Implementation of AI in Indian Manufacturing Companies: An Overview

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Abstract

Artificial intelligence (AI) has emerged as a transformative trend in the modern business ecosystem. Human-like intelligence and the ability of AI to learn from past data, reshape how businesses operate and make decisions worldwide. The study delves into the current landscape of AI utilization within Indian manufacturing enterprises. Further, factors such as inadequate infrastructure, financial constraints, and skill gaps will also be examined to provide a comprehensive understanding of the challenges and obstacles hindering AI adoption in Indian manufacturing enterprises. An evaluation of the benefits and improvements resulting from the integration of AI technologies to enhance efficiency, effectiveness, innovations, and competitiveness in the manufacturing processes of Indian corporates will be analysed. This encompasses enhancements in productivity, predictive maintenance, quality assurance, and cost optimization achieved through AI-driven solutions. Through addressing these objectives, this study aims to provide valuable insights for policymakers, researchers, and industry practitioners, facilitating their informed decision-making and fostering the sustainable adoption of AI in Indian manufacturing companies.

Keywords: Artificial intelligence, Indian manufacturing, Technology

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Introduction

We are on the verge of a new revolution driven by transformative emerging technologies. Technologies like Artificial Intelligence, robotics, Generative AI, virtual reality, genetic engineering, and 3D printing are becoming incomparably more potent and growing faster than ever before. From automation of repetitive tasks to advanced predictive analytics, AI technologies threaten human employment and roll us to the dawn of the Fourth Industrial Revolution or Industry 4.0.

Artificial Intelligence (AI), in parlance, is the simulation of human intelligence processes by machines. Their potential is derived from their ability to deliver huge data through the Internet of Things (IoT), recognise voice and images and learn and update continuously. In other words, they are the machine which does the work a brain can do and offers unprecedented capabilities in data processing, decision-making, and automation. This enormous advent of AI technologies reshaped how businesses operate worldwide and is being leveraged to enhance operational efficiency, improve customer experiences, and foster innovation. As per PwC's 2023 Emerging Technology Survey, 73% of US organisations have already implemented AI in some capacity within their business. Further, over 86% of CEOs stated that artificial intelligence (AI) powers their daily operations rather than intricated robotics(levity.ai). AI-powered applications such as predictive analytics, machine learning algorithms, and natural language processing in the form of Speech Recognition, computer vision, and image recognition enable businesses to make more informed decisions, process huge data, optimize processes, and create new revenue streams. The employee's decision-making quality for enhancing industrial performance has been directly linked with the evolution of AI (Chaudhuri, S., Krishnan, L.R.K. & Poorani, S., 2022)

The manufacturing sector, in particular, has witnessed a profound transformation due to the integration of AI. It has transformed the way products are designed, developed, and produced (Balasubramanian, S,2023). Indeed, 44% of respondents from the automotive and manufacturing industries rated artificial intelligence as "highly important" to the manufacturing function in the next five years, and 49% said it was "absolutely critical to success," according to the 2018 Forbes Insights study on artificial intelligence. By facilitating smart manufacturing, enhanced supply chain management, and improved product quality, AI technologies are

redefining worldwide manufacturing processes in real-time. It is enabling companies to create a more intelligent and automated system that not only increases efficiency but also reduces costs and minimizes downtime.

However, the journey of widespread integration of AI in manufacturing is fraught with numerous challenges. Research shows that while 58 % of manufacturers are actively interested in AI adoption, only 12 % are implementing it (Puittinen, 2018). Organizational factors, such as digital skills, company size, and R&D intensity, have the greatest impact on the adoption of AI in manufacturing (Kinkel, s., Baumgartner, M., Cherubini, E., 2021). In India, high implementation costs, a shortage of skilled professionals, data management issues, and inadequate infrastructure are significant barriers which hinder the adoption of AI in manufacturing. The present study explores the multifaceted implications of AI in Indian manufacturing and aims to provide a comprehensive overview, focusing on key concepts, challenges, and AI technologies within the industry. Further, the study also provides a snapshot of the current landscape of AI implementation in Indian manufacturing, including an assessment of the extent to which AI technologies have been adopted, identifying the leading companies in this domain, and evaluating the impact of AI on their operations and performance.

Objectives of the Study

The study focuses on threefold:

1. To analyse the concepts of AI in manufacturing companies.
2. To identify the issues and challenges faced by Indian manufacturing companies in the implementation of AI technologies
3. To examine the current status of AI technologies within Indian manufacturing companies

Research Methodology

The present study intended to provide a comprehensive overview of AI integrated Manufacturing in the Indian landscape. The study is descriptive in nature and completely relied on secondary data collected through various published and unpublished sources. Journal articles, industry reports, research papers, companies' annual reports and case studies have been utilised to collect the data.

