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THE USE OF AI TOOLS IN MANUFACTURING SECTOR FOR OVERALL COST REDUCTION.

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ABSTRACT

The manufacturing sector converts raw materials like metals, chemicals, and wood into valuable finished goods such as automobiles, electronics, textiles, and pharmaceuticals, forming the economy's secondary sector. Distinct from primary extraction and tertiary services, it drives GDP growth, job creation, and global trade through large-scale production, automation, and innovation. Key processes span design, fabrication, assembly, and supply chains linking inputs to consumers. Despite challenges like skill shortages and infrastructure gaps, it fuels economic development. Current trends, especially in India via Make in India and PLI schemes, emphasize Industry 4.0, digitalization, and smart factories to elevate manufacturing's GDP share. (1) Every manufacturing organisation is concerned with its cost reduction for several reasons such as competition, market share so on and so forth.

Key AI tools examined includes: Machine Learning, Algorithms for Predictive Maintenance, Computer Vision for Quality Control, Robotic Process Automation (RPA) for assembly lines and generative AI for Supply Chain forecasting. Predictive Maintenance Models powered by ML platforms like: TensorFlow and IBM Watson, reduced unplanned downtime by an average of 42%, translating to 18.25% savings in maintenance expenditures. Computer Vision Systems such as, those using convolutional neural networks (CNNs) detected defects with 97% accuracy, slashing scrap rates by 35% and rework costs by 28%. RPA Integrations streamlined repetitive tasks, yielding labour cost of 22%, while AI-driven data forecasting minimised inventory holding costs by 30% through optimised Just-In-Time procurement (Source:).

The Artificial Intelligence tools for example predictive maintenance, AI-powered quality control, and supply chain optimization etc can reduce manufacturing costs by up to 30% to 50%, improved yield and many more. Though the initial investment and implementation cost seems heavy but delivers a return on investment within 12-24 months.

The current research article attempts to study the transformative potential of Artificial Intelligence (AI)tools in achieving substantial overall cost reduction across manufacturing operations.

Key Words: - *AI tools, Cost reduction, Manufacturing sector, Supply Chain, IoT, ML, Just-In-Time*

INTRODUCTION: -

The manufacturing sector in India contributes approximately 16-17% to the nation’s Gross Domestic Product (GDP) and employs over 27 million workers. This sector comprises of key industries such as automobiles, pharmaceuticals, textile chemical and many more. It is also adopting automation, AI, IoT for better productivity and cost reduction at fast pace. Further it is strengthened by government initiatives like Make in India, National Manufacturing Mission.

Cost reduction is a systematic process and ongoing method aimed at lowering business expenses to enhance profitability, to make the product cost effective, competitive advantage and for many more objectives. Manufacturing industries are always concerned about their cost reduction. There are different ways with which organisation can reduce its costs such as Outsourcing, hiring remote workers, etc. Hence AI tools can help manufacturing companies to great extent in cost reduction. Therefore, it is necessary to explore and study application of AI tools and its impact on cost reduction in manufacturing sector.

It is interesting to study what is Artificial Intelligence (AI) and how it is revolutionizing our daily life, work, and interactions across multiple sectors. By enabling machines to learn, reason, and decide autonomously, AI enhances efficiency, customization, and innovation. From intelligent virtual assistants to autonomous vehicles, its impact is profound.

Following are the 10 real life examples that demonstrate AI's transformation across industries, highlighting emerging trends that drive progress from smart applications to advanced transportation systems. How our lives and lifestyles are impacted by AI with just a click.

