contractor Movement tracking</li> <li>• Employee Day Pass</li> <li>• Courier / mail room management</li> <li>• Registers Digitisation (like Keys, occurrence, sanitization, etc.)</li> <li>• Consumable inventory management</li> </ul> <ul style="list-style-type: none"> <li>• Royal Enfield</li> <li>• Bonfiglioli</li> <li>• Danfoss</li> <li>• NATCO Pharma</li> <li>• MTR Foods</li> <li>• Solara</li> <li>• Strides Shasun</li> <li>• Resil</li> <li>• Diageo</li> <li>• VECV</li> <li>• Sensera</li> <li>• Mother Dairy</li> <li>• Dabur</li> <li>• Sterlite Technologies</li> <li>• TVSSL</li> <li>• Eicher</li> </ul>

<p style="text-align: right;">238</p> <p>Unit-4, UGF, Innovator Building, ITPL, Whitefield Road, Bangalore, Karnataka, India – 560066</p> <p><b>Contact Details:</b></p> <p>Name: Mr. Amar Pandhare Designation: Head Sales &amp; Business Development Phone No.: +91 99860 03111 Email Id: sales@happy-visitor.com</p> <p><b>Website:</b> <a href="http://www.happy-visitor.com/">http://www.happy-visitor.com/</a></p>		
<p><b>10. Hexagon</b> Hexagon is a worldwide leader in sensor, software, and digital technology solutions. We harness the power of data to enhance quality, efficiency, and productivity in various sectors such as industry, manufacturing, infrastructure, safety, and mobility. Our cutting-edge technologies are driving the evolution of smart manufacturing and smart cities, creating interconnected and autonomous systems. By enabling scalability and sustainability, we are shaping a future that is built to last.</p> <p><b>Address:</b> 179 Hexagon Manufacturing Intelligence A-9 Sector-65 Noida (Uttar Pradesh) 201 301 India</p> <p><b>Contact Details:</b></p> <p>Name: Dr. Kaustubh Nande Phone No.: +91 9742236532 Email Id: kaustubh.nande@hexagon. com</p> <p><b>Website:</b></p>	<ul style="list-style-type: none"> <li>• Q-DAS</li> <li>• Xalt</li> </ul>	<ul style="list-style-type: none"> <li>• Automotive</li> <li>• Aerospace</li> <li>• Electronics</li> <li>• Energy &amp; Power</li> <li>• Machinery &amp; Manufacturing</li> </ul>

<a href="https://www.hexagonmi.com/">https://www.hexagonmi.com/</a>		
<p><sup>204</sup>  <b>11.ifm electronic India Private Limited</b>  ifm electronic India Private Limited, a leading manufacturer in the automation industry, has a global presence with over 7,000 employees in more than 85 countries.  Recognizing the potential of the Indian economy, ifm established its branch in India in 1994, making it one of the pioneering German companies to do so. ifm electronic offers a diverse range of high-quality <sup>181</sup>ducts across various industries such as Machine Tools, Dairy, Food &amp; Brewery, Automobile, Steel &amp; Coal, and Mobile Machines. With more than 25 years of operation in India, ifm electronic India <sup>91</sup>as earned a strong reputation as a trusted brand for sensors and automation technology in the country.</p> <p><b>Address:</b>  <sup>205</sup>  Plot No. P – 39/1, MIDC Gokul Shirgaon, Kolhapur – 416234 MH</p> <p><b>Contact Details:</b>  <sup>91</sup>  Phone No: +91 231 2672770 Toll Free: 1800 233 2065 Email Id: info.india@ifm.com</p> <p><b>Website:</b>  <a href="http://www.ifm.com/in">http://www.ifm.com/in</a></p>	<ul style="list-style-type: none"> <li>• IO-Link</li> <li>• Real-Time Maintenance</li> <li>• Identification System</li> <li>• Industrial Imaging</li> <li>• Process Sensors, etc.</li> </ul> <ul style="list-style-type: none"> <li>• TATA Motors</li> <li>• SAIL</li> <li>• BFW</li> <li>• ACE Manufacturing</li> <li>• Amul</li> <li>• BEML etc.</li> </ul>	
<p><b>12.Integra Software Services Pvt Ltd</b> <sup>248</sup>  Integra is a leading global company that provides comprehensive Digital Content Solutions and Immersive</p>	Immersive Solutions <ul style="list-style-type: none"> <li>• Mixed Reality</li> <li>• Virtual Reality</li> </ul>	

<p style="text-align: right;">79</p> <p>Technology Services. With its headquarters in India and offices in the US and UK, Integra specializes in leveraging technology to enhance human performance. Since its establishment in 1994, Integra has been serving enterprises and education media organizations by delivering content and digital solutions. Integra's dedicated team of experts in various fields, such as Unity3D, Unreal Engine, JavaScript, C#, C++, Python, HTML5, Native &amp; Hybrid App Development, Maya &amp; 3DsMax Artistry, Animation, UI/UX Design, Accessibility, and Quality Assurance, work in their in-house XR Studio. They provide state-of-the-art effective solutions utilizing immersive technologies such as Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and 360° video.</p> <p><b>Address:</b></p> <p>Corporate Headquarters &amp; Principal Delivery Centre 100 Feet Road (ECR), Pakkamudiyarpet, Pondicherry – 605 008, India. Career Enquiries: +91 413 4212124 Business Enquiries: +91 413 4212229 / +91 413 421219</p> <p><b>Contact Details:</b></p> <p>Name: Sriram Subramanya Designation: Founder, CEO and Managing Director Email Id: <a href="mailto:sriram.subramanya@integra.co.in">sriram.subramanya@integra.co.in</a></p> <p><b>Website:</b> <a href="http://www.integra.co.in/">http://www.integra.co.in/</a></p>	<ul style="list-style-type: none"> <li>• Augmented Reality • 360 degree videos</li> <li>• Digital Transformation Solutions</li> <li>• Software Engineering Services</li> <li>• Cloud Migration</li> <li>• Testing</li> <li>• DevOps</li> <li>• Application development and modernization</li> </ul>	
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<p><b>13. Microsoft Corporation India Pvt. Ltd.</b></p> <p>Microsoft, founded in 1975, is a leading platform and productivity company dedicated to empowering individuals and organization<sup>34</sup> worldwide. With a focus on the mobile-first, cloud-first world, Microsoft's mission is to help everyone achieve more. Since establishing its presence in India in 1990, Microsoft has grown its operations significantly. Today, Microsoft has over 11,000 employees in India, working in various roles such as sales, marketing, research, development, and customer support. They are located across 11 cities in India, including Ahmedabad, Bengaluru, Chennai, New Delhi, Gurugram, Noida, Hyderabad, Kochi, Kolkata, Mumbai, and Pune. Microsoft provides global cloud services through local data centers in India, enabling the acceleration of digital transformation for Indian startups, businesses, and government organizations.</p> <p><b>Address:</b>  <sup>43</sup>Level 10, Tower C, DLF EPITOME  Building No. 5 DLF Cyber City,  Phase III Gurugram 122002,  Haryana Country: IN</p> <p><b>Contact Details:</b>  Name: C<sup>258</sup>hu Sharma Email Id:  chshar@microsoft.com</p> <p><b>Website:</b>  <a href="https://www.microsoft.com/en-in/">https://www.microsoft.com/en-in/</a></p>	Industry 4.0 Technologies	
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<p><b>Omron<sup>29</sup> Automation Pvt. Ltd</b>  Based in Kyoto, Japan, OMRON Corporation stands as a diversified, multi-billion-dollar company with various business units specializing in industrial automation products, electronic components, healthcare equipment, and social system solutions. Within OMRON, the Industrial Automation business<sup>29</sup> unit holds a prominent position as a global leader, delivering comprehensive automation solutions for industrial applications. This unit revolutionizes manufacturing sites by incorporating "Integrated," "Intelligent," and "Interactive" concepts into its automation processes, boasting an impressive product range encompassing panel components, smart sensors, Vision technologies, PLCs, Servos, Drives, Robots &amp; Cobots, and Machine safety solutions (ILOR+S) technology.</p> <p>122  <b>Address:</b></p> <p>THE QUBE 5th Floor, Unit No. 501 – 504, M V Road, Marol, Andheri (EAST), Mumbai – 400059, Maharashtra, India</p> <p><b>Contact Details:</b></p> <p>Name: RAJARAM S Phone No.: 90030 18647 Email Id: rajaram.s@omron.com</p> <p><b>Website:</b>  <a href="http://www.omron-ap.co.in/">http://www.omron-ap.co.in/</a></p>	<p>By introducing innovation to manufacturing sites, the company revolutionizes automation by incorporating the concepts of "Integrated," "Intelligent," and "Interactive." It boasts one of the world's most sophisticated and extensive product ranges, including panel components, smart sensors, vision technologies, PLCs, servos, drives, robots &amp; cobots, and machine safety solutions (ILOR+S) technology.</p>	<ul style="list-style-type: none"> <li>• Maruti</li> <li>• HUL</li> <li>• Nokia</li> <li>• ABB</li> </ul>

<p><b>Plus Innovations Technologies LLP</b></p> <p>Established in 2014, IdeaBridge, part of Plus Innovations Technologies LLP, serves as an Enterprise Innovation Management Platform catering to global enterprises and institutions with specific objectives, including:</p> <ul style="list-style-type: none"> <li>• Pioneering novel and innovative methods, strategies, products, and more.</li> <li>• Streamlining costs and enhancing savings.</li> <li>• Elevating engagement levels through Rewards &amp; Recognitions.</li> <li>• Markedly improving the employee, research &amp; development, and consumer experience.</li> <li>• Implementing automated business process applications for swift and effective outcomes.</li> </ul> <p>IdeaBridge's core strength lies in its adept management of innovation, consistently pushing the boundaries of peak performance. The platform assists clients in cultivating an innovation-driven culture by empowering their employees to become staunch advocates of innovation and collaboration.</p> <p><b>Address:</b></p> <p>246 Shwas' Pundalik Nagar, Alto-Betim, Bardez, Goa – 403 521 Tel: +91.832.241.436</p> <p><b>Contact Details:</b></p> <p>Name: Manav Kapoor Designation: Chief Business Officer Phone No.:</p>	<p>Ideabridge Enterprise Innovation Platform <sup>25</sup></p> <ul style="list-style-type: none"> <li>• Ideabridge Software As A Service</li> <li>• Ideabridge Platform AS A Service</li> </ul>	<ul style="list-style-type: none"> <li>• VFS Global • Adani Group • Uno Minda Group • CK Birla Group • TAFE Grou</li> </ul>
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<p>9820194157 Email Id: manav@ideabridge.co</p> <p><b>Website:</b> <a href="https://ideabridge.co/">https://ideabridge.co/</a></p>		
<p><b>Rockwell Automation</b></p> <p>Rockwell Automation, Inc. (NYSE: ROK) stands as a prominent worldwide force in the realms of industrial automation and digital transformation. Our mission is to bridge the creative visions of individuals with the transformative power of technology, thereby pushing the boundaries of what humans can achieve. By doing so, we aim to foster greater productivity and sustainability across the globe. With our headquarters based in Milwaukee, Wisconsin, Rockwell Automation proudly employs around 23,000 dedicated problem solvers committed to serving our diverse customer base in over 100 countries.</p> <p><b>Address:</b> 118 Tower 10, DLF Tower 8th Rd, DLF Cyber City, DLF Phase 2, Sector 24, Gurugram, Haryana 122002</p> <p><b>Contact Details:</b></p> <p>Name: Ruchi Mathur Email Id: rmathur@ra.rockwell.com</p> <p><b>Website:</b> <a href="https://www.rockwellautomation.com/en-in.html">https://www.rockwellautomation.com/en-in.html</a></p>	<p>Industrial automation The Connected Enterprise</p>	<ul style="list-style-type: none"> <li>• CIPLA • Reliance • Nestle •</li> <li>MRF • Hindalco</li> </ul>

<p><b>SAP Labs India Pvt. Ltd.</b></p> <p>SAP, as the leading provider of enterprise application software, plays a crucial role in enabling companies of all sizes and across industries to achieve their optimal performance. A staggering 77% of the world's transaction revenue is supported by SAP systems, demonstrating the company's widespread impact. Leveraging cutting-edge technologies such as machine learning, Internet of Things (IoT), and advanced analytics, SAP transforms its customers' businesses into intelligent enterprises. Through a comprehensive suite of applications and services, SAP empowers its customers to operate profitably, adapt seamlessly to evolving challenges, and create a positive impact. With a vast global network comprising customers, partners, employees, and thought leaders, SAP actively contributes to improving the world's operations and enhancing people's lives. SAP has maintained a strong research and development presence in India since 1998, with SAP Labs India serving as the second-largest R&amp;D location globally. This facility plays a significant role in enriching SAP's product portfolio, encompassing crucial areas such as Digital Supply Chain and IoT.</p> <p><b>Address:</b></p> <p>190 #138, EPIP Zone Whitefield Bangalore – 560066 India Phone: +91 80 4139 5139</p> <p><b>Contact Details:</b></p>	<p>cutting-edge Industry 4.0 and IIoT solution</p>	<p>INDEX-Werke Adida Exide</p>
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<p>Name: KG Chandrasekhar  Designation: Vice President Digital Manufacturing SAP Labs India Email Id: chandrasekhar.kg@sap.com</p> <p><b>Website:</b>  <a href="http://www.sap.com/">http://www.sap.com/</a></p>		
<p><b>Siemens Limited</b>  Siemens India is dedicated to electrification, automation, and digitalization, embodying the values of engineering excellence, innovation, and dependability. As a trailblazer in infrastructure and energy solutions, automation, and industrial software, Siemens also holds a prominent position in the field of medical diagnosis.  Within Siemens, the Digital Industries division leads the charge in industrial automation and digitalization. Working closely with our valued partners and customers, we play a pivotal role in spearheading the digital transformation across both discrete and process industries.</p>	Cutting-Edge Industry 4.0 Technologies	<ul style="list-style-type: none"> <li>• Fine Chemicals: Dulux •</li> <li>Pharmaceutical: BioNTech •</li> <li>Automotive: MINO Equipment •</li> <li>Machine Building: Optima Consumer GMBH •</li> <li>Fine Chemicals: Dulux •</li> <li>Pharmaceutical: BioNTech •</li> <li>Automotive: MINO Equipment •</li> <li>Machine Building: Optima Consumer GMBH</li> </ul>
<p><b>SMS India Pvt. Ltd.</b>  SMS digital takes the forefront as a prominent digital solution provider in the metals industry. As a part of the SMS group GmbH, a leading supplier of metallurgical plants and machinery, our focus lies in crafting innovative solutions in the realm of digitalization. With our cutting-edge digital applications, we elevate your plants and machines into the realm of Industry 4.0, merging digitalization expertise with 150 years of profound metallurgical knowledge.</p>	Industry 4.0 solutions	<ul style="list-style-type: none"> <li>• Big River Steel LLC •</li> <li>ArcelorMittal • Salzgitter AG •</li> <li>Tata Steel IJmuiden BV</li> </ul>

<p><b>Address:</b></p> <p>240 286, Udyog Vihar Phase – II, GURGAON 122016 Haryana</p> <p><b>Contact Details:</b></p> <p>Name: Atanu Dey Designation: Vice President Phone No.: + 91 (0) 124 / 473 1833 Email Id: atanu.dey@sms-group.com</p> <p><b>Website:</b> <a href="http://www.sms-group.com/">http://www.sms-group.com/</a></p>		
<p><b>Tally Solutions Private Limited</b></p> <p>At Tally, our core belief lies in harnessing the potential of technology to enhance your efficiency, empower you, and contribute to your overall happiness, allowing you to concentrate on what truly matters for your business. We recognize that each business has its unique requirements and distinct working style. Therefore, we have developed the all-new TallyPrime to be highly adaptable, catering specifically to your business needs and instilling confidence in your transition to a digitized approach to business management.</p> <p>TallyPrime stands as a comprehensive business management software, covering all aspects of accounting, inventory management, compliance, and payroll requirements. Renowned for its unmatched speed, user-friendly simplicity, unwavering reliability, and remarkable flexibility, TallyPrime ensures that your business management processes are seamless and efficient.</p>	<ul style="list-style-type: none"> <li>• Industry 4.0 Technologies</li> <li>• Proprietary software product</li> </ul>	<ul style="list-style-type: none"> <li>• MSME • Government &amp; Enterprises</li> </ul>

<p><b>Address:</b></p> <p>101 AMR Tech Park II, No.23 &amp; 24, Hongasandra, Hosur Main Road, Bangalore 560 068, India Customer Care: 1800 425 8859</p> <p><b>Contact Details:</b></p> <p>Name: Harish Rajput Designation: Head – Government Sales &amp; Large Accounts Phone No.: 9878430505 Email Id: harish.rajput@ tallysolutions.com</p> <p><b>Website:</b> <a href="http://www.tallysolutions.com/">http://www.tallysolutions.com/</a></p>		
<p><b>Websym Solutions Pvt Ltd</b> Established in 2015, Websym Solutions has emerged as a prominent provider of Industrial Internet of Things (IIOT) solutions for manufacturing organizations and original equipment manufacturers (OEMs) worldwide. Our extensive technological expertise has consistently delivered tangible value to manufacturers, industrial OEMs, businesses focusing on connected products, and Smart City projects. Our flagship products, Factorywize 261 Tezeva, empower organizations to offer comprehensive end-to-end digital solutions to their customers, aligning with their digitization objectives. By leveraging our 58 solutions, organizations can harness the potential of big data and analytics to drive performance improvement, enforce enhanced compliance, and achieve greater returns on investment. Websym takes pride in its position as a Microsoft &amp; AWS ISV partner for</p>	<p>IIOT Platform technologies for Manufacturing (FaktoryWize) and OEMs (Tezeva) built on Azure and AWS cloud infrastructure</p>	<ul style="list-style-type: none"> <li>• Piramal Glass • TEAL • DEIF</li> <li>• Jyothy labs • Fiat Chrysler</li> </ul>

<p>IIOT solutions, backed by robust domain experience across multiple manufacturing industry verticals and strong ecosystem partnerships.</p> <p><b>Address:</b></p> <p>76 Plot No 34/2, Rajiv Gandhi IT Park, Phase 1, Hinjewadi, Pune, Maharashtra 411057</p> <p><b>Contact Details:</b></p> <p>Name: Ashish Nene Designation: CEO, Websym Solutions Email Id: ashish@websym.com</p> <p><b>Website:</b> <a href="http://www.websym.com/">http://www.websym.com/</a></p>		
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### 1.5.3 Startups:

NAME	LINK	REFERENCE
<p>Pratiti Technologies (Company Providing Industry 4.0 techs to factories)</p> <p>Pratiti Technologies, an India-based firm, develops and sells digital twin data analytics tools for solar power infrastructure.</p>	<a href="https://www.pratititech.com/">https://www.pratititech.com/</a>	<a href="https://indiaai.gov.in/article/five-interesting-digital-twin-startups-in-india#:~:text=Pratiti%20Technologies,root%20cause%20analysis.">https://indiaai.gov.in/article/five-interesting-digital-twin-startups-in-india#:~:text=Pratiti%20Technologies,root%20cause%20analysis.</a>
<p>Paninian (AI Based Company for Aerospace)</p> <p>Paninian develops the digital twin platform for next generation aerospace products and services</p>	<a href="https://www.paninian.com/airvoxels-digitaltwin">https://www.paninian.com/airvoxels-digitaltwin</a>	<a href="https://indiaai.gov.in/article/five-interesting-digital-twin-startups-in-india#:~:text=Paninian,3%20%9312%20KN.">https://indiaai.gov.in/article/five-interesting-digital-twin-startups-in-india#:~:text=Paninian,3%20%9312%20KN.</a>

SwitchOn (Automated Quality Inspection service provider company)  SwitchOn is a cutting-edge technology company that uses digital twins to foresee production outcomes	<a href="https://switchon.io/">https://switchon.io/</a>	<a href="https://indiaai.gov.in/article/five-interesting-digital-twin-startups-in-india#:~:text=SwitchOn%20is%20a,generating%20digital%20twins.">https://indiaai.gov.in/article/five-interesting-digital-twin-startups-in-india#:~:text=SwitchOn%20is%20a,generating%20digital%20twins.</a>
Twin Health:	<a href="https://ind.twinhealth.com/">https://ind.twinhealth.com/</a>	54 <a href="https://analyticsindiamag.com/top-digital-twin-startups-in-india#:~:text=Twin%20Health%20invented,to%2Duse%20app.">https://analyticsindiamag.com/top-digital-twin-startups-in-india#:~:text=Twin%20Health%20invented,to%2Duse%20app.</a>
Genesis	<a href="https://harpsichord-duck-k598.squarespace.com/company-profile">https://harpsichord-duck-k598.squarespace.com/company-profile</a>	54 <a href="https://analyticsindiamag.com/top-digital-twin-startups-in-india#:~:text=Genesys%E2%80%99s%20geospatial%20solutions,Banking%2C%20and%20Insurance.">https://analyticsindiamag.com/top-digital-twin-startups-in-india#:~:text=Genesys%E2%80%99s%20geospatial%20solutions,Banking%2C%20and%20Insurance.</a>
Intangles  Digital twins for automobiles	<a href="https://www.intangles.ai/">https://www.intangles.ai/</a>	54 <a href="https://analyticsindiamag.com/top-digital-twin-startups-in-india#:~:text=Intangles%20provides%20accurate,from%20the%20office.">https://analyticsindiamag.com/top-digital-twin-startups-in-india#:~:text=Intangles%20provides%20accurate,from%20the%20office.</a>
TwinGrid  TwinGrid is developing Digital twin technology to digitalize Power Distribution Utilities.		<a href="https://www.f6s.com/company/twingridlabs#about:~:text=%E2%80%9CToday%E2%80%99s%20energy%20grids.Power%20Distribution%20Utilities.">https://www.f6s.com/company/twingridlabs#about:~:text=%E2%80%9CToday%E2%80%99s%20energy%20grids.Power%20Distribution%20Utilities.</a>
109  Twin Health: Twin Health invented the 'Whole Body Digital Twin' to help reverse and prevent chronic metabolic diseases	<a href="https://ind.twinhealth.com/">https://ind.twinhealth.com/</a>	54 <a href="https://analyticsindiamag.com/top-digital-twin-startups-in-india#:~:text=Twin%20Health%20invented,to%2Duse%20app.">https://analyticsindiamag.com/top-digital-twin-startups-in-india#:~:text=Twin%20Health%20invented,to%2Duse%20app.</a>

<p>MapmyIndia</p> <p><sup>48</sup> MapmyIndia to builds first Digital Map Twin of Real World (Initiated 2017)</p>	<p><a href="https://www.mappls.com/@jcattoll,qcslvsja,lbjqslsfjsfsfvsvt,l,f,f,f,f,f,fzdata">https://www.mappls.com/@jcattoll,qcslvsja,lbjqslsfjsfsfvsvt,l,f,f,f,f,f,fzdata</a></p>	<p><sup>48</sup><a href="https://about.mappls.com/blog/mapmyindia-builds-first-digital-map-twin-of-real-world-releases-intelligent-multi-lingual-hybrid-map-keyboard-app-with-map-and-eloc-integrated-and-announces-isro-idea-cellular-and/">https://about.mappls.com/blog/mapmyindia-builds-first-digital-map-twin-of-real-world-releases-intelligent-multi-lingual-hybrid-map-keyboard-app-with-map-and-eloc-integrated-and-announces-isro-idea-cellular-and/</a></p>
<p>NOVAC (AR Services)</p> <p><sup>88</sup> NOVAC can create AR/VR training courses for manufacturing companies to train their employees in machine designs, product designs, plant layouts, safety lessons.</p>	<p><a href="https://www.novactech.in/arvr-manufacturing/">https://www.novactech.in/arvr-manufacturing/</a></p>	
<p><sup>51</sup> SOLULAB(AR APP Development Company)</p>	<p><a href="https://www.solulab.com/ar-app-development-company/">https://www.solulab.com/ar-app-development-company/</a></p>	
<p>Ediiie (AR/VR Service Provider)</p>	<p><a href="https://www.ediiie.com/">https://www.ediiie.com/</a></p>	
<p><sup>117</sup> Group: Harnessing the Power of AR/VR To Tackle Assembly and Maintenance Challenges in Smart Factories</p>		<p><a href="http://investors.esi-group.com/news/harnessing-the-power-of-arvr-to-tackle-assembly-and-maintenance-challenges-in-smart-factories">http://investors.esi-group.com/news/harnessing-the-power-of-arvr-to-tackle-assembly-and-maintenance-challenges-in-smart-factories</a></p>
<p>FUSION VR</p>		<p><a href="https://www.fusionvr.in/?gclid=CjwKCAjwm4ukBhAuEiwA0zQxkw2QZz30xOgm6qINDkFbDkIEMfulb3gbuxUxxneDvkw3la7rl_cRoCzJ0QAvD_BwE#:~:text=Fusion%20VR%20is,the%20Immersive%20Metaverse.">https://www.fusionvr.in/?gclid=CjwKCAjwm4ukBhAuEiwA0zQxkw2QZz30xOgm6qINDkFbDkIEMfulb3gbuxUxxneDvkw3la7rl_cRoCzJ0QAvD_BwE#:~:text=Fusion%20VR%20is,the%20Immersive%20Metaverse.</a></p>

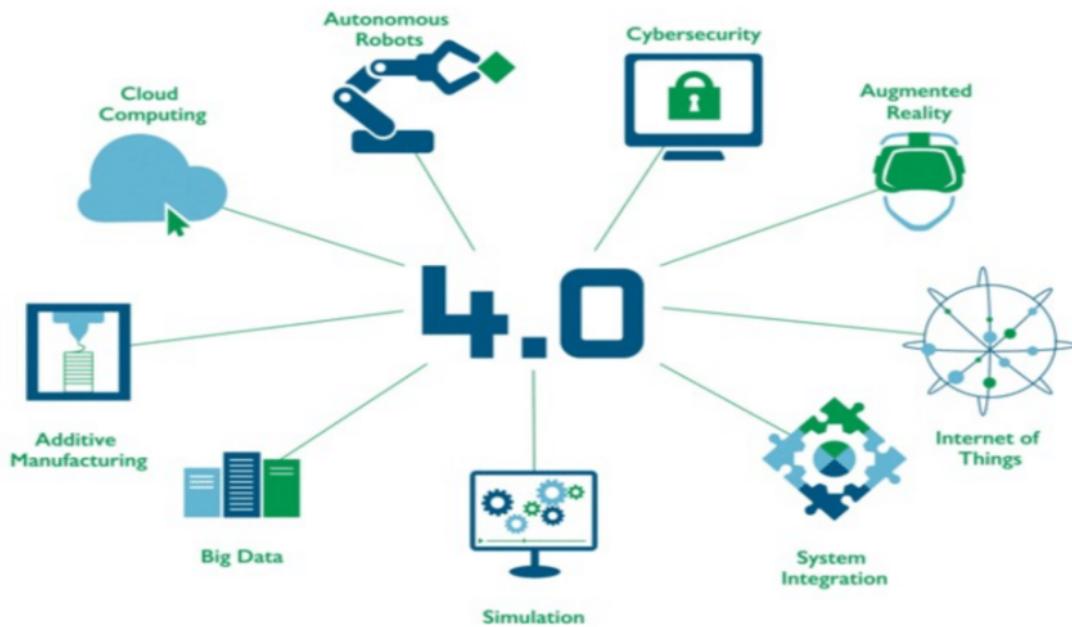
### Visit:

1. <https://indiaai.gov.in/startup/all>
2. [Startups – Nasscom CoE IoT](#)
3. [Top 10 IoT Startups In India | 2023 List](#)

## 2. Industry 4.0 Practices: Let's dive deeper into each of the Industry 4.0 practices

### 2.1 Exploring Smart Manufacturing Technologies

Following Technologies <sup>264</sup> are the building blocks of Industry 4.0, these are known as the smart manufacturing technologies:



#### 1. Cyber-Physical Systems (CPS):

Cyber-Physical Production Systems (CPPS), Advanced Cyber-Physical Systems (ACPS): <sup>57</sup> CPS, CPPS, and ACPS refer to the integration of physical systems (such as machines, equipment, and devices) with digital systems (such as sensors, software, <sup>108</sup> connectivity). These systems create a feedback loop where data is collected from physical assets, analyzed in real-time, and used to make autonomous or optimized decisions to improve manufacturing processes.

