Creating a future ready workforce for industry 4.0

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Abstract
India is the world's fourth largest economy and is on track to become the third largest by 2028. To speed up its growth rate towards this end, we have, inter-alia, create a future ready workforce for Industry 4.0, because it provides the tools and technologies that enables it to become more efficient, data-driven, and responsive to changing needs. It extends well beyond manufacturing, actively transforming speciality hospital services, e-Commerce, online retail, retail malls, and infrastructure through digital integration and smart technologies. It requires vertical, horizontal, and end-to-end integration across people, technology, processes, and infrastructure, impacting both technical and human aspects of organizations. Creating a future-ready workforce needs strengthening of specialised skills in tools and technologies of the "Fourth Industrial Revolution framework" in India, corresponding to its adoption level in the advanced economies.

Keywords: Industry 4.0, Great benefits, Technologies, Tools, Strategies

1. Introduction

Industry 4.0 also known as the fourth Industrial Revolution is a comprehensive concept. It requires vertical, horizontal, and end-to-end integration across people, technology, processes and infrastructure, impacting both technical and human aspects of organizations. Advanced digital technologies are integrated to transform operations and customer experience. The integration is into physical processes and systems across a wide spectrum and systems of industries in various sectors. Thus, in essence, Industry 4.0 provides the tools and technologies that enables to become more efficient, data-driven and responsive to changing needs. Service industries, not just manufacturing, are recognised as key beneficiaries of industry advancements.

2. Coverage of Industry 4.0 across sectors

Industry 4.0 extends well beyond manufacturing, actively transforming hospital services, e-Commerce, online retail, retail malls, and infrastructure through digital integration and technologies.

Speciality hospital services: Industry 4.0 technologies (like loT, AI, and data analytics) are increasingly applied in healthcare to improve operational efficiency, supply-chain management, and patient care, which were especially highlighted during challenges like the Covid-19 pandemic.

E-commerce and online retail: These sectors are at the forefront of adopting industry 4.0, using technology to analyze customer behaviour, personalize experiences, and optimize logistics and inventory management.

Retail malls: Physical retail spaces are integrating digital tools for customer relations management, inventory tracking, and enhanced shopping experiences, aligning with the Industry 4.0 principle.

Infrastructure: Industry 4.0 includes the digital transformation of infrastructure, focusing on smart systems automation, and data-driven management for improved efficiency and sustainability.

Sector	Industry 4.0 Application Examples
Speciality Hospital Services	Smart supply chains, digital patient management
eCommerce/online Retail	AI-driven personalisation, automated logistics
Retail Malls	Digital CRM, real-time inventory, smart kiosks
Infrastructure	Smart buildings, IoT enabled monitoring

3. Foundational types of disruptive technologies

In fact, Industry 4.0 has focused on four foundational types of disruptive technologies that can be applied all along the values chain:

- Connectivity, data, and computational power: cloud technology, the internet block chain, sensors.
- Analytics and intelligence: advanced analytics, machine learning, artificial intelligence.
- Human-machine interaction: virtual reality (VR) and augmented reality (AR), robotics and automation, autonomous guided vehicles.
- Advanced engineering additive manufacturing (such as, 3-D printing), renewable energy, nano particles.

4. Key technologies of the Industry 4.0 framework

- System Integration
- Cyber- Physical System
- Internet of Things and Service

- Big Data
- Additive Manufacturing
- Cloud Computing
- Augmented Reality
- Autonomous Robot
- Simulation

5. What industries are being transformed by Industry 4.0?

Every single industry will be transformed during the Fourth Industrial Revolution, but some to a greater degree than others. The nature of the Industry 4.0 transition will differ according to the specific types of technology being adopted, as well as the existing infrastructure and skills of organizations.

Operationally intensive sectors, such as manufacturing transportation, and retailing, will experience the greatest change because many companies in these sectors employ large numbers of people for tasks particularly suited for automation or digitization. Operations-intensive sectors have 1.3 times more automation potential than others do.

In these operations-intensive sectors, McKinsey analysis indicates that up to 58 per cent of work activities could be automated with current technology. Education, by contrast, is projected to undergo the least degree of change during Industry 4.0; only 25 percent of the sector's work is automatable.

6. Creating a future-ready work-force for Industry 4.0

Valuable suggestions have been made by CEO Ravi Kumar of COGNIZANT:

- "Cross-functional skills are needed by mid – level managers. Inter-disciplinary skills are very important. Managers will need to develop expertise in new functional areas, knowing the operations of the (client) enterprise"
- "Vibe Coding helps individuals from non-STEM fields build software using natural language." The company is also currently running a GenAI hackathon as part of its Vibe Coding initiative, where more than 2,50,000 employees from verticals like HR, sales, engineering, and marketing will register to develop ideas using AI programming.

