



INTRODUCTION OF IoT DEVICES TO SHOP FLOORS FOR ENHANCED OEE

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ABSTRACT

The IIoT Revolution: The shop floor, once dominated by manual processes, now stands at the precipice of transformation. The advent of the Industrial Internet of Things (IIoT) heralds a new era—a convergence of physical machinery and digital intelligence. By embedding smart sensors, actuators, and interconnected devices, manufacturers unlock unprecedented insights. These data-rich devices facilitate real-time monitoring, predictive maintenance, and process optimization. The shop floor metamorphoses into a dynamic ecosystem where every machine communicates, learns, and adapts.

1. From Data to Wisdom: IIoT devices act as vigilant sentinels, capturing granular information about production lines, energy consumption, and equipment health. This torrent of data flows seamlessly to cloud platforms, where it undergoes rigorous analysis. Machine learning algorithms discern patterns, anomalies, and correlations. The result? Informed decision-making. Managers receive alerts before a critical machine falters. Operators adjust parameters based on real-time feedback. The shop floor becomes a living organism, perpetually optimizing its own vitality [2].

2. Challenges and Triumphs: Implementing IIoT devices isn't without hurdles. The shop floor grapples with legacy systems, proprietary protocols, and security concerns. Retrofitting existing machinery demands finesse—a delicate dance between tradition and innovation. Yet, the rewards are manifold. Reduced downtime, efficient resource utilization, and predictive maintenance lead to cost savings. Moreover, IIoT paves the way for agile, demand-responsive production. The shop floor evolves from a reactive space to a proactive powerhouse [3].

3. Human-Machine Symbiosis: Amid the hum of machines, human expertise remains irreplaceable. Skilled technicians interpret IIoT-generated insights, bridging the gap between data streams and actionable strategies. Training the workforce to embrace IIoT is paramount. New roles emerge—data analysts, system integrators, and cyber-physical engineers. The shop floor becomes a collaborative arena where humans and machines coalesce, each enhancing the other's capabilities. The symbiosis of man and technology propels productivity [4].

4. The Path Forward: As IIoT permeates the shop floor, organizations must foster a culture of continuous learning. Cross-functional teams dismantle silos, fostering interdisciplinary collaboration. Cybersecurity protocols shield against digital threats. And as IIoT devices proliferate, ethical considerations arise. Transparency, privacy, and data ownership demand attention. The shop floor, once a bastion of tradition, now embraces the digital tide. IIoT devices are not mere tools; they are catalysts for industrial metamorphosis [5].

In this epoch of IIoT adoption, the shop floor transcends its physical boundaries, weaving a digital tapestry that binds efficiency, innovation, and resilience. The journey has begun, and the shop floor—once silent—now hums with promise [1] [2] [3] [4].

INTRODUCTION:

What's IIoT?

• The Industrial Internet of Things (IIoT) refers to the application of IoT technology in industrial settings.



- It involves integrating advanced sensors, software, and machinery with internet connectivity to collect, analyze, and act upon vast amounts of data.
- IIoT enables real-time decision-making, predictive analytics, and improved operational efficiency.
- It's a crucial component of Industry 4.0, characterized by the fusion of digital, physical, and biological technologies.

Challenges of IIoT Implementation:

- o **Complexity:** IIoT requires deep integration of existing production processes with information and communication technology.
 - o **Interdisciplinary Approach:** Successful IIoT solutions demand intertwining production, process automation, and IT.
 - o **Human Factors:** Despite technological progress, people remain critical. New roles and tasks emerge due to digital transformation and IIoT adoption.
- Remember, IIoT isn't just about technology; it's about leveraging data to drive business results and create smarter, more efficient industrial operations.

Fundamentals of IIoT systems:

1. Introduction to IIoT:

The IIoT refers to a network of interconnected devices and systems within industrial and manufacturing environments. These devices leverage data, analytics, and connectivity to enhance processes. Key components include sensors, cloud computing, and data analytics. IIoT enables real-time insights, operational optimization, and informed decision-making. Imagine factories with smart machines, predictive maintenance, and efficient supply chains.

2. Device and Sensor Integration:

IIoT devices encompass a wide range: from sensors embedded in machinery to actuators controlling valves. These devices collect data on temperature, pressure, vibration, and more. Sensors play a crucial role in monitoring equipment health, detecting anomalies, and ensuring safety.

3. Connectivity and Networks:

Robust connectivity is essential for IIoT. Devices communicate via wired (Ethernet, fieldbuses) or wireless (Wi-Fi, cellular, LoRa) networks. Industrial protocols like Modbus, OPC UA, and MQTT facilitate seamless data exchange. Network reliability ensures uninterrupted data flow across the factory floor.

4. Data Processing and Edge Computing:

Raw data from sensors needs processing. Edge devices (gateways, PLCs) perform real-time analytics at the source. They filter, aggregate, and transform data before transmitting it to the cloud. Edge computing reduces latency, enhances security, and optimizes bandwidth usage.