Artificial Intelligence in the Manufacturing sector

The manufacturing sector is at the forefront of technological advancement, with AI standing out as a transformative force. Adopting AI technologies in manufacturing companies can potentially improve sales or optimise processes (Bughin et al., 2019). PwC analysis in 2021, states that 86% of manufacturers are accommodating AI to enhance their operations and the estimated AI market of the manufacturing sector worldwide is expected to rise at a compound annual growth rate (CAGR) of 57.2% to reach $16.7 billion by 2026. AI integration strengthens manufacturing processes by driving efficiency, innovation, productivity, and quality and helps businesses remain competitive amidst changing demand.

The study of AI started in 1956 when researchers in New Hampshire explored the possibilities of machines performing "intelligent actions" (Buchmeister, B., Palcic, I. & Ojstersek, R., 2019) and the development of intelligent machines further advanced the study on AI (Müller, 2014). 2017, PwC's report on AI analysis, "Sizing the prize – What's the real value of AI for your business and how can you capitalize AI" identified four main types of AI manufacturing.

Assisted Intelligence: AI tools that assist humans in decisions decision or taking actions but do not learn from their interactions.

Augmented Intelligence: Artificial intelligence (AI) technologies that support human judgment and are always learning from their interactions with people and their surroundings.

Automation: Automation of manual and cognitive tasks, both routine and non-routine, without involving new ways of doing things.

Autonomous Intelligence: AI systems that adapt to different situations and act autonomously without human assistance.

Artificial Intelligence (AI) technology is a persuasive tool which can be a powerful source of disruption as well as a game changer in manufacturing. Manufacturing firms that fail to recognize the importance of AI risk losing their competitive edge. Figure 1 showcases the different key activities of manufacturing procedures where AI capabilities are being utilised. It indicates that, while AI is being implemented across the value chain, companies have put slightly more focus on adding AI solutions to their core production processes which are assembly and quality testing (24%) product development, and engineering (23%).

Figure-1 4: AI implementation in manufacturing functions
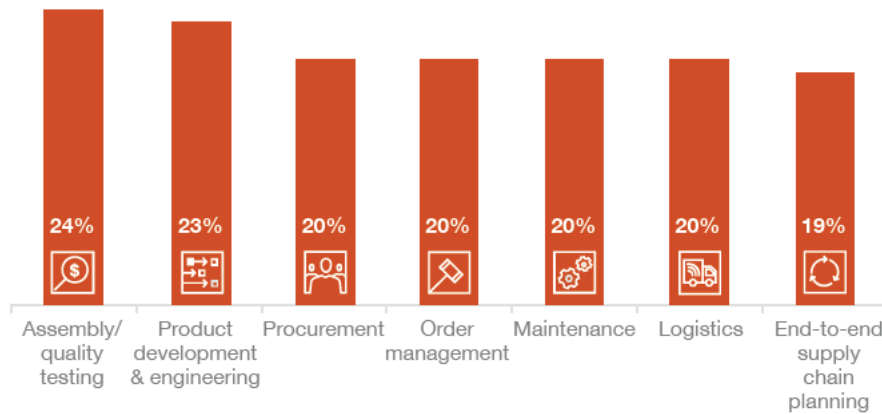
Source: The Global Manufacturing and Industrialisation Summit (GMIS) report titled "An introduction to implementing AI in manufacturing" published by PwC, 2020.

AI Technologies in Manufacturing

Manufacturing industries are utilizing AI systems worldwide primarily to automate manual and cognitive tasks, assist in making decisions or taking actions and augment decision-making through continuous learning. It includes,

1. **Directed Automation**

   Robotics and artificial intelligence (AI) are being extensively used in industrial manufacturing as they revolutionize mass production. Automated systems can perform repetitive tasks with high precision and process huge data to provide automated solutions. This helps manufacturing industries to increase accuracy and productivity, reduce human error, and deliver better-quality products.

2. **Predictive Equipment Failure**

   One of the most common uses of AI and Machine Learning (ML) in manufacturing industries, such as aerospace, electronics, chemicals, and consumer goods manufacturing is Predictive Analytics. It is the second most important reason for industrial manufacturing to use AI solutions. Due to unanticipated breakdowns of machinery, manufacturers face huge downtime, which generally results in a significant

amount of idle time and lower production. Artificial intelligence (AI) anticipates such events and reduces waste and material costs instantly by utilizing sensor and machine learning algorithms.