<sup>71</sup> 2. Internet of Things (IoT) and Industrial Internet of Things (IIoT): IoT and IIoT involve the interconnection of physical devices, machines, and systems, enabling them

to collect and exchange data. IoT allows for seamless connectivity and communication between various components in a manufacturing environment. IIoT specifically focuses on the application of IoT in industrial settings, enabling real-time data collection, remote monitoring, and control of manufacturing processes.<sup>39</sup>

### **3. Augmented Reality (AR) and Virtual Reality (VR):**

AR and VR technologies enhance human-machine interaction and improve operational efficiency. AR overlays digital information onto the physical environment, providing real-time guidance, instructions, or data visualization to operators. VR, on the other hand, immerses users in a simulated environment, facilitating virtual training, design simulations, or remote collaboration.

### **4. Digital Twin:**

A digital twin is a virtual replica or digital representation of a physical asset, process, or system. It enables real-time monitoring, analysis, and simulation of the physical counterpart, allowing for predictive maintenance, optimization, and performance evaluation. Digital twins facilitate improved decision-making, reduced downtime, and enhanced product development.

### **5. Artificial Intelligence (AI) and Machine Learning (ML):**

AI involves the simulation of human intelligence in machines, enabling them to perform tasks and make decisions. ML is a subset of AI that focuses on algorithms and models that can learn from data<sup>187</sup> and improve their performance over time. AI and ML are used in Industry 4.0 to analyze large volumes of data, identify patterns, make predictions, optimize processes, and enable autonomous decision-making.

### **6. Robotics and Automation (including Drones/UAVs):**

Robotics and automation involve the use of machines, robots, and automated systems to perform tasks traditionally done by humans. This includes assembly, material handling, quality control, and more. Drones or Unmanned Aerial Vehicles (UAVs) are also utilized for inspection, surveillance, and inventory management in manufacturing environments.

### **7. Cybersecurity:**

With increased connectivity and digitization, ensuring robust cybersecurity measures is crucial. Industry 4.0 emphasizes the implementation of security protocols, encryption, access control, and monitoring to protect critical manufacturing systems and data from cyber threats.

138

### 8. Additive Manufacturing (3D Printing):

Additive manufacturing, commonly known as 3D printing, enables the production of complex and customized objects by layering materials based on digital models. It offers advantages such as rapid prototyping, on-demand production, reduced waste, and increased design flexibility.

### 9. Cloud and Edge Computing:

Cloud computing involves the storage, processing, and analysis of data on remote servers accessed through the internet. Edge computing, on the other hand, performs data processing and analytics closer to the source, reducing latency and enabling real-time decision-making. Both cloud and edge computing play vital roles in handling the vast amounts of data generated in Industry 4.0.

137

### 10. Big Data Analytics:

Big data analytics involves extracting insights and patterns from large and complex datasets. In Industry 4.0, big data analytics enables the processing and analysis of massive volumes of data generated from sensors, machines, and various sources. These insights help optimize processes, predict maintenance needs, improve quality, and support data-driven decision-making

5

These technologies collectively form the key elements of Industry 4.0, driving the transformation of traditional manufacturing into smart, connected, and efficient processes.

## 2.2 Exploring Smart Manufacturing Technologies

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### 2.2.1 Data-Driven Decision Making:

Industry 4.0 relies on real-time data analysis to make informed decisions.

**Data Collection:** Sensors, IoT devices, and machines collect vast amounts of data throughout the manufacturing process. This data includes production metrics, equipment performance, quality parameters, and supply chain information.

41

**Data Analysis:** Advanced analytics techniques, including machine learning and statistical algorithms, process the collected data to identify patterns, correlations, and insights. Manufacturers can uncover hidden relationships, predict outcomes, and optimize processes based on data-driven insights.

**Decision-Making Support:** Real-time analytics and visualizations provide decision-makers with actionable information to improve operational efficiency, identify bottlenecks, optimize resource allocation, and respond to market demand. Dashboards and reports present relevant KPIs, trends, and performance metrics for quick and informed decision-making.

49

### 2.2.2 Collaboration between Humans and Machines:

Industry 4.0 emphasizes collaboration between human workers and automated systems.

**Task Allocation:** Humans and machines are assigned tasks based on their respective strengths. Humans focus on tasks that require creativity, problem-solving, complex decision-making, and interpersonal skills. Machines handle repetitive, physically demanding, or precise tasks with speed and accuracy.

2

**Cobots:** Collaborative robots, or cobots, work alongside human operators in a shared workspace. Cobots can assist with assembly, material handling, or inspection tasks, reducing physical strain on workers and improving productivity.

**Human-Machine Interfaces:** Intuitive interfaces and augmented reality tools facilitate interaction between humans and machines. Workers can receive real-time instructions, guidance, or alerts through wearable devices or display screens, enhancing their capabilities and ensuring safety.

### 2.2.3. Flexibility and Agility:

Industry 4.0 enables flexibility and agility to respond to system changes, disruptions, or customer demands.

**Modular Production Systems:** Production systems are designed to be modular, allowing for easy reconfiguration and adaptation to changing requirements. Modular components can be assembled or disassembled quickly, enabling flexible manufacturing processes and rapid product customization.

**Agile Supply Chains:** Industry 4.0 promotes agile supply chains that can respond quickly to fluctuating demand, changes in customer preferences, or disruptions in the supply network. By integrating data across the supply chain, manufacturers can optimize inventory management, logistics, and production planning.

### 2.2.4 Incorporation of Advanced Technologies:

### **Artificial Intelligence (AI):**

158 AI algorithms analyze large amounts of data to identify patterns, anomalies, and optimize manufacturing processes. For instance, AI can optimize production schedules based on demand forecasts, minimize energy consumption by dynamically adjusting machine settings, or detect quality defects in real-time.

2 **Internet of Things (IoT):** IoT connected devices, sensors, and machines to gather real-time data and enable communication between them. This enables manufacturers to monitor equipment health, track inventory, collect data for analysis, and facilitate remote monitoring and control.

38 **Robotics:** Robotics involves the use of automated systems and robots to perform tasks traditionally done by humans. These robots can handle repetitive, labor-intensive, or hazardous tasks, improving productivity, reducing errors, and ensuring consistent quality.

173 **Cloud Computing:** Cloud computing provides on-demand access to computing resources and storage over the internet. It enables manufacturers to store and analyze large amounts of data, collaborate globally, and deploy scalable applications without the need for extensive on-site infrastructure.

### **2.2.5 Sustainability:**

Industry 4.0 practices focus on sustainability by reducing energy consumption, minimizing resource waste, and adopting eco-friendly manufacturing processes.

2 **Energy Efficiency:** Smart manufacturing systems optimize energy usage by monitoring energy consumption in real-time, identifying inefficiencies, and adjusting operations accordingly. For instance, machines can automatically enter low-power modes during idle periods or adjust their energy consumption based on production demand.

2 **Waste Reduction:** Additive manufacturing (3D printing) enables on-demand production, reducing the need for excess inventory and minimizing material waste. Additionally, advanced analytics can identify opportunities for waste reduction and process optimization, leading to improved sustainability.

**Resource Optimization:** Smart sensors, IoT devices, and data analytics help optimize resource usage, such as water, raw materials, and chemicals. By monitoring resource consumption and identifying inefficiencies, manufacturers can reduce their environmental footprint and operational costs.

## 2.2.6 Data Analysis and Visualization:

Industry 4.0 relies on data analysis and visualization techniques to gain insights and facilitate decision-making.

75

**Data Analytics:** Data analytics involves extracting valuable information from large datasets<sup>2</sup>. Techniques such as descriptive, diagnostic, predictive, and prescriptive analytics are applied to identify patterns, trends, anomalies, and correlations. This enables manufacturers to gain insights, make predictions, and optimize processes.

153

**Visualizations:** Data is presented through intuitive and interactive visualizations, such as dashboards, charts, graphs, and heat maps. Visual representations help decision-makers understand complex data quickly, identify trends, and take appropriate actions. Real-time visualizations enable monitoring of KPIs, production metrics, and quality parameters.

## 2.2.7 Less Human Intervention:

64

Industry 4.0 aims to automate routine tasks, reducing the need for human intervention and allowing workers to focus on higher-value activities.

136

**Robotic Process Automation (RPA):** RPA involves automating repetitive and rule-based tasks through software robots. These robots can perform data entry, data validation, and other administrative tasks, reducing manual effort and improving accuracy.

**Autonomous Systems:** Autonomous systems, such as self-driving vehicles or robots, can operate with minimal human intervention. They can navigate warehouses, transport goods, or perform inspections independently, reducing the need for constant human supervision.

286

**Machine Learning:** Machine learning algorithms can analyze historical data and learn from patterns to make predictions or automate decision-making. For instance, algorithms can autonomously adjust machine settings based on real-time data, reducing the need for manual intervention.

## 2.2.8 Predictive Maintenance:

Predictive maintenance techniques leverage data analysis and machine learning algorithms to identify maintenance needs before equipment failures occur. Here's a deeper understanding:

2

**Condition Monitoring:** Sensors installed on machines collect data on temperature, vibration, pressure, or other performance indicators. This real-time data is continuously monitored to detect early signs of equipment degradation or potential failures.

2

**Machine Learning Algorithms:** By analyzing historical and real-time data, machine learning algorithms can identify patterns that indicate potential issues or failure modes. This allows manufacturers to schedule maintenance activities proactively, minimizing unplanned downtime and extending equipment lifespan.

**Predictive Analytics:** Predictive maintenance systems use machine learning models to predict future equipment failures or degradation. These predictions enable manufacturers to plan maintenance activities, optimize spare parts inventory, and reduce overall maintenance costs.

94

## 2.2.9 Augmented Reality:

Augmented Reality (AR) technology overlays digital information onto the physical world, enhancing worker productivity and training.

**Remote Assistance:** AR enables experts to provide remote guidance and support to on-site technicians. Through AR-enabled devices, experts can annotate live video feeds, provide step-by-step instructions, or overlay digital information on physical objects, facilitating troubleshooting and reducing downtime.

**Training and Simulations:** AR can be used for interactive training programs, allowing workers to practice complex tasks in a virtual environment.

**Example:** technicians can learn to operate new equipment or perform maintenance procedures through realistic AR simulations, reducing the need for physical training setups.

**Data Visualization:** AR can overlay real-time data visualizations onto physical equipment or processes, enabling workers to monitor performance metrics, equipment status, or safety information without referring to separate screens or devices.

### **3. Involvement of Government Ministries, Schemes, missions: To boost industry 4.0.**

#### **3.1 Government Ministries and Schemes for Industry 4.0 in India:**

<https://www.psa.gov.in/technology-frontiers/smart-manufacturing-technologies/552>

##### **3.1.1 Ministry of Commerce & Industry**

###### **EEPC India Advocates for the Adoption of Industry 4.0**

**161** The Engineering Export Promotion Council of India (EEPC India), in association with the Department **278** of Heavy Industries (DHI), has emphasized the need for India to transition from traditional manufacturing models to Industry 4.0 and beyond. **68** Mr. Ravi Sehgal, representing EEPC India, highlighted the importance of Industry 4.0 for driving the Indian manufacturing sector towards becoming a "Smart and Intelligent Manufacturing" hub.

**196** Under the scheme on **105** Enhancement of Competitiveness in the Indian Capital Goods Sector, the Department of Heavy Industry, Government of India, has launched an initiative called **Smart Advanced Manufacturing and Rapid Transformation Hub (SAMARTH) - Udyog Bharat 4.0**. SAMARTH aims to promote Industry 4.0 awareness among Indian manufacturers through demonstration centers.

**30** Presently, there are four centers operating under this initiative:

1. Center for Industry 4.0 (C4i4) Lab Pune
2. IITD-AIA Foundation for Smart Manufacturing
3. I4.0 India at IISc Factory R&D Platform
4. Smart Manufacturing **11** Demo & Development Cell at CMTI.

EEPC India and the Department of Heavy Industries advocate the adoption of Industry 4.0 in Indian manufacturing.

- 7**
- **SAMARTH - Udyog Bharat 4.0** is an initiative promoting Industry 4.0 awareness through demonstration centers.

- Indian engineering exports have stagnated <sup>18</sup> as a percentage of ASEAN and World Exports.
- The Department <sup>18</sup> of Commerce has assigned EEPC India the responsibility of establishing a Technology Centre to enable MSMEs to benefit from new technologies.
- The EEPC India Technology Centre is set to open in Bengaluru and Kolkata.
- The centers will serve as platforms <sup>244</sup> for industry-academia discussions and learning. The Technology Centre is expected to play a crucial role in achieving this goal.

For more information visit the below links

[eepc india advocates the adoption of industry 4.0](#)

 Automation & Industry 4.0 for MSMEs

[Initiatives taken by the government to boost manufacturing](#)

8

### 3.1.2 Ministry of Electronics and Information Technology

#### Production Linked Incentive (PLI) scheme

The objective of the scheme is to encourage the adoption of smart manufacturing practices among companies by offering financial incentives to those engaged in domestic production and meeting specific criteria regarding investment, sales, and exports. By incentivizing these companies, the scheme aims to enhance their competitiveness in the market while simultaneously bolstering the overall value and growth of India's manufacturing sector, thereby driving the country towards <sup>272</sup> Industry 4.0.

- The PLI Scheme, launched on April 1, 2020, offers incentives of 4% to 6% on incremental sales <sup>106</sup> for eligible companies in target segments manufactured in India, over a period of five years following the base year (2019-20).
- A total of 22 companies, including global mobile phone manufacturers and domestic companies, have applied under the <sup>92</sup> scheme.
- International mobile phone manufacturing companies such as Samsung, Foxconn <sup>92</sup>, Hon Hai, Rising Star, Wistron, and Pegatron have applied, with Foxconn Hon Hai, Wistron, and Pegatron serving <sup>62</sup> contract manufacturers for Apple iPhones.
- Several Indian companies, namely Lava, Dixon Technologies, Bhagwati (Micromax), Padget Electronics, Sojo Manufacturing Services, and Optiemus Electronics, have expressed their interest in the scheme and submitted applications. It is anticipated that if

approved, these companies will substantially scale up their manufacturing operations, contributing to the scheme's objectives of promoting domestic production and fostering growth in the manufacturing sector.<sup>6</sup>

- The scheme is expected to generate a total production of approximately INR 11.5 lakh crore (INR 11.50 trillion) over the next five years.
- Companies under the Mobile Phone (Invoice Value INR 15,000 and above) segment propose production worth over INR 9 lakh crore, while companies under the Mobile Phone (Domestic Companies) segment propose production of about INR 2 lakh crore.
- Companies in the Specified Electronic Components segment propose a production of over INR 45,000 crore.
- The scheme aims to promote exports, with over 60% of the total production (INR 7 lakh crore)<sup>11</sup> expected to come from exports.
- The scheme will attract an additional investment of INR 11,000 crore in electronics manufacturing.
- It is projected to create approximately 3 lakh direct employment opportunities over the next five years, with additional indirect employment.
- Increase in Domestic Value Addition is significant, with expectations of reaching 35-40% for mobile phones and 45-50% for electronic components, up from the current levels of 15-20%. This rise in domestic value addition indicates a positive trend towards higher local production and manufacturing capabilities in the mobile phone and electronics industries.

### 3.1.3 Ministries Adopted the PLI Scheme

<u>Beneficial industry and Sub scheme</u>	<u>MINISTRY</u>	<u>FOR PRODUCTS</u>
178 Production Linked Incentive (PLI) scheme for Automobile & Auto components:	Ministry of heavy industries	<ul style="list-style-type: none"> <li>Automobile and the Auto Components</li> </ul>
113 Production <sup>27</sup> linked Incentive (PLI) scheme for Aviation	Ministry of Civil aviation	<ul style="list-style-type: none"> <li>Drones &amp; Drone Components</li> </ul>

269 Production Linked Incentive (PLI) scheme for Chemicals	Ministry of Heavy Industries and NITI Ayog	Advanced Chemical Cell Batteries
113 Production Linked Incentive (PLI) scheme for Electronic systems	9 Ministry of Electronics and Information Technology	<ul style="list-style-type: none"> <li>• Servers</li> <li>• Laptops</li> <li>• Specified Electronic Components</li> <li>• All-in-one PC</li> <li>• Mobile phones</li> <li>• Tablets</li> </ul>
113 Production Linked Incentive (PLI) scheme for Food processing	9 Ministry of Food Processing Industries	<ul style="list-style-type: none"> <li>• Fruits and Vegetables</li> <li>• Ready to Eat / Ready to Cook (RTE/ RTC)</li> <li>• Marine Products</li> <li>• Mozzarella Cheese</li> </ul>
3 Production Linked Incentive (PLI) scheme for Medical devices	Department of Pharmaceuticals	<ul style="list-style-type: none"> <li>• Medical Devices</li> </ul>
Production Linked Incentive (PLI) scheme for Metals & mining	9 Ministry of Steel	<ul style="list-style-type: none"> <li>• Coated/Plated Steel Products</li> <li>• Specialty Rails</li> <li>• Electrical Steel</li> <li>• Alloy Steel Products and Steel Wires</li> <li>• High Strength/ Wear Resistant Steel</li> </ul>
56 Production Linked Incentive (PLI) scheme for Pharmaceuticals	Department of Pharmaceuticals	<ul style="list-style-type: none"> <li>• Biopharmaceuticals</li> <li>• Patented drugs or drugs nearing patent expiry</li> <li>• Cell based or gene therapy products</li> <li>• Complex generic drugs</li> <li>• Special empty capsules</li> <li>• Complex excipients</li> <li>• Phyto-pharmaceuticals</li> <li>• Orphan drugs</li> <li>• Key Starting Materials (KSMs)</li> <li>• Drug Intermediaries (DIs)</li> <li>• Repurposed drugs</li> </ul>

		<ul style="list-style-type: none"> <li>● Auto-immune drugs</li> <li>● Cardiovascular drugs</li> <li>● Anti-cancer drugs</li> <li>● Anti diabetic drugs</li> <li>● Anti-infective drugs</li> <li>● Active Pharma Ingredients (APIs)</li> <li>● Psychotropic drugs</li> <li>● Anti-Retroviral drugs</li> </ul>
281 Production Linked Incentive (PLI) scheme for Renewable energy	9 Ministry of New and Renewable Energy	<ul style="list-style-type: none"> <li>● Solar PVs</li> <li>● Polysilicon + Wafer+ Cell+ Module</li> <li>● Cell + Module</li> </ul>
56 Production Linked Incentive (PLI) scheme for Telecom	Department of Telecommunications	<p>9</p> <ul style="list-style-type: none"> <li>● Core Transmission Equipment</li> <li>● Access &amp; Customer Premises Equipment (CPE), Internet of Things (IoT) Access Devices and Other Wireless Equipment</li> <li>● 4G/5G, Next Generation Radio Access Network and Wireless Equipment</li> <li>● Enterprise equipment: Switches, Router</li> </ul>
Production Linked Incentive (PLI) <sup>27</sup> scheme for Textiles & apparel	Ministry of Textiles	<ul style="list-style-type: none"> <li>● Man-Made Fiber Segment</li> <li>● Technical Textiles</li> </ul>
56 Production Linked Incentive (PLI) scheme for White goods	Department for Promotion of Industry and Internal Trade	<p>9</p> <ul style="list-style-type: none"> <li>● High Value Intermediates (Copper Tubes, Aluminium Foil and Compressors)</li> <li>● Low Value Intermediates (PCB assembly for controllers, BLDC motors, Service Valves and Cross Flow fans for AC and other components)</li> <li>● LED Lighting Products LED Chips, LED Drivers, LED Engines, Mechanicals, Packaging, Modules,</li> </ul>

		<p>Wire Wound Inductors etc</p> <ul style="list-style-type: none"> <li>• LED Chip Packaging, Resistors, ICs, Fuses etc</li> </ul>
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<sup>61</sup>  
For more Information Visit the below link

<https://pib.gov.in/PressReleseDetail.aspx?PRID=1642823>

[\*\*Production Linked Incentive \(PLI\) Schemes in India\*\*](#)

### **3.1.4 Ministry of Heavy Industries**

- <sup>62</sup>
- The Department of Heavy Industry (DHI) has inaugurated three Technology Development Projects at IISc Bangalore, CMTI Bengaluru, PSG College of Technology, and SiTARC Coimbatore. Additionally, eight Centers of Excellence (CoEs) for Technology Development have been established by the DHI. These initiatives aim to enhance competitiveness in the capital goods sector and promote the development of cutting-edge industrial technologies in India.

#### **Key Points:**

- <sup>3</sup>
- IISc Bangalore has developed a technology for metal additive printing machine, supported by the DHI. This is the first time such technology is being developed in India.
  - An Industry 4.0 SAMARTH UDYOG Centre is being established at IISc Bangalore to facilitate the adoption of Industry 4.0 technologies in Indian manufacturing, including data analytics, 3D printing, artificial intelligence, and more.
  - CMTI Bengaluru is setting up a Sensor Technology manufacturing/fabrication facility with DHI support. This facility will enable the deployment of function-specific sensors for making products and machines smarter.
  - PSG College of Technology and SiTARC Coimbatore have developed indigenous technology in collaboration with industry partners, focusing on welding robots, special alloy electrodes, power supply, and smart

submersible pumping solutions.