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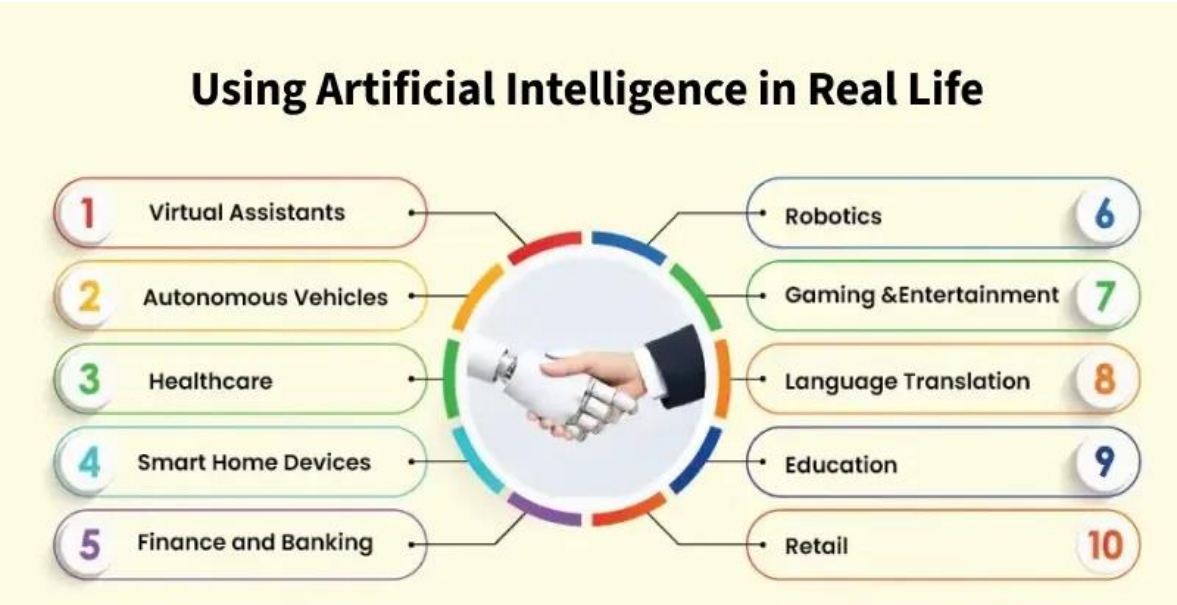

(**source:https://**www.geeksforgeeks.org/artificial-intelligence/10-examples-of-artificial-intelligence-in-real-life-202

OBJECTIVES: -

1. To study the concept of AI tools and cost reduction in manufacturing sector
2. To identify and assess the AI tools in manufacturing sector for cost reduction
3. To study usage, benefits and challenges in implementation
4. To assess recent trends and strategies of AI tools adoption in manufacturing sector.

LITERATURE REVIEW: -

1. Nuthana Shetty (2024) explores AI implementation in Indian firms like Asian Paints and Tata Steel, achieving 10-14% production cost reductions and 30% downtime cuts via supply chain optimization.

2. **Mechanical Journals (2024)** analyzes AI-enabled smart automation in India, enhancing productivity and energy efficiency under Make in India, despite high initial costs.
3. **IJCAI (2025)** demonstrates AI/ML in Indian print manufacturing, yielding 10-35% savings in downtime, waste, and pricing via predictive models and defect detection.
4. **Gao et al. (2024)** examine AI applications across manufacturing, from design to quality control, achieving 20-30% cost reductions via process modelling and optimization.
5. **Plathottam et al. (2023)** review AI/ML in manufacturing, noting 25-40% maintenance savings and efficiency gains when integrated with IoT sensors.
6. **Cannas et al. (2024)** analyse AI in supply chain operations, highlighting cost/lead time reductions and service improvements in OSCM contexts.
7. Study AI adoption in SMEs, finding 15-25% savings through predictive maintenance and resource orchestration.
8. **Wang et al. (2024)** demonstrate ML for Pd.M., cutting unplanned downtime by 30-45% and overall costs in industrial case studies.
9. **Cortright (2025)** synthesizes AI for cost estimation, using predictive analytics and real-time adjustments for 20%+ accuracy improvements in material/labor forecasting.

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RESEARCH METHODOLOGY: -

The current research article is based on secondary data collection A comprehensive review of 50+ peer-reviewed articles (2018-2026) from journals like International Journal of Production Economics and Journal of Manufacturing Systems was conducted, alongside industry reports from Deloitte, McKinsey, and NAM. The research scholar has referred to online International and national reference books, Journals and Reports for this article.

DISCUSSION: -

Recent trends and strategies of AI tools adoption in the manufacturing sector:
AI adoption has become nearly ubiquitous in manufacturing. This year's survey reveals that 95% of manufacturers have already invested in or intend to invest in AI/ML within the next five years.

AI-DRIVEN MANUFACTURING COST REDUCTION APPLICATIONS:

1. **Predictive Maintenance**: ML algorithms process sensor data to forecast equipment failures, slashing downtime by 60%.
2. **AI Quality Control**: Computer vision detects defects with superior precision, cutting inspection times by 80%.
3. **Supply Chain Optimization**: AI forecasts demand, fine-tunes inventory to prevent excess stock, and enhances logistics efficiency.
4. **Energy Optimization**: AI analyses consumption patterns to pinpoint waste and recommend adjustments, lowering utility expenses.
5. **Generative Design**: AI generates optimal product designs rapidly, minimizing material usage and accelerating market entry.
6. **Waste Reduction**: Real-time process monitoring enables precise control, reducing material waste by 8-15%.

(Source:https://www.rapidcanvas.ai/blogs/ai-in-manufacturing-enhancing-efficiency-and-reducing-cost)

AI Implementation Costs in Manufacturing

Though the AI deployment expenses in manufacturing differ significantly based on system complexity, organizational size, and rollout scope, generally spanning $50,000 for entry-level solutions to over $1 million for comprehensive enterprise implementations. Primary costs encompass licensing fees, bespoke development, data infrastructure, and staff training, typically recouped through 15-40% operational cost reductions within 12-24 months.