3. **Predictive Equipment Maintenance**

Predictive maintenance devices powered by AI, allow manufacturers to cut device maintenance costs. By using machine learning, AI technologies for industry forecast when machinery requires maintenance services. IoT (Internet of Things) sensors and cloud-embedded devices also play a crucial role in modernizing the manufacturing experience by helping in better prediction of machines' health and resolving equipment issues. This will improve equipment reliability and reduce machinery downtimes.

4. **Internal Quality Control and Inspection**

Generally, internal defects in the equipment cannot be detected easily and AI-driven machine-vision tools can find these microscopic defects in products at high speed and accuracy, using a machine-learning algorithm. For instance, BMW uses AI for real-time quality control in their production lines which not only enhances the product quality but also reduces overall costs.

5. **Supply Chain Optimization**

The majority of industrial manufacturing uses AI services and applications in their manufacturing routines to optimize their inventory management and automate their logistics. Machine learning, computer vision, natural language processing, robotics, automated vehicles, and speech recognition applications transform the supply chain in manufacturing. These technologies estimate future demand, schedule production activities, automate supplier negotiation, and allocate resources efficiently.

6. **Collaborative Robots (Cobots)**

Cobots, or AI-driven human-machine collaborative robots, assist human workers with routine tasks that demand, precision, repetition, and physical strength. By replacing humans with robots for risky tasks, AI advancements can reduce workplace accidents all across (Buchmeister, B., Palcic, I. & Ojstersek, R., 2019). This empowered human workers to focus on more intricate, innovative and decision-based tasks such as arranging, programming, monitoring and coordinating robotic operations. For instance,

collaborative warehouse robots (or cobots) handle much of the laborious tasks, while workers concentrate on delicate tasks like directing, supervising and assisting robots in picking objects off shelves, slotting them into different orders and loading them onto vehicles.

7. **Design Twins and product design**

Digital Twins are AI-powered digital replicas of physical assets used to visualize the products infrastructure, or services collected by sensors or cameras. It combines virtual and tangible attributes to imitate and improve industrial processes and analyse huge volumes of data. The core objective of digital twins is to develop and test equipment virtually, assist businesses in designing new products and optimizing the overall manufacturing process.

8. **Generative Design**

AI-powered technologies are the flagship for fostering innovation in contemporary business practices. They assist in creating ideal designs based on specified requirements and constraints. For instance, utilizing generative design, Airbus produces lighter and more efficient aircraft components and guarantees innovation and effective design in the product development process.

9. **Unveiling Pattern of Big Data**

Recent AI developments, particularly Machine Learning, have the potential to revolutionize the manufacturing industry by providing advanced analytics tools for handling vast amounts of manufacturing data generated by machines, sensors, controllers, and labour records. This data includes environmental, process, production operation, and product quality inspection data.

10. **Other possibilities**

Apart from the above-core activities, AI systems also enable manufacturers in rapid data-driven decisions, facilitate enhanced production outcomes, advance process effectiveness, and support superior scalability and product development. Cloud-based machine learning enhances communication among manufacturers by interpreting and sharing data from across branches. Further, AI facilitates product customization based on customer preferences, maximizing customer satisfaction and providing new revenue

opportunities for manufacturers (Balasubramanian, 2023). This automation of material provision, maintenance, and other previously manual tasks is driving wider adoption of AI in manufacturing. Smart factories are expected to generate $37 trillion in additional value by 2025, according to McKinsey (Puittinen, 2018).

Issues and challenges in the adoption of AI in the Indian Manufacturing sector

There is no doubt that the manufacturing sector is paving the path in the application of AI technology. From significant cuts in unexpected downtime to quality-designed products, manufacturers are using AI-powered analytics to data to enhance productivity, product quality and worker safety (Kushmaro, 2018). However, the implementation of AI analytics presents several financial and operational challenges, including issues with data management, security risk, huge investment costs involved, immaturity of AI technologies, under-skilled personnel etc. Further, it also poses ethical, social and legal issues such as data privacy, trust, algorithmic bias, and job loss. From Figure 2 we can interpret that the immaturity of AI technologies and lack of workforce skills (with 40%) have been the major setbacks for industrial manufacturing in the successful integration of AI for their operations.

