

Pune: Industry 4.0 Capital of India in the Making



Mahratta Chamber of Commerce, Industries and Agriculture
Pune - India

Knowledge Partner:



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Foreword



Prashant Girbane
Director General
Mahratta Chamber of Commerce
Industries and Agriculture

I am privileged to present to you the latest publication of Mahratta Chamber of Commerce, Industries and Agriculture which is an Exclusive Report on today's buzzword – Industry 4.0.

Building on the momentum generated through a Series of events and a sample survey of MCCIA members in the recent months, we conceptualized an International Level Industry 4.0 Summit. I am particularly happy that we are able to release the Report on the occasion of MCCIA's Industry 4.0 Summit on 4th February 2020.

The Report vividly captures the current state and potential for Industry 4.0 in India and around the world. The Report does contain a few important pointers which indicate that Pune has the potential to become the epicenter of Industry 4.0 adoption and several solution providers not only for Indian market but for the global market. It also has a special place for Start Ups which are coming out with unique and cost effective solutions to address some of the problem areas of the manufacturing sector.

Taking a cue from several suggestions, we feel that Small, Medium and Large scale enterprises as well as Educational and Research Institutions can adopt a few steps towards Industry 4.0 journey. MCCIA would organise many events and undertake several initiatives in Industry 4.0 in the months ahead to spread the message far and wide.

I thank Dr. Aravind Chinchure and his colleagues for their painstaking efforts in preparing this exclusive report with MCCIA. I also thank Mr. Mandar Garge for his efforts in conducting a study of 10 MSMEs to assess their preparedness for their Industry 4.0 journey and making recommendations for implementation.

I am sure this Special Report will be a delightful read for all of you.

Wish you all the best in this exciting journey towards Industry 4.0.

About the Author



Dr. Aravind Chinchure
Founder & CEO
QLeap Academy

Aravind Chinchure holds a PhD in Physics, and has an experience spanning 25 years in R&D, innovation, intellectual property, startup incubation, venture investment, social development, policy, consulting and teaching. He is a Founder & CEO of QLeap Academy focused on propelling organizations towards Industry 4.0. Till recently, he served as a Chair Professor of Innovation and Entrepreneurship at the Symbiosis International University, Pune, India. He is credited with designing and implementing India's first two-year residential and experiential MBA course on Innovation and Entrepreneurship, at Symbiosis Institute of Business Management (SIBM), Pune.

Dr. Chinchure is actively engaged with several national and international organizations including:

- Member of the International Committee constituted by the World Bank to develop research and innovation programs for Higher Education Acceleration & Transformation (HEAT) for South Asian countries
- Member of International Advisory Board of Intellectual Property Models for Accelerating Sustainability Transitions (IPACST) project executed by the team of researchers at the University Cambridge, UK, Lund University, Sweden, Freie University, Germany, HTW University, Berlin and IISc, India.
- Member of Innovation Council of L&T Electrical and Automation
- Senior Fellow at the Pune International Centre. Conducting research and drafting policy recommendations in the areas of Industry 4.0 and Innovation
- Chair Mentor at Centre for Entrepreneurship and Innovation, Flame University, Pune
- Board member of Gyanome, Sandbox Startups, and Swayan Sikshan Prayog
- Advisor to startups - EHE Innovations Autoyos & Metamorphosys
- Served as an International Expert (IP & Innovation) for World Bank funded project in Bangladesh to build capacity in science, research and innovation
- Served as a Member of (a) CII's national committees for innovation, startup and entrepreneurship for four years, (b) Sectoral Innovation Council for Ministry of Trade and Commerce, Government of India, (c) State Innovation Council of Government of Gujarat

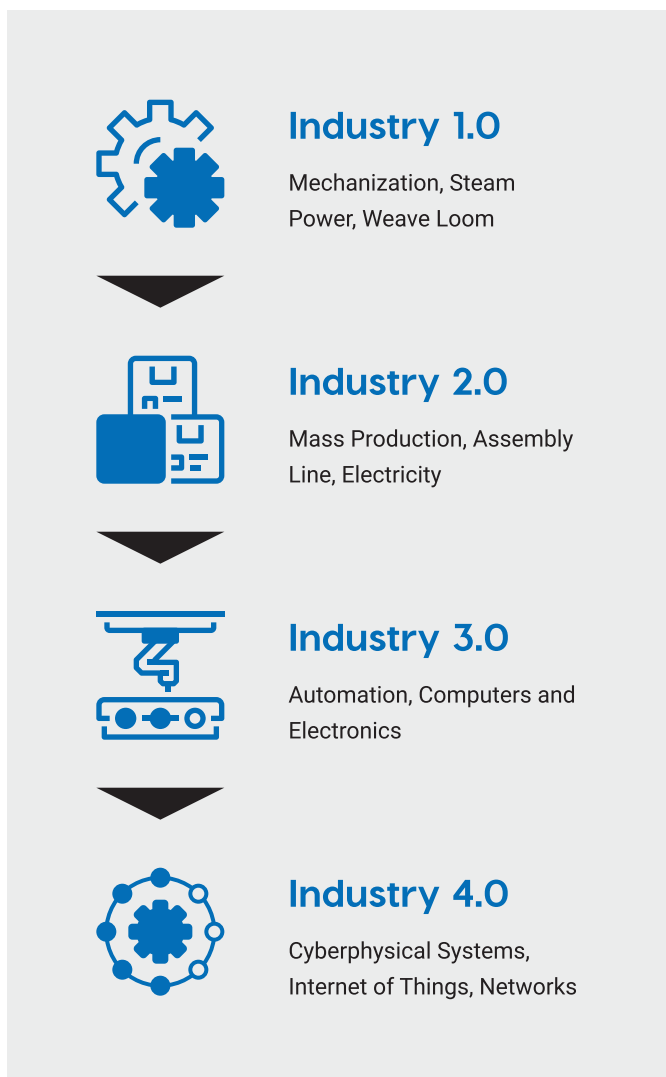
Dr. Chinchure received fellowships from the European Union, Dutch Academy of Sciences, Max-Planck Institute, Tata Institute of Fundamental Research (TIFR) and Department of Science & Technology (India). Previously, Dr. Chinchure was working as "Asst. Vice President – Innovations" at Reliance Innovation Leadership Centre (RILC), Pune. Prior to joining RILC, he has worked at Honeywell Technology Solutions, Bangalore, General Electric (GE) Global Research Centre, Bangalore, Kammerlingh Onnes Laboratory, Netherlands, and Tata Institute of Fundamental Research (TIFR), Mumbai. He has received "Exceptional Leaders of Excellence" award from Women Economic Forum and "Innovation Excellence Award" award from Indira Group of Institutions. He has authored 28 research articles published in international journals in the area of condensed matter physics and has filed 4 patents as lead and co-inventor in different geographies including US, Europe, Japan in the area of fuel cells.



Introduction

Introduction

Each Industrial Revolution propelled an exponential growth in human evolution and efficiency. Now, the Fourth Industrial Revolution (Industry 4.0) is well underway. The manufacturing industry is undergoing a major technological revolution in the way products are designed, manufactured, and distributed. Industry 4.0 involves rapid, end-to-end digitisation of all physical assets and their integration into digital ecosystems. Industry 4.0 can enable smart factories, connect the supply-chain network and logistics capabilities, and inform planning and inventory processes, along with a host of other capabilities, enabling organisations to know things they didn't know before.



Industry 4.0 promises a new frontier in the manufacturing and other sectors, with enhanced value creation through higher productivity and efficiency throughout the value chain. If the steam engine, electricity and information technology powered the first, second and third Industrial Revolutions respectively, IoT and artificial intelligence powers the fourth one, blurring the boundary between the physical world and the virtual one, where the efforts of

human and machine are combined to create a formidable force. The technologies that enable Industry 4.0 include smart sensors, automation devices, advanced robots, Internet of Things (IoT), cloud computing, location detection technologies, human-machine interfaces, augmented reality, 3D printing, artificial intelligence (AI), big data analytics, and mobile devices, among others.

Industry 4.0 is a new paradigm where devices and machines communicate with each other and take control of production on the shop floor. Machines and their software make effective decisions on production planning as well as on actual production, based on triggers in the demand of the product, thus efficiently managing manufacturing as well as distribution.