Cost Components of companies incurred are as follows:

- **Software Licensing**: $30K-$200K per facility for predictive maintenance platforms like IBM Maximo; subscription models lower initial outlay to $10K-$50K yearly.
- **Development & Systems Integration**: $50K-$300K for manufacturing execution systems, IIoT connectivity, and ERP modifications (20-25% of total budget).
- **Data Engineering & Model Training**: 15-25% of overall spend ($20K-$150K) covering sensor pipelines and domain-specific algorithm refinement.
- **Infrastructure Investment**: $50K-$600K for edge devices, cloud capacity, and sensors; annual AI compute adds $8K-$30K.

These 10 AI tools, categorized by primary cost-saving function, deliver measurable reductions across manufacturing operations through predictive analytics, computer vision, and simulation technologies. Industry benchmarks show combined adoption yielding 25-40% overall savings.

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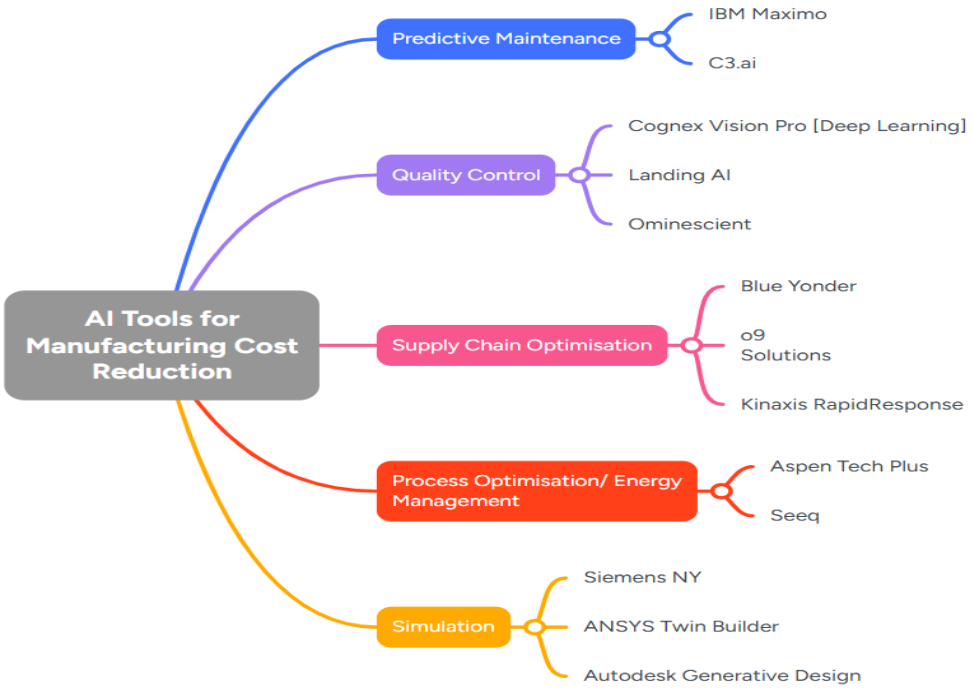
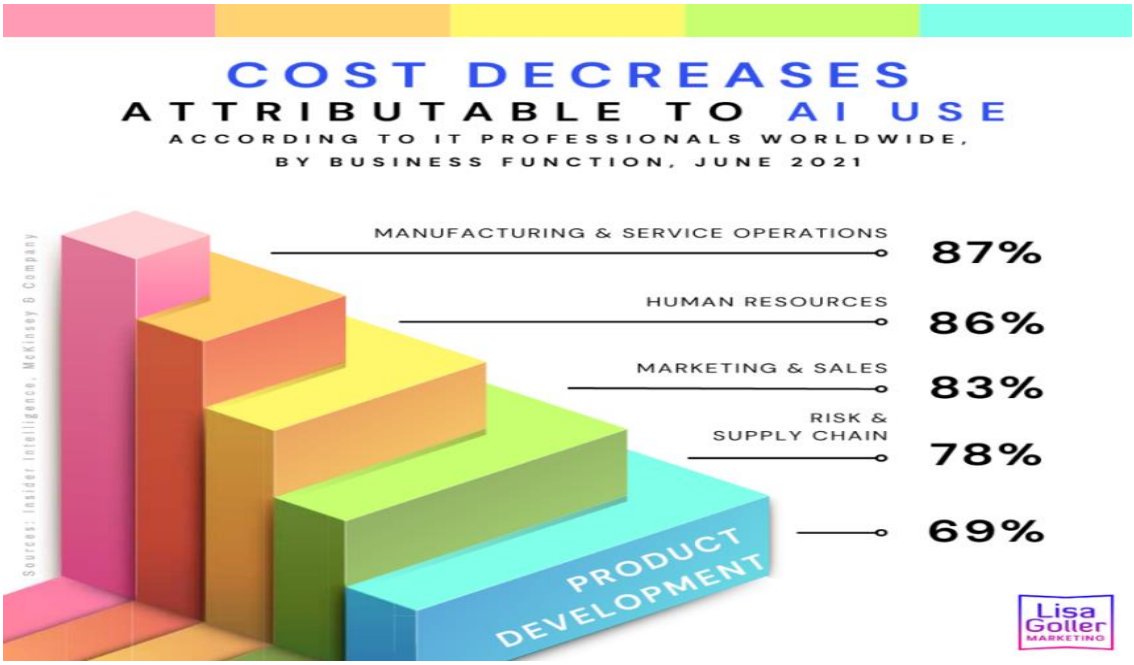