Figure 2: Challenges of manufacturing with the integration of AI at scale.
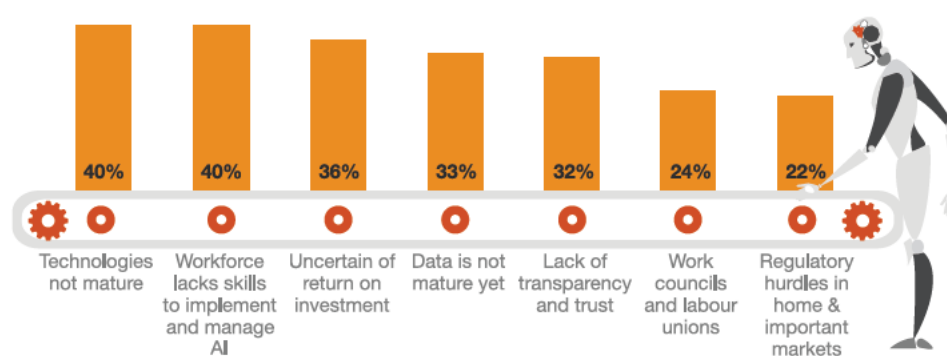
Source: The Global Manufacturing and Industrialisation Summit (GMIS) report titled "An introduction to implementing AI in manufacturing" published by PwC, 2020.

Correspondingly, India, being one of the fastest-growing economies, has a substantial manufacturing base that alone contributes approximately 17.4% of its overall GDP. It has been

an integral pillar of Indian economic development and job expansion with more than 12% of working employees engaged in various industrial manufacturing, reducing reliance on agriculture. The government's initiatives such as 'Make in India' aim to boost the manufacturing sector and position India as a global manufacturing hub. In this context, the implementation of AI, including machine learning, deep learning, robotics, and computer vision will unlock huge potential for the Indian manufacturing experience. Therefore, addressing and overcoming the obstacles in the effective utilisation of AI technologies is crucial to harnessing the full potential of AI and maintaining sustainable growth in the Indian manufacturing sector. Here are some of the key issues and challenges that hindering AI-integrated manufacturing in India.

1. **Limited AI-skilled workforce**

   There is a shortage of professionals with expertise in AI, machine learning, and data science, which is essential for the development, deployment, and maintenance of AI systems. Notable disconnections between skills imparted by educational institutions and practical skills required by the industries have been the bottlenecks for optimum utilization of these technologies in the Indian context.

2. **High Initial investment cost and uncertainty of Return on investment (ROI)**
   Another major issue connected with the requirement of huge funds for the implementation of AI-powered devices. The hardware, software, and training costs required make it challenging for small and medium-sized enterprises (SMEs) to integrate AI solutions to enhance their productivity and operational efficiency. Further, for capital-intensive industries like manufacturing, measurement of the ROI of AI investments, especially in the initial stages can be challenging and companies may struggle to justify the costs and determine the long-term benefit.

3. **Infrastructure Barriers**
   Inadequate infrastructure, including limited high-speed internet and outdated computing resources in rural areas, hinders the effective utilization of AI in Indian manufacturing. This results in inefficient data processing reduced AI system performance, and delays in adopting advanced AI-driven technologies.

4. **Data Privacy and Security Concerns**

    AI technologies extensively rely on high-quality, relevant data to function effectively. However, many Indian manufacturers struggle with quality data collection, management, and ensuring data integrity. Further, the implementation of AI systems increases the risk of cyberattacks, data breaches, and other security issues. These hurdles impede accurate analysis, increase vulnerability to cyber threats, and complicate efficient AI system implementation. Ensuring robust cybersecurity measures is crucial to protecting sensitive data and enhancing productivity.

5. **Cultural Resistance to Technological Changes**

    There is often resistance from employees and management to adopt new technologies due to fear of job losses, disruption of established processes, and a lack of understanding of AI's benefits. Further, Organizational culture and internal politics can also impede AI adoption. A lack of leadership support and clear vision can hinder the successful implementation of AI projects.

6. **Regulatory compliance issues**

    Navigating the evolving legal and regulatory landscape surrounding AI can be complex. Companies must ensure compliance with data protection laws, industry standards, and ethical guidelines.

7. **Integration with Legacy Systems**:

    Many manufacturing companies operate with legacy systems and outdated technologies. Integrating AI with these existing systems can be challenging and may require significant modifications or upgrades.

8. **Ethical and societal challenges**

    Concern about job disruption, and data breaches are posing major hindrances for the effective adoption of AI in Indian manufacturing and this necessitates a comprehensive strategy to balance between technological advancement and ethical consideration.