- The pilot scheme launched by the DHI in November 2014 aims to enhance competitiveness in the Indian capital goods sector. It consists of five components: Advanced CoEs, Integrated Industrial Infrastructure Facilities (IIFC), Common Engineering Facility Centre (CEFC), Testing & Certification Centre (T&CC), and Technology Acquisition Fund Programme (TAFP).
- Twenty-five projects have been selected under the scheme, including the development of shuttleless rapiers looms, additive manufacturing technology, smart submersible pumping solutions, and more.
- Eight CoEs for Technology Development have been established at various institutions such as:
  - The Center of Excellence at the Central Manufacturing Technology Institute (CMTI) in Bengaluru, initiated by the Textile Machinery Manufacturers' Association (TMMA), focuses on the development of shuttle-less rapier looms capable of reaching 450 RPM.
  - At the Indian Institute of Technology (IIT) Madras, another CoE is dedicated to the development of 11 advanced technologies in the fields of Machine Tools & Production Technology.
  - The CoE at PSG College of Technology concentrates on the development of three Welding Technologies.
  - In Coimbatore, a CoE established by Sitarc is dedicated to researching and innovating Smart Submersible (6 inch) Pumping Solutions for Industrial and Water Supply Applications.
  - The Indian Institute of Technology (IIT) Delhi is home to a CoE focused on Textile Machinery, exploring advancements in this sector.
  - Similarly, IIT Kharagpur hosts a CoE specializing in Advanced Manufacturing, aiming to drive innovation and technological growth in this field.
  - The Heavy Engineering Corporation (HEC) in Ranchi operates a CoE that collaborates with the institutional support of ISM Dhanbad to advance manufacturing techniques, with a specific focus on Hydraulic Excavator production.
  - Lastly, a CoE at the Indian Institute of Science (IISc) in Bengaluru collaborates with Wipro 3D to design and develop 3D Printing

technologies, aiming to push the boundaries of additive manufacturing.<sup>3</sup>

- A world-class machine tool park spanning 500 acres has been established in Tumkur, Karnataka, in partnership with the Government of Karnataka.

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- The manufacturing sector, including the capital goods industry, plays a crucial role in the country's economy, contributing about 12% to total manufacturing activity and around 2% to GDP.

- The government has set a target of achieving a USD one trillion manufacturing economy in the next five years, emphasizing the need for double-digit growth in the sector.

For more information visit:

<https://pib.gov.in/PressReleaselframePage.aspx?PRID=1597823>

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### 3.1.5 Ministry of Statistics & Programme Implementation

- The Quick Estimates of Index of Industrial Production (IIP) is a monthly indicator of the overall performance of the industrial sector in India. It is compiled by the Central Statistical Organisation (CSO) and released on the 12th of every month (or previous working day if 12th is a holiday).
- The IIP is a composite index, which means that it is a weighted average of a number of different industrial sectors. The sectors included in the IIP are:
  - Mining
  - Manufacturing
  - Electricity

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- The weights for each sector are determined based on their relative importance to the overall industrial sector.
- The IIP is calculated with a base year of 2011-12. This means that the index value of 100 in the base year represents the average level of industrial production in that year.
- The Quick Estimates of IIP are released with a six-week lag. This means that the data for the month of April is released on the 12th of June, the data for the month of May is released on the 12th of July, and so on.
- The Quick Estimates of IIP are revised at a later date to incorporate more complete data. The revised estimates are released in the form of Final Estimates.
- The IIP is a useful indicator of the health of the Indian economy. A rising IIP indicates that the industrial sector is growing, which is generally seen

as a positive sign for the economy. However, a falling IIP can be a sign of economic trouble.

- The IIP is also used by economists and policymakers to track the performance of the industrial sector and to make decisions about economic policy.

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➤ **Here are some of the benefits of using the Quick Estimates of IIP:**

- They are released on a timely basis, which allows policymakers and economists to track the performance of the industrial sector on a monthly basis.
- They are relatively reliable, as they are based on data from a large number of industrial establishments.
- ○ They are relatively easy to understand, which makes them accessible to a wide range of users.

➤ **However, there are also some limitations to using the Quick Estimates of IIP**

- They are based on a six-week lag, which means that they may not be a completely accurate reflection of the current state of the industrial sector.
- They are not as comprehensive as the Final Estimates, which are released at a later date.

For more information visit:

[IIP | Ministry of Statistics and Program Implementation | Government Of India](#)

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### 3.1.6 Department of Science and Technology:

- The purpose of NM-ICPS is to develop solutions for people-centric problems by leveraging advancements in technology. The scheme focuses on interdisciplinary approaches that combine physical systems with computing, communication, and control to address complex societal challenges.

#### Health Sector:

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- ARTPARK at IISc Bangalore developed XraySetu, an AI-driven platform for rapid screening of COVID-19 through Chest X-ray interpretation. 23
- XraySetu works with low-resolution images sent via mobiles, enabling detection in rural areas.

- It uses machine learning algorithms to generate patient reports showing abnormal regions in the lungs and detects COVID-19, pneumonia, or other lung abnormalities
- This solution aids doctors who lack access to X-ray machines.

### **COVID-19 Screening:**

- IIT Bombay<sup>23</sup> developed the Tapestry method under the project RAKSHAK supported by the Technology Innovation Hub (TIH) at IIT Jodhpur.
- The Tapestry method for COVID-19 screening has been shortlisted by X-prize in <sup>6</sup> open Innovation Track.
- It involves a chest X-ray-based COVID diagnosis system, open data for Indian and international COVID cases (COVBASE), and a decision framework for campus safety (Campus RAKSHAK).

### **Vaccine Transportation Monitoring:**

- AmbiTag, an IoT device developed at IIT Ropar Technology Innovation Hub - AWaDH, monitors ambient temperature during the transportation of vaccines and other sensitive products.
- Previously, such devices were imported, but now India can produce them domestically at a lower cost.
- The device will be made available to companies involved in COVID-19 vaccine transportation across the country.

### **Space Technology Consortium:**

- IITM Pravartak Technologies Foundation and five start-up companies launched a <sup>50</sup> consortium called I-STAC.DB.
- I-STAC.DB aims to build an end-to-end ecosystem for space technologies, including on-demand access to space, rapid launch capability, satellites, sensors, future generation communication (such as 6G), satellite data, and its applications.
- The consortium focuses on creating a self-reliant (Atmanirbhar) space technology ecosystem.

### **For more Visit below links:**

1. [New and emerging technologies are powering national initiatives in health, education, energy, environment, agriculture, strategic cum security, Industry 4.0](#)
2. [Department Of Science & Technology](#)

### **3.1.7 Ministry of Skill Development and Entrepreneurship:**

- Ministry of Skill Development and Entrepreneurship (MSDE) is helping Industry 4.0:
- Providing training in new skills<sup>45</sup>. The MSDE is providing training in new skills that are in demand in Industry 4.0, such as robotics, artificial intelligence, and data analytics. For example, the MSDE has launched the Pradhan Mantri Kaushal Vikas Yojana (PMKVY), which is a flagship skill development program that has trained over 40 million people in various skills, including many in Industry 4.0-related fields.
- Promoting apprenticeships. The MSDE is promoting apprenticeships, which give young people the opportunity to learn new skills on the job. For example, the MSDE has launched the National Apprenticeship Promotion Scheme (NAPS), which provides financial assistance to employers who hire apprentices.<sup>51</sup>
- Supporting the development of new technologies. The MSDE is supporting the development of new technologies, such as 3D printing and additive manufacturing. For example, the MSDE has launched the National Additive Manufacturing Centre (NAMC), which is a research and development center that is developing new 3D printing technologies.<sup>186</sup>
- Creating a conducive environment for innovation. The MSDE is creating a conducive environment for innovation, such as by providing tax breaks for businesses that invest in new technologies. For example, the MSDE has launched the National Innovation and Startups Policy, which provides tax breaks and other incentives for businesses that are developing new technologies.
- Here are some of the proof that MSDE is helping Industry 4.0:
  - In 2021, the MSDE launched the Industry 4.0 Skill Council, which is working to develop a roadmap for the adoption of Industry 4.0 in India.<sup>33</sup>
  - The MSDE has also partnered with industry leaders to develop new training programs in Industry 4.0-related fields. For example, the MSDE has partnered with Siemens to develop a training program in robotics.
  - The MSDE is also working to create a national network of Industry 4.0 labs, which will provide businesses with access to new technologies and expertise.

<https://www.msde.gov.in/en/about-msde>

### 3.1.8 Ministry of Textiles

- The Amended Technology Upgradation Fund Scheme (ATUFS) is a government-backed scheme that provides financial assistance to textile units in India that are upgrading their technology. The scheme was launched in 2016, and it is administered by the Ministry of Textiles.
- The main objective of ATUFS is to promote the adoption of new technologies in the textile sector, which will help to improve the productivity, quality, and competitiveness of Indian textile products. The scheme also aims to create new jobs in the textile sector and to reduce the country's dependence on imported textile machinery.
- Under ATUFS, eligible textile units can avail of a capital investment subsidy of up to 15% of the cost of installing new machinery. The subsidy is available for the installation of both new and used machinery, and it can be used to cover the cost of machinery, civil works, and training.
- To be eligible for ATUFS, textile units must meet certain criteria. These criteria include:
  - The unit must be located in India.
  - The unit must be engaged in the production of textile products.
  - The unit must have a minimum investment of Rs. 50 lakh.
  - The unit must install new machinery that is on the approved list of machinery.
- The application process for ATUFS is online. Textile units can apply for the scheme through the Ministry of Textiles' website. The application process is simple and straightforward.
- The benefits of ATUFS are numerous. The scheme helps to improve the productivity, quality, and competitiveness of Indian textile products. It also creates new jobs in the textile sector and reduces the country's dependence on imported textile machinery.
- The scheme has been well-received by the textile industry. Since its launch, ATUFS has helped to upgrade the technology of thousands of textile units in India. The scheme has also helped to create thousands of new jobs in the textile sector.
- Here are some of the key features of ATUFS:
  - The scheme provides a capital investment subsidy of up to 15% of the cost of installing new machinery.
  - The subsidy is available for both new and used machinery.
  - The subsidy can be used to cover the cost of machinery, civil works, and training.

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- Textile units must meet certain criteria to be eligible for the scheme.
  - The application process for ATUFS is online.
- The benefits of ATUFS include:
- Improved productivity, quality, and competitiveness of Indian textile products.
  - Creation of new jobs in the textile sector.
  - Reduction of the country's dependence on imported textile machinery

For more information visit:

- 33
1. <https://pib.gov.in/PressReleaselframePage.aspx?PRID=1782689>
  2. <https://texmin.nic.in/schemes/technology-upgradation-fund-scheme>

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## 3.2 Missions Working on Industry 4.0 in India:

### SAMARTH Udyog Bharat 4.0 CEFC Projects:

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#### 3.2.1 Center for Industry 4.0 (C4i4) Lab Pune

- The C4i4 Lab in Pune, India, is an Innovation Centre focused on Industry 4.0, which aims to enhance the global competitiveness of the Indian manufacturing industry. It offers various solutions and services designed by industry experts for industry professionals. Here are some important points about the C4i4 Lab and its programs that have an impact on Indian industries:
  - **"Are You Ready" Workshops:** Awareness workshops for managers to understand Industry 4.0 technologies and implementation. Over 1000 companies have participated since 2018.
  - **Digital Champions Program:** Develops internal champions who can define and implement digital visions through a 16-week hands-on program.
  - **I4.0 Model Factory Demonstration:** Live demonstrations with partners showcasing technologies like energy monitoring, productivity improvement, quality enhancement, and augmented reality.

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- **Assessment & Workshops:** Provides an Industry 4.0 Maturity & Readiness assessment tool to help organizations understand their digitalization level and identify gaps in their roadmap.
- **I4.0 Implementation Advisory:** Assists organizations in creating strategic plans for implementing Industry 4.0 solutions, building confidence through pilot projects.
- **I4.0 Academia & Certification:** Facilitates cooperation between industry and academia, ensuring students have Industry 4.0 skills. Academic institutions can receive certification.
- **Knowledge Club:** Bimonthly programs where international experts share experiences and challenges, offering valuable insights to industry professionals.

For more information visit:

1. [C4i4 Lab](#)
2. <https://www.samarthudyog-i40.in/project>

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### 3.2.3 IITD-AIA Foundation for Smart Manufacturing

- The IITD-AIA Foundation for Smart Manufacturing (FSM) is a joint initiative of the Indian Institute of Technology Delhi (IIT Delhi) and the Automation Industry Association (AIA). The FSM was established in 2017 with the aim of promoting the adoption of smart manufacturing technologies in India.

The FSM has a number of initiatives in place to achieve its goals. These initiatives include:

- **Demonstration facilities:** The FSM has set up a number of demonstration facilities that showcase the latest smart manufacturing technologies. These facilities are open to industry and academia, and they provide a hands-on experience of smart manufacturing technologies.
- **Training programs:** The FSM offers a number of training programs on smart manufacturing technologies. These programs are designed for industry professionals, and they provide the skills and knowledge necessary to adopt smart manufacturing technologies.
- **Research:** The FSM conducts research on smart manufacturing technologies. This research is aimed at developing new smart

manufacturing technologies and improving the understanding of smart manufacturing.

- **Industry engagement:** The FSM engages with industry to promote the adoption of smart manufacturing technologies. This engagement takes a number of forms, including workshops, seminars, and conferences.

- **Projects they are worked on :**

- Multi Process Robotic Cell
- Smart Lathe Machine
- Robotic Welding Cell
- FSM AR Demo
- Mechanism Kit Assembly and Disassembly
- AR Maintenance Using HoloLens
- Expert Maintenance System Using HoloLens
- Cyber Physical Assembly Line
- CP Lab Autonomy
- Smart Mechanism Kit Realtime Values
- PLC Kit Parts Introduction
- Smart Mechanism Kit Motor Replacement

➤ **Automation Industries Association (AIA) patterns:**

**Platinum sponsors:**

Rockwell Automation  
Mitsubishi Electric  
PepperL+fuchs  
Kuka  
PTC  
Deloitte  
Hexagon

**Gold sponsors:**

Siemens  
Festo  
MathWorks

**Msme sponsors:**

Adroitec

For more visit :

1. [IITD-AIA Foundation For SMART MANUFACTURING \(PDF\)](#)

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2. [IITD-AIA Foundation For Smart Manufacturing](#)

### 3.2.4 I4.0 India at IISc Factory R & D Platform

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- CEFC (Center of Excellence for Faculty) at the Indian Institute of Science (IISc), known as <sup>25</sup>I4.0forIndia@IISc, is to address the gaps in India's adoption of Industry 4.0 and support the growth and development of the manufacturing industry.
- Two Concepts of Smart: The initiative aims to explore both concepts of smart - one focused on high levels of industrial automation and minimal human labor, and the other on empowering traditional industries with smart technologies and tools.
- Focus on MSMEs: The initiative recognizes the importance of MSMEs in job creation and the need for them to move up the value chain by adopting smart technologies.
- Gaps in Industry 4.0 Adoption: Major gaps identified include a lack of <sup>7</sup>indigenous R&D capability for Industry 4.0, limited awareness and training programs, absence of applicable standards and protocols, and limited support for entrepreneurship in the Industry 4.0 domain.
- Objectives of I4.0forIndia@IISc: The initiative aims to address the identified gaps through various offerings, including platforms for demonstration and exploration of Industry 4.0 technologies, smart solutions for labor empowerment, affordable tools for MSMEs, training programs, indigenous research support, <sup>7</sup>development of standards and protocols, international conferences and workshops, support for Industry 4.0 startups, and policy advice for industry and government.
- Platforms: The initiative <sup>7</sup>provides two contrasting platforms for showcasing the capabilities of Industry 4.0 - one focused on networked automation and the other centered around empowering labor.
- Training and Research: The initiative offers training programs for industry leaders, R&D personnel, and advanced students in the field of Industry 4.0. It also aims to support indigenous research in Industry 4.0.
- Standards and Protocols: <sup>7</sup>I4.0forIndia@IISc seeks to support the development of indigenous Industry 4.0 standards, protocols, and middleware for integrating various devices across vendors.
- Support for Startups: The initiative provides support for Industry 4.0 startups, recognizing the importance of fostering entrepreneurship in this domain.

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- **Policy Advice:** I4.0forIndia@IISc offers policy advice for both the industry and the government to facilitate the adoption and growth of Industry 4.0 in India.

Visit:

<sup>81</sup>

<https://www.samarthudyog-i40.in/project>

<https://cpdm.iisc.ac.in/smartmanufacturing/>

<sup>7</sup>

### 3.2.5 Smart Manufacturing Demo and Development Cell at CMTI

**The Demo & Development Cell for Smart Manufacturing at CMTI** (Central Manufacturing Technology Institute) aims to create a platform for Indian manufacturing industries to explore and adopt Smart Manufacturing/Industry 4.0 technologies.

- **Technology-driven Pilot Implementation:** The cell establishes a Smart Manufacturing Demo cum Development Centre focused on machine tool-centric applications. It serves as a pilot implementation of Smart Manufacturing in India, showcasing concepts, tools, and solutions related to Industry 4.0.
- **Showcase & Experience Centre:** The facility serves as an awareness and propagation center for Industry 4.0, allowing industry stakeholders to explore the capabilities, advantages, and limitations of Smart Manufacturing technologies through demonstrations and hands-on experiences.
- **R&D and System Evaluation:** The cell aims to push the limits of unmanned and automated smart production systems, benchmarking Industry 4.0 elements and tools. It also evaluates system security aspects to ensure the reliability and safety of smart manufacturing systems.
- **Support for Solution Developers:** The cell provides a tryout and evaluation facility for solution developers, enabling localization and customization of Smart Manufacturing solutions. This encourages the development and adoption of locally relevant technologies.
- **Consultation and Support for Industry:** CMTI offers consultation services to industries, assisting them in configuring, selecting, and analyzing the viability of smart production systems. They provide customized solutions, technology transfer, and handholding support to ensure successful deployment of Smart Manufacturing technologies.

Visit:

[Central Manufacturing Technology Institute , Project | SAMARTH Udyog](#)

### <sup>11</sup> 3.2.6 DHI CoE in Advanced Manufacturing Technology, IITK

The DHI Centre of Excellence in Advanced Manufacturing Technology (CoE) is a research and development center established at IIT Kharagpur in 2017. The CoE is funded by Department of Heavy Industry (DHI) of the Government of India. CoE's mission is to promote the adoption of advanced manufacturing technologies in India. The CoE does this by conducting research and development, providing training, and offering consultancy services.

#### <sup>65</sup> Project 1:

Remote Monitoring and Real-Time Control of Defects in Friction Stir Welding Process and Preventive Health Monitoring of Friction Stir Welding Machine

**Industry partner:** Tata Consultancy Services (TCS)

**Objective:**

Develop an integrated sensing unit for acquiring and analyzing sensor data to optimize and make informed decisions in the Friction Stir Welding (FSW) process.

**Technical work modules:**

- Experimental model of FSW process with machine tool attributes for manufacturing quality.
- Creation of a knowledge base for welding different materials through FSW, integrating TCS PREMAP and IoT platform for data collection.
- Development of a 3D simulation model for understanding material flow behavior and real-time correction of the FSW process.
- Infrastructure: Micro/Macro FSW machine, CNC turning center, acoustic array, thermal imager, power sensor.
- Benefits to the Capital Goods (CG) sector: Increased capacity utilization, productivity, and workforce optimization; energy savings and waste reduction; prevention of costly unplanned downtime.

#### <sup>44</sup> Project 2:

Digital Manufacturing and Industrial Internet of Things (IoT) for Enhanced Supply Chain Coordination, Quality, and Maintenance

**Industry partner:** Tata Sons

<sup>41</sup>

- **Objective:** Study and analyze the implementation of IoT-based technologies in supply chain management, manufacturing operating efficiency, predictive maintenance, and inventory optimization.

- **Vision:** Leveraging emerging IoT technologies to connect different assets in the manufacturing life cycle and make better business decisions for heavy industry sectors.
- Pilot projects with Tata Metaliks and Tata Hitachi to validate and test the solutions in the Indian industry.
- Establishment of a Smart Manufacturing Lab at IIT Kharagpur to develop frameworks and conduct experimentation for identified objectives.
- Infrastructure in the lab: CNC machining center, CNC turning machine, coordinate measuring machine, conveyor belt and material handling system, robotic arm, sensors, connectivity equipment, centralized computer system, and IoT hardware.

Visit:

[Project | SAMARTH Udyog](http://www.coeamt.com/)  
<http://www.coeamt.com/>

### 3.2.7 Other Missions:

#### ★ Digital India Manufacturing Program

- This is a scheme launched by the Department of Electronics and Information Technology to promote the adoption of ICT in manufacturing. The scheme provides financial assistance to manufacturing companies to adopt ICT solutions, such as cloud computing, big data analytics, and the Internet of Things.<sup>40</sup>

#### ★ Skill India Program

- This is a scheme launched by the Ministry of Skill Development and Entrepreneurship to develop the skills of India's workforce. The scheme provides training in Industry 4.0 technologies to manufacturing workers, such as robotics, artificial intelligence, and machine learning.<sup>152</sup><sup>3</sup>

#### ★ Make in India

- This is a national program launched by the Government of India to attract foreign investment and promote manufacturing in India. The program includes a number of initiatives to promote Industry 4.0, such as the establishment of smart manufacturing clusters.

#### ★ National Manufacturing Competitiveness Council:

- This is a government-industry body that works to improve the competitiveness of the Indian manufacturing sector. The council has developed a roadmap for the adoption of Industry 4.0 in India.<sup>270</sup><sup>33</sup>

and it is working with the government and industry to implement the roadmap.

### 3.3 Govt-Academia Institutions Promoting Smart Manufacturing

SERB (Science and Engineering Research Board) is collaborating with MHRD (Ministry of Human Resource Development) for UAY (Uchhatar Avishkar Yojana) projects and providing funds for selected projects. This partnership aims to promote interaction between industry and academia, support research and development that is relevant to industries, and utilize the expertise and resources available in academic institutions. The funding for these projects will be divided, with SERB contributing 25%, MHRD contributing 50%, and the industry providing the remaining 25%.

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#### 3.3.1 Indian Institute of Information Technology, Design and Manufacturing, Jabalpur (IIITDMJ)

The Government<sup>99</sup> has Introduced Smart Manufacturing Discipline under the Bachelor's of Technology B.Tech as well as Masters of Technology M.Tech Programme at IIITDMJ for promoting Smart Manufacturing for Industry 4.0 revolution in India.

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#### 3.3.2 Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram (IIITDMK)

The Government<sup>99</sup> has Introduced Smart Manufacturing Discipline under the Bachelor's of Technology B.Tech as well as Masters of Technology M.Tech Programme at IIITDMK for promoting Smart Manufacturing for Industry 4.0 revolution in India.

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#### 3.3.3 Maulana Azad National Institute of Technology(MANIT)-Centre of Excellence in Product Design & Smart Manufacturing (CPDSM)

16

This Centre of Excellence is being developed as a special platform for collaboration and the infusion of advanced technologies in product design and smart manufacturing. It aligns with the "Make-in-India" initiative by the Government of India. The center will focus on providing high-quality education and research opportunities related to industries in areas such as design and automation, advanced welding techniques, additive

manufacturing, digital manufacturing, industrial Internet of Things, automated/virtual reality, and specialty materials. It will encourage students to develop innovative ideas for products that address social, physical, and ecological concerns. The center also offers opportunities for students to work on real-life projects as part of their master's and Ph.D. programs. Since 2021, the center has been offering a Post Graduate program on "Smart Manufacturing" to foster a culture of innovation and open engineering.

### **3.3.4 Smart Manufacturing Competency Centre' (SMCC)**

In collaboration with NASSCOM, the Ministry of Electronics and Information Technology (MeitY) and the Department of Science and Technology (DST), Government of Gujarat, have inaugurated the world's first 'Smart Manufacturing Competency Centre' (SMCC) in Ahmedabad. The SMCC aims to accelerate the adoption of smart manufacturing solutions by India's top innovators

### **3.3.5 National Institute of Industrial Engineering**

This is a premier engineering institute in India that offers training and research in Industry 4.0. The institute has developed a number of Industry 4.0 courses and programs, and it is working with industry to help companies adopt Industry 4.0 technologies.