The implementation of Industry 4.0 enables manufacturing companies to increase productivity (by drastically shortening the period between the development of a new product and its delivery to customers in the market by 50%), efficiency (automation allows for greater flexibility, better quality of products and more efficient production) and energy savings (for example, while waiting for materials processing, robots can be switched off, if necessary, which saves up to 15% electricity) to ensure competitiveness in the global market. Industry 4.0 offers flexibility, efficient use of resources, and integration of customers and business partners in the business process.

The ultimate aim is to increase the top and bottom-line of business by process automation and optimisation, integration, and faster time-to-market - resulting in higher revenues, new products, and new value-added services.



Industry 4.0 is Imperative for Manufacturing Companies

It is essential for every manufacturing business, big or small, regardless of its position in the overall manufacturing supply chain, to adopt and move towards the Industry 4.0 and make this transformation journey a top priority for itself to remain competitive.

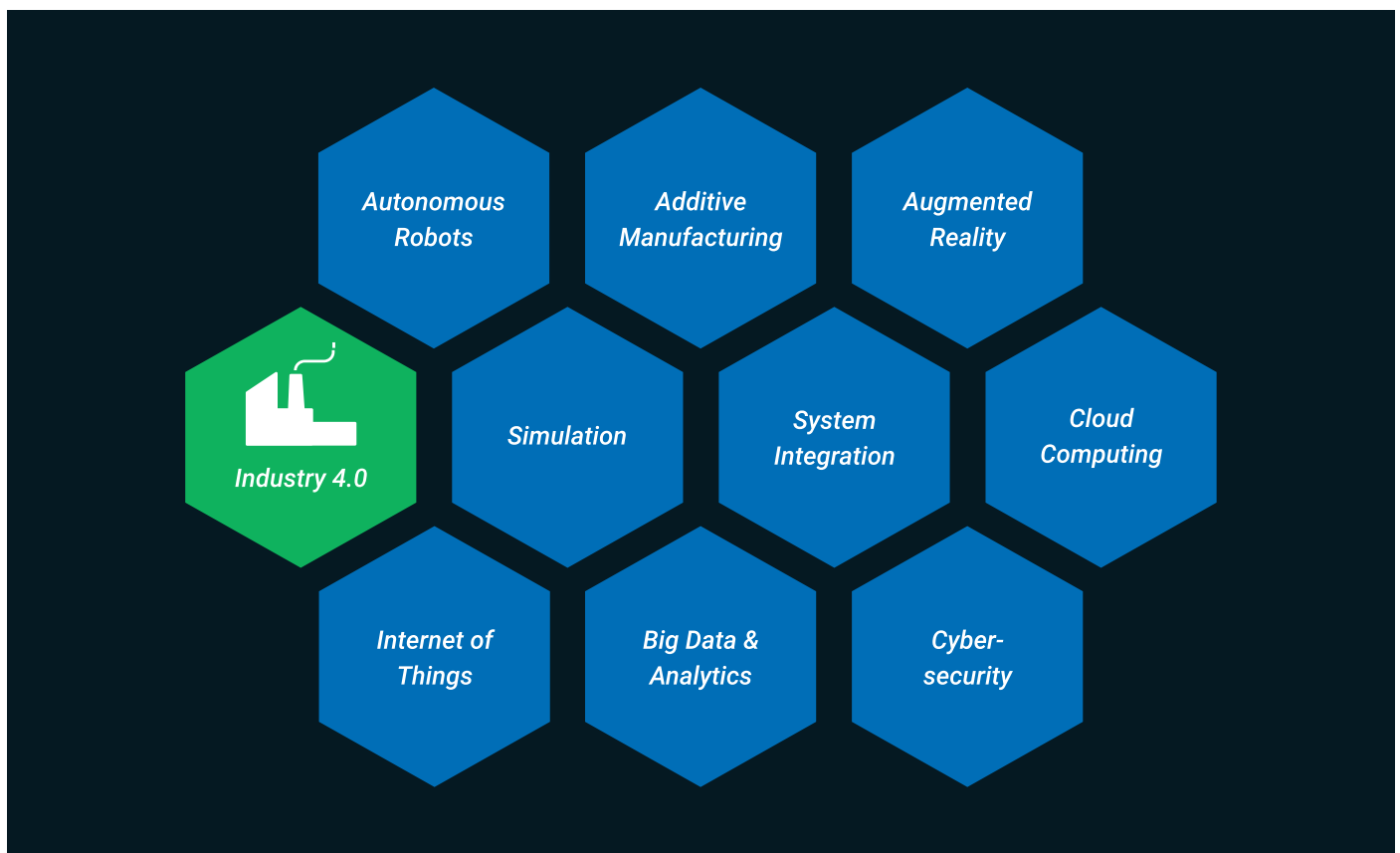
According to a recently published study, only 17% of the businesses in India are really "attempting to transform" themselves. The rest are not. As the industry attempts to transition itself to Industry 4.0, it is of prime importance for every manufacturing company to first know where it stands currently in that journey. Companies need to evaluate their understanding of Industry 4.0, level of IT and OT systems implementation, level of integration between processes, level of process automation, availability of 'insightful data' to make easy and quick decisions, cost overheads, and pockets of optimisation (of cost of operations).

India's manufacturing sector has evolved through several phases - from the initial industrialisation and the license raj, to liberalisation and the current phase of global competitiveness. Today, Indian manufacturing companies in several sectors are targeting global markets and are becoming fierce global competitors. Many are already amongst the most competitive in their sectors.

Industry 4.0 is a Multi-billion-dollar Opportunity for IT Companies & Startup Ventures

While manufacturing companies progress towards Industry 4.0, there is a multi-billion-dollar opportunity for Indian companies to develop products and solutions for smart manufacturing for the Indian and global markets. It is estimated that smart factories could add over \$1.0 trillion in value to the global economy in the next five years.

India is a leader in the IT industry - which began in the '90s as a source of low-cost engineering talent to global companies for routine work and later transitioned to taking up full responsibility for the product and go-to-market strategies. Today, India is the world's largest sourcing destination for the IT industry, which employs about 10 million professionals. Industry 4.0 sees massive usage of IT in the manufacturing sector and requires IT solutions on assembly lines. Extending India's current strength of IT to operational technologies (OT) is the next multi-billion-dollar opportunity for Indian IT companies and startup ventures





India's Efforts in Industry 4.0

India's Efforts in Industry 4.0

India is on the threshold of major reforms and is poised to become the third-largest economy of the world by 2030. India is aspiring to be a \$5 trillion economy in the next five years. The manufacturing sector forms an integral part of the country's long-term vision, as seen by the government's strong focus on the 'Make in India' campaign.

The government aims to augment the share of manufacturing in the GDP to 25 per cent from the current 17 per cent by 2022. Several initiatives and policy reforms, such as the implementation of GST (Goods and Services Tax) and the easing of the FDI policy, has been taken by the government.

The primary area of focus in India will be technological advancement across various industries. IIOT (Industrial Internet of Things), 3D printing, 3D sensors, social software, augmented reality, and location awareness are considered to usher in the next era of smart production. These automation technologies collectively are moving the manufacturing industry towards the next phase of technological advancement. India is expected to command nearly 20 per cent of the global IoT market. Industrial IoT, or the segment of the IoT market that particularly caters to the manufacturing sector, currently accounts for 60 per cent of the Indian IoT market.

Major Indian states are taking initiatives to adapt to Industry 4.0. Andhra Pradesh has taken an initiative to capitalise on the IoT potential in the country. The state government has approved a first-of-its-kind IoT policy with the aim to turn the state into an IoT hub by 2020 and tap close to 10 per cent market share in the country.

Department of Heavy Industries, Government of India has set up four centres at IIT Delhi, IISc Bangalore, CMTI Bangalore and C4i4 Lab Pune. This is a national initiative named SAMARTH (Smart Automated Manufacturing and Rapid Transformation Hub) Udyog and brings together industry, institutes, industry associations and the government to invest in this program to enhance our global competitiveness. These centres will provide awareness and education on some of the smart manufacturing technologies, implementing ideas on the manufacturing floor and developing capabilities with manufacturers to innovate and compete.