(**Source:** https://research.aimultiple.com/manufacturing-ai/

Benefits of Use of AI tools in manufacturing sector for overall cost reduction are discussed below**:**



(**Source:** https://www.lisagoller.com/2023/02/ai-driven-cost-reduction/)

- Lower Maintenance Costs: Proactive repairs prevent expensive, unplanned machinery failures.
- Reduced Labor Inefficiencies: Automation of repetitive tasks reduces labour costs and human error.
- Optimized Resource Allocation: Improved production scheduling ensures higher efficiency and better material utilization.
- Improved Yield: Precise formulation adjustments in production processes, such as in chemical or process manufacturing, minimize material waste.
- Quality control improvements.
- Inventory optimisation,

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- labour efficiency gains
- energy consumption reduction,
- supply chain, resilience,
- scalable ROI realisation.

Challenges in AI Adoption for Manufacturing Cost Reduction:
Following are some of the hurdles commonly faced are pointed out

- **Data Quality Problems**: Poor sensor data, gaps, and fragmented systems reduce AI reliability, delaying 40% of initiatives according to Deloitte 2025 data.
- **High Upfront Expenses**: Initial outlays burden SMEs, with ROI taking 12-24 months amid rising input costs (5.8%).
- **Talent Shortages**: Limited AI skills and employee resistance to automation hinder progress.
- **Outdated Systems**: Integrating old equipment with modern IT blocks real-time insights and pilot expansion.
- **Security & Compliance Hurdles**: Vulnerable IIoT setups and regulations (GDPR, ISO) inflate costs.
- **Scaling Difficulties**: High numbers proofs-of-concept fail company-wide rollout due to tracking issues and lost expertise.

CONCLUSION: -

To conclude with the current research article tries to assess the usage of AI tools in the manufacturing sector cost reduction. The data shows adoption of AI tools like Predictive Maintenance, AI Quality Control, AI Generative Designs, etc **are** very effective in reducing overall manufacturing cost. The initial cost can be heavy but can be recovered in a year to three years' time period. Considering the benefits such as Lower Maintenance Costs, Quality control improvements, Inventory optimisation, labour efficiency gains, scalable ROI realisation etc. make it more reasonable.

Though there are limitations like scalability issues, outdated systems or resistance from labourers. Which can be dealt by the organisations by arranging proper training programs, **Data Quality** improvements, Upgrading the machines, hiring or retention of required talents. Finance or funds supply for necessary system installation can bring fruitful long-term results. Thus, identifying and removal of hurdles at implementation level can help organisations achieve the objectives cost reduction.

AI in Manufacturing Market (2025-2030): Regional Analysis reports
offer comprehensive regional insights into AI adoption and growth within manufacturing. North America maintains leadership with 32-43% market share, supported by cutting-edge infrastructure, while Asia Pacific demonstrates the highest compound annual growth rates driven by rapid industrial digitization. Adoption maturity varies significantly across other global regions. (19)

Looking ahead, AI will revolutionize operations through autonomous workflows, digital twins, and Industry 5.0 integration, delivering over 50% productivity gains by 2030 according to PwC forecasts and Lighthouse Network standards. Trends like AI-powered reindustrialization—slashing CNC programming time by 80% via startup innovations—will address labour shortages and market volatility, empowering SMEs with scalable quality control, scheduling, and sustainable practices. Success hinges on strategic implementation featuring hybrid AI systems, employee reskilling programs, and responsible AI governance, creating agile manufacturing ecosystems that achieve dramatic cost reductions while establishing market leadership in the hyper-efficient era. Visionary adopters will secure dominant competitive positions. (27)

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