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## **4. Stakeholders**

### **4.1 Stakeholders for Industry 4.0:**

#### **4.1.1 Front Runner Industries (Initiators- world):**

- Bosch
- Siemens
- SAP
- ZF Friedrichshafen
- Continental

#### **Front runner industries (initiators) in India:**

- Mahindra & Mahindra (Automotive, Agriculture)
- Tata Motors (Automotive)
- Larsen & Toubro (Manufacturing, Construction, Energy)
- Jindal Steel & Power (Energy)
- Reliance Industries (Energy, Retail)

#### **4.1.2 Existing Industries in India:**

- Automotive: Maruti Suzuki, Hero MotoCorp, Tata Motors, Mahindra & Mahindra
- Manufacturing: TCS, Infosys, Wipro, HCL, Tech Mahindra
- Retail: Reliance Retail, Future Retail, D-Mart, Flipkart, Amazon
- Energy: ONGC, IOCL, BPCL, HPCL, NTP

#### **4.1.3 Possible Industries India:**

- Agriculture: ITC, Adani Wilmar, Godrej Agrovet, Rallis India, Monsanto India
- Construction: Larsen & Toubro, Hindustan Construction Company, Shapoorji Pallonji Group, Jaiprakash Associates, UltraTech Cement
- Logistics: Adani Ports and Special Economic Zones, Container Corporation of India, Gati, Blue Dart Express, Delhivery
- Transportation: Indian Railways, Air India, IndiGo, SpiceJet, Uber

### **4.2 The stakeholders Should involve in establishing Industry 4.0 standards in India :**

#### **4.2.1 Government Institutions:**

- Bureau of Indian Standards (BIS)
- Ministry of Electronics and Information Technology (MeitY)
- Ministry of Commerce and Industry

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#### **4.2.2 Industry Associations :**

- Confederation of Indian Industry (CII)
- Federation of Indian Chambers of Commerce and Industry (FICCI)
- NASSCOM (National Association of Software and Service Companies)

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#### **4.2.3 Research and Development Institutes:**

- Indian Institutes of Technology (IITs)
- Indian Institute of Information Technology (IIITs)
- National Institutes of Technology (NITs)
- Research institutions associated with universities (IISc)
- Council of Scientific and Industrial Research (CSIR)

#### **4.2.4 Technology Providers and Solution Providers:**

- Tata Consultancy Services (TCS)
- Wipro
- Infosys
- Tech Mahindra

#### **4.2.5 Industrial Experts and Consultants:**

- Bosch
- Schneider Electric
- Ola Future Factory

#### **4.2.6 Manufacturing Companies:**

- Larsen & Toubro (L&T)
- Mahindra & Mahindra
- Hindalco Industries
- Maruti Suzuki
- Godrej Consumer Products

#### **4.2.7 Industry-specific Associations:**

- Society of Indian Automobile Manufacturers (SIAM)
- Indian Pharmaceutical Association (IPA)

- <sup>61</sup> National Association of Software and Service Companies (NASSCOM)

## 5. Export and Import Potential: Trade for smart Manufacturing

### 5.1. Import Potential of Industry 4.0

The import potential for Industry 4.0 in India is significant. The country is still in the <sup>69</sup> early stages of adopting these technologies, but the government is committed <sup>219</sup> to making India a global leader in Industry 4.0.

There are a number of factors that contribute to the import potential for Industry 4.0 in India, includin<sup>84</sup>

- The size and growth of the Indian manufacturing sector: India has a large and growing manufacturing sector, which is expected <sup>68</sup> to continue to grow in the coming years. This provides a large market for Industry 4.0 technologies.
- The availability of a skilled workforce: India has a large and skilled workforce, which is well-suited for the adoption of Industry 4.0 technologies.
- The government's support for Industry 4.0: The Indian government is providing a number of initiatives to support the adoption of Industry 4.0 technologies. These initiatives include providing financial incentives, developing skills training programs, and creating a regulatory framework that is conducive to the adoption of these technologies.

The "Make in India" initiative has an aim to promote import substitution, boost exports, and create more employment opportunities in these sectors , it have achieved <sup>157</sup> significant milestones and is currently focusing on 27 sectors as part of its Make in India 2.0 plan.. The Department for Promotion of Industry and Internal

Trade (DPIIT) is closely collaborating with 24 sub-sectors that have been selected based on the strengths and competitive advantages of Indian industries.<sup>135</sup> These sub-sectors include furniture, air-conditioners, leather and footwear, ready-to-eat food, fisheries, agricultural products, auto components, aluminum, electronics, agrochemicals, steel, textiles, EV components, and integrated circuits.<sup>86</sup>

Here are some of the technologies that the Indian government imported in 2023 for Industry 4.0:

- Semiconductors: India is heavily reliant on imported semiconductors, and the government has been working to boost domestic production. In 2023, the government imported \$4.5 billion worth of semiconductors, up from \$3.5 billion in 2022, needed for industry 4.0
- Machinery: The Indian government imported \$3.5 billion worth of machinery in 2023, up from \$2.5 billion in 2022. This includes machinery for use in manufacturing, construction, and agriculture and industry 4.0
- Electronics: The Indian government imported \$2.5 billion worth of electronics in 2023, up from \$2 billion in 2022. This includes electronics for use in telecommunications, consumer electronics, and industrial applications and industry 4.0
- Software: The Indian government imported \$1.5 billion worth of software in 2023, up from \$1 billion in 2022. This includes software for use in government applications, education, and healthcare and industry 4.0

These are just a few of the technologies that the Indian government imported in 2023. The government is committed to <sup>52</sup> boosting domestic production of these technologies, but imports will continue to play a role in meeting the country's needs.

## 5.2. Export potential of industry 4.0

The export and import potential of Industry 4.0 technologies is high. Countries that are early adopters of these technologies are likely to have a competitive advantage in the global market. The specific technologies that need to be imported will vary depending on the specific industry and the needs of the manufacturer. At the same time, Smart manufacturing improves the efficiency of manufacturing processes and reduces costs. As a result, countries that are able to export these technologies are likely to see a boost in their economic growth.

For example, a country that exports Additive Manufacturing (AM) technology could see a significant increase in demand for AM-enabled products, such as customized medical devices or aerospace components. AM technology allows

manufacturers to create complex parts with high precision, which is not possible with traditional manufacturing methods. This makes AM-enabled products more attractive to buyers in the global market.

For example, a country that wants to set up a smart factory for the automotive industry would need to import robotics, sensors, and software that are specifically designed for the automotive industry.

Similarly, a country that exports Artificial Intelligence (AI) technology could see a demand for AI-powered <sup>2</sup> products, such as self-driving cars or smart home devices. AI technology can be used to automate tasks, improve decision-making, and personalize products and services. This makes AI-powered products more efficient, flexible, and customizable than traditional products.

Some of the key technologies that are likely to be exported include:

- \* Robotics
- \* Sensors
- \* Software
- \* Connectivity infrastructure
- \* Additive manufacturing (AM) <sup>58</sup>
- \* Artificial intelligence (AI)
- \* The Internet of Things (IoT)
- \* Cloud computing
- \* Big data analytics

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### 5.2.1 Export Potential of Industry 4.0 Pros and Cons

The export potential of Industry 4.0 applications/products is significantly higher than that of products that are not enabled by these technologies. This is because Industry 4.0 products are more efficient, flexible, and customizable than traditional products. As a result, they are more attractive to buyers in the global market.

Here is a comparison of the export potential of Industry 4.0 applications/products with that of traditional products

Pros of Industry 4.0 for Export Potential:

- i. Competitive Advantage: Industry 4.0 enables manufacturers to gain a competitive advantage by offering high-quality products with shorter lead times, customization, and efficient supply chain management.

ii. Scalability: Automation and digitization allow for flexible production and quick scaling, enabling manufacturers to meet the increasing export demands efficiently.

iii. Improved Supply Chain Visibility: Real-time data from connected devices provides better visibility into the supply chain, enabling accurate tracking, inventory management, and timely deliveries.

iv. Cost Reduction: Industry 4.0 technologies can optimize production costs, reduce waste, and improve

- \* Increased market share
- \* Higher profit margins
- \* Access to new markets

resource utilization, making exported products more price-competitive.

### 5.2.2 Cons of Industry 4.0 for Export Potential:

i. Initial Investment: Setting up Industry 4.0 infrastructure requires a significant upfront investment, which may pose a financial challenge for smaller manufacturers.

ii. Skill Requirements: The implementation of Industry 4.0 demands a skilled workforce proficient in handling advanced technologies and data analytics. A lack of skilled personnel could be a barrier.

iii. Data Security and Privacy: With increased connectivity, there is a greater need for robust cybersecurity measures to protect sensitive data from cyber threats.

Here are some additional examples of Industry 4.0 applications/products that have high export potential:

- \* Smart agriculture products, such as sensors that can monitor crop health and soil conditions
- \* Smart logistics products, such as drones that can deliver packages
- \* Smart energy products, such as smart meters that can track energy usage
- \* Smart healthcare products, such as wearable devices that can monitor vital signs

## 6. Manufacturing/implementation scenario in country and abroad.

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The manufacturing sector plays a crucial role in driving economic growth and development, both in India and globally. This report provides an overview of the current manufacturing landscape in India, focusing on the competitiveness of the country, the state of manufacturing, emerging technologies, government initiatives and policies, market opportunities, and the competitiveness of various countries in the manufacturing sector.

### 6.1 Competitiveness of Countries:

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- India has emerged as a competitive player in the global manufacturing sector. The Indian manufacturing industry generated 16-17% of India's GDP pre-pandemic, and it is projected to be one of the fastest-growing sectors. Key sectors such as automotive, engineering, chemicals, pharmaceuticals, and consumer durables contribute significantly to India's manufacturing growth. The country has the potential to become a major global manufacturing hub, with the capacity to export goods worth US\$1 trillion by 2030.
- Other countries that demonstrate competitiveness in manufacturing include Germany, the USA, the UK, France, Japan, and China. Each of these countries has unique strengths and advantages in terms of raw materials, industrial expertise, entrepreneurship, and market opportunities. They have implemented various strategies and policies to enhance their manufacturing capabilities and remain competitive in the global market.

#### Current State of Manufacturing:

- India's manufacturing sector has shown remarkable growth and resilience. The sector's gross value added (GVA) at current prices was estimated at US\$626.5 billion in the first quarter of FY22. The manufacturing GVA in India was estimated at US\$77.47 billion in the third quarter of FY22. The Index of Industrial Production (IIP) reflects positive sentiments and expansion in the manufacturing sector, with India's Manufacturing PMI reaching a three-month high of 55.7 in November 2022.

- The Indian government has introduced significant initiatives like Aatmanirbhar Bharat and Make in India to enhance manufacturing capabilities and promote exports. The Production Linked Incentive (PLI) scheme has been introduced to incentivize domestic and foreign investments in manufacturing, resulting in the development of global champions in the industry. These initiatives have contributed to the growth and competitiveness of the manufacturing sector in India.

### **Emerging Technologies:**

- Technological advancements are revolutionizing the manufacturing industry globally. India is adopting various emerging technologies to drive innovation and improve efficiency in manufacturing. Some of these technologies include:
- **Industrial Internet of Things (IIoT) and Industry 4.0:** The fourth industrial revolution, Industry 4.0, is enabling the automation of manufacturing processes by linking the cyber and physical worlds. IIoT and advanced analytics are facilitating real-time monitoring, predictive maintenance, and customization in mass production.
- **Digital Technologies:** Digital transformation is a critical element in gaining a competitive edge in the manufacturing sector. Technologies such as robotics, automation, artificial intelligence (AI), machine learning, and data analytics are being deployed to enhance productivity, quality, and safety in manufacturing processes. Additive manufacturing technologies are revolutionizing the production of complex and customized parts. It offers benefits like reduced material wastage, shorter lead times, and cost-effective prototyping

### **Government Initiatives and Policies:**

- The Indian government has implemented several initiatives and policies to support the manufacturing sector. The Make in India campaign aims to position India as a global manufacturing hub and attract investments. The Production Linked Incentive (PLI) scheme provides incentives to specific sectors to enhance domestic manufacturing capabilities and exports. Other initiatives like Digital India and Startup India are promoting innovation and entrepreneurship in the manufacturing sector.

### **Market Opportunities:**

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- The manufacturing sector in India and abroad offers significant market opportunities. Expanding exports, localizing imports, increasing internal demand, and contract manufacturing are some of the market opportunities that Indian manufacturers can leverage. India's advantages in terms of raw materials, industrial expertise, entrepreneurship, and a young and educated workforce position it well to benefit from these market opportunities.

#### 6.1.1 Current India's Manufacturing Scenario:

- **Factors influencing growth:** India is benefiting from China's declining competitiveness due to factors like substandard product quality, trade disputes, and border problems. This presents a significant opportunity for Indian producers, as companies adopt the China-plus-one strategy, diversifying their businesses to alternative destinations. The ban on Chinese goods imports further enhances India's manufacturing sector.
- **Service sector dependence:** The pandemic has highlighted the flaws of the service industry, leading the Indian government to promote the manufacturing industry through incentives and programs. Manufacturing also creates employment opportunities in various service sector areas.
- **Export Potential:** India has the capacity to export goods worth \$1 trillion by 2030, positioning itself as a major global manufacturing hub. The Indian manufacturing sector plays a significant role in the country's economy, contributing 17% to the nation's GDP and employing over 27.3 million workers.
- **Market opportunities:** India has the potential to participate in global markets through factors such as electricity expansion, long-term employment possibilities, a young and educated population, and skill development. The country's assets in terms of raw materials, industrial expertise, and entrepreneurship position it well to benefit from value chains and market opportunities, including contract manufacturing, localizing imports, increasing exports, and satisfying internal demand.
- **Government initiatives:** The Indian government has introduced programs like the National Manufacturing Policy and the "Make in India" campaign, aiming to raise the manufacturing sector's GDP share to 25% by 2025. The Production-Linked Incentive Scheme provides incentives for

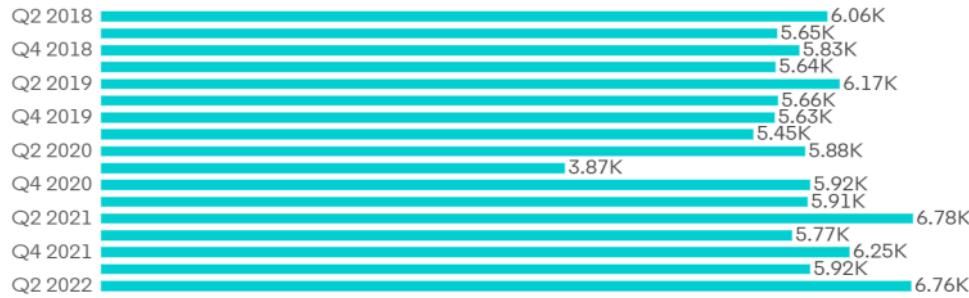
incremental sales in the manufacturing sector, encouraging new business ventures.

Visit: [https://www.ibef.org/download/1682315234\\_Manufacturing-February-2023.pdf](https://www.ibef.org/download/1682315234_Manufacturing-February-2023.pdf)

### 6.1.2 Current Manufacturing Scenario Abroad:

- **China's trade war:** The US-China trade war has created opportunities for Indian businesses to access a sizable market, as China exports commodities worth more than \$2.5 trillion annually.
- **Foreign direct investment (FDI):** India has attracted significant FDI inflows in sectors like automobile manufacturing, chemicals, and pharmaceuticals. This indicates international confidence in India's manufacturing capabilities.
- **Global manufacturing investments:** Major global companies like General Electric, Siemens, HTC, Toshiba, and Boeing have established manufacturing plants in India due to the "Make in India" policy and the rising purchasing power of Indian consumers.
- **Industrial clusters and technology adoption:** The development of industrial clusters, along with policies allowing 100% FDI through the automatic route, bank loan accessibility, and technology implementation, are driving the expansion of India's manufacturing sector.

Contribution of manufacturing to India's GDP from 2nd quarter 2018 to 2nd quarter 2022 (in billion Indian rupees)



Source: Ministry of Statistics and Programme Implementation



### How is India emerging in the global manufacturing sector

## 6.2 Current and emerging Smart Manufacturing Industries in India

### 6.2.1 A Case Study of Ola future factory

#### Introduction:

- India's push towards becoming <sup>35</sup> global manufacturing hub, coupled with the rise of smart technologies, has led to the <sup>51</sup> emergence of various smart manufacturing industries in the country. We aims to provide an overview of the current and emerging smart manufacturing sectors in India, with a focus on Ola's electric vehicle (EV) manufacturing plant and its use of Siemens' Digital Enterprise software.

#### Ola's Electric Vehicle Manufacturing Plant:

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- Ola, one of the world's leading mobility platforms, has signed an MoU with the Tamil Nadu government to set up its first EV manufacturing facility in the state. The plant, with an investment of 2,400 crore <sup>53</sup>, aims to make India a manufacturing hub for electric vehicles. It will be the world's largest scooter manufacturing <sup>167</sup> facility, initially capable of producing 2 million units annually. The factory aligns with Prime Minister Narendra Modi's vision of an AtmaNirbhar Bharat and will contribute to reducing India's import dependence in the EV sector.

#### Siemens' Digital Enterprise Software:

- Ola's EV manufacturing plant will be built on Industry 4.0 principles and leverage Siemens' Digital Enterprise software. This software will enable Ola to digitize and validate product and production processes before actual operations. The integrated Digital Twin design and manufacturing solutions provided by Siemens will enhance efficiency, automation, and quality in the manufacturing process. Ola's factory will be AI-powered, with deep integration of its proprietary AI engine and tech stack, ensuring continuous self-learning and optimization of operations.

#### Impact on Smart Manufacturing in India:

- The establishment of Ola's advanced manufacturing facility and its partnership with Siemens signify the growth and importance of smart manufacturing industries in India. The following key impacts can be observed:

- a) Job Creation and Skill Development: Ola's factory is expected to create nearly 10,000 jobs, contributing to employment opportunities and skill development in the manufacturing sector.
- b) Reduction of Import Dependence: By manufacturing electric scooters domestically, Ola's facility will help reduce India's reliance on imported EVs, promoting self-sufficiency and supporting the government's Make in India initiative.
- c) Technological Advancement: Ola's adoption of Industry 4.0 principles and Siemens' Digital Enterprise software demonstrates India's commitment to embracing cutting-edge technologies in manufacturing. This will drive innovation, enhance productivity, and improve the competitiveness of Indian manufacturing on a global scale.
- d) Global Market Access: Ola's factory aims to cater not only to the domestic market but also to global markets in Europe, Asia, Latin America, and more. This expansion will position India as a key player in the global EV manufacturing space and boost the country's export capabilities.

#### **Challenges and Opportunities:**

- While Ola's smart manufacturing initiative is a significant step forward, challenges and opportunities remain:
- a) Quality Control and Customer Satisfaction: Ola needs to address customer complaints and ensure consistent performance and reliability of its electric scooters. Quality control measures, including rigorous testing and validation, must be implemented to meet customer expectations.
- b) Supply Chain Management: Managing a robust and efficient supply chain for sourcing components and materials is crucial to ensure smooth operations and timely delivery of products.
- c) Skill Development and Training: As smart manufacturing technologies continue to evolve, investing in skill development programs and training initiatives is essential to empower the workforce with the necessary expertise to operate and maintain advanced manufacturing systems.

### **Conclusion:**

- Ola's electric vehicle manufacturing plant, driven by smart manufacturing principles and Siemens' Digital Enterprise software, exemplifies India's progress in the smart manufacturing domain. This initiative will contribute to job creation, reduction of import dependence, technological advancement, and market expansion. However, addressing challenges related to quality control, supply chain management, and skill development will be crucial for long-term success. India's journey towards becoming a global hub for smart manufacturing requires continued innovation, investment, and collaboration between industry and technology providers.

Visit

- 1. [Ola Future Factory: Largest Two Wheeler Factory - Ola Electric](#)
- 2. [Ola to deploy ABB robotics and automation solutions at e-scooter factory in TN, ET Auto.](#)
- 3. [Inside the Ola Electric Futurefactory feature | Autocar India](#)

### **6.2.2 A Case Study of Schneider Electric's Bengaluru Smart Factory**

#### **145 Introduction**

- Smart manufacturing, also known as Industry 4.0 or the fourth industrial revolution, is transforming the manufacturing industry globally. It involves the integration of advanced technologies, such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and robotics, to create more efficient, sustainable, and flexible manufacturing processes.
- **Schneider Electric:** A Pioneer in Smart Manufacturing, Schneider Electric, a multinational corporation based in France, is a leading player in the field of digital automation and energy management solutions. With its commitment to Industry 4.0, Schneider Electric has established the Bengaluru Smart Factory as a platform to showcase the advantages of industrial digital transformation. The factory demonstrates how smart manufacturing technologies can improve performance, reliability, and sustainability in manufacturing operations.

#### **Smart Factory Program and Objectives**

- The Smart Factory Program at Schneider Electric aims to address key pain points in manufacturing operations 253 through the adoption of digital tools 188 and technologies. The program focuses on six areas: agile management, process efficiency, asset performance management, empowered operators, reliability, and energy efficiency. By leveraging these technologies, Schneider Electric aims to enhance efficiency, customer service, and sustainability.

### Technologies Implemented in the Bengaluru Smart Factory

- **Internet of Things (IoT):** Schneider Electric's EcoStruxure platform enables IoT connectivity, allowing real-time monitoring and control of machines, processes, and equipment. This provides valuable insights, predictive maintenance capabilities, and improved agility in response to issues on the factory floor.
- **Augmented Reality (AR):** The EcoStruxure Augmented Operator Advisor (AOA) application provides operators with real-time information, instructions, and diagnostics through augmented reality. This empowers operators to make effective decisions, improve maintenance efficiency, and reduce errors.
- **Additive Manufacturing (3D Printing):** Schneider Electric utilizes 3D printing technology for prototyping, customization, and the production of maintenance spare parts. This enables faster availability, cost-effective production, and customization of components.
- **Digital Twin:** While not extensively used in the Bengaluru Smart Factory, the concept of digital twin systems has the potential for improving operational efficiency by creating virtual replicas of physical assets, enabling better monitoring, simulation, and optimization of manufacturing processes.
- **Artificial Intelligence and Machine Learning:** Schneider Electric leverages AI and ML algorithms to enhance decision-making, agility, and energy efficiency. For example, the Virginia App provides data-driven recommendations to sales teams, optimizing customer interactions and improving operational efficiency.
- **Uninterruptible Power Supply (UPS) Production** in the Bengaluru Smart Factory, The Bengaluru Smart Factory focuses on the production of Uninterruptible Power Supply (UPS) units and Drives in a sustainable manner. UPS units play a critical role in providing backup power during power outages, protecting sensitive electronic equipment from power fluctuations. The factory adopts a job shop manufacturing process, where production quantities are relatively low, and customization is possible.

### Benefits and Future Outlook

- The implementation of smart manufacturing technologies in the Bengaluru Smart Factory has yielded several benefits for Schneider Electric, including improved operational efficiency, enhanced product quality, reduced downtime, and optimized energy consumption. By consolidating its existing factories onto a single campus, Schneider Electric aims to further <sup>94</sup> expand its manufacturing capacity, create new jobs, and increase revenue. The company's commitment to sustainability and digital transformation positions it as a key player in India's smart manufacturing industry.

### **Conclusion**

- The case study of Schneider Electric's Bengaluru Smart Factory exemplifies the <sup>36</sup> current and emerging smart manufacturing industries in India. By embracing Industry 4.0 technologies, such as IoT, AR, additive manufacturing, and AI, Indian manufacturers can enhance operational efficiency, product quality, and sustainability. As more companies invest in smart manufacturing and the government supports digital transformation initiatives, India has the potential to become a global leader in smart manufacturing.

<sup>274</sup>  
Visit: <https://www.se.com/in/en/work/campaign/smart-factory/>

## **6.3 Current and emerging Smart Manufacturing Industries Globally**

### **6.3.1. Smart Manufacturing Scenario in Germany:**

#### **Tesla Gigafactory, Berlin:**

- Tesla's Gigafactory in Berlin exemplifies the vision of a smart factory. With a focus on sustainability, the factory utilizes solar panels on the rooftop, demonstrating a commitment to green energy. The use of advanced casting systems, an efficient body shop, and a next-generation paint shop highlight Tesla's constant drive for innovation. The factory aims to be the most advanced high-volume electric vehicle production plant globally.

#### **Adidas Speed Factory, Ansbach:**

- Adidas' Speed Factory in Ansbach revolutionizes the footwear industry by combining robotics, 3D printing, and computerized knitting. This smart factory enables mass customization and shorter lead times, meeting

shifting consumer demands quickly. The integration of 3D printing technology allows for rapid prototyping and a faster response to market needs.

#### **Connected Factory, Bosch, Blaichach:**

- Bosch's lead plant in Blaichach demonstrates the power of connected manufacturing. Through the use of tablets, performance tracking systems, and an operator support system, the factory ensures efficient production processes and quick error detection. The implementation of Bosch's smart software suite, Nexeed, enables real-time monitoring of manufacturing operations and facilitates predictive maintenance.

#### **Siemens Elektronikwerk Plant, Amberg:**

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- Siemens' Elektronikwerk in Amberg is recognized as a smart factory leader, winning the Industry 4.0 Award in 2018. The factory achieves comprehensive networking of machines and products, leveraging dashboards for real-time monitoring of machine performance and product quality. The integration of collaborative robots, 3D printing, and digital twins enhances productivity and enables predictive maintenance.

#### **Infineon's Smart Factory, Dresden:**

- Infineon's smart factory in Dresden boasts an automation level of 92% and over 200 robots, showcasing the power of intelligent networked manufacturing. The factory's systems are interconnected, enabling real-time control and communication with other Infineon sites worldwide. Automated wafer transport, central operating systems, and advanced algorithms optimize production control and responsiveness to customer needs.

#### **Key aspects of the smart manufacturing scenario in Germany include:**

- **Digitalization and Automation:** Smart factories integrate emerging technologies such as IoT, big data, cloud computing, and robotics to automate and optimize production processes. This enables increased efficiency, reduced costs, and improved quality control.
- **Connectivity and Real-time Monitoring:** The use of interconnected systems, dashboards, and IoT platforms enables real-time monitoring of production operations. Data analytics and predictive maintenance enhance productivity and minimize downtime.
- **Customization and Flexibility:** Smart factories embrace mass customization, enabling the production of personalized products with shorter lead times. Technologies like 3D printing and digital twins facilitate rapid prototyping and product customization.