9. **Integration with existing systems**

Many Indian manufacturing companies rely on legacy systems which are outdated and not designed to support advanced AI technologies. These systems may lack the necessary data infrastructure and computational capabilities required for AI integration and upgrading or replacing can be expensive and time-consuming, posing financial and operational burdens for businesses. Additionally, the possibilities for disruption during the transition period can affect production schedules and operational efficiency, making the smooth integration of AI an intimidating task for many manufacturers.

Despite these challenges, AI is widely seen as a key driver of innovation and growth in the manufacturing sector. The projected expansion of artificial intelligence (AI) could lead to a 14% increase in global economic production, measured by gross domestic product (GDP), in 2030 over baseline forecasts of $114 trillion, according to a 2017 PwC report. Therefore, manufacturers can enhance operations, minimize expenses, and develop new goods and services by effective utilization of AI in industrial manufacturing.

AI in Indian Manufacturing: Current Status

India has been steadily strengthening its position as a global manufacturing leader in recent years with a 1.8% contribution to the world's manufacturing. Recognising its potential, the Indian government has been working on transforming the Indian manufacturing experience into strategic smart manufacturing. Government initiatives like the production-linked incentive scheme (PLI) and 'Make in India' set a favourable environment for domestic manufacturing and attract global partnerships through foreign direct investments. Initiatives such as the National Artificial Intelligence Mission and Technology Incubation and Development of Entrepreneurs (TIDE) scheme, aim to foster AI innovation and redesign the existing business models. Additionally, the Ministry of Electronics and Information Technology of the Indian government is encouraging industry-academia collaboration and providing financial support for projects by educational institutions in the area of AI solutions, to bridge the skills gap and promote knowledge sharing. Various incentives and subsidies are also being provided to support SMEs in adopting advanced technologies.

Indian manufacturing is constantly open to new technological breakthroughs and the deployment of AI resulted in an unprecedented shift in the operational efficiency and productivity of various industrial groups, as per their company's reports. The world's largest market research store, Research and Markets, in their report on "Artificial Intelligence in

Manufacturing Industry in India, 2024" published on January 2024 claimed that the market for artificial intelligence (AI) in Indian manufacturing is expected to reach INR 12.59 billion and grow at a compound annual rate of 58.96% from 2023 to 2028.

India's steel industry has seen significant improvements in manufacturing processes after the integration of AI technologies. Tata Steel, one of India's largest steel producers, has implemented AI-powered predictive maintenance systems to monitor equipment health and predict failures. This has resulted in a 20% reduction in unplanned downtime and a significant improvement in product quality, leading to increased customer satisfaction and reduced costs. Bajaj Auto, India's largest automobile manufacturer, has also adopted AI to streamline production lines and enhance quality control. Maruti Suzuki, India's other largest automobile manufacturer, has also integrated AI into its manufacturing and supply chain operations. AI-driven analytics have optimized their supply chain, forecast demand, and managed inventory, resulting in a 14% reduction in production costs and a 30% reduction in unplanned downtime.

Similarly, Asian Paints, a major player in the paint industry, has also adopted AI for demand forecasting, production planning, and inventory management. This has led to a 20% improvement in forecasting accuracy, resulting in cost savings and improved customer satisfaction. Godrej & Boyce, a diversified manufacturing company, has also integrated AI for predictive maintenance and process optimization. This has led to a 15% increase in production efficiency and a 10% reduction in operational costs. These case studies provide a snapshot of the current landscape of AI implementation in Indian manufacturing.

Conclusion

Artificial Intelligence (AI), in modern business scenarios, has fundamentally transformed human interactions with machines. As a supportive tool, AI has redefined the way businesses operate worldwide, including in the manufacturing sector. The present study conducted to overview the implementation of AI in Indian manufacturing highlights the immense potential and notable challenges associated with AI adoption. The research underlines AI's ability to enhance productivity, efficiency, effectiveness, and innovation within the manufacturing sector, emphasizing it as a critical driver of Industry 4.0. AI technologies such as machine learning, predictive analytics, and robotics in manufacturing offer substantial benefits, including enhanced quality control, predictive maintenance, and optimized supply chain management. However, challenges, include high upfront expenditure, shortage of AI-skilled

professionals, inadequate infrastructure, data privacy and security concerns, and cultural reluctance. etc impedes the successful adoption of AI in manufacturing. To overcome these hurdles, it is imperative for policymakers, industry practitioners, and researchers to collaborate and address these issues. By investing in infrastructure, providing comprehensive training, and engaging in strategic planning, the Indian manufacturing sector can fully harness the potential of AI. This concerted effort will drive innovation, enhance operational efficiency, and contribute significantly to the country's economic development, ultimately boosting competitiveness in the global market.

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