India's first smart factory, moving from automation to autonomy - where machines speak with each other, is being set up in Bengaluru. It is making progress at the Indian Institute of Science's (IISc) Centre for Product Design and Manufacturing (CPDM) with an investment from The Boeing Company. Various Indian companies are increasing their focus and partnering with other companies for developing new IoT and Machine-to-Machine (M2M) solutions. The Digital India initiative from the Government of India is expected to enhance the focus on IoT in tackling the domestic challenges.

Given the task in hand, Industry 4.0 presents a great opportunity for India to realise its manufacturing ambitions. At present, India lags its global peers in Industry 4.0 adoption. A significant portion of the Indian manufacturing sector is still in the Industry 3.0 phase with the automation limited to systems that function independently of each other. The Micro, Small & Medium Enterprises (MSME) segment has very little access to technology due to the cost barrier. That said, going by the progress that India is making in the two very critical technologies enabling Industry 4.0 - IoT and big data - the country seems to be developing the right platform to base its smart factories.





Pune – Readiness for Industry 4.0

Pune – Readiness for Industry 4.0

Traditionally known for its strong automobile manufacturing base, Pune has evolved into a hub of manufacturing and IT. Barring the years of the global slowdown, as per the district profile prepared by the Directorate of Economics and Statistics, the district has always recorded a healthy 10-15 per cent year-on-year growth in all sectors. Pune has now seen strong signs towards digitisation of mechanical industries. Large manufacturing companies in Pune are now readying to use sensors, internet of things (IoT), data analytics, artificial intelligence (AI), and other technologies. GE India's manufacturing plant at Chakan is cited as an example of an Industry 4.0 plant, with other companies like Bharat Forge, Bajaj Auto, and RPG investing heavily in specific areas of Industry 4.0 that are relevant to their industry sector and nature of business.

MSMEs have formed the backbone of Pune's industrial ecosystem. According to Udyog Aadhaar data, one in five micro, small and medium enterprises (MSMEs) in the state are in the Pune region (comprising Pune, Satara, Sangli, Solapur and Kolhapur). As on March 2019, the Pune region had 2.14 lakh out of the 9.86 lakh MSMEs in the state. Pune city has over 30,000 active MSMEs predominantly in automobile spare parts, machine tools, food products, diesel engines, electronics, and pharma products.



Pune Region

- IT & Manufacturing Hub with 800+ IT companies, 30,000+ industrial MSMEs, and 60+ multinational companies and R&D centers
- 10-15% year-over-year growth in all sectors

The future of MSMEs depends largely on their capacity to respond to the industry needs by improving industrial management processes with the right planning, optimal use of resources, controlled production, and by continuously evaluating operational performance to maintain a competitive advantage in the market. Adoption of Industry 4.0 for MSME has the potential to make a positive impact on costs, revenues, maintenance of equipment, design, and customer interface for their overall growth. It is becoming necessary for MSMEs to adapt to these changes to remain competitive and business growth.

Mahratta Chamber of Commerce, Industries and Agriculture (MCCIA) has taken the lead to enable its members to embark on the transformation journey with a long term goal of making Pune a hub for Industry 4.0. MCCIA conducted high-level Industry 4.0 maturity assessment of some select members from the MSME segment to learn their readiness for Industry 4.0, identify possible opportunities and adoption challenges. The assessment was carried out on the following criteria:

1. Organisational Readiness

The organisational priority towards Industry 4.0:

- Willingness and seriousness of the organisation to align with the roadmap
- Level of seriousness in taking steps to implement the roadmap
- The extent to which the leadership is ready to change the mindset and approach of workers
- Level of realisation of the necessity to develop new skills (new talent or reskilling the existing talent)

2. Product Design, Simulation & Virtual Prototyping

The extent of digitalisation in design and prototyping:

- The extent of the use of CAD systems for product design
- The extent of use of PLM system for Product Lifecycle management
- The extent of simulation-based (virtual) prototyping and testing of various phases of the product lifecycle

3. Automation of Manufacturing & Planning

- The extent of automation on the shop floor as well as with ERP/MIS
- The extent of implementation of IoT on production lines - sensors, PLC, robots, CNC, actuators, mobile apps
- The extent of control of machine programs from a remote location
- The extent of automation of core business processes across business functions
- Automation of supporting (secondary) business processes
- Automation of repetitive manual process (via creating custom software or RPA applications)
- Level of use of cloud and mobility
- Level of connected factories (in case of multiple setups)

4. Data-Driven Manufacturing

- The extent to which the organisation is leveraging data and analytics
- The extent of KPIs defined for every single business operation and regularity in measuring those KPIs
- Ease of acquiring the data from all systems to calculate the KPIs automatically
- Ease of generating 'actionable insights' automatically that let you make immediate decisions that lead to further optimisation of business operations (planning, scheduling & execution)
- Ability to generate continuous triggers, alarms and notifications
- Ability to predict failures/downtimes in critical applications

5. Integrations within Organizational Boundary

The extent of integration at multiple levels:

- Horizontal integration: the extent to which the IT systems underneath different business functions are integrated
- Vertical integration: the extent of integration of IT systems with machines, sensors, devices

6. Readiness for Cyber & Physical Production

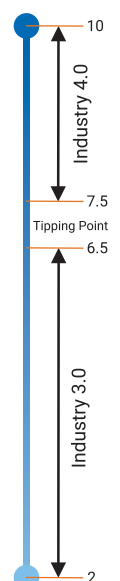
The readiness for self-controlling and self-sustaining production:

- Data integration from horizontal and vertical systems (meaning, across the entire landscape)
- The extent of ease of controlling machines from a remote location (level of connectedness)
- Smart setup: smart analytics (prediction, intelligence, decision-making capability), the extent of simulation-based production planning, and smart control (the ability to automatically and remotely control machines and production)

Each of the categories was assigned a different weight based on the relevance of the category to the organisation's business functions. The overall score was a carefully evaluated weighted average of the individual scores in each of the eight categories.

The scores (out of 10) of some of the MSMEs are listed in the table below.

Industry	Organizational Readiness	Simulation and Virtual Prototyping	Automation and Manufacturing Planning	Data Driven Manufacturing	Integration with organization boundary	Readiness for cyber physical production system	Overall Score
Chemical and bio-processing	7	6	7	6	3	3	5.3
Batch Manufacturing	7	6	5	6	5	2	5.4
Project based and batch manufacturing	6	5	4	5	3	2	4.3
Precision components manufacturing	6	6	4	5	5	2	4.4
Level gauges manufacturing	6	6	5	4	4	3	4.4
Discrete manufacturing	5	5	5	4	5	2	3.5
EPC	5	5	4	5	3	2	4.1



Findings

It is encouraging to see higher scores of selected MSMEs for their organisational readiness, application of simulation and modelling, automation, and use of data that closer to the tipping point in their transformational journey towards Industry 4.0. These MSME companies are some of the most progressive companies in using industrial automation solutions in their sector. However, none of the MSME companies could reach the Industry 4.0 compliant Smart Factory standards due to the lack of two key factors:

1. Lack of Cyber-Physical Production Systems

- Limited use of sensors as the sensors are connected to the PLC of the machine only. They are not connected over the network, making them non-IoT sensors.
- Data is not collected from machines directly via sensors or even digitally. Hence there is no ability to continuously analyse the machine parameters and produce any kind of insights in real-time.
- No setup for smart analytics (prediction, intelligence, decision-making capability), simulation-based production planning, or smart control (ability to automatically and remotely control machines and production). Also, no actuators are available to trigger activities on the machines.