- **Sustainability and Green Initiatives:** Many smart factories in Germany prioritize sustainability, incorporating renewable energy sources and environmentally friendly practices. This aligns with the country's commitment to green manufacturing and reducing carbon emissions.<sup>150</sup>
- **Collaborative Workforce:** Smart factories empower human workers by integrating them with advanced technologies. Collaborative robots, operator support systems, and smart software solutions enhance productivity and safety.

Visit:

1. [German manufacturing and the smart factory](#)
2. [Intelligent Manufacturing: 5 Examples of Smart Factories across Germany](#)

### 6.3.2 Smart Manufacturing Scenario in Japan

Main Smart Industries in Japan:

- **KDDI:** KDDI is a Japanese telecommunications provider with a global presence. They offer innovative digital solutions encompassing devices, communications, platforms, applications, and consulting services. KDDI assists clients in their digital transformation journey and works across various sectors, including industrial manufacturing, automotive, logistics, and warehousing.
- **Mitsubishi Electric Air Conditioning Systems Europe Ltd (remotely):** Mitsubishi Electric is a leading manufacturer of air conditioning systems. Their participation in the event showcases their expertise in providing advanced air conditioning solutions for industrial and commercial applications.
- **Senseye (remotely):** Senseye is an AI-based industrial analytics company that specializes in machine performance and reliability. Their analytics platform helps global industrial organizations optimize machine health and improve efficiency in sectors such as automotive, manufacturing, heavy industry, and consumer packaged goods (CPG) and fast-moving consumer goods (FMCG).
- **Crypto Quantique:** Crypto Quantique focuses on developing secure IoT communication systems, software, wireless modules, and chips for commercial applications. They have developed their own patented radio transceiver silicon chip, enabling the creation of battery-based sensor/actuator products connected to the internet via secure standards.

- **Cascoda:** Cascoda specializes in low-power IoT communication systems. Their solutions include software, wireless modules, and chips for commercial applications. Cascoda's technology, including their patented radio transceiver silicon chip, enables the deployment of wireless IoT solutions in building and factory automation, such as controlling smart lighting.
- **ToffeeAM:** ToffeeAM is a cloud-based platform developed by a spin-out company from Imperial College London. It utilizes generative design and topology optimization techniques to automatically create optimal designs for engineering components. ToffeeAM's software is used in applications like heat exchangers, mixers, valves, and more, offering increased complexity and efficiency compared to traditional design methods.

#### **Analysis of Japanese Manufacturing Trends:**

- Japan's manufacturing trend revolves around producing high-performance, high-quality core products and developing products that meet market needs through big data analysis and artificial intelligence.
- Innovations in Japanese manufacturing include the adoption of artificial intelligence, machine learning, and smart manufacturing technologies to overcome challenges posed by an aging workforce and labor shortages.
- The main challenges facing the Japanese manufacturing industry are the need to develop products independently, overcome labor shortages through automation, and stay competitive in the face of global IT giants.

#### **Opportunities:**

- The automotive manufacturing industry offers opportunities for related industries, including parts and materials, as the industry evolves to meet the requirements of the CASE era.
- The development of Smart Manufacturing technologies, including IoT networks, data analytics, artificial intelligence, and cybersecurity, presents opportunities for UK companies to collaborate with Japanese manufacturers.

#### **The Future of Japanese Manufacturing:**

- The Japanese manufacturing industry focuses on high-end products such as manufacturing robots, airplanes, vehicles, carbon fiber, and fine chemicals.
- The Industrial Value Chain Initiative (IVI) aims to maintain Japan's global competitive advantage by connecting factories and ensuring international standards. This plan promotes technical standards and production revolution to improve efficiency.

Visit

1. [Japan Smart Manufacturing Industry to Grow at a CAGR 18.7% from 2021 to 2027](#)
2. [Smart Manufacturing at Japanese Companies](#)

### 6.3.3 Smart Manufacturing Scenario in China

➤ Smart manufacturing has emerged as a critical focus in China's manufacturing sector, driven by the government's "Made in China 2025" strategy. This initiative aims to transform China from a big manufacturing country to a strong one, enhancing its global competitiveness. The government's push, coupled with increasing competition from emerging lower-cost manufacturers, has created a sense of urgency among Chinese manufacturers to adopt smart manufacturing approaches. This report provides an overview of the smart manufacturing scenario in China, highlighting government drivers, supplier involvement, and pioneering applications.

#### Government Drivers and Support:

"Made in China 2025" is a ten-year national plan that prioritizes manufacturing promotion in the country. The Ministry of Industry and Information Technology (MIIT) has issued guidelines and funded numerous smart manufacturing pilot projects across different industrial sectors. The government's efforts are focused on areas such as discrete manufacturing, process manufacturing, network-based collaborative manufacturing, mass-customized manufacturing, and remote operations and maintenance. The MIIT subsidizes projects and promotes standardization and application models for smart manufacturing. Additionally, joint programs with international companies like Siemens, SAP, and Phoenix Contact have been established to advance smart manufacturing initiatives.

#### Supplier Involvement:

Leading global automation companies have actively supported Chinese manufacturers in their smart manufacturing journey. Siemens, with a significant presence in China, has established digital factories and innovation centers, partnering with local companies like Baosteel to develop Industrie 4.0 solutions. GE promotes its Predix platform for the Industrial Internet and collaborates with Chinese companies to deliver IIoT solutions. Phoenix Contact has made significant investments and formed joint ventures to provide smart manufacturing solutions and consulting services. Other automation suppliers, including Rockwell Automation, Mitsubishi Electric, Omron, Schneider Electric, and ABB, have also introduced their smart manufacturing solutions in the Chinese market.

## Pioneering Smart Manufacturing Applications:

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State-owned companies like Sinopec, one of the world's largest oil refiners, have been early adopters of smart manufacturing. Sinopec implemented pilot projects focusing on vertical and horizontal integration, asset lifecycle management, and Big Data applications, resulting in improved operational stability, labor productivity, and energy cost savings. Construction machinery supplier SANY implemented M2M and IIoT applications in its equipment, enabling real-time asset monitoring, predictive maintenance, and enhanced customer service. Haier, a global household appliance supplier, developed connected factories with vertical and horizontal integration, reducing product delivery times, operational costs, and inventory days.

- ARC Advisory Group offers several recommendations for manufacturers in China regarding smart manufacturing implementation:
  - 
  - Encourage adoption among small and medium-sized manufacturers, as smart manufacturing solutions are scalable and cost-effective.
  - Develop a strategic vision, medium- to long-term strategy, and clear roadmap for smart manufacturing implementation, starting with smaller projects.
  - Identify specific pain points and set clear goals, gaining buy-in from all stakeholders.
  - Treat smart manufacturing as an ongoing journey, monitoring developments and incorporating relevant technologies and practices.
  - Form multi-disciplinary teams comprising representatives from IT, engineering, operations, maintenance, and business management.

Visit<sup>15</sup>

1. [What Is China's Smart Manufacturing Strategy? | ARC Advisory](#)
2. <https://www.globaltimes.cn/page/202112/1243614.shtml>
3. [Smart Manufacturing In China Supported by Made in China 2025](#)
4. ['Made in China' enters new stage of 'intelligent manufacturing' - Chinadaily.com.cn](#)

## 7. Technology Scan at National Level and International Level

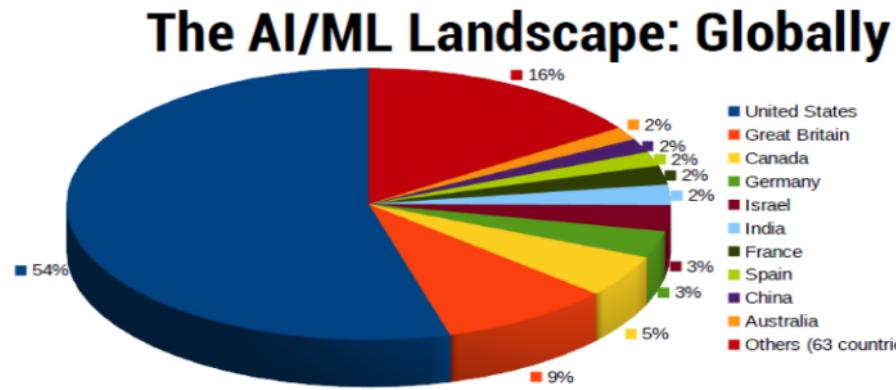
Technology scanning is a process that helps us understand the current technological environment and make predictions about future technological advancements. It involves examining different technologies to determine their potential impact and direction of development.

### 7.1 Technology Scan at National Level

(With Market Size and Revenue Market)

India is experiencing a rapid growth in its IT market and is one of the fastest-growing in the world, following the US and China. Over the past two decades, the IT industry in India has witnessed significant expansion, and it is anticipated to reach a milestone of \$100 billion soon. The budget for the year 2023-24 has allocated Rs 16,549 crore to the Ministry of Electronics and Information Technology, marking an increase of nearly 40% compared to the previous year.

#### 7.1.1. Artificial Intelligence (AI) and Machine Learning (ML) in India



85% of the world's AI/ML startups are based in just 10 countries.

India features in this top 10 list.

India's strength and preparedness in Artificial Intelligence (AI) will play a significant role in its Economy.<sup>146</sup> It has been recognized as one of the top three global locations (alongside the US and China) for the advancement and application of AI technologies. Moreover, India has received praise for having more than 58% of its AI implementations beyond the pilot and test phases, demonstrating a high level of adoption and utilization.

- More than half (58%) of the companies in India that utilize AI technology are implementing it at a large scale. This means they have moved beyond pilot and are adopting AI on a broader level, nearly 1,000 companies across nine countries use AI and have revenues exceeding \$500 million.
- It is found that 57% of companies in India had implemented AI in their business operations. In contrast, only 27% of companies were considering AI for future use. The adoption of AI was more prevalent among larger companies compared to smaller ones.<sup>67</sup>
- The number of AI start-ups in India has grown remarkably. According to a study by Excubator, which examines over 2,300 companies worldwide, 85% of all AI start-ups are located in just 10 countries. India has achieved a position among the top 10 countries globally with a considerable presence of AI start-ups.
- India has 386 PhD-educated researchers out of a total of 22,000 worldwide, placing it at the 10th position globally for research. In terms of AI conferences, India ranked 13th globally and had 44 excellent presenters. The focus of AI research in India is primarily on institutes like IITs, IIITs, and IISc.
- To further advance AI in the country, Niti Aayog and MeITY are actively collaborating to develop a National AI Strategy document<sup>11</sup>, which will outline a roadmap for India's AI development. Additionally, the Department of Industrial Policy and Promotion (DIPP) recently released a committee report addressing the use of AI.
- The governments of Karnataka and Telangana have made investments to establish Centers of Excellence in Data Science and Artificial Intelligence in Bengaluru and Hyderabad respectively. Additionally, the National Institute of Electronics and Information Technology (NIELIT) under the Ministry of Information Technology plans to collaborate with the industry to introduce new courses that focus on training individuals in the field of AI.

#### ❖ AI and ML Market Size and Revenue Market

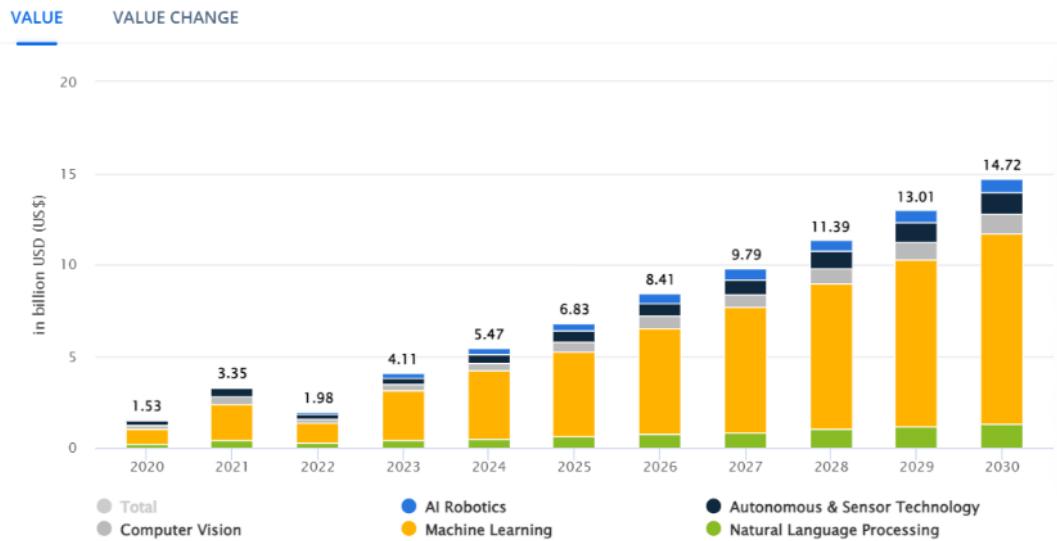
##### ➤ Artificial Intelligence (AI):

- The value of the Artificial Intelligence market is expected to reach US\$4.11 billion by 2023.<sup>1</sup>

- 5
- The value is expected to grow at a rate of 20.01% per year from 2023 to 2030, reaching a market size of US\$14.72 billion by 2030.
  - When compared globally, the United States is projected to generate the highest value, reaching US\$87.18 billion in 2023.
  - By 2025, it was estimated that data and AI technologies would contribute at least 90 billion U.S. dollars to the consumer goods and retail sector. When considering all sectors combined, artificial intelligence was projected to contribute approximately 500 billion dollars to India's GDP by 2025.

➤ Machine Learning (ML):

- The Machine Learning market is predicted to reach €2.57 billion in 2023.
- The value is anticipated to grow at an annual rate of 21.50% from 2023 to 2030, leading to a market size of €10.03 billion by 2030.
- When compared globally, the United States is expected to generate the highest value, amounting to €53.30 billion in 2023.



❖ Important Platforms for AI/ML in India

National AI Platform - <https://indiaai.gov.in/>

Ministry of Electronics and Information Technology <https://www.meity.gov.in/>

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90

<https://coe-dsai.nasscom.in/govt-of-karnataka-launches-centre-of-excellence-for-data-science-and-artificial-intelligence/> 83  
103 [https://www.meity.gov.in/writereaddata/files/Committees\\_A-Report\\_on\\_Platforms.pdf](https://www.meity.gov.in/writereaddata/files/Committees_A-Report_on_Platforms.pdf)  
<https://qz.com/india/1073903/india-leads-the-artificial-intelligence-race-thanks-to-the-local-offices-of-us-firms>  
<https://www.statista.com/statistics/1344262/india-ai-adoption-rate/>  
<https://www.careerindia.com/features/artificial-intelligence-in-india-034667.html>  
<https://www.indiascienceandtechnology.gov.in/sites/default/files/AI%20Trend%20story.pdf>  
[https://www.meity.gov.in/writereaddata/files/Committees\\_C-Report-on\\_RnD.pdf](https://www.meity.gov.in/writereaddata/files/Committees_C-Report-on_RnD.pdf)

### 7.1.2. Internet of Things (IOT) in India

As of 2023, there are <sup>229</sup> around 15.14 billion IoT devices connected worldwide, which is nearly twice **the total number of people** on **the planet**. By 2023, **the number of IoT-connected devices** is expected to triple, reaching 25 billion. This growth will result in the majority of cars and homes being connected to the internet.

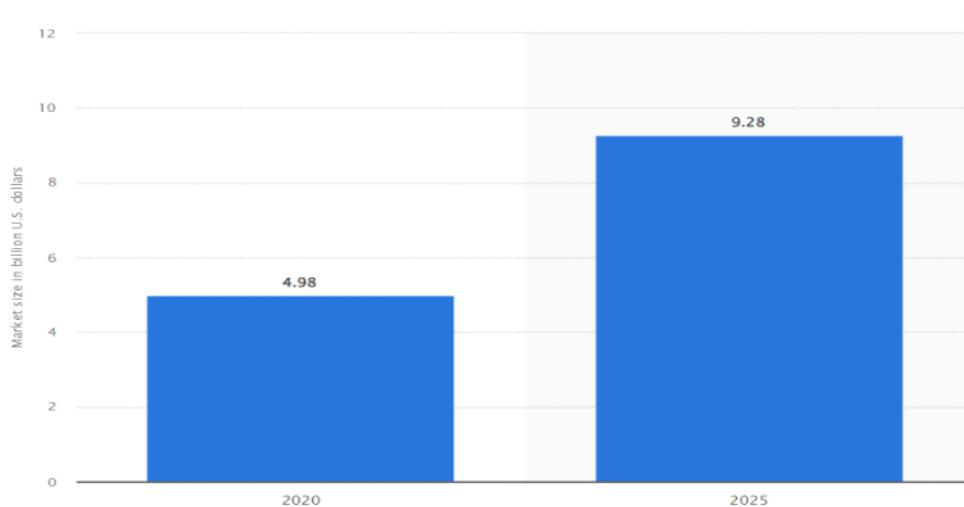
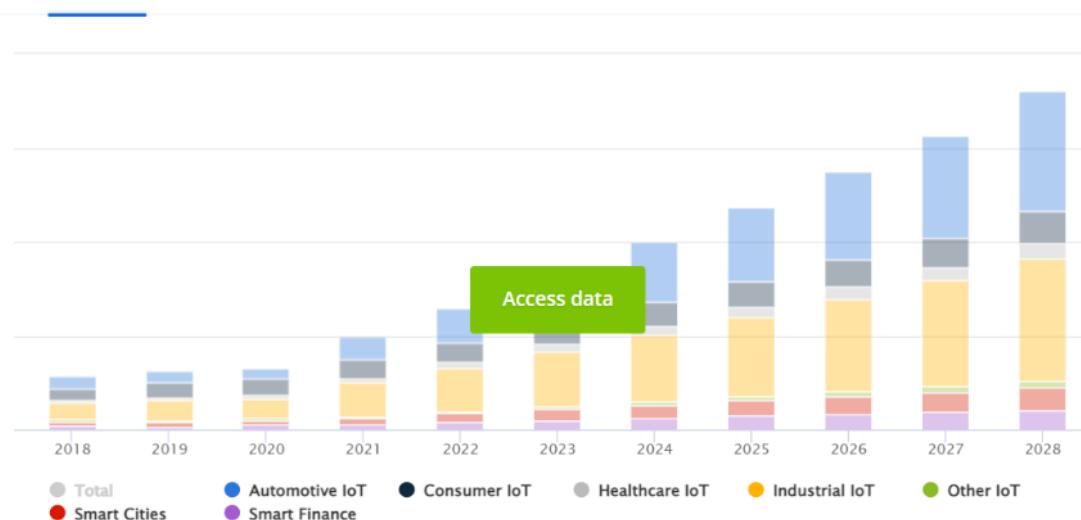
- In 2023, IoT Analytics predicts a 16% increase in **the global number of connected IoT devices**, reaching 16.7 billion active endpoints. Although the growth rate may be slightly lower than in 2022, IoT device connections are expected to continue growing for many years to come.
- It is estimated that by 2025, 60-67% of all generated data will be non-human or <sup>22</sup> machine-to-machine (M2M) data.
- Under the Digital India initiatives, MeitY, NASSCOM, and state governments have established Internet of Things Centers of Excellence in Bengaluru, Gurugram, Gandhi Nagar, and Visakhapatnam. The first center was established in Bengaluru in 2016 in collaboration with the Government of Karnataka and <sup>268</sup> NASSCOM. These centers aim to position India as an innovation hub in IoT by promoting <sup>22</sup> innovation democratization and the realization of prototypes. They connect startups, enterprises, venture capitalists, government, and academia, supporting startups in IoT, Big Data, Augmented Reality/Virtual Reality, Artificial Intelligence, and Robotics to reach their full potential.

#### ❖ IOT Market Size and Revenue Market in India:

- The revenue in the IoT market is projected to reach US\$27.31 billion in 2023.
- The Industrial IoT market is the largest segment within IoT, and it is expected to have a market volume of US\$9.67 billion in 2023.
- The revenue is anticipated to grow at an annual rate of 17.05% from 2023 to 2028, leading to a market volume of US\$60.01 billion by 2028.

- When compared globally, the United States is expected to generate the highest revenue, amounting to US\$172.30 billion in 2023.
- The IoT market size in India is projected to reach around US\$9.3 billion in 2025. The main drivers during this period are changes in company behavior and a focus on automation, largely influenced by the pandemic.

REVENUE BY SEGMENT



#### ❖ Important Platforms for AI/ML in india

NASSCOM - <https://nasscom.in/> , <https://www.coe-iot.com/>

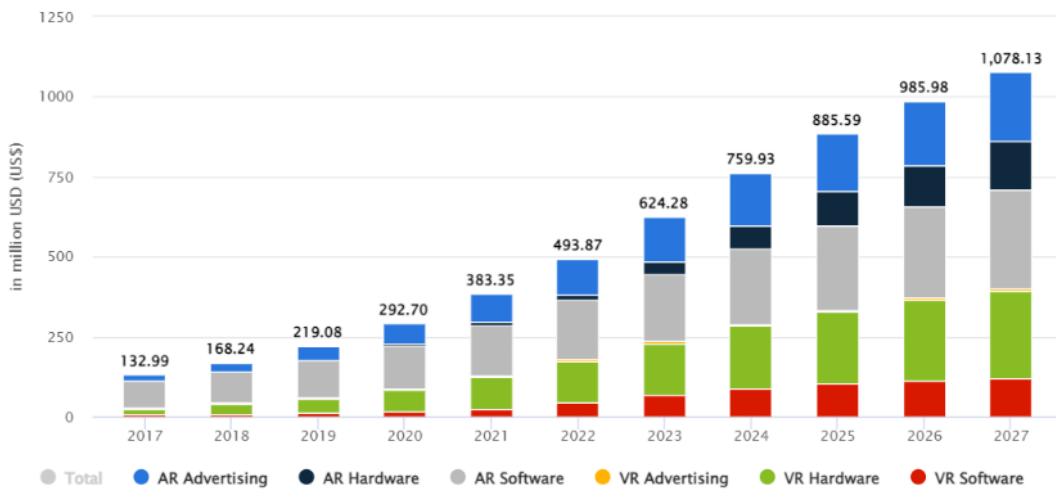
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### 7.1.3. <sup>202</sup> Augmented Reality (AR) / Virtual Reality (VR) in India

Virtual Reality (VR) and Augmented Reality (AR) have great potential for innovation in various industries and research fields. These technologies are currently being utilized in industries such as product development, skill enhancement, healthcare, art, architecture, transportation, construction, tourism, entertainment, education, and productivity software. To explore the opportunities in this specialized area, Software Technology Parks <sup>22</sup> of India, in collaboration with MeitY, the Government of Odisha, IIT-Bhubaneswar, and a philanthropist, has established the Centre of Entrepreneurship for Virtual and Augmented Reality (VARCoE) at IIT-Bhubaneswar.

#### ❖ AR/VR Market Size and Revenue Market in India

- The revenue in the AR & VR market is projected to reach US\$624.30 million in 2023.
- The revenue is expected to grow at an annual rate of 14.63% from 2023 to 2027, resulting in a projected market volume of US\$1,078.00 million by 2027.
- The largest market within <sup>14</sup> AR & VR is AR Software, with a market volume of US\$211.30 million in 2023.
- The United States generates the most revenue in the AR & VR market, with <sup>43</sup> projected market volume of US\$8,568.00 million in 2023.
- The number <sup>4</sup> of users in the AR & VR market is expected to reach 505.30 million by 2027.
- User penetration is predicted to be 27.2% in 2023 and is expected to increase to 34.4% by 2027.
- The average revenue per user (ARPU) is expected to be US\$1.61.
- The revenue values provided only account for <sup>12</sup> B2C revenues, meaning they do not include B2B revenues. Based on the displayed market share of B2C, none of the total market (B2C & B2B) is covered in the displayed revenue values.



❖ **Important Platforms for AR/VR**

**Virtual and Augmented Reality Centre of Excellence (VARCoE) –**

<https://www.iitbbs.ac.in/VARCoE/>

Ministry of Electronics and Information Technology -<https://www.meity.gov.in/>

#### 7.1.4. Cybersecurity in India:

As the manufacturing industry embraces Industry 4.0, it becomes a prime target for attackers. They can exploit vulnerabilities in both IT and OT systems within manufacturing networks, posing risks like industrial espionage, intellectual property theft, IP leakage, and even production sabotage. India's rapid growth as a technology hub has exposed it to increased cyber threats. Organizations in India face various security challenges, including financial fraud, data breaches, and state-sponsored attacks. The utility sector, in particular, may experience more breaches in 2023. Therefore, cybersecurity has become a top priority in India due to the rising number of cyber-attacks on businesses and government institutions.

