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AI IN DEFENCE MANUFACTURING

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The Digital Supply Chain: Impact of Artificial Intelligence in the Defence Electronics Manufacturing Sector.

Abstract

The becoming known of Artificial Intelligence has transformed Traditional Supply Chains into Intelligent Digital Eco Systems. In the defence electronics manufacturing sector, where reliability, security, operability and speed are of Paramount Importance. AI-driven digital Supply Chains are revolutionizing procurement, production, inventory management, logistics and Predictive maintenance. The integration of AI enhances operational efficiency, Reduces Costs, Strengthens Security, Improving decision-making Capabilities.

This Article - examines the impact of AI on Digital Supply Chains within the defence electronics manufacturing industry and demonstrating the practical benefits.

Keywords – Artificial Intelligence, Digital Supply Chain, Predictive Analytics, Smart manufacturing etc.

Introduction

This sector is responsible for producing sophisticated system, like RADAR Equipment, Communication devices, Missile guidance systems, Surveillance Equipment, Avionics and electronic warfare systems.

These procedures require highly Specialized Components, Stringent quality Standards and Secure Supply Chain networks.

Traditionally Defence Manufacturing relied on manual planning, fragmented data systems and reactive decision making process. However, increasing geopolitical uncertainty, Supply Chain Disruptions, Technological Complexity and cyber security threats have compelled defence organization to adopt digital transformation initiative.

Artificial Intelligence has emerged as key enabler of the digital supply Chain. AI Technology Such as Machine learning, Predictive analysis, natural Language processing and intelligent automation provide real time visibility and proactive decision making capabilities across the supply chain.

What is Digital Supply chain?

A supply chain is an interconnected network that uses digital technologies to integrate Suppliers, Manufacturers, distributors and Customers - through real time information sharing and intelligent decision making.

Prime characteristics Includes the following:

1. Real Time Visibility of Inventory and operation.
2. Automated procurement and sourcing.
3. Predictive demand forecasting.
4. Smart Manufacturing Systems.
5. End to end Traceability.
6. Intelligent Logistics, and distribution.
7. Enhanced Cybersecurity, and Monitoring.

In defence Electronics Manufacturing digital Supply chains help maintain Uninterrupted Production while ensuring compliance with National security requirements.

1. **Role of AI in defence Electronics Manufacturing** - AI Based, demand forecasting defence procurement often Involves long term projects and fluctuating demand patterns. AI analyses historical procurement data, Geopolitical data, developments, Maintenance schedules and operational requirements to forecast future demand accurately.

Benefits Includes.

- Reduced Inventory Carrying Cost
- Better production planning.
- Improved resource allocation.
- Lower Risk of stock out.
- Intelligent procurement and Supplier Management.

AI evaluates Supplier performance based on Quality, Delivery, Reliability, Cost and Risk Factor.

Applications include

1. Supplier Risk Assessment
2. Brand selection
3. Contract Compliance Monitoring.
4. Automated Supplier Selection.

This enables defence manufacturing to maintain resilient and secure supplier networks.

2. Smart Manufacturing and production optimization.

AI-Powered Manufacturing Systems Continuously Monitor machine, production lines, and quality parameters.

1. Reduced downtime.
2. Increased productivity.
3. Improved Product Quality.
4. Better Utilization of resources.

Machine learning algorithms identify process inefficiencies and recommend corrective action. Clear problem is clear.

3. Predictive Maintenance – Defence, Electronics, Manufacturing includes Expensive and highly sensitive equipment

AI Analyses sensor data from Machine to predict failure, before they occur.

Advantages

- Reduced Maintenance Cost.
- Increased Equipment availability.
- Extend Asset life.
- Improved operational reliability.
- Predictive Maintenance Shifts Maintenance activities from reactive to proactive Approach.

4. Quality Assurance: Assurance through Computer Vision

AI enabled Computer Vision Systems Inspect Electronic Components and Assembly with greater Accuracy than Manual Inspections.

Applications Include

PCB - Inspection.

Component Assignment – Verification

Defect detection

Solder Joint Analysis - This significantly improves Product reliability and reduce rework Cost.