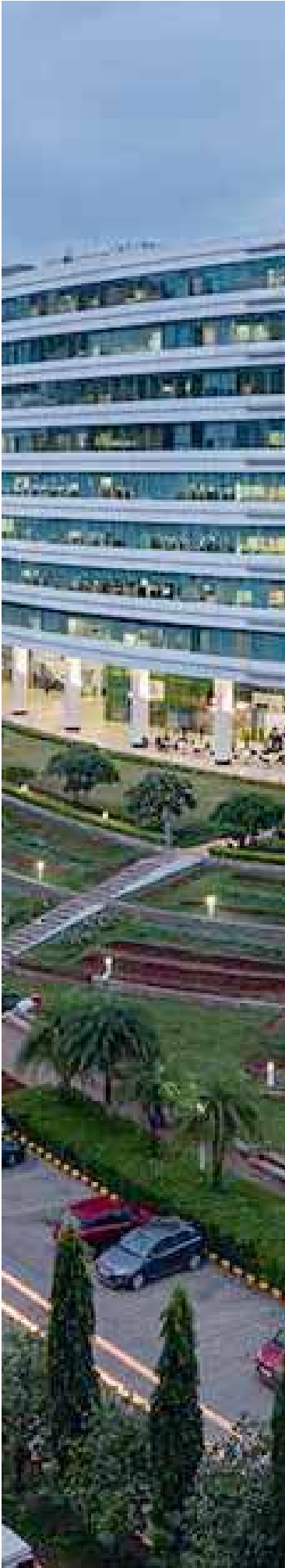
2. Lack of Integration within the Organisational Boundary

- Almost no integration between different business functions. ERP has all the data but is not integrated.

- Level of connectedness between machines and the IT systems is almost none.
- Business process integrations of non-primary business processes (supporting processes) are minimal.
- There is no integration between ERP, MES and actual machines. Humans need to correlate this data manually.
- Each piece of the final output is checked for quality, but the process is manual and time-consuming. It carries a significant opportunity for automation.
- Data extracted/exported from one business function has to be manually fed or imported into an IT system of the next business function.
- Business process integrations of non-primary business processes (supporting processes) are minimal.

The findings of the study provide specific needs of MSMEs to work towards Industry 4.0. These findings also offer an excellent opportunity for Industry 4.0 solution providers to develop and implement specific solutions to meet the needs of MSMEs. Adapting to Industry 4.0 standards and building smart factories might seem complicated, but global evidence points to numerous benefits in terms of increasing value creation by lowering the costs of production, increasing quality and flexibility, and reducing the time to market that leads to higher sales growth, greater market penetration, and increased profitability. Pune has the right ecosystem elements to transform large and small companies towards smart and intelligent manufacturing through technology, talent and innovation.





Advantage PUNE: To Become India's Industry 4.0 Hub

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Pune has seen major wave of change - from being a small university town to becoming a manufacturing and IT hub. The city is best known for its automotive manufacturing, IT, government & private sector research institutes, education and technology startups. The city is endowed with:

1. Vibrant Manufacturing Industry
2. Established IT & Engineering Services Industry
3. Premier Research Institutes
4. Leading Universities & Colleges
5. Emerging Startup Hub
6. Enabling Organizations and Programs

Abundant availability of a skilled workforce has consistently helped attract investments from domestic and foreign companies. Combining all these factors makes Pune the right place to build India's Industry 4.0 hub.

Advantage 1: Vibrant Manufacturing Industry

Pune is a key region for industries in India. Pune is the second biggest city in Maharashtra that has bagged the maximum FDI and local investments available under Make in Maharashtra and Magnetic Maharashtra. Pune has housed some traditional and new-age companies with some spectacular growth in recent time. Pune is the largest auto hub of India with over 4,000 manufacturing

units in the Pimpri-Chinchwad region alone. MSMEs have formed the backbone of Pune's industrial ecosystem with over 30,000 active companies. Pune has several large manufacturing companies, including:

- **Bajaj Auto** is a major Indian automobile manufacturer. The company is the world's fourth-largest two- and three-wheeler manufacturer. The company manufactures and exports scooters, motorcycles and auto rickshaws.
- **Tata Motors** is the world's fourth-largest truck and bus manufacturer. The company has an auto manufacturing and assembly unit at Pune. The Pune unit is spread over two geographical regions – Pimpri (800 acres) and Chinchwad (130 acres).
- **Mahindra and Mahindra** is one of the major auto manufacturers of India. The company's products include tractors, SUVs and LCVs with state of the art manufacturing in Pune.

Numerous automobile manufacturers and ancillary companies have today invested heavily to set up state-of-the-art production facilities in Pune, including VW, Mercedes-Benz, and JCB.

The plant of **GE** in Chakan, which was set up in 2015, has been cited as an example of an Industry 4.0 plant, with other companies making their movement towards the same. GE invested \$200 million for this connected factory and has taken the initiative to make Pune an Industry 4.0 hub of India. While larger industries in Pune, like **GE, Bajaj Auto, Bharat Forge, RPG** have already taken steps in Industry 4.0, progressive MSMEs are also on this transformational journey.



GE's Industry 4.0 certified plant in Chakan | Fortune India Magazine



Advantage 2: Established IT and Engineering Services Industry

In the last 15 years, Pune has been swiftly growing as an IT hub. The Hinjewadi Rajiv Gandhi IT park now has more than 800-1000 IT companies. The presence of established IT giants like Tata Consultancy Services (TCS), Infosys, Cognizant, Wipro, Tech Mahindra, as well as global IT companies, shows Pune's contribution in India's IT journey. Some of these companies are developing products and solutions in the areas related to Industry 4.0:

- **TCS** has introduced the concept of a Digital Twin - one of the pillars of Industry 4.0 in the automobile industry. TCS is also working with Indian manufacturers to boost manufacturing and maintenance efficiency using Industry 4.0 solutions.
- On the other hand, **Infosys** is offering solutions for maintenance strategies including condition-based monitoring, predictive analysis and prescriptive analysis to help manufacturers increase their overall efficiency. Infosys is also educating manufacturers to make them aware of the concept of Industry 4.0.
- **Tech Mahindra's** Factory of Future (FoF) solution offers visibility across the plant and enterprise to achieve higher quality throughput, higher utilization, flexible manufacturing lines, reduced time-to-market and higher visibility across other enterprise applications like MES, SCM, and ERP.

- **Wipro** has developed Industry 4.0 solutions for enhanced mobility, to improve field tracking and workforce efficiency through IoT technologies and automation, to optimize energy costs, and to improve customer experience through data and analytics.

While Indian MNCs are investing in Industry 4.0, global MNC's are also building a much stronger base in Pune to provide Industry 4.0 solutions.

Pune based **Persistent Systems** has developed a portfolio of Industry 4.0 solutions and services designed to help manufacturers to drive better products to market faster, with more efficient, effective and productive operations across organizations using cloud, machine learning/AI, Industrial IoT (IIoT), industrial data lake and analytics. Another Pune based IT company **KPIT Infotech** is a leader in software solutions for mobility applications in autonomous, clean, smart and connected future specializing in embedded software, AI & digital solutions.

Smaller companies in the Rajiv Gandhi Infotech Park in Pune are also aiming to work in Industry 4.0. The fact that Pune is one of India's largest IT hubs can be leveraged to make it a home for Industry 4.0.

Advantage 3: Premier Research Institutions

Pune has the highest number of research labs in the country, spanning from chemistry, life sciences, energy, earth sciences, defence, engineering, computing, and more. Pune has the presence of over 60 global multinational companies and R&D centres. One of the top CSIR Labs (National Chemical Laboratory), the second oldest engineering college in India (COEP) and one of the best new science institutions (IISER, Pune) are all based here. There are quite a few research organizations in Pune that have tools and processes to develop Industry 4.0 products, solutions and platforms.