- Common cyber threats in India include phishing, malware, and ransomware. Phishing involves attackers using fake emails or websites to deceive victims into revealing personal or financial information. Malware is malicious software that can infect computers and cause significant damage. Ransomware encrypts a victim's files and demands a ransom for decryption.
- The Indian government has taken steps to enhance cybersecurity. Initiatives such as the establishment of the National Critical Information Infrastructure Protection Centre (NCIIPC) and the National Cyber Coordination Centre (NCCC) aim to improve the country's cybersecurity posture. Furthermore, awareness

campaigns have been launched to educate citizens about cybersecurity threats and protective measures.

- As part of the government's AICTE initiative, technical institutions are encouraged to observe "Cyber Jaagrookta Diwas" on the first Wednesday of every month. This includes organizing cyber awareness sessions on themes like cybercrime and safety, cyber hygiene, social networks, and electronic payments. Institutions are also advised to display awareness posters and banners within their premises.
- ❖ Cyber threat analysis in India:
- In the healthcare sector, India ranks 11th in vulnerability to cyber-attacks. In 2022, there were 1.9 million reported cyber-attacks, with an average data breach cost of 176 million.
  - For manufacturing companies, ransomware was responsible for 23% of cy<sub>255</sub> attacks.
  - In the government sector, India's share of total cyber-attacks on government agencies increased from 6.3% in 2021 to 13.7% in 2022.
  - In the financial services industry, Indian banks reported 248 successful data breaches. Public sector banks accounted for 41 cases, private sector banks for 205 cases, and overseas banks for two cases.
- ❖ Cybersecurity Market Size and Revenue Market in India
- Revenue in the Cybersecurity market is projected to reach US\$2.50bn in 2023.
  - The largest market within Cybersecurity is Security Services with a projected market volume of US\$1.25bn in 2023.
  - Revenue is expected to show an annual growth rate (CAGR 2023-2028) of 12.87%, resulting in a market volume of US\$4.57bn by 2028.
  - The average Spend per Employee in the Cybersecurity market is projected to reach US\$4.80 in 2023.
  - In global comparison, most revenue will be generated in the United States (US\$68,680.00m in 2023).



- ❖ Important Platforms:

Indian Institute of cyber security -

<https://indianinstituteofcybersecurity.com/>

National Security C0uncil (NSC) - <https://www.whitehouse.gov/nsc/>

Centre of Excellence for Cyber Security Research & Development in India

(CECSRDI) - <https://ccoe.dsci.in/>

Cyber Security India (CSI) - <https://www.cybersecurityindia.org/>

#### References:

<https://www.businessstoday.in/technology/news/story/india-witnesses-demand-for-40000-cybersecurity-jobs-check-the-most-popular-jobs-386536-2023-06-21#:~:text=Healthcare%3A%20India,of%20%241.85%20million.>

#### 7.1.5 Digital Twin in India

As India's economy and industries continue to grow, technology plays a crucial role in driving progress. One emerging technology with great potential is digital twin technology. It creates a digital replica of real-world objects and processes, promising to revolutionize manufacturing, infrastructure development, and more. However, like any new technology, there are challenges to overcome. In this blog, we will explore the opportunities and challenges of digital twin technology in India and what the future holds for this exciting development.

The Asia Pacific region, including China, India, Japan, Australia, and other countries, is expected to experience the fastest growth in the digital twin market, with a compound annual growth rate (CAGR) of 42.1%. This growth is attributed to the

well-developed manufacturing and automotive sectors in countries like China, India, Japan, and South Korea.<sup>10</sup>

Digital twin technology is a game-changer in various industries, and its importance in India cannot be underestimated. With the ongoing digital transformation across sectors, adopting digital twin technology has become crucial for organizations aiming to improve operational efficiency and make data-driven decisions. Its ability to provide real-time insights and optimize operations makes it a valuable tool in multiple sectors. Embracing this technology not only enhances productivity but also contributes significantly to India's vision of becoming a digitally empowered nation.

### **7.1.6 Robotics and Automation in India**

<sup>1</sup>The Robotics market is influenced by various trends, including the Industrial Internet of Things, mobile autonomous robots, collaborative robots, and open-source software. Additionally, topics like 5G, edge computing, and smart mobility are also impacting the market. AI is boosting the field of automation, the use of self-learning robots is becoming a trend

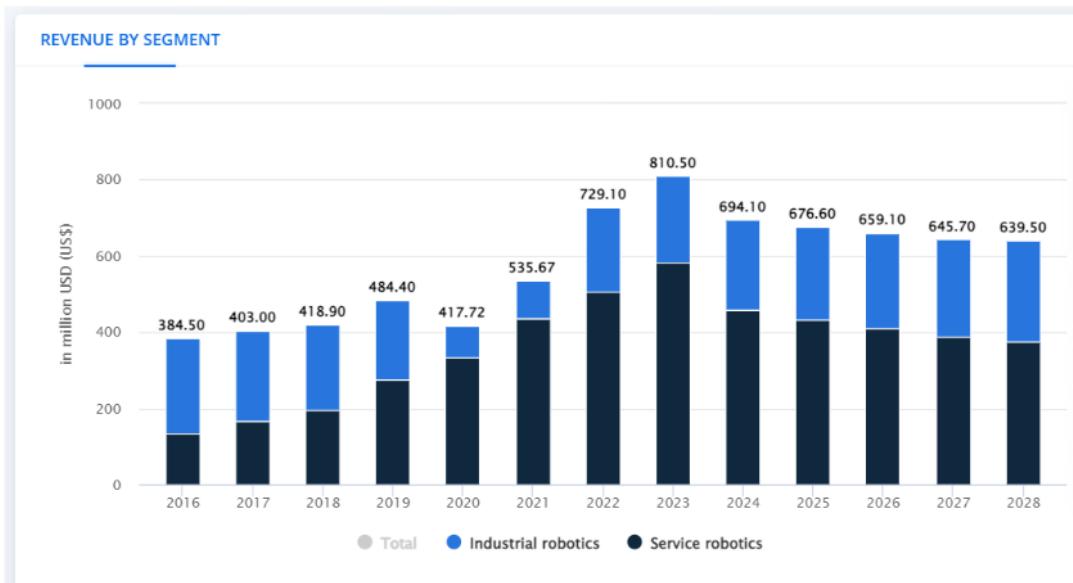
<sup>1</sup>Simplification is a significant factor driving the growth of the Robotics market. As implementation efforts decrease, robotics is becoming more relevant in industries that previously didn't utilize robots. Manufacturers are striving to make their products more user-friendly by offering comprehensive solutions that combine hardware and software. This simplifies the implementation of autonomous systems.

With these trends shaping the Robotics market, it is expected to continue growing in the future, leading to positive revenue growth rates in the forecast period.

#### **❖ Robotics and Automation Market Size and Revenue <sup>140</sup>Market in India**

- The revenue in the Robotics market is projected to reach US\$810.50 million in 2023.
- The India Industrial Automation Market is expected to grow from USD 13.25 billion in 2023 to USD 25.80 billion by 2028, with a compound annual growth rate (CAGR) of 14.26% during the forecast period (2023-2028).
- The market is dominated by service robotics, with a projected market volume of US\$582.20 million in 2023.

- The revenue is expected to have a negative annual growth rate of -4.63% from 2023 to 2028, resulting in a market volume of US\$639.50 million by 2028.
- When compared globally, the United States is projected to generate the highest revenue, amounting to US\$7,722.00 million in 2023.



#### ❖ Important Platforms:

All india council for robotics and automation - <https://www.aicra.org/>

#### References:

<sup>266</sup> <https://www.statista.com/outlook/tmo/robotics/india#:~:text=Revenue%20in%20the%20Robotics%20market,US%24582.20m%20in%202023.>

<sup>33</sup> [https://www.mordorintelligence.com/industry-reports/india-industrial-automation-market/market-size#:~:text=The%20India%20Industrial%20Automation%20Market%20size%20is%20expected%20to%20grow%20from%20USD%2013.25%20billion%20in%202023%20to%20USD%2025.80%20billion%20by%202028%2C%20at%20a%20CAGR%20of%2014.26%25%20during%20the%20forecast%20period%20\(2023%2D2028\).](https://www.mordorintelligence.com/industry-reports/india-industrial-automation-market/market-size#:~:text=The%20India%20Industrial%20Automation%20Market%20size%20is%20expected%20to%20grow%20from%20USD%2013.25%20billion%20in%202023%20to%20USD%2025.80%20billion%20by%202028%2C%20at%20a%20CAGR%20of%2014.26%25%20during%20the%20forecast%20period%20(2023%2D2028).)

#### 7.1.7 Additive Manufacturing in India

The Indian government introduced a national additive manufacturing strategy with the goal of contributing \$2-3 billion to the GDP by 2025. The Indian 3D printer market is projected to grow at a compound annual growth rate (CAGR) of 20.33% by 2028.

The National Center of Additive Manufacturing<sup>90</sup>, under the Ministry of Electronics and Information Technology (MeitY), suggests the establishment of a dedicated agency to promote the adoption of additive manufacturing (AM) technologies through a public-private partnership (PPP) model. This agency should include subject-matter experts and industry leaders as members, and collaborative initiatives can be undertaken with international partners. It also recommends conducting a detailed study to assess the adoption potential of AM in the manufacturing sector. The center can provide support through activities such as formulating standards for quality control and safety, focusing on advanced material development, creating design tools, strengthening cyber laws, and establishing a legal framework.<sup>250</sup>

To drive indigenous AM technologies and foster innovation<sup>3</sup>, the Centre for Promotion of Additive Manufacturing (CPAM) will be established as a hub for end-to-end innovation, also contributing to e-governance. The strategy suggests fostering international research and development<sup>3</sup> partnerships as well.

In line with these efforts, the Gujarat government has signed an MoU with the US Institute of 3D Technology and OEM 3D Systems to establish seven 3D printing Centers of Excellence in technical institutes and engineering colleges. The Andhra Pradesh MedTech Zone has collaborated with the University of Wollongong to establish a 3D bioprinting lab. The Department of Heavy Industries COE at IISc Bengaluru has partnered with Wipro to build India's first industrial-grade 3D printer. Additionally, the Andhra Pradesh government and HP Inc. have signed an MoU to establish a Centre for Excellence for 3D printing.

#### References:

<https://www.techsciresearch.com/report/india-3d-printer-market/10703.html>

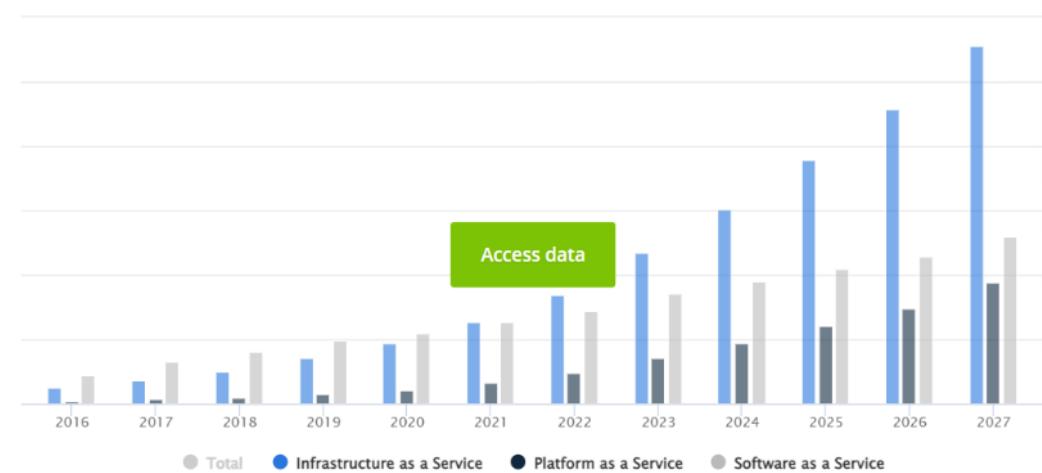
#### 7.1.8 Public Cloud in India

Cloud computing is a popular<sup>1</sup> and transformative topic in the field of IT. It has a significant impact on various business processes and can address dynamic and complex requirements. Infrastructure as a Service (IaaS) enables easy scalability of physical servers and data center infrastructure. Platform as a Service (PaaS) provides virtual tools for application development and deployment. Software as a Service (SaaS) is a cloud model for licensing and delivering<sup>1</sup> business applications accessed through web browsers. In addition to private and public cloud options, hybrid cloud and multi-cloud models are becoming increasingly important for future cloud strategies in enterprises.

##### ❖ Public Cloud Market Size and Revenue Market in India:

- The revenue in the Public Cloud market is projected to reach US\$5.96 billion in 2023.
- Infrastructure as a Service (IaaS) dominates the market, with a projected market volume of US\$2.92 billion in 2023.
- The revenue is expected to grow at an annual rate of 20.47% from 2023 to 2027, resulting in a market volume of US\$12.55 billion by 2027.
- The average spend per employee in the Public Cloud market is projected to be US\$11.47 in 2023.
- When compared globally, the United States is expected to generate the highest revenue, amounting to US\$258.10 billion in 2023.

REVENUE BY SEGMENT



### 7.1.9 Big Data Analytics

The big data market in India was worth INR 132.63 billion in 2021. It is projected to reach INR 558.24 billion by 2027, growing at a compound annual growth rate (CAGR) of approximately 26.80% during the period of 2022 to 2027. Currently, India is among the top 10 countries in this market, with over 600 data analytics firms.

#### References:

[https://www.marketwatch.com/press-release/india-big-data-market-report-2023-industry-trends-share-size-demand-and-future-scope-2030-2023-06-21?mod=search\\_headline](https://www.marketwatch.com/press-release/india-big-data-market-report-2023-industry-trends-share-size-demand-and-future-scope-2030-2023-06-21?mod=search_headline)

## 7.2 Technology Scan at International Level:

### 42 7.2.1 Artificial Intelligence (AI) and Machine Learning (ML) -Worldwide

- The Artificial Intelligence market is estimated to reach a value of US\$241.80 billion in 2023.
- It is expected to grow at an annual rate of 17.30% from 2023 to 2030, leading to a market volume of US\$738.80 billion by 2030.
- Among all countries, the United States is projected to generate the highest value, with US\$87.18 billion in 2023, when compared globally.

USA	Japan	Germany	China	France
Value in the Artificial Intelligence market is projected to reach US\$87.18 billion in 2023.  Value is expected to show an annual growth rate (CAGR 2023-2030) of 15.36%, resulting in a market volume of US\$237.10 billion by 2030.	Value in the Artificial Intelligence market is projected to reach US\$10.30 billion in 2023.  Value is expected to show an annual growth rate (CAGR 2023-2030) of 16.34%, resulting in a market volume of US\$29.72 billion by 2030.	Value in the Artificial Intelligence market is projected to reach US\$10.30 billion in 2023.  Value is expected to show an annual growth rate (CAGR 2023-2030) of 16.34%, resulting in a market volume of US\$29.72 billion by 2030.	Value in the Artificial Intelligence market is projected to reach US\$29.02 billion in 2023.  Value is expected to show an annual growth rate (CAGR 2023-2030) of 20.12%, resulting in a market volume of US\$104.70 billion by 2030.	Value in the Artificial Intelligence market is projected to reach US\$6.63 billion in 2023.  Value is expected to show an annual growth rate (CAGR 2023-2030) of 16.59%, resulting in a market volume of US\$19.41 billion by 2030.

### 1 7.2.2. Internet of Things (IOT) Worldwide

- Revenue in the IoT market is projected to reach US\$1,177.00 billion in 2023.
- Automotive IoT dominates the market with a projected market volume of US\$397.20 billion in 2023.
- Revenue is expected to show an annual growth rate (CAGR 2023-2028) of 13.60%, resulting in a market volume of US\$2,227.00 billion by 2028.

- In global comparison, the United States is projected to generate the highest revenue, amounting to US\$172.30 billion in 2023.

USA	Japan	Germany	China	France
Revenue in the IoT market is projected to reach US\$172.30 billion in 2023.  Industrial IoT dominates the market with a projected market volume of US\$66.28 billion in 2023.  Revenue is expected to show an annual growth rate (CAGR 2023-2028) of 11.50%, resulting in a market volume of US\$297.00 billion by 2028.	Revenue in the IoT market is projected to reach US\$31.72 billion in 2023.  Industrial IoT dominates the market with a projected market volume of US\$11.05 billion in 2023.  Revenue is expected to show an annual growth rate (CAGR 2023-2028) of 11.04%, resulting in a market volume of US\$53.54 billion by 2028.	Revenue in the IoT market is projected to reach US\$29.99 billion in 2023.  Industrial IoT dominates the market with a projected market volume of US\$10.43 billion in 2023.  Revenue is expected to show an annual growth rate (CAGR 2023-2028) of 11.94%, resulting in a market volume of US\$52.70 billion by 2028.	Revenue in the IoT market is projected to reach US\$147.20 billion in 2023.  Industrial IoT dominates the market with a projected market volume of US\$55.76 billion in 2023.  Revenue is expected to show an annual growth rate (CAGR 2023-2028) of 14.59%, resulting in a market volume of US\$290.80 billion by 2028.	Revenue in the IoT market is projected to reach US\$21.55 billion in 2023.  Industrial IoT dominates the market with a projected market volume of US\$7.10 billion in 2023.  Revenue is expected to show an annual growth rate (CAGR 2023-2028) of 11.74%, resulting in a market volume of US\$37.54 billion by 2028.

### 133 7.2.3. Augmented Reality (AR) / Virtual Reality (VR) Worldwide

- Revenue in the AR & VR market is projected to reach US\$31.12bn in 2023.
- Revenue is expected to show an annual growth rate (CAGR 2023-2027) of 13.72%, resulting in a projected market volume of US\$52.05bn by 2027.
- The largest market is AR Software with a market volume of US\$11.58bn in 2023.
- With a projected market volume of US\$8,568.00m in 2023, most revenue is generated in the United States.

- In the AR & VR market, the number of users is expected to amount to 2,593.00m users by 2027.
- User penetration will be 28.8% in 2023 and is expected to hit 32.6% by 2027.
- The average revenue per user (ARPU) is expected to amount to US\$14.08.
- Revenue values displayed here do only account for B2C revenues. Meaning, according to the displayed market share of B2C, 0.0% of the total market (B2C & B2B) is covered.

USA	Japan	Germany	China	France
<p>Revenue in the AR &amp; VR market is projected to reach US\$8.57bn in 2023. Revenue is expected to grow annually at a rate of 13.54% from 2023 to 2027, resulting in a projected market volume of US\$14.24bn by 2027. The largest market segment is AR Software, with a market volume of US\$3.61bn in 2023. The United States generates the most revenue in the AR &amp; VR market, with a projected market volume of US\$8,568.00m in 2023. The number of users in the AR &amp; VR market is expected to reach 282.40m by 2027. User penetration is estimated to be 68.1% in 2023 and is projected to increase to 82.1% by 2027. The average revenue per user (ARPU) is</p>	<p>Revenue in the AR &amp; VR market is projected to reach US\$1,880.00m in 2023. Revenue is expected to grow annually at a rate of 13.44% in 2023 to 2027, resulting in a projected market volume of US\$3,113.00m by 2027. The largest market segment is AR Software, with a market volume of US\$719.70m in 2023. The United States generates the most revenue in the AR &amp; VR market, with a projected market volume of US\$8,568.00m in 2023. The number of users in the AR &amp; VR market is expected to reach 67.79m by 2027.</p>	<p>Revenue in the AR &amp; VR market is projected to reach US\$1,560.00m in 2023. Revenue is expected to grow annually at a rate of 13.74% from 2023 to 2027, resulting in a projected market volume of US\$2,611.00m by 2027. The largest market segment is AR Software, with a market volume of US\$564.30m in 2023. The United States generates the most revenue in the AR &amp; VR market, with a projected market volume of US\$8,568.00m in 2023.</p>	<p>Revenue in the AR &amp; VR market is projected to reach US\$6.61bn in 2023. Revenue is expected to grow annually at a rate of 12.95% from 2023 to 2027, resulting in a projected market volume of US\$10.75bn by 2027. The largest market segment is VR Hardware, with a market volume of US\$2.40bn in 2023. The United States generates the most revenue in the AR &amp; VR market, with a projected market volume of US\$8,568.00m in 2023. The number of users in the AR &amp;</p>	<p>Revenue in the AR &amp; VR market is projected to reach US\$1,131.00m in 2023. Revenue is expected to grow annually at a rate of 14.40% in 2023 to 2027, resulting in a projected market volume of US\$1,937.00m by 2027. The largest market segment is VR Hardware, with a market volume of US\$408.70m in 2023. The United States generates the most revenue in the AR &amp; VR market, with a projected market volume of US\$8,568.00m in 2023. The number of users in the AR &amp;</p>

expected to be US\$37.39.	User penetration is estimated to be 43.5% in 2023 and is projected to increase to 55.2% by 2027. The average revenue per user (ARPU) is expected to be US\$34.52	<sup>82</sup> The number of users in the AR & VR market is expected to reach 47.66m by 2027. User penetration is estimated to be 46.4% in 2023 and is projected to increase to 57.2% by 2027. The average revenue per user (ARPU) is expected to be US\$40.13.	<sup>4</sup> VR market is expected to reach 845.60m by 2027. User penetration is estimated to be 53.8% in 2023 and is projected to increase to 57.5% by 2027. The average revenue per user (ARPU) is expected to be US\$8.41.	User penetration is estimated to be 55.9% in 2023 and is projected to increase to 66.2% by 2027. The average revenue per user (ARPU) is expected to be US\$30.75.
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#### **7.2.4 Cybersecurity worldwide:**

- Revenue in the Cybersecurity market is projected to reach US\$162.00bn in 2023.
- Security Services dominates the market with a projected market volume of US\$85.49bn in 2023.
- Revenue is expected to show an annual growth rate (CAGR 2023-2028) of 9.63%, resulting in a market volume of US\$256.50bn by 2028.
- The average Spend per Employee in the Cybersecurity market is projected to reach US\$46.54 in 2023.
- In global comparison, most revenue will be generated in the United States (US\$68,680.00m in 2023).

USA	Japan	Germany	China	France
<sup>1</sup> Revenue in the Cybersecurity market is projected to reach US\$68.68bn in 2023. Security Services dominates the market with a projected market volume of US\$37.95bn in 2023.	<sup>1</sup> Revenue in the Cybersecurity market is projected to reach US\$8.78bn in 2023. Security Services dominates the market with a projected market	<sup>1</sup> Revenue in the Cybersecurity market is projected to reach US\$6.19bn in 2023. Security Services dominates the market with a	<sup>4</sup> Revenue in the Cybersecurity market is projected to reach US\$14.30bn in 2023. Cyber Solutions dominates the market with a	<sup>1</sup> Revenue in the Cybersecurity market is projected to reach US\$4.74bn in 2023. Security Services dominates the market with a projected market

<p>Revenue is expected to grow annually at a rate of 8.5% from 2023 to 2028, resulting in a market volume of US\$103.40bn by 2028. The average Spend per Employee in the Cybersecurity market is projected to reach US\$407.70 in 2023.</p>	<p>volume of US\$5.01bn in 2023. Revenue is expected to grow annually at a rate of 8.80% from 2023 to 2028, resulting in a market volume of US\$13.39bn by 2028. The average Spend per Employee in the Cybersecurity market is projected to reach US\$130.20 in 2023.</p>	<p>projected market volume of US\$3.40bn in 2023. Revenue is expected to grow annually at a rate of 9.44% from 2023 to 2028, resulting in a market volume of US\$9.71bn by 2028. The average Spend per Employee in the Cybersecurity market is projected to reach US\$142.60 in 2023.</p>	<p>projected market volume of US\$9.82bn in 2023. Revenue is expected to grow annually at a rate of 12.78% from 2023 to 2028, resulting in a market volume of US\$26.09bn by 2028. The average Spend per Employee in the Cybersecurity market is projected to reach US\$17.99 in 2023.</p>	<p>volume of US\$2.66bn in 2023. Revenue is expected to grow annually at a rate of 8.88% from 2023 to 2028, resulting in a market volume of US\$7.25bn by 2028. The average Spend per Employee in the Cybersecurity market is projected to reach US\$155.50 in 2023.</p>
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### 7.2.5 Robotics and Automation worldwide

- Revenue in the Robotics market is projected to reach US\$37.37bn in 2023.
- Service robotics dominates the market with a projected market volume of US\$28.49bn in 2023.
- Revenue is expected to show an annual growth rate (CAGR 2023-2028) of 3.83%, resulting in a market volume of US\$45.09bn by 2028.
- In global comparison, most revenue will be generated in the United States (US\$7,722.00m in 2023).