5. Cloud Platforms and Analytics:

Cloud platforms (AWS, Azure, Google Cloud) store and process IIoT data. They offer scalability, data visualization, and machine learning capabilities. Analytics tools identify patterns, predict failures, and optimize production. Data lakes and dashboards empower decision-makers.

6. Security and Standards:

IIoT security is critical. Devices must authenticate, encrypt data, and prevent unauthorized access. Standards like ISO/IEC 27001 guide secure implementations. Zero Trust Architecture and secure boot mechanisms safeguard against cyber threats.

IIoT revolutionizes industries by enabling smarter factories, predictive maintenance, and efficient resource utilization. Its impact extends beyond manufacturing to energy, logistics, and healthcare.

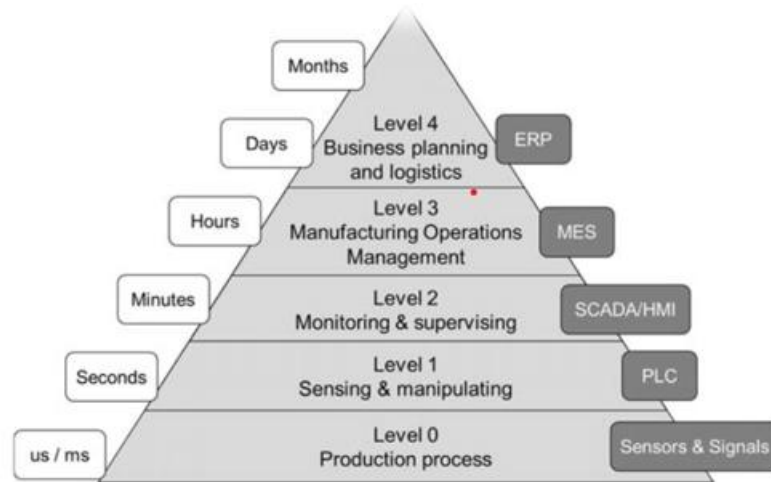
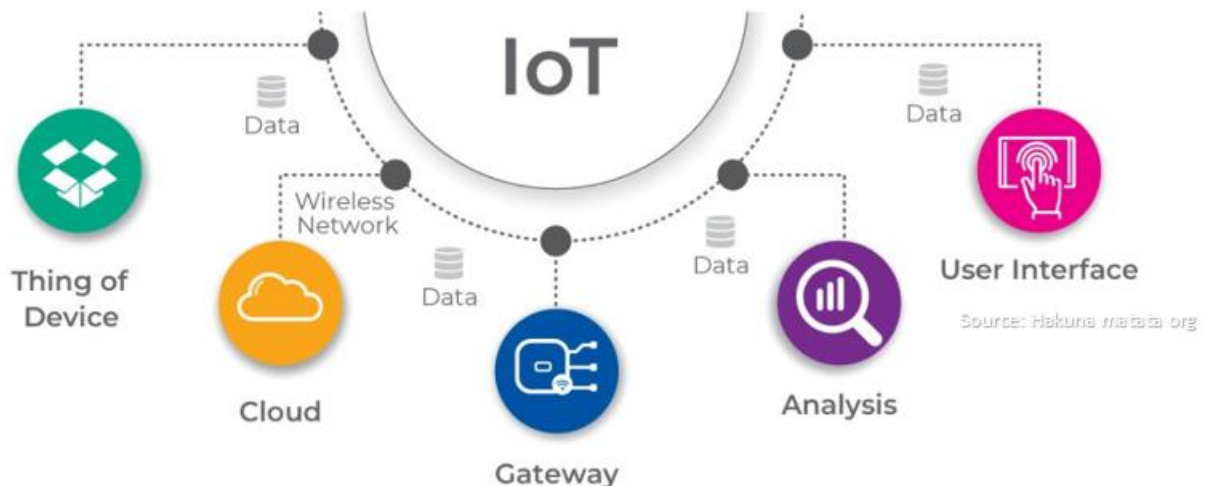


Figure 2: The automation pyramid according to the ISA 95 model. The five levels, 0-5, are defined in the middle. At each level, the typical system(s) used are showed to the right. Different levels are concerned with different timeframes which are visualised to the left.

WHAT IS IoT?

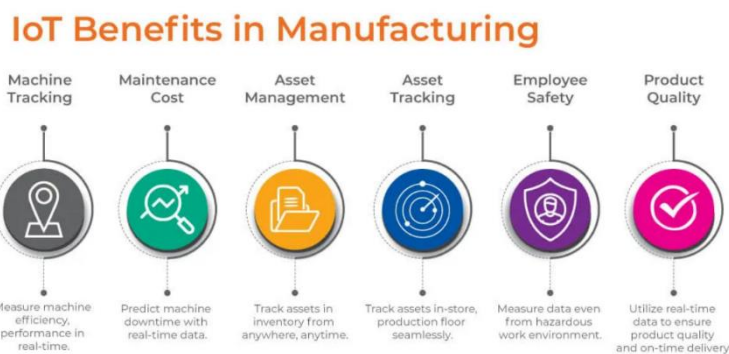