Some of these institutions are:

- **National Chemical Laboratory (NCL)**, which is India's largest and most important chemical research institute, is working on developing improved 3D printing materials. The institute is working on the introduction of hybrid polymers for 3D printing as a substitute to the conventional materials. 3D printing is the only area of Industry 4.0 where no significant electronic hardware and sophisticated software is needed, but the molecular level study of materials is required. The expertise of NCL in chemicals and materials can be used as a boost for industrial developments.
- **IISER Pune** is one of India's top 10 research institutes in basic sciences. They have sophisticated labs for biomedicine, physics, chemistry, and all the allied fields of basic sciences, and they collect a huge amount of data from simulations and experiments on small tissues to chemical & physics experiments. Their main work is to build models and form theories based on these datasets by augmenting it with newer technologies such as machine learning, artificial intelligence and statistical learning. There is a new initiative - **Centre of Data Science at IISER, Pune** - dedicated to solving data science problems have come to the forefront in recent years. Also, IISER has the National Supercomputing Mission Param Brahma established, which would be a contributing factor for this initiative.
- **National Centre for Radio Astronomy (NCRA)** is dedicated to research in astrophysics. NCRA runs the world's largest low-frequency radio telescope facility – The Giant Metrewave Radio Telescope (GMRT), located about 80 km from Pune. Using the GMRT facility, NCRA collects huge volumes of data at the rate of around 20GB per second. NCRA applies Machine learning to extract features from final images in search for new planets around nearby stars to discover novel space objects.
- **The Inter-University Centre for Astronomy and Astrophysics (IUCAA)** is an autonomous institution dedicated to the research Astronomy and Astrophysics (A & A). IUCAA has various kinds of research projects that require designing experiments to generate enough useful data to back the theories. The astronomical data is in the form of electromagnetic radiation and more recently in gravitational radiation. This large amount of data is classified based on specified parameters using multi-dimensional clustering and classification techniques. Then, machine learning and deep learning techniques are applied to find smarter ways of analysing this data and finding unconventional solutions to problems.
- **Centre for Development of Advanced Computing (C-DAC)**, Pune is a premier R&D centre credited for the first indigenously developed PARAM supercomputer. It carries the national credential as an enabler of advanced technologies. C-DAC is working on geomatics, human-centred design & computing, health informatics, and education & training.

There are several other research organizations and groups at the universities of Pune which are centres of excellence in science and engineering research. The scientists and researchers are solving some of the most complex problems of the world using the tools and techniques that are relevant to Industry 4.0. Integrating the deep expertise of research institutes into the IT and manufacturing sectors will enable Pune to take leadership in some unique areas of Industry 4.0.



National Chemical Laboratory, Pune

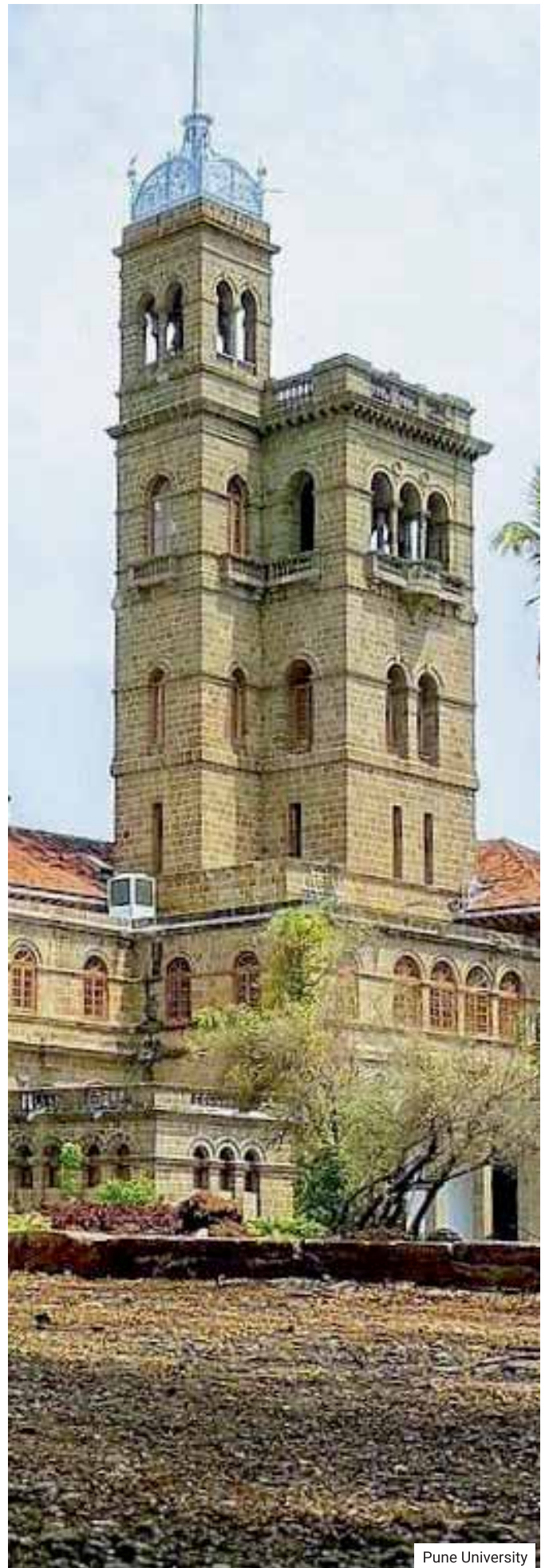
Advantage 4: Leading Universities and Colleges

Pune has historically been a centre of learning and knowledge. There are several leading universities and colleges in Pune, including Maharashtra's largest university **Savitribai Phule Pune University (SPPU)** and Asia's third oldest engineering institute, the College of Engineering, Pune. SPPU with its 890 colleges, 43 academic departments, and 70 research institutes is known for academic excellence and high quality of research. Along with SPPU, there are other leading private and deemed universities offering academic and research excellence in Pune, including:

- Ajeenkya DY Patil University
- Bharati Vidyapeeth
- Deccan College Post-Graduate and Research Institute
- Defence Institute of Advanced Technology
- Dnyaneshwar Vidyapeeth
- Flame University
- Gokhale Institute of Politics and Economics
- Indian Institute of Science Education and Research, Pune
- MIT - World Peace University
- MIT Art, Design & Technology University
- Spicer Adventist University
- Symbiosis International University
- Symbiosis Skills and Open University
- Tilak Maharashtra University
- Vishwakarma University

Many of these universities offer academic and research programs in the areas relevant to Industry 4.0. In addition, **College of Engineering Pune (COEP)** is researching robotics and allied fields using the state of the art Robotics and Rapid Prototyping Lab. **Pune Institute of Computer Technology (PICT)** - the institute solely dedicated to serving the emerging computer and IT sector, has been working on developments in data science and AI for industries.

The city is known as the Oxford of East for educating a large number of students in different fields at the public, private and deemed universities. The research and education in these universities and institutes will play a pivotal role in making Pune a hub for Industry 4.0.



Pune University

Advantage 5: Emerging Startup Hub

Pune is regularly ranked among the top five startup hubs in the country with over 3,000 active technology startups. The startups in Pune have developed innovative products, solutions and platforms using new-age technologies in financial services, agriculture, healthcare and life sciences, automobiles and manufacturing. Pune startups have successfully raised close to billion dollars in investment in the last 5 years to achieve growth and scale. In a 2018 report titled Rise of the Global Startup City, the Centre for American Entrepreneurship described Pune as an emerging startup hub in the 'Global Next' category.

Some of the leading startups from Pune include:

- **Altizon** brings the power of IoT and operational intelligence together to help organizations drive key business decisions. Altizon's Datonis Industrial IoT Product Suite serves as the bridge between existing and new smart manufacturing decisions for an enterprise to power productivity improvement, predictive quality, predictive maintenance, and traceability and genealogy initiatives. With a global footprint of over 100 enterprise users, Altizon is a leading Industrial IoT platform provider recognized in the Gartner 2019 Magic Quadrant for Industrial IoT Platforms, for the second consecutive year.
- **Druva**, Pune's unicorn venture delivers data protection and management using their patented cloud architecture. Their solution transforms backup data into an asset, making it more open and accessible so that customers can streamline governance, improve cyber resiliency, and gain critical insights to uncover opportunities and expedite decision making.
- **Icertis** is another unicorn from Pune founded in 2009 that helps enterprise clients increase their compliance metrics, improve management processes and overall productivity. The Icertis Contract Management (ICM) platform transforms contracts into strategic business assets, giving global enterprises powerful new capabilities to maximize revenue, control costs, and manage risk.
- **PubMatic** is a digital advertising technology company for premium content creators. The PubMatic platform empowers independent app developers and publishers to control and maximize their digital advertising businesses.
- **ElasticRun**, founded in 2015, has been hailed as the 'Uber for logistics' - it is an aggregated variable capacity transportation network built using idle transportation and logistics capacities from a large number of dispersed entrepreneurs.
- **Tork Motors** is a high-performance electric vehicle and charging infrastructure manufacturing startup based out of Pune. T6X is India's first electric performance motorcycle built on 7 years of exhaustive research and development.