USA	Japan	Germany	China	France
Revenue in the Robotics market is projected to	Revenue in the Robotics market is	Revenue in the Robotics market is projected to	Revenue in the Robotics market is projected to	Revenue in the Robotics market is

<p>reach US\$7.72bn in 2023. Service robotics dominates the market with a projected market volume of US\$7.09bn in 2023.</p> <p><sup>13</sup> Revenue is expected to grow annually at a rate of 3.86% from 2023 to 2028, resulting in a market volume of US\$9.33bn by 2028.</p>	<p><sup>1</sup> projected to reach US\$2.69bn in 2023. Service robotics dominates the market with a projected market volume of US\$1.47bn in 2023. Revenue is <sup>13</sup> expected to decline annually at a rate of -1.15% from 2023 to 2028, resulting in a market volume of US\$2.54bn by 2028.</p>	<p><sup>1</sup> reach US\$3.15bn in 2023. Service robotics dominates the market with a projected market volume of US\$2.35bn in 2023. Revenue is <sup>13</sup> expected to grow annually at a rate of 0.86% from 2023 to 2028, resulting in a market volume of US\$3.29bn by 2028.</p>	<p><sup>1</sup> reach US\$6.40bn in 2023. Service robotics dominates the market with a projected market volume of US\$4.91bn in 2023. Revenue is <sup>13</sup> expected to grow annually at a rate of 7.06% from 2023 to 2028, resulting in a market volume of US\$9.00bn by 2028.</p>	<p><sup>1</sup> projected to reach US\$1.31bn in 2023. Service robotics dominates the market with a projected market volume of US\$1.05bn in 2023. Revenue is <sup>13</sup> expected to grow annually at a rate of 2.63% from 2023 to 2028, resulting in a market volume of US\$1.50bn by 2028.</p>
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### <sup>5</sup> 7.2.6 Additive Manufacturing - worldwide

The global additive manufacturing market size was valued at USD 13.84 billion in 2021 and is expected to expand at a compound annual growth rate (CAGR) of 20.8% from 2022 to 2030. A total of 2.2 million units of 3D printers were shipped globally in 2021 and the unit shipments are expected to reach 21.5 million units by 2030. Factors such as the growing demand for prototyping applications from various industries and industry verticals, particularly healthcare, automotive, and aerospace & defense, and the aggressive research and development in 3D printing are expected to drive the growth of the market.

### <sup>4</sup> 7.2.7 Public Cloud worldwide

- <sup>4</sup> Revenue in the Public Cloud market is projected to reach US\$525.60bn in 2023.
- Software as a Service dominates the market with a projected market volume of US\$253.90bn in 2023.
- Revenue is expected to show an annual growth rate (CAGR 2023-2027) of 13.81%, resulting in a market volume of US\$881.80bn by 2027.

- The average spend per employee in the Public Cloud market is projected to reach US\$151.00 in 2023.
- The global market share of Other was 50.9% in 2021.
- In global comparison, most revenue will be generated in the United States (US\$258.10bn in 2023).

USA	Japan	Germany	China	France
<p>Revenue in the Public Cloud market is projected to reach US\$7.72bn in 2023. Software as a Service dominates the market with a projected market volume of US\$7.09bn in 2023.</p> <p>Revenue is expected to grow annually at a rate of 3.86% from 2023 to 2028, resulting in a market volume of US\$9.33bn by 2028. The average spend per employee in the Public Cloud market is projected to reach US\$1.53k in 2023.</p>	<p>Revenue in the Public Cloud market is projected to reach US\$18.37bn in 2023. Software as a Service dominates the market with a projected market volume of US\$9.85bn in 2023.</p> <p>Revenue is expected to grow annually at a rate of 15.46% from 2023 to 2027, resulting in a market volume of US\$32.65bn by 2027.</p> <p>The average spend per employee in the Public Cloud market is projected to reach US\$272.30 in 2023.</p>	<p>Revenue in the Public Cloud market is projected to reach US\$21.18bn in 2023. Software as a Service dominates the market with a projected market volume of US\$13.06bn in 2023.</p> <p>Revenue is expected to grow annually at a rate of 11.40% from 2023 to 2027, resulting in a market volume of US\$32.62bn by 2027.</p> <p>The average spend per employee in the Public Cloud market is projected to reach US\$488.40 in 2023.</p>	<p>Revenue in the Public Cloud market is projected to reach US\$54.25bn in 2023. Infrastructure as a Service dominates the market with a projected market volume of US\$34.16bn in 2023.</p> <p>Revenue is expected to grow annually at a rate of 22.23% from 2023 to 2027, resulting in a market volume of US\$121.10bn by 2027.</p> <p>The average spend per employee in the Public Cloud market is projected to reach US\$68.25 in 2023.</p>	<p>Revenue in the Public Cloud market is projected to reach US\$12.46bn in 2023. Software as a Service dominates the market with a projected market volume of US\$7.38bn in 2023.</p> <p>Revenue is expected to grow annually at a rate of 11.81% from 2023 to 2027, resulting in a market volume of US\$19.47bn by 2027.</p> <p>The average spend per employee in the Public Cloud market is projected to reach US\$409.20 in 2023.</p>

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## 8. Standardization (National and International)

### 8.1 National Standardization:

In India, the Bureau of Indian Standards (BIS) is the national standardization body responsible for developing and promoting standards across various industries. BIS has adopted and adapted several international standards for use in India.<sup>33</sup>

The Bureau of Indian Standards (BIS) has developed a number of Indian Standards (IS) for Industry 4.0. These standards cover a wide range of topics, including cybersecurity, data exchange, interoperability, manufacturing technologies, and product traceability.

The purpose of these standards is to help Indian businesses adopt Industry 4.0 technologies and practices. They provide a common framework for ensuring the security, interoperability, and traceability of manufacturing processes.<sup>21</sup>

The following are some of the Indian Standards for Industry 4.0:

- IS 17305:2020, Information security for industrial automation and control systems
- IS 19218:2021, Data exchange for the manufacturing enterprise
- IS 21466:2021, Interoperability for industrial automation and control systems
- IS 16062:2021, Additive manufacturing - General principles and terminology
- IS 17304:2020, Traceability in manufacturing

In addition to the standards listed above, BIS is also working on a number of other standards for Industry 4.0. These standards are still under development, but they will cover topics such as cloud computing, the Internet of Things (IoT), and artificial intelligence (AI).

## 8.2 International Standardization:

### 8.2.1 Some notable organizations and standards include:

**International Organization for Standardization (ISO):** ISO develops and publishes international standards covering a wide range of industries and domains. Some relevant ISO standards for Industry 4.0 include:

Technological and Operation related Standards	Quality Management Systems related Standards	Sustainability Related Standards
<p><b>1. Automation and Robotics Standards</b></p> <ol style="list-style-type: none"><li>1. ISO 15066:2016:</li><li>2. ISO 12100:2010:</li><li>3. ISO 20218:2017</li><li>4. ISO 10218:2011:</li></ol> <p><b>2. Additive Manufacturing</b></p> <ul style="list-style-type: none"><li>• ISO 17296:2014</li><li>• ISO 52910:2018</li><li>• ISO 52911:2019</li></ul> <p><sup>273</sup> <b>3. Autonomous Guided Vehicles (AGV)/ Autonomous Mobile Robots (AMR)</b></p> <ul style="list-style-type: none"><li>• ISO 13849:2015</li><li>• ISO 12100:2010</li></ul> <p><b>4. Sensorisation, Remote Monitoring &amp; Control</b></p> <ul style="list-style-type: none"><li>• ISO/IEC 29182:2015</li><li>• ISO/IEC 30128:2014</li><li>• ISO/IEC 20005:2013</li></ul> <p><b>5. Integrated Supply Chain Management</b></p> <ul style="list-style-type: none"><li>• ISO 22301:2019</li><li>• ISO 28000:2007</li><li>• ISO 9001:2015</li></ul>	<p>➤ <b>ISO 9000:</b> Quality Management Systems: This standard provides guidelines for implementing a quality management system, ensuring consistent product quality, and customer satisfaction.</p> <p>➤ <b>ISO 9001:</b> Quality Management Systems: It provides a set of requirements for establishing and maintaining a quality management system, emphasizing customer satisfaction and continual improvement.</p>	<p>➤ <b>ISO 14001:</b> Environmental Management Systems: This standard sets out the criteria for implementing an effective environmental management system, addressing environmental impacts and promoting sustainability</p> <p>➤ <b>ISO 14000:</b> Environmental Management Systems: This standard focuses on implementing effective environmental management systems to enhance sustainability and reduce environmental impacts.</p>

<p><b>6 Data Analytics</b></p> <ul style="list-style-type: none"> <li>• ISO 22514:2014</li> <li>• ISO 18876:2003</li> </ul> <p><b>7.Demand Planning &amp; Enterprise Resource Planning</b></p> <ul style="list-style-type: none"> <li>• IEC 62264:2013</li> <li>• ISO 22400:2018</li> <li>• ISO 18828:2016</li> </ul> <p><b>8Asset Management</b></p> <ul style="list-style-type: none"> <li>• ISO 55000:2014</li> <li>• ISO 55001:2014</li> <li>• ISO 55002:2014</li> </ul> <p><b>9,Connectivity</b> IEC 62541:2015</p> <p><b>10.Digital Twin</b> ISO 13374:2003</p> <p><b>257 Security:</b></p> <p>➤ ISO/IEC 27001: Information Security Management Systems: It provides a framework for establishing, implementing, maintaining, and continually improving information security management systems.</p>		<p><b>Energy Efficiency and Sustainability ISO 50001:2018</b></p>
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### 8.2.2 International Electrotechnical Commission (IEC):

IEC is a global organization that prepares and publishes international standards for electrical and electronic technologies. Some relevant IEC standards for Industry 4.0 include:

- **IEC 62443: Industrial Communication Networks Network and System Security:** It defines security requirements and guidelines for industrial automation and control systems.
- **IEC 61131: Industrial Process Control Programming Languages:** This standard defines programming languages for industrial control systems, ensuring interoperability and ease of programming.

## 8.3 Industrial Standards:

In addition to national and international standards organizations, several industries have developed their own standards and guidelines specific to their respective domains. These industrial standards are often driven by industry associations, research organizations, and collaborations. Some examples include:

### OPC Foundation:

The OPC (OLE for Process Control) Foundation develops and maintains standards for industrial interoperability, including OPC Unified Architecture (OPC UA) for secure and reliable data exchange in industrial automation.

- **IEC 61508:** This standard, developed by IEC, addresses functional safety in electrical and electronic systems across various industries, including manufacturing and process control.
- **ISO 45001: Occupational Health and Safety Management Systems:** It sets requirements for establishing and maintaining occupational health and safety management systems, ensuring a safe working environment in industries.
- **IEEE 802 Standards:** Developed by the Institute of Electrical and Electronics Engineers (IEEE), these standards cover various aspects of networking and communication technologies, including wireless networks and Ethernet.

References:<http://standardsi40.sg/industry-solution/automation-and-robotics>

## 9. Sustainability Impact

Sustainable manufacturing is the practice of combining systems and processes to create high-quality products while using fewer resources, utilizing sustainable materials, and ensuring safety for customers, employees, and communities. It focuses on demonstrating the benefits of social, economic, and environmental sustainability at each stage of production.

### 9.1 Sustainability Impact for Industry 4.0 -"Sustainability 4.0"

The sustainability for industry 4.0 is termed as Sustainability 4.0. The technological advancements of Industry 4.0, are predicted to greatly enhance sustainability in industrial manufacturing. Sustainability in Industry 4.0 is currently a key focus for industry experts and researchers as it enables optimal resource utilization and waste reduction.. It offers the necessary technology for companies to address environmental challenges such as global warming and climate change, while promoting industrial growth and efficiency

Sustainability 4.0 aims a sustainable manufacturing with Green Manufacturing and Lean Manufacturing. The market for ESG-Environmental, social, and corporate governance and sustainability is projected to grow at a compound annual growth rate (CAGR) of 7.42% from 2022 to 2030.

#### 9.1.1 The concept of Sustainability 4.0 encompasses various dimensions, including:

21 Sustainability Dimension in I4.0	Main Influence from I4.0
<b>Environmental Dimension:</b> This dimension focuses on minimizing environmental impact and promoting resource efficiency. It involves the adoption of clean technologies, energy-efficient processes, waste reduction strategies, and the responsible use of natural resources. Sustainability 4.0 aims to reduce carbon emissions, conserve energy, and protect ecosystems.	<ul style="list-style-type: none"><li>• Industrial waste reduction</li><li>• Promote circular economy</li><li>• Use and production of renewable sources</li><li>• Reduction in use of non-renewable sources and energy consumption</li><li>• Reduction in global warming,</li><li>• resource consumption,</li><li>• energy consumption</li></ul>

<p><b>Social Dimension:</b></p> <p>The social dimension of Sustainability 4.0 emphasizes the well-being of employees, communities, and society as a whole. It involves promoting fair working conditions, ensuring health and safety, fostering diversity and inclusion, and supporting local communities. Companies strive to create positive social impact by engaging in responsible practices and addressing societal needs.</p>	<ul style="list-style-type: none"> <li>● Employment</li> <li>● Better collaboration among stakeholders</li> <li>● Reduction in accidents</li> <li>● Improved living conditions for societies</li> <li>● Improved working conditions</li> </ul>
<p><b>Economic Dimension:</b></p> <p>The economic dimension recognizes the importance of sustainable economic growth and long-term value creation. It involves incorporating sustainability considerations into business strategies, optimizing resource allocation, and fostering innovation. Sustainability 4.0 aims to enhance competitiveness, improve financial performance, and create economic opportunities while considering the broader social and environmental context</p>	<p>● Sustainable value creation,</p> <p>● Efficiency and profits</p> <p>● Reduction in operational costs</p> <p>● Impact on market share,</p> <p>● Supply chain,</p> <p>● Security</p> <p>● New business model opportunities, turnover</p>

### Importance of sustainability in Businesses

Businesses have a crucial role in promoting sustainability, and it is now considered their responsibility to adopt environmentally friendly practices. Leading companies are actively taking steps to measure and reduce their negative impact on the environment and address the priorities of both internal and external stakeholders.

Here are some key benefits of sustainable practices for businesses:

Enhanced Brand Reputation: When companies implement sustainable methods in their manufacturing systems, it improves their reputation among investors, stakeholders, and consumers. <sup>37</sup>

Improved Operational Efficiency: By reducing energy and resource consumption, businesses can lower costs and improve their overall operational efficiency.

Positive Societal Impact: Embracing sustainable practices helps companies build a positive image and sends a strong message to society. This, in turn, has a positive impact on consumers' perception of the company.

**Transparency in Business Partnerships:** Companies now expect their partners to engage in sustainable business practices, and they are moving away from working with partners who pose a risk to sustainability.

**Shareholder Considerations:** Shareholders are increasingly using Environmental, Social, and Governance (ESG) scores as criteria for making investment decisions.

**Compliance with Regulatory Requirements:** Regulations related to sustainability are becoming more stringent, and businesses need to comply with these requirements.

**Customer Preferences:** Customers are becoming more conscious of sustainable products and practices. They dislike "greenwashing" and prefer companies that genuinely embrace sustainability.

By considering these factors and incorporating sustainable practices into their operations, businesses can not only contribute to a greener future but also reap the benefits of a positive brand image, cost savings, and increased stakeholder satisfaction.

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## 9.2 Sustainable Development Goals (Sdg's) For Industry

### 4.0 Implementation In India:

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In India, the integration of Industry 4.0 technologies aligns with the Sustainable Development Goals (SDGs) established by the United Nations. The following are the key SDGs for Industry 4.0 in India:

- Goal 9: Industry, Innovation, and Infrastructure - This goal focuses on building resilient infrastructure, promoting sustainable industrialization, and fostering innovation. In the context of Industry 4.0, it involves the development and deployment of advanced technologies, digitalization, and automation to enhance productivity, efficiency, and competitiveness while minimizing environmental impacts.
- Goal 7: Affordable and Clean Energy - This goal emphasizes the transition to affordable and clean energy sources. In the context of Industry 4.0, it entails the adoption of renewable energy solutions, energy-efficient technologies, and smart energy management systems to reduce reliance on fossil fuels, decrease carbon emissions, and promote sustainable energy practices.
- Goal 12: Responsible Consumption and Production - This goal encourages sustainable patterns of consumption and production. In the context of Industry 4.0, it entails the adoption of circular economy principles, waste reduction strategies, and sustainable supply chain practices to minimize resource consumption, reduce waste generation, and promote the efficient use of resources throughout the production lifecycle.
- Goal 13: Climate Action - This goal focuses on combating climate change and its impacts. In the context of Industry 4.0, it involves leveraging digital technologies,

**data analytics**, **and** predictive models to optimize energy usage, monitor environmental performance, and develop climate-resilient solutions that **contribute** to greenhouse gas mitigation and adaptation efforts.

- Goal 8: Decent Work and Economic Growth - This goal emphasizes the creation of decent work opportunities and inclusive economic growth. In the context of Industry 4.0, it involves **skill development** programs, workforce **training** initiatives, and equitable access to digital technologies to promote employment, **entrepreneurship**, and sustainable economic development.
- Goal 5: Gender Equality - This goal aims to achieve gender equality and empower women. In the context of Industry 4.0, it involves promoting equal participation and opportunities for women in the digital workforce, ensuring gender-inclusive policies, and addressing gender-based disparities in access to **technology** and skills training.
- Goal 17: Partnerships for the Goals - This goal underscores the importance of multi-stakeholder partnerships to achieve sustainable development. In the context of Industry 4.0, it involves collaborations between the government, private sector, academia, and civil society to foster innovation, knowledge sharing, capacity building, and resource mobilization for sustainable development in the era of digital transformation.

By aligning with these SDGs, India can harness the potential of Industry 4.0 to drive sustainable industrialization, economic growth, social progress, and environmental Enhancements.

## 9.3 How Industry 4.0 Technologies Contribute Towards Sustainability

In contrast with the Traditional Manufacturing and Industry 4.0, Industry 4.0 plays a Major role in contributing sustainability. Here is how the Smart Manufacturing/Industry 4.0 Technologies contribute towards sustainability:

Industry 4.0 Technologies	Sustainability Contribution
1. Cyber Physical System (CPS)	<ul style="list-style-type: none"><li>• <b>Energy Efficiency:</b> CPS enables intelligent monitoring and control of physical systems, leading to optimized energy consumption. By integrating sensors, actuators, and real-time data analysis capabilities, CPS can optimize energy usage based on demand and environmental conditions. This results in reduced energy waste and improved energy efficiency, contributing to sustainability goals.</li><li>• <b>Resource Optimization:</b> CPS facilitates the efficient utilization of resources in various industries. Through real-time monitoring and data analysis, CPS can optimize resource allocation, production processes, and supply chain</li></ul>

	<p>management. This optimization minimizes waste, reduces resource consumption, and improves overall resource efficiency, leading to sustainable operations.</p> <ul style="list-style-type: none"> <li>● <b>Predictive Maintenance:</b> CPS enables predictive maintenance by continuously monitoring equipment and systems. By analyzing real-time data, CPS can detect anomalies, identify potential failures, and schedule maintenance activities proactively. This approach minimizes downtime, reduces unnecessary repairs, and extends the lifespan of equipment, resulting in resource and energy savings.</li> <li>● <b>Waste Reduction:</b> CPS enables real-time data collection and analysis, allowing organizations to identify and minimize waste generation throughout the production process. By optimizing workflows, minimizing material usage, and ensuring proper recycling and disposal practices, CPS contributes to waste reduction and promotes sustainable manufacturing practices.</li> <li>● <b>Smart Grids and Energy Management:</b> CPS enables the integration of renewable energy sources and the efficient management of energy grids. By leveraging real-time data and control systems, CPS can balance energy supply and demand, optimize grid operations, and incorporate distributed energy resources. This integration promotes the use of renewable energy, reduces reliance on fossil fuels, and enhances the resilience and sustainability of energy systems.</li> <li>● <b>Intelligent Transportation Systems:</b> CPS enhances transportation systems by optimizing traffic flow, reducing congestion, and minimizing fuel consumption. Through real-time monitoring, data analysis, and coordination among vehicles and infrastructure, CPS can improve traffic management, route planning, and vehicle efficiency. This leads to reduced emissions, energy savings, and more sustainable transportation practices.</li> <li>● <b>Environmental Monitoring:</b> CPS enables comprehensive environmental monitoring by integrating sensors, networks, and data analysis capabilities. This enables organizations to monitor air quality, water resources, and other environmental parameters in real time. By collecting and analyzing this data, CPS supports proactive decision-making and facilitates the implementation of sustainable practices to mitigate environmental impact.</li> <li>● <b>Improved Safety and Health:</b> CPS enhances safety and health conditions in various industries by enabling real-time monitoring, early detection of hazards, and immediate response to emergencies. By reducing accidents, minimizing occupational hazards, and ensuring worker well-being, CPS contributes to sustainable and socially responsible work environments.</li> </ul>
2. Internet of Things	<p>● <b>Energy Efficiency:</b> IoT enables the monitoring and control of energy-consuming devices and systems in real time. By collecting data on energy usage and optimizing energy distribution and consumption, IoT helps organizations identify energy inefficiencies and implement measures to reduce energy waste. This leads to improved energy efficiency and reduced carbon emissions, contributing to sustainability goals.</p>

	<ul style="list-style-type: none"> <li>• <b>Resource Management:</b> IoT facilitates efficient resource management by enabling real-time monitoring of resource consumption, such as water, electricity, and materials. Through sensors and data analytics, IoT systems can track usage patterns, detect anomalies, and optimize resource allocation. This optimization minimizes waste, conserves resources, and promotes sustainable practices in industries.</li> <li>• <b>Waste Management:</b> IoT enables smart waste management systems by monitoring and optimizing waste collection processes. IoT sensors can track fill levels in waste containers, enabling optimized collection routes and schedules. This reduces unnecessary collection trips, minimizes fuel consumption, and improves waste management efficiency, leading to reduced environmental impact.</li> <li>• <b>Supply Chain Optimization:</b> IoT enhances supply chain visibility and traceability, enabling organizations to optimize logistics and reduce environmental impact. By tracking products throughout the supply chain and collecting data on factors such as transportation conditions and inventory levels, IoT helps identify inefficiencies, reduce waste, and improve overall supply chain sustainability.</li> <li>• <b>Environmental Monitoring:</b> IoT enables real-time environmental monitoring by collecting data on air quality, water quality, and other environmental parameters. This data can be analyzed to detect pollution sources, identify environmental risks, and inform timely interventions. By facilitating proactive environmental management, IoT contributes to sustainability efforts.</li> <li>• <b>Smart Buildings:</b> IoT enables intelligent and energy-efficient building management systems. Through connected sensors, IoT systems can monitor and control various building parameters such as lighting, HVAC systems, and occupancy levels. By optimizing energy usage based on real-time data, IoT promotes energy efficiency, reduces carbon footprint, and enhances the sustainability of buildings.</li> <li>• <b>Precision Agriculture:</b> IoT technologies are transforming the agricultural sector by enabling precision farming techniques. By deploying sensors and IoT devices, farmers can collect data on soil moisture, nutrient levels, and crop health. This data-driven approach allows for precise irrigation, targeted fertilization, and optimized resource usage, leading to increased crop yields, reduced resource wastage, and sustainable agricultural practices.</li> <li>• <b>Remote Monitoring and Maintenance:</b> IoT enables remote monitoring and predictive maintenance of equipment and infrastructure. By continuously monitoring asset performance, detecting anomalies, and providing real-time alerts, IoT helps optimize maintenance schedules, reduce downtime, and prevent costly equipment failures. This proactive maintenance approach improves operational efficiency, reduces waste, and promotes sustainable asset management.</li> </ul>
3. Artificial Intelligence (AI)	<ul style="list-style-type: none"> <li>• <b>Resource Optimization:</b> AI/ML algorithms can analyze large volumes of data generated by smart sensors and devices in Industry 4.0 systems. By optimizing resource allocation, predictive maintenance, and production planning, AI/ML</li> </ul>

and Machine Learning (ML)	<p>helps minimize waste, reduce energy consumption, and enhance overall resource efficiency.</p> <ul style="list-style-type: none"> <li>● <b>Energy Management:</b> AI/ML enables intelligent energy management systems in Industry 4.0. By analyzing real-time energy data, predicting energy demand, and optimizing energy usage, AI/ML algorithms help industries achieve energy efficiency, integrate renewable energy sources, and reduce greenhouse gas emissions.</li> <li>● <b>Waste Reduction:</b> AI/ML techniques can identify patterns and anomalies in production processes, enabling proactive waste reduction measures. By optimizing product design, production workflows, and quality control, AI/ML helps minimize defects, reduce scrap, and enhance the circular economy principles in Industry 4.0.</li> <li>● <b>Predictive Maintenance:</b> AI/ML algorithms can analyze sensor data from machines and equipment in real-time. By detecting potential failures or deviations from normal operations, AI/ML enables predictive maintenance strategies. This results in reduced downtime, improved asset utilization, and extends the lifespan of machinery, contributing to sustainability through optimized resource utilization. <span style="background-color: #e0f2e0; border: 1px solid #80c0ff; padding: 2px;">256</span></li> <li>● <b>Supply Chain Efficiency:</b> AI/ML enhances supply chain management in Industry 4.0 by optimizing inventory levels, demand forecasting, and logistics operations. By reducing transportation distances, optimizing routes, and improving inventory management, AI/ML helps minimize carbon emissions, reduce waste, and enhance supply chain sustainability. <span style="background-color: #e0f2e0; border: 1px solid #80c0ff; padding: 2px;">252</span></li> <li>● <b>Environmental Monitoring:</b> AI/ML algorithms enable real-time monitoring and analysis of environmental data in Industry 4.0 systems. By detecting environmental risks, such as pollution levels or hazardous conditions, AI/ML contributes to sustainable practices by facilitating early interventions, minimizing environmental impact, and ensuring compliance with environmental regulations.</li> <li>● <b>Sustainable Product Development:</b> AI/ML assists in sustainable product design and development by simulating and analyzing various scenarios. By optimizing material usage, improving energy efficiency, and considering life cycle assessments, AI/ML helps develop products that are environmentally friendly, energy-efficient, and aligned with sustainability goals.</li> <li>● <b>Workforce Optimization:</b> AI/ML technologies optimize workforce management in Industry 4.0, leading to improved efficiency and reduced human error. By automating repetitive tasks, enhancing safety measures, and providing real-time insights for decision-making, AI/ML contributes to a safer and more productive work environment.</li> </ul>
4. Robotics and Automation	<ul style="list-style-type: none"> <li>● <b>Energy Efficiency:</b> Industrial robots and automated systems are designed to operate with high energy efficiency. They can perform tasks with precision and accuracy, minimizing energy waste and optimizing energy consumption. By replacing manual labor with automated processes, energy-intensive tasks can be executed more efficiently, leading to reduced energy usage and lower carbon emissions.</li> </ul>