Challenges in skills development-National Skills Policy:

"Key challenges include aligning training with market needs, expanding short-term courses and apprenticeships, ensuring placements, standardising content, and improving course quality," opines Dr. Uma & Suneha Sharma, Associate Prof. Dept of Economics (D.U).

7. Key AI/ML career paths

A) Technical roles

- **Machine learning engineers:** Designs, bulks, and deploys AI and ML models and systems.
- **AI engineer:** Develops tools, software, and processes to implement AI in real-world applications.
- **Data scientist:** Uses data, AI, and ML to extract insights and solve problems.
- **Data engineer:** Builds and maintains infrastructure for data collection, storage, and processing.
- **Natural Language Processing (NLP) engineer:** Enables AI to understand and process human language.
- **Computer vision engineer:** Develops AI systems to interpret visual data.
- **Robotics engineer:** Designs and develops robotic systems, integrating AI and ML.
- **Deep learning engineer:** Specialises in developing and optimisting neutral networks.

B) Research and development

- **AI research scientist:** Conducts research to create new AI and ML algorithms and techniques.

C) Product and business roles

- **AI product manager:** Oversees development and delivery of AI products.
- **AI/ML consultant:** Provides expert advice on AI and ML projects.
- **AI ethics specialist:** Addresses the ethical implications of AI technologies.
- **AI/ML educator:** Trains others in AI and ML.

D) Other roles

- **Business intelligence developer:** Applies data and AI/ML insights to improve decision-making.
- **Consultant:** Offers strategic guidance on AI/ML applications.
- **Data analyst:** Identifies trends and insights from data.
- **Software engineer:** Develops software incorporating AI/ML capabilities.

8. Popular AI libraries and their use cases

- **TensorFlow (python, C++):** Deep learning, image recognition, NLP.
- **PyTorch (Python):** Neural networks, computer vision, reinforcement learning.
- **Scikit-learn (Python):** TraditionalML, data pre-processing, clustering.
- **Keras (Python):** Rapid prototyping and research in deep learning.
- **OpenCV (C++, Python):** Image processing, object detection
- **NLTK (Python):** Text analysis and NLP basics.
- **spaCy (Python):** Industrial NLP tasks like tagging and parsing.
- **Apache MxNet (Python, Scala):** Scalabie model training and deployment.
- **Caffe (C++, Python):** CNNs for image classification.
- **Gensim (Python):** Topic modelling, word embeddings.
- **H20, ai (Java, R, Python):** Enterprise-scale machine learning.
- **Theano (Python):** Enterprise-scale machine learning.
- **Apache Mahout** (Java, Scale)**:** Scalable ML for clustering, filtering.

9. New/Next frontiers of artificial intelligence

"Agentic AI combines the flexibility and generality of AI foundation models with the ability to act in the world by creating "virtual co-workers" that can autonomously plan and execute multi-step workflows. Although quantitative measures of interest and equity investment levels are as yet relatively low compared with more established trends, agentic AI is among the fastest growing of this year's trends, signalling its potentially revolutionary possibilities." opines experts Lareina yee & others, in their recent report titled McKinsey technology trends, Outlook (2025).

10. Old gen AI vs new agents

Early chatbots

- Content generation, summarization
- Static, pre-trained knowledge, often outdated.
- Single-step, direct commands
- Hallucinations, lack of verifiability

Reasoning AI

- Complex problem-solving, planning, automation
- Live real-time access to external and proprietary data
- Multi-step, autonomous tasks requiring planning
- Computational cost, ethical oversight complexity.

11. Global I. A leaders

To lead the AI arms race. Meta is aggressively recruiting top talent from across the industry from Open AI, Anthropic, Microsoft, and cutting-edge start-ups. But among all those experts, Deitke stood out. He co-founded Verecept – a prestigious, bold IA which could thin and explore, and adapt to complex digital environments. He is 24 years old and has been offered $250 million over four years – doubling the offer he received from Meta during 2022. It has launched during June 2025, a Super Intelligence lab where IA is expected to surpass human intelligence, reports Special correspondant, The Millennium Post.

12. Suggestions

In the context of the above noted background, following suggestions are offered:

- Success stories in 'Industry 4.0" should be published to encourages other industry leaders to follow them suitably. These should include tools and methodologies adopted by the top achieving organizations.
- A mission-mode nodal organization for 'Industry 4.0's progress should be set-up in the context of India's aspirations for becoming the Third Economic Power.
- The autonomous Non-Govt organizations conducting advanced courses/practicals on emerging technologies should either be completely exempted from GST or be charged a lower rate.

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