The growth of the startup ecosystem in Pune is attributed to the presence of established IT & manufacturing industry, availability of high-skilled talent, co-working and incubation spaces, government policies and cosmopolitan quality of life. The progressive 'Maharashtra State Innovative Startup Policy 2018' and 'Fintech Policy' is helping in strengthening the startup ecosystem. Pune also has a presence of a wider startup community for networking, mentoring and incubation which includes PuneTech, Pune Open Coffee Club, TiE Pune, SEAP, Venture Centre and others. The success of startups and their supporting ecosystem will help in creating a new generation of Industry 4.0 startups in Pune.



Advantage 6: Enabling Organizations and Programs

Besides the established industry, leading educational and research institutions, and vibrant startup ecosystem, Pune has some important enabling organizations and programs to support and catalyse the growth of Industry 4.0 in the city.

Some of these organizations and programs in Pune include:

- **Automotive Research Association of India (ARAI)**, established in 1966, has played a crucial role as a catalyst for growth and development of the auto industry in Pune and all over India. ARAI provides research, development, testing and certification services. ARAI works in the areas of IoT and Data Science for mobility applications to simulate real-life situations, interaction with road entities, unplanned movement of entities and compliance requirements.
- **C4I4 (Centre for Industry 4.0) Lab** in Pune is established under the Indian Government's Samarth Udyog initiative for smart industries to build a favourable ecosystem for Industry 4.0. C4I4 aims to provide education on smart manufacturing technologies and develop capabilities with manufacturers to innovate and compete. The Savitribai Phule Pune University may soon get a 6,000 sqft of Centre for Industry 4.0 (C4i4) laboratory equipped with an IoT (Internet of Things) lab, experience centres, data centre server and mobile demo kits.
- **Pune Chapter of CIO Klub** has launched a special interest group on Industry 4.0 with a vision to bring forward best practices in implementing Industry 4.0, create a common database of best practices, connect with the startup ecosystem, and partner with industry associations & academia.
- **Software Technology Parks of India (STPI)**, Pune is part of the Ministry of Electronics & Information Technology (MeitY), Government of India with the objective of encouraging, promoting and boosting software exports from India. STPI Pune is actively supporting large and small companies and startups. Recently, STPI launched **MOTION - an automotive Centre of Excellence (CoE)** - to facilitate innovation in emerging automotive technologies, primarily autonomous, connected, electric and shared (ACES) mobility.

Pune also has active presence of industry associations - Confederation of Indian Industries (CII), Software Exports Association of Pune (SEAP), Federation of Indian Chambers of Commerce and Industry (FICCI), National Association of Software and Services Companies (NASSCOM), Indo American Chamber of commerce (IACC), Indo German Chamber of Commerce (IGCC) and others who are actively promoting the growth of industries in Pune.

Pune does very well on quality of life with its small-city charm, developed infrastructure, relatively shorter commute times, and good weather compared to other cities. These factors attract top talent, companies, customers and VCs. With these and other strong enablers, Pune is on the way to lead in Industry 4.0 in India.



Hinjewadi's IT Park



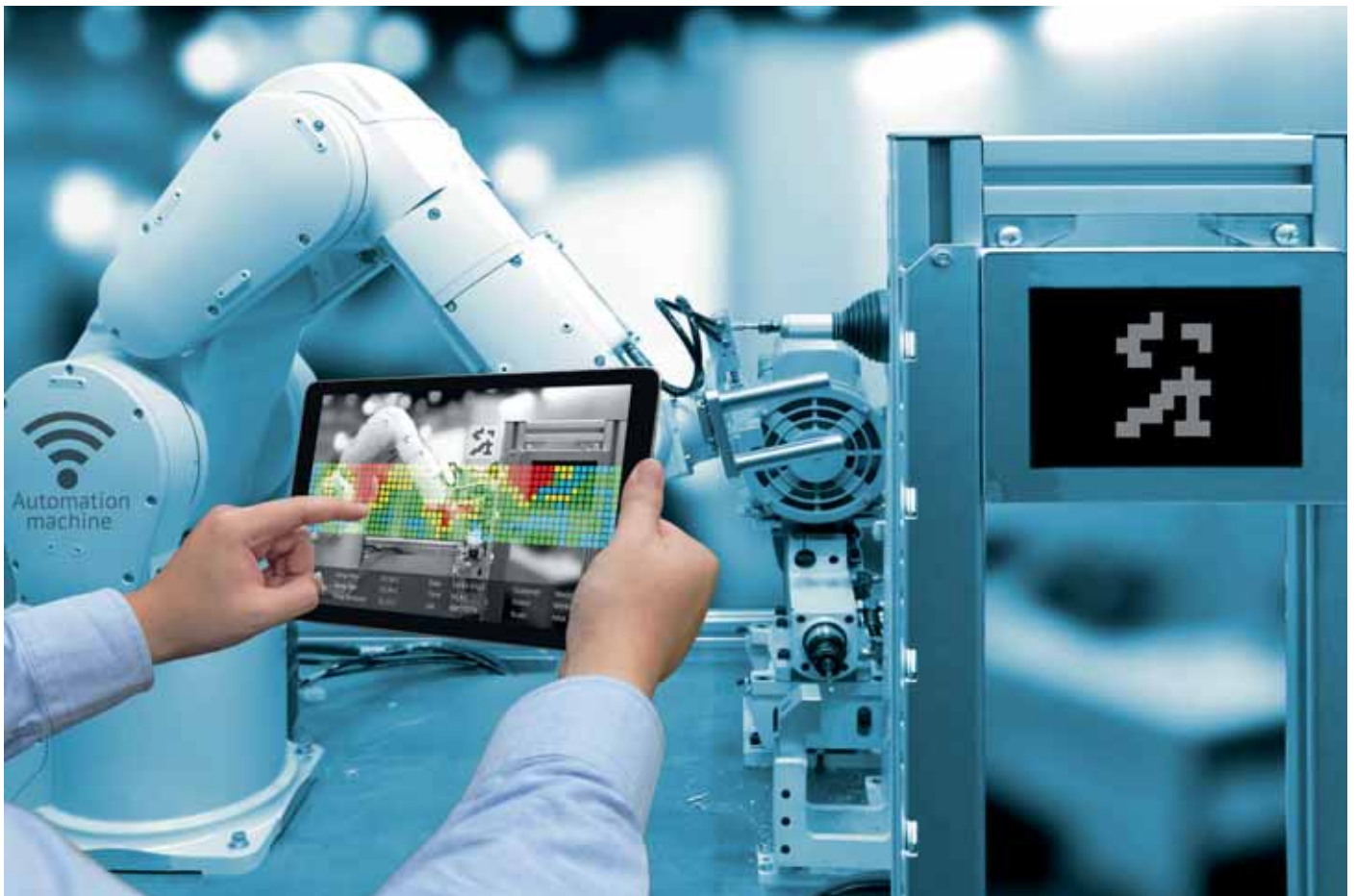
Pune's Opportunities for Achieving Leadership in Industry 4.0