5. Inventory optimization: Maintaining Correct Inventory Levels. It's very critical in defence Manufacturing due to high value of Components.

AI helps by doing following.

- Monitor Inventory in real time.
- Pre-ordering replenishment needs.
- Identifying Slow moving items.
- Optimizing Warehousing operations.

As a result, Inventory Cost decrease reduce Service Level & improves.

6. Logistics and distribution: AI enhances transportation planning and Logistics operation through.

- Route optimization
- Shipment Tracking.
- Risk Monitoring.
- Delivery de-hedging

These capabilities improve responsiveness and Reduce Transportation Cost.

Benefits — AI drives digital Supply Chain.

- Improved Visibility
- Enhanced decision Making.
- Cost Reduction.
- Risk Mitigation.
- Increased Security.
- Sustainability.

Challenges in AI Implementation: Despite its advantages – AI Implementation presents several challenges

- Data Quality Issue.
- Cyber Security Risk.
- High Initial Investment.
- Skill gap.
- Regulatory Compliance.

Improved Visibility — It provides end to end Visibility across Supply Chain, Production facilities -> Warehouses and Logistics networks.

Enhanced decision making – through real time analytics enables Manufacturer to make informed strategic operational decisions.

Conclusion:

AI is transforming the Defence Electronics Manufacturing sector by enhancing the development of intelligent digital supply chains through predictive analytics, smart manufacturing, automated procurement, quality assurance and inventory optimization.

AI enhances the Operational Efficiency and supply chain resilience.

Case Study on AI Implementation

We consider a hypothetical defence Electronics Manufacturer - ABC Electronics Ltd. Producing Radar, Communication Modules and Military grade Electronic Systems. The Company faced several operational challenges.

1. Shortage of Critical Electronics Active Components
2. Long procurement lead time
3. High Inventory Carrying Cost
4. Unexpected Equipment Breakdown
5. Delayed Customer deliveries

Management decided to implement AI driven digital Supply chain transformation programme.

- Data Integration
- The Company Integrated data from
- ERP
- Supplier database.

Manufacturing Execution System:

WMS (Warehouse Management System).

Equipment sensor (through centralized digital platforms.)

2nd phase.

Machine learning - algorithms analyzed

- Past order Pattern
- Defence procurement Plan.
- Maintenance Schedule.
- Market Intelligence.

By the adoption of Machine learning algorithms the forecast accuracy improved 60% to 80%.

Predictive Maintenance - Sensors were installed on critical manufacturing equipment through AI Monitor Temperature, Visualization, Energy consumption, Machine utilization. Mechanical failures were predicted several days in advance.

The eventual result was:

- Equipment down time was reduced by 35%
- Maintenance cost was reduced by 20%

Supplier Risk mitigation

AI continuously assessed supplier performance, based on

1. Delivery history
2. Quality metrics
3. Financial stability
4. Geopolitical risk

Alternative suppliers were automatically identified, when risk increased.

Procurement disruptions reduced by 40%.

Supplier Reliability Improved significantly.

Computer Vision-Based quality inspection.

AI powered camera inspected Electronics Assembly

The following were observed:

- Micro-defects.
- Component placement errors.
- Soldering defects.

Ultimate results – Defects detection Accuracy Increased by 95% - 98% while rework costs reduced by 25%.

Overall improvements after two years Implementation

Performance Indicator

- (1) Forecast accuracy: Before AI 70% and After AI 90%
- (2) Equipment downtime: 100% Baseline - 35%
- (3) Maintenance cost - 100% Baseline Reduced by 28%
- (4) Inventory cost - 100 Baseline, Reduced by 18%
- (5) Procurement disruption: 100% Baseline, Reduced by 40%
- (6) Product defect: 100% Baseline, Reduced by 25%

The case study demonstrates how AI can significantly improve efficiency and competitiveness, reliability in defence, electronics, manufacturing sector.

Future Trends.

Several emerging technology will further strengthen AI driven digital supply chain.

- (1) Digital twins.
- (2) Autonomous Supply chain
- (3) Blockchain integration

(4) Generative AI.

(5) Advance Robotics.

These above mentioned technology will create more resilient, responsive, and intelligent defence supply chain.

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