	<ul style="list-style-type: none"> <li>● <b>Waste Reduction:</b> Robotics and automation systems contribute to waste reduction in manufacturing processes. With precise control and consistent operation, robots minimize errors and defects, resulting in reduced material waste and scrap. Automated systems can also optimize material handling, minimizing product damage and ensuring proper resource utilization.</li> <li>● <b>Resource Optimization:</b> By streamlining production processes and improving material handling, robotics and automation enable better resource utilization. They can optimize inventory management, minimize overproduction, and enhance the overall efficiency of resource allocation. This reduces resource consumption, conserves raw materials, and promotes sustainable production practices.</li> <li>● <b>Safety Enhancement:</b> Automation and robotics help improve workplace safety in Industry 4.0 environments. By replacing humans in hazardous or physically demanding tasks, robots can prevent accidents and injuries. Automated systems can also incorporate safety features such as sensors, emergency stops, and safety protocols, reducing the risk of workplace incidents and promoting a safer working environment.</li> <li>● <b>Improved Product Quality:</b> Robotics and automation systems contribute to enhanced product quality through precise and consistent manufacturing processes. By reducing human error and variability, automated systems deliver products with higher quality standards. This leads to fewer product defects, less rework, and improved customer satisfaction, resulting in reduced waste and increased sustainability.</li> <li>● <b>Enhanced Production Efficiency:</b> With their speed, precision, and continuous operation capabilities, robots and automated systems enhance production efficiency in Industry 4.0. They can work around the clock, optimize cycle times, and minimize idle time, leading to increased productivity. Higher production efficiency translates into resource savings, reduced energy consumption, and improved overall operational sustainability.</li> <li>● <b>Flexibility and Adaptability:</b> Robotics and automation enable flexible and adaptable manufacturing processes. They can be reprogrammed or reconfigured to accommodate different product variations or production requirements. This agility allows for efficient customization and reduces the need for excessive setup times or retooling, contributing to sustainable manufacturing practices.</li> <li>● <b>Workforce Support:</b> While automation and robotics may replace certain manual tasks, they<sup>41</sup> also provide support to the workforce. Collaborative robots, also known as <b>cobots</b>, can work alongside <b>human</b> operators, assisting <b>them</b> in tasks <b>that require strength</b> or precision. This collaboration enhances productivity and job satisfaction, promoting a sustainable work environment.</li> </ul>
5. Additive Manufacturing	<ul style="list-style-type: none"> <li>● <b>Resource Efficiency:</b> Additive manufacturing allows for precise and minimal use of materials, reducing waste compared to traditional manufacturing methods. It enables the production of complex geometries with optimized designs, minimizing the need for excess raw materials. This resource efficiency leads to reduced material consumption and conservation of natural resources.</li> </ul>

	<ul style="list-style-type: none"> <li>● <b>Waste Reduction:</b> Traditional manufacturing processes often generate significant amounts of waste material. Additive manufacturing, on the other hand, is an additive process where materials are selectively deposited layer by layer, resulting in minimal waste generation. Unused materials can be recycled and reused, further reducing environmental impact.</li> <li>● <b>Energy Efficiency:</b> Additive manufacturing can be more energy-efficient than conventional manufacturing techniques. By directly building components layer by layer, it eliminates the need for extensive tooling and machining processes, which can consume a significant amount of energy. Additionally, additive manufacturing allows for localized production, reducing energy-intensive transportation and logistics.</li> <li>● <b>Customization and Personalization:</b> Additive manufacturing enables on-demand production and customization of products. This reduces the need for mass production and inventory storage, leading to reduced waste and inventory obsolescence. By producing items based on specific customer requirements, additive manufacturing supports sustainable consumption practices.</li> <li>● <b>Supply Chain Optimization:</b> Additive manufacturing facilitates decentralized production, enabling local manufacturing hubs and reducing the reliance on global supply chains. This can lead to shorter lead times, lower transportation needs, and decreased carbon emissions associated with long-distance shipping.</li> <li>● <b>Design Optimization:</b> Additive manufacturing encourages design innovation and optimization. The freedom of design provided by additive processes allows for lightweighting and material reduction, enhancing product performance while minimizing resource consumption. It enables the creation of complex, integrated parts that were previously challenging to manufacture, resulting in more efficient and sustainable products.</li> <li>● <b>Product Life Cycle Extension:</b> Additive manufacturing can extend the lifespan of products by enabling the repair and refurbishment of components. Instead of discarding and replacing entire products, additive manufacturing allows for localized repairs and replacement of specific parts. This reduces waste and extends the overall product life cycle.</li> </ul>
2	<p>6. Augmented Reality (AR) / Virtual Reality (VR)</p> <ul style="list-style-type: none"> <li>● <b>Remote Collaboration and Communication:</b> AR/VR technologies enable remote collaboration and communication, reducing the need for travel and physical presence in various activities. By conducting virtual meetings, training sessions, and inspections, AR/VR reduces travel-related carbon emissions and promotes sustainable business practices.</li> <li>● <b>Training and Skills Development:</b> AR/VR-based training programs provide immersive and interactive learning experiences. This technology allows for realistic simulations and virtual practice, reducing the need for physical training equipment and resources. By minimizing material waste and optimizing training efficiency, AR/VR contributes to sustainable skill development.</li> <li>● <b>Design and Visualization:</b> AR/VR tools enhance the design and visualization process, enabling engineers and designers to create and review digital prototypes before physical production. This capability helps identify and address</li> </ul>

	<p>potential design flaws and reduces the number of physical prototypes required, thereby minimizing material waste and resource consumption.</p> <ul style="list-style-type: none"> <li>• <b>Maintenance and Repairs:</b> AR/VR can assist in maintenance and repair tasks by overlaying digital information onto real-world objects. This technology provides technicians with real-time guidance and instructions, improving efficiency and reducing errors. By facilitating accurate and timely repairs, AR/VR helps extend the lifespan of products and equipment, reducing the need for premature replacements and promoting sustainable resource utilization.</li> <li>• <b>Remote Monitoring and Data Analysis:</b> AR/VR technologies enable remote monitoring of machines, systems, and processes. This capability allows for real-time data collection, analysis, and optimization, leading to improved energy efficiency and resource management. By identifying and addressing inefficiencies promptly, AR/VR contributes to sustainable operations and resource conservation.</li> <li>• <b>Product Visualization and Marketing:</b> AR/VR can enhance product visualization and marketing experiences, enabling customers to preview and interact with products virtually. This technology reduces the need for physical product samples and demonstrations, minimizing waste associated with traditional marketing practices. It also helps customers make informed decisions, potentially reducing product return and waste.</li> <li>• <b>Digital Twin Technology:</b> AR/VR plays a significant role in the development and implementation of digital twin technology. Digital twins are virtual replicas of physical assets or processes, allowing for real-time monitoring, analysis, and optimization. By simulating and optimizing operations in a virtual environment, AR/VR-driven digital twins can help identify energy-saving opportunities, reduce resource consumption, and improve overall sustainability performance.</li> </ul>
7.Digital Twin	<ul style="list-style-type: none"> <li>• <b>Optimal Resource Utilization:</b> Digital Twin technology enables real-time monitoring and analysis of physical assets and processes. By creating a virtual replica of the physical system, it becomes possible to simulate and optimize resource utilization, such as energy, water, and raw materials. This optimization reduces waste, minimizes resource consumption, and promotes sustainable practices.</li> <li>• <b>Predictive Maintenance and Asset Management:</b> Digital Twins facilitate predictive maintenance by continuously monitoring the performance and condition of assets in real-time. By analyzing data from sensors and other sources, potential failures or maintenance needs can be identified in advance. This proactive approach to maintenance minimizes unplanned downtime, optimizes asset performance, and reduces unnecessary replacements, contributing to sustainable resource management.</li> <li>• <b>Energy Efficiency and Optimization:</b> Digital Twins can be utilized to optimize energy consumption in manufacturing processes and operations. By monitoring energy usage patterns and simulating various scenarios, energy inefficiencies can be identified and addressed. This optimization helps reduce energy waste, lower carbon emissions, and improve overall energy efficiency, supporting sustainability goals.</li> </ul>

	<ul style="list-style-type: none"> <li><b>Process Optimization and Waste Reduction:</b> With the help of Digital Twins, processes and operations can be simulated and optimized for maximum efficiency. By analyzing data and simulating different scenarios, inefficiencies and bottlenecks can be identified and eliminated, leading to waste reduction and improved productivity. This optimization reduces resource consumption, minimizes material waste, and contributes to sustainable manufacturing practices.</li> <li><b>Lifecycle Assessment and Circular Economy:</b> Digital Twins enable the monitoring and analysis of the entire lifecycle of a product, from design and production to use and disposal. By tracking product performance, usage patterns, and end-of-life considerations, opportunities for improving resource efficiency and implementing circular economy principles can be identified. This holistic approach supports sustainable product design, reduces waste generation, and promotes responsible product lifecycle management. <span style="color: #0000ff; font-size: small;">[2]</span></li> <li><b>Decision Support and Risk Management:</b> Digital Twins provide a platform for data-driven decision making and risk management. By analyzing real-time data and simulating different scenarios, potential risks and their environmental impacts can be assessed. This knowledge enables proactive risk mitigation, minimizing environmental harm and promoting sustainable operations.</li> <li><b>Collaboration and Knowledge Sharing:</b> Digital Twins facilitate collaboration and knowledge sharing across different stakeholders and departments. This collaboration fosters innovation and the exchange of best practices, enabling the implementation of sustainable solutions. By leveraging collective knowledge and expertise, Digital Twins contribute to continuous improvement and sustainable development.</li> </ul>
8. Cybersecurity	<ul style="list-style-type: none"> <li><b>Protection of Intellectual Property:</b> Effective cybersecurity measures safeguard the intellectual property and confidential information of companies. By protecting valuable designs, processes, and data from cyber threats, cybersecurity promotes sustainable business practices by ensuring the longevity and competitiveness of organizations.</li> <li><b>Data Privacy and Compliance:</b> Robust cybersecurity measures help protect sensitive personal and customer data. By ensuring data privacy and compliance with regulations, organizations build trust with their stakeholders. This trust fosters sustainable relationships, enhances brand reputation, and reduces the risk of legal and financial consequences.</li> <li><b>Operational Resilience:</b> Cybersecurity strengthens the resilience of industrial systems and processes. By safeguarding critical infrastructure and operational technologies from cyber threats, organizations can prevent disruptions and maintain continuity. This resilience minimizes downtime, reduces the environmental impact of disruptions, and supports sustainable production practices.</li> <li><b>Supply Chain Security:</b> Industry 4.0 relies heavily on interconnected supply chains. Cybersecurity ensures the security and integrity of digital supply networks, protecting them from cyberattacks and unauthorized access. By mitigating risks in the supply chain, cybersecurity contributes to sustainable</li> </ul>

	<p>supply chain management, preventing disruptions, reducing waste, and promoting responsible sourcing practices.</p> <ul style="list-style-type: none"> <li>● <b>Energy Efficiency and Resource Conservation:</b> Cybersecurity measures, such as network monitoring and intrusion detection, contribute to energy efficiency by identifying and preventing unauthorized activities that consume resources. By minimizing the impact of cyber threats and unauthorized access, organizations can optimize their energy consumption and resource utilization, supporting sustainable operations.</li> <li>● <b>Environmental Impact Reduction:</b> Cybersecurity helps prevent cyber incidents that can lead to environmental damage. For example, protecting industrial control systems from unauthorized access reduces the risk of environmental disasters caused by system malfunctions. By safeguarding critical infrastructure and minimizing environmental risks, cybersecurity promotes sustainable environmental management.</li> <li>● <b>Responsible Innovation:</b> Strong cybersecurity practices enable organization<sup>129</sup> to embrace emerging technologies securely. By integrating cybersecurity into the design and development of new technologies, Industry 4.0 innovations can be more sustainable from the outset. This proactive approach prevents cybersecurity vulnerabilities, promotes ethical technology use, and ensures the long-term viability of sustainable innovations.</li> <li>● <b>Stakeholder Trust and Resilience:</b> Cybersecurity builds trust among stakeholders, including customers, investors, and regulators. By demonstrating a commitment to protecting sensitive information and mitigating cyber risks, organizations enhance their reputation and sustainability credentials. This trust fosters long-term relationships, attracts investment, and supports organizational resilience in the face of evolving cybersecurity threats.</li> </ul>
9. Big Data Analytics	<ul style="list-style-type: none"> <li>● <b>proved Resource Efficiency:</b> Big data analytics enables organizations to gain insights into resource consumption patterns and identify areas for optimization. By analyzing large volumes of data, organizations can identify opportunities to reduce waste, optimize energy and water usage, and improve overall resource efficiency. This leads to more sustainable operations and reduced environmental impact.</li> <li>● <b>Predictive Maintenance and Reduced Downtime:</b> Big data analytics enables the implementation of predictive maintenance strategies. By analyzing data from sensors and equipment, organizations can detect patterns and anomalies that indicate potential equipment failures. This proactive approach helps prevent unplanned downtime, reduces maintenance costs, and extends the lifespan of assets, contributing to sustainability through improved operational efficiency.</li> <li>● <b>Supply Chain Optimization:</b> Big data analytics provides organizations with insights into their supply chain operations. By analyzing data related to supplier performance, transportation, inventory management, and demand forecasting, organizations can optimize their supply chains. This leads to waste reduction.</li> <li>● <b>Product Lifecycle Management:</b> Big data analytics helps organizations monitor and analyze data throughout a product's lifecycle, from design and production to usage and disposal. By gaining insights into usage patterns, customer feedback,</li> </ul>

	<p>and environmental impact, organizations can optimize product designs, reduce material waste, and enhance product sustainability. This promotes a circular economy approach and supports sustainable product development.</p> <ul style="list-style-type: none"> <li>● <b>Enhanced Decision-Making<sup>63</sup> and Planning:</b> Big data analytics provides organizations with the tools to make informed and data-driven decisions. By analyzing large datasets, organizations can gain insights into market trends, customer preferences, and sustainability opportunities. This enables them to develop sustainable strategies, optimize operations, and align their activities with environmental and social goals.</li> <li>● <b>Environmental Monitoring and Compliance:</b> Big data analytics facilitates real-time environmental monitoring by collecting and analyzing data from sensors, satellites, and other sources. This enables organizations to monitor air and water quality, track emissions, and ensure compliance with environmental regulations. By proactively identifying and addressing environmental risks, organizations can minimize their environmental footprint and promote sustainable practices.</li> <li>● <b>Sustainable Innovation and Product Development:</b> Big data analytics enables organizations to identify new sustainability opportunities and develop innovative solutions. By analyzing data on emerging technologies, market trends, and customer preferences, organizations can drive sustainable product innovation. This includes developing eco-friendly materials, renewable energy solutions, and sustainable business models that meet the evolving needs of a sustainable market.</li> <li>● <b>Social Impact and Stakeholder Engagement:</b> Big data analytics helps organizations understand the social impact of their operations and engage with stakeholders effectively. By analyzing social data and sentiment analysis, organizations can identify areas for social improvement, respond to customer expectations, and foster sustainable relationships with communities. This promotes transparency, accountability, and social sustainability.</li> </ul>
10. Cloud and Edge Computing	<ul style="list-style-type: none"> <li>● <b>Energy Efficiency:</b> Cloud computing enables organizations to optimize their IT infrastructure and reduce energy consumption. By leveraging cloud-based services, companies can avoid the need for maintaining and cooling extensive on-premises data centers, leading to significant energy savings. Cloud providers can achieve higher energy efficiency through resource consolidation and efficient data center management practices.</li> <li>● <b>Scalability and Resource Optimization:</b> Cloud computing allows organizations to scale their computing resources based on demand. This scalability eliminates the need for overprovisioning and underutilization of resources, reducing energy waste and minimizing the environmental impact. By dynamically allocating resources as needed, cloud computing ensures optimal resource utilization, leading to improved sustainability.</li> <li>● <b>Virtualization and Consolidation:</b> Cloud computing relies on virtualization technologies that enable the efficient sharing of physical infrastructure among multiple users. This virtualization reduces the total number of physical servers required, leading to space and energy savings. By consolidating workloads onto</li> </ul>

- a smaller number of servers, cloud computing reduces the carbon footprint and promotes sustainable resource utilization.
- **Reduced Hardware Waste:** Cloud computing reduces the need for individual organizations to maintain and replace their own hardware infrastructure. This leads to a decrease in electronic waste, as organizations can leverage shared resources provided by cloud service providers. By extending the lifespan of hardware and promoting responsible disposal practices, cloud computing contributes to sustainable waste management.
- **Data Center Efficiency:** Cloud providers focus on optimizing the energy efficiency of their data centers. They employ advanced cooling systems, power management techniques, and energy-efficient hardware to minimize energy consumption. Cloud providers also invest in renewable energy sources to power their data centers, reducing their carbon emissions and supporting sustainable energy practices.
- **Edge Computing for Localized Processing:** Edge computing brings computing resources closer to the data source, reducing the need for transmitting large volumes of data to centralized cloud data centers. By processing data at the edge of the network, closer to where it is generated, edge computing reduces network congestion, latency, and bandwidth requirements. This localized processing minimizes energy consumption associated with data transmission and enables real-time decision-making, leading to more efficient and sustainable operations.
- **IoT Data Processing and Optimization:** Cloud and edge computing provide the necessary infrastructure for processing and analyzing data generated by IoT devices. By harnessing the power of these technologies, organizations can collect and analyze large volumes of IoT data to optimize operations, reduce energy waste, and identify opportunities for resource efficiency. This enables sustainable practices in areas such as smart buildings, energy management, and supply chain optimization.
- **Collaborative and Agile Workflows:** Cloud computing enables distributed teams to collaborate effectively, reducing the need for travel and physical meetings. By leveraging cloud-based collaboration tools, organizations can promote remote work, reduce carbon emissions associated with commuting, and improve work-life balance. This flexible and agile work environment contributes to sustainability efforts by minimizing the ecological impact of traditional work practices.

Reference: [Sustainability Imperatives in Manufacturing Companies | nasscom | The Official Community of Indian IT Industry](#)

## 10. Conclusion

In conclusion, the implementation of Industry 4.0 and Smart Manufacturing in India heralds a new era of industrial growth and innovation. As one of the world's fastest-growing economies, India stands at the cusp of a digital transformation that can redefine the landscape of its manufacturing sector. By integrating cutting-edge technologies such as the Internet of Things (IoT), artificial intelligence (AI), advanced robotics, and data analytics, the nation's industries can unleash a wave of unprecedented efficiency, productivity, and competitiveness.

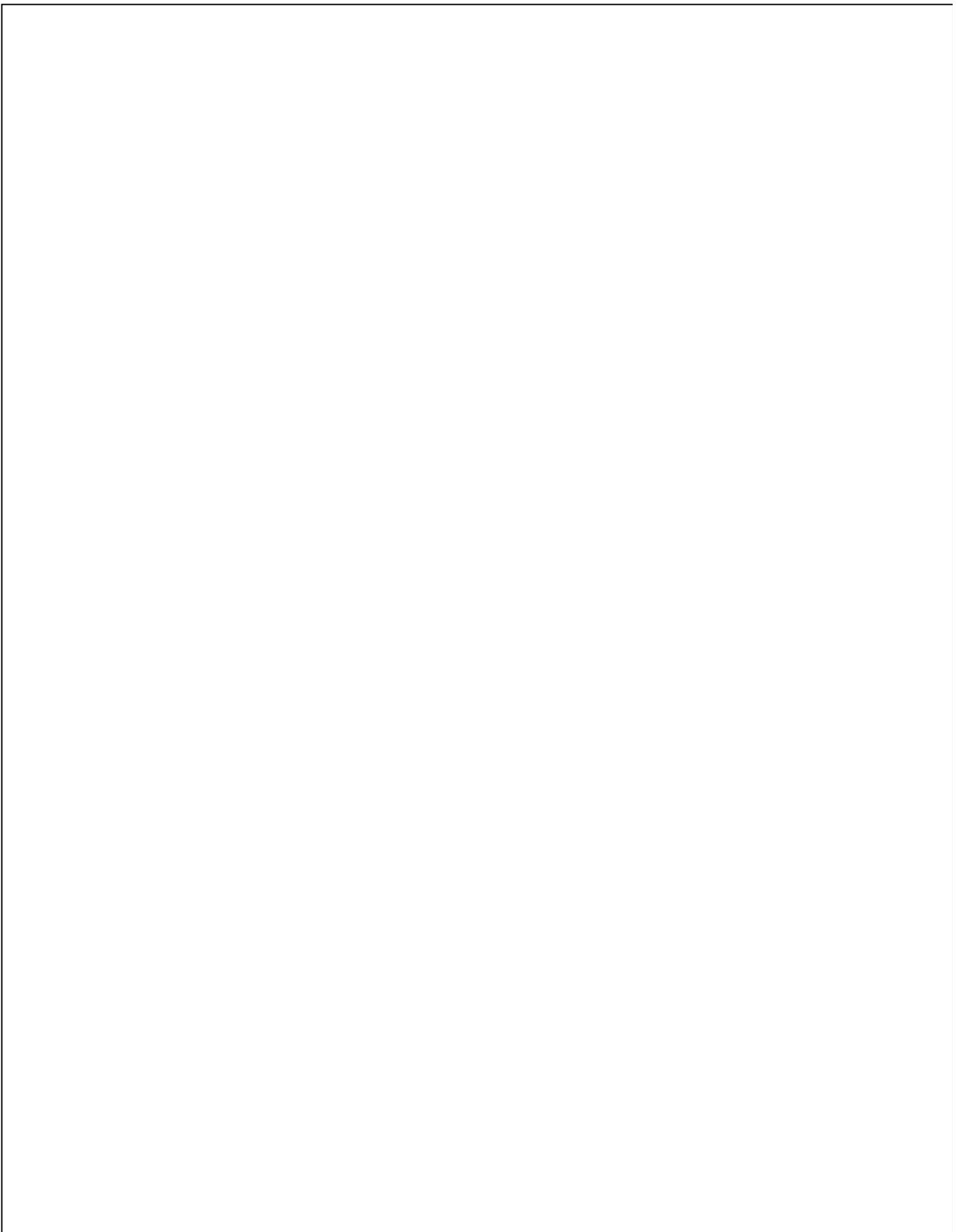
The adoption of Industry 4.0 principles promises to streamline processes, optimize resource utilization, and reduce operational costs across various sectors, ranging from automotive and electronics to pharmaceuticals and textiles. With an extensive network of Micro, Small, and Medium Enterprises (MSMEs) forming the backbone of its industrial fabric, India's journey towards Industry 4.0 offers unique opportunities for these enterprises to leapfrog into the forefront of global manufacturing.

By leveraging data-driven insights and real-time analytics, companies can make informed decisions, anticipate market demands, and offer highly personalized products and services. This not only enhances customer satisfaction but also fosters a culture of continuous improvement and innovation within the manufacturing ecosystem.

However, it is crucial to acknowledge that the successful implementation of Industry 4.0 is not without its challenges. As India embraces the digital revolution, there is a need for comprehensive skill development initiatives to equip the workforce with the necessary technical expertise. Additionally, addressing issues related to data security, privacy, and the interoperability of diverse systems requires a collaborative effort from government, industry leaders, and technology providers.

To fully harness the potential of Industry 4.0, it is imperative for India to build a robust digital infrastructure that reaches the farthest corners of the country. This calls for sustained investments in high-speed internet connectivity and the establishment of Smart Manufacturing hubs that promote technology adoption and knowledge sharing.

In conclusion, the journey towards Industry 4.0 and Smart Manufacturing in India represents a significant paradigm shift that can reshape the nation's manufacturing prowess on the global stage. By nurturing a culture of innovation, investing in skill development, and fostering collaborative partnerships, India can position itself as a leading force in the fourth industrial revolution. Embracing this transformative path will not only bolster economic growth but also create a more sustainable and technologically empowered future for the nation and its citizens.



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