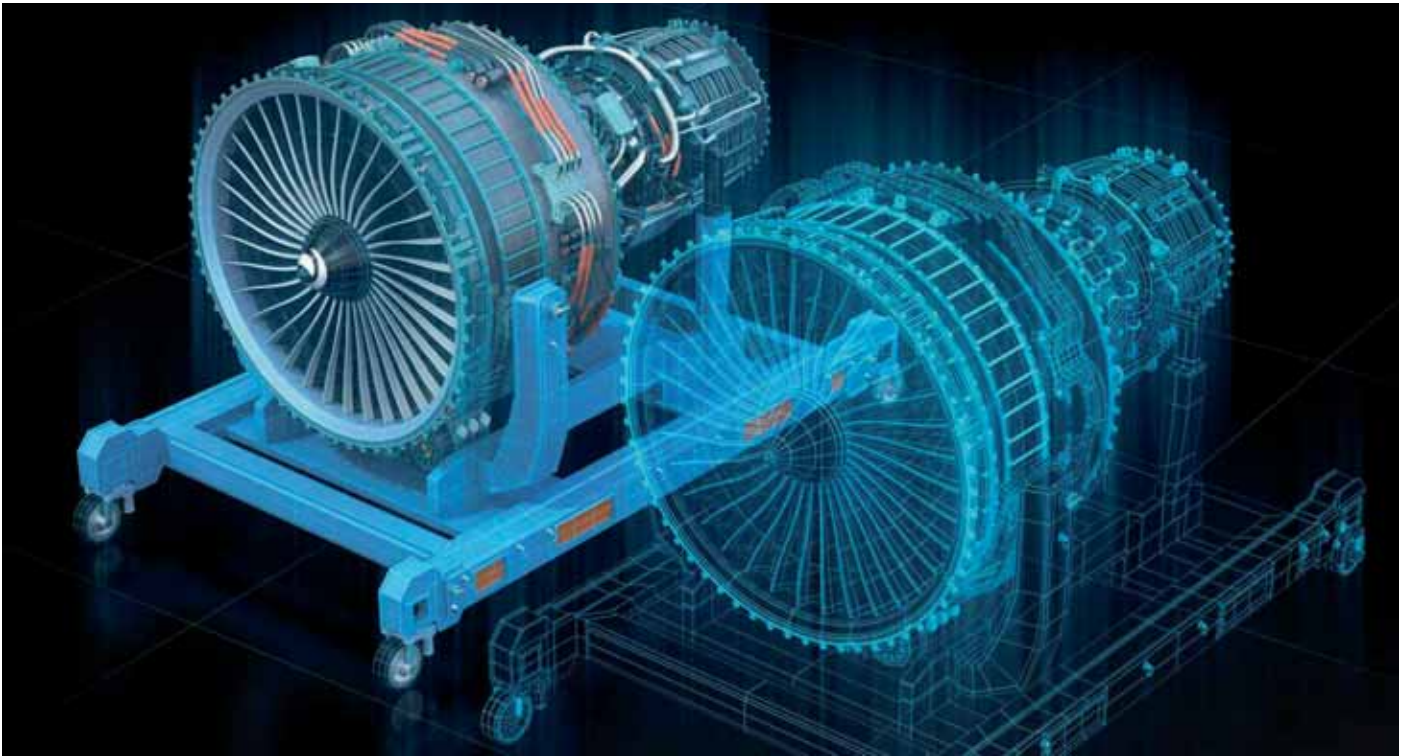
Pune's Opportunities for Achieving Leadership in Industry 4.0

Pune is a centre for automotive and machine manufacturing due to its geographical location and availability of resources. Over the last decade, Pune has also developed into an Information Technology (IT) hub. Because Pune is an established IT and manufacturing hub, along with excellence in education, research and technology entrepreneurship, it has a perfect amalgam to lead in the Fourth Industrial Revolution and to become the Industry 4.0 hub of India. The ideas presented in this section focus on:

1. Aspirations and needs of India
2. Leveraging the strength of IT and moving towards OT
3. Developing innovative products, solutions and services from India for India and the world
4. Opportunities in emerging and new frontiers of Industry 4.0
5. Laying the foundation for the Fifth Industrial Revolution (Industry 5.0)

Executing on the opportunities shared in this report will prepare Pune to be a competitive player today, and to achieve leadership in the future.





Opportunity 1: Building a New Digital Twin Industry

A digital twin is a virtual copy of the physical world. Every component of the manufacturing plant, products, processes and its environment could have a digital twin. In future, everyone and everything, including people, services, enterprises, and even cities, will have digital twins. Digital twin solutions backed by simulation & modelling, big data analytics, AI algorithms, and machine & deep learning, are helping in:

- Efficient real-time tracking & monitoring of machines, driving predictive analysis to eliminate downtime and reduce unplanned shutdowns resulting in enhanced plant performance
- Analysing real-world data to extract insights into how the product is being used and its user experience - to improve the product, assist in decision making, and process advancement
- Testing and accelerating innovations to take products to market faster
- Controlling inventory shrinkage in supply chains

A digital twin enables small and large companies to increase plant reliability, optimize the use of resources, minimise downtime, and improve performance and efficiency in factories by intelligently using data and simulating & modelling conditions quickly to make changes in the physical world. As a result, large and small organizations across industries can benefit from the capabilities of digital twin solutions.

Today, companies are using digital twin capabilities in automotive, aviation, healthcare, education, and training. Singapore uses a detailed virtual model of itself for urban planning, maintenance, and disaster readiness projects.

The growth and scale of the industry around digital twin will evolve for years to come. IDC projects that, by 2022, 40 per cent of IoT platform vendors will integrate simulation platforms, systems, and capabilities to create digital twins, with 70 per cent of manufacturers using this technology to conduct process simulations and scenario evaluations. The digital twin market is estimated to be \$24 to 26 billion in the next five years. Digital twin as a service is becoming an option for small and medium scale businesses to get access to digital twin solutions to solve complex problems. Digital twin solutions are a transformational technology that stands to change the innovation game.

Digital twinning requires capabilities in the intelligent use of data and applying multi-physics, multi-system simulation and modelling of complex physical assets. Pune's research institutes and IT companies have unique capabilities in the areas of data science, advanced simulation & modelling of complex systems, application of AI & ML with required computing infrastructure. Pune is well poised to leverage its unique capabilities to create a new "Digital Twin" Industry from India for India and the world.

Opportunity 2: Becoming Cognitive Systems Hub

Building on the capabilities of data science, analytics, and IT, Pune has the potential to become a hub for Cognitive Systems involving cognitive automation, production, analytics & computation to achieve leadership in new frontiers of Industry 4.0. A cognitive system is designed to operate in a way that mimics human behaviour where machines perform a task in a way that is considered smart or intelligent. Cognitive systems learn by processing structured, unstructured, audio, video, text or image data to work together as an engine that augments human ability.

Cognitive systems can transform the entire manufacturing value chain by utilizing connected sensors, analytics, and cognitive capabilities to:

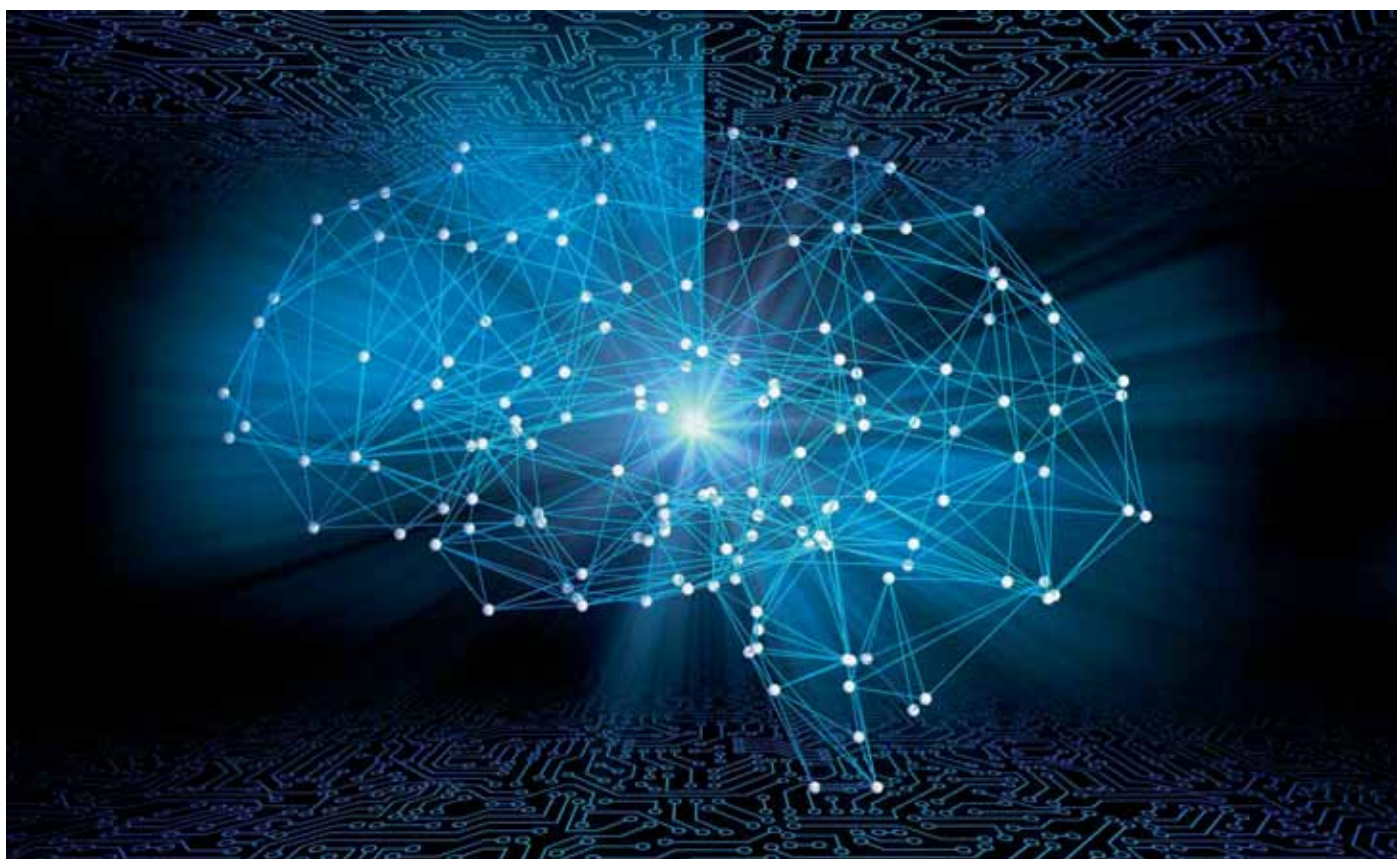
- Sense, communicate and self-diagnose issues in order to optimize performance and reduce unnecessary downtime in improving operational efficiency
- Automate tasks by analysing a variety of information from workflows, context, process, and environment to drive quality, enhance operations & decision-making and overall customer satisfaction
- Combine various forms of data from individuals, location, usage, and expertise with cognitive insight to optimize and enhance resources

- Keep learning unsupervised, and continuously adjusting to the new information resulting in higher-quality insights and business intelligence
- Open up opportunities to harness untapped data sources to provide highly personalised services, improve service consistency and quality, and enhance knowledge sharing

A cognitive system synthesizes the data residing across machines, systems and processes to derive intelligent and actionable insight across the horizontal and vertical value chain to drive key productivity improvements in reliability, quality and efficiency of the manufacturing environment.

Building a cognitive system is becoming feasible as access to cloud data storage is becoming affordable, and the number of smart sensors on machines is increasing exponentially. Also, low-cost 5G wireless networks are launching globally and in India in the coming months.

Cognitive systems is an emerging field that holds huge potential compared to big data analytics because it unlocks the potential of new human-machine capabilities. Pune has an excellent opportunity to venture into this area in developing and implementing products and solutions for Indian and global companies. Across the world, insights from data are being recognized as a new valuable resource/oil, which can be abundantly harnessed in India, that will drive forward innovation, competitiveness, and profits.



Opportunity 3: Creating a New Generation of Entrepreneurs in Industry 4.0

India is one of the fastest-growing startup hubs in the world, and today, it is the third-largest in technology-driven product startups, after USA and UK. India's startup ecosystem now stands firm with over 300 incubators and accelerators, about 30,000 active startups, institutional venture funding of over \$14.4 billion (in 2019) with 24 unicorns of which nine new entrants joined the club in 2019, indicating the growing size of this ecosystem. India has experienced three waves of entrepreneurship. It has evolved from its first wave of IT businesses, then moved to the second wave of consumer-driven startups, and now is in its third wave of deep-tech and IP-driven innovative products and solution from India, for the world.

Pune is one of the leading startup hubs of India. Today, Pune has over 3000 startups that have raised close to a billion dollars investment in the last five years. The Centre for American Entrepreneurship recently identified Pune as an 'emerging global startup hub'. The growth of the startup ecosystem in Pune is attributed to the presence of science-based technology incubators, research institutes & universities nurturing young entrepreneurs, thriving ICT industry, innovation-friendly government policies, and availability of technology talent.



The Industry 4.0 market by technology is estimated to reach over \$150 billion in 2024 from \$70 billion in 2019. Some potential opportunities for entrepreneurs to develop innovative products, solutions and platforms to benefit small and large manufacturing companies from Industry 4.0 include:

1. Application of big data and analytics to optimise production quality, save energy improve services allow real-time decision-making.
2. 3D computer simulations for product development, optimising production processes, and rapid prototyping and testing for faster innovation
3. IoT solutions to monitor, collect, exchange, analyse and deliver valuable new insights to improve efficiency, save time and cost through condition monitoring, predictive maintenance, improved safety and other operational efficiencies, and enable real-time responses
4. 3D printing to produce small batches of individual components, complex customised products and designs to reduce transport distances and inventory management costs.
5. Augmented reality-based solutions for selecting parts in a warehouse, sending repair instructions over mobile devices, and training
6. Cybersecurity solutions to protect systems, networks and data from cyber attacks
7. Cloud services to provide real-time information from a multitude of devices and sensors, collaborate with suppliers and distributors.
8. Develop autonomous, flexible and cooperative robots to tackle complex assignments in the assembly lines and assemble products alongside humans with flexible hands, feeding systems, camera-based part location and control systems

One of the challenges for deep-tech entrepreneurs is access to advanced technological laboratories and experts. Pune's research institutes and universities offer access to some of the exponential technologies laboratories required for developing solutions in Industry 4.0. In addition, aspiring entrepreneurs in Pune have access to successful entrepreneurs and experts from different startups, companies, technology domain, and industry sectors. The guidance from leading experts from multiple domains offers a synergistic view of developing a business model and overcoming the challenges of developing and launching new products.

The Global Entrepreneurship Monitor estimates some 20% of Indians (aged between 18 and 64 years) intend to start a business in the next three years, while more than 11% are nascent entrepreneurs. Industry 4.0 offers a unique opportunity to create the next generation of deep-tech, IP-driven innovative products and solutions for large and small companies. Pune has achieved leadership in technology startups and now provides the next multi-billion-dollars opportunity for entrepreneurs venturing into Industry 4.0. Pune can create a new generation of high impact entrepreneurs and ventures in Industry 4.0 to benefit MSMEs and large companies alike.

Opportunity 4: Building Industry 4.0 Talent Factory

One of the key challenges for widespread adoption of Industry 4.0 in India is the lack of skills and expertise in the current workforce and leadership to apply new-age technologies to achieve business goals. Technology change is happening rapidly. New talent has to be created while the existing workforce needs to be upskilled to meet the requirements. Like any other revolution, Industry 4.0 is also demanding education and skilling to achieve leadership. Changes caused by Industry 4.0 are likely to be radically faster than anything yet experienced.

Though some jobs will certainly disappear, many jobs will be transformed, and new jobs will be created. Multi-skilled people will be the key to the success of the industries in the near future. Building Industry 4.0 capacity will also require social changes and readiness. During the development of Industry 4.0, industries need to go through a change in both the technical and social aspects and develop the necessary skills to succeed. Along with modern technical education, new skills that need to be developed include critical thinking, creativity & innovation, dealing with complexity, emotional intelligence, and cognitive flexibility.

Educational institutes in Pune can develop customized modules, coupled with adaptive, dynamic, and agile learning environment to create a workforce with long-term sustainability. With the presence of leading educational and research organizations, Pune is in a unique position to create a talent factory of Industry 4.0 for India and the world.



Conclusion

Industry 4.0 is vital in achieving India's long-term vision of increasing the share of manufacturing in the GDP from the current 17% to 25% by 2022. Maharashtra state is also on a mission to become a \$1.0 trillion economy. Maharashtra has set the target to achieve 13 per cent growth in the manufacturing sector, attract investments worth INR 10 lakh crore by 2023-24, and create employment opportunities for 40 lakh people by 2023-24. Pune can play a leading role in boosting the manufacturing sector in India and Maharashtra.

All stakeholders need to work together and develop strategies and policies required to make Pune the Industry 4.0 capital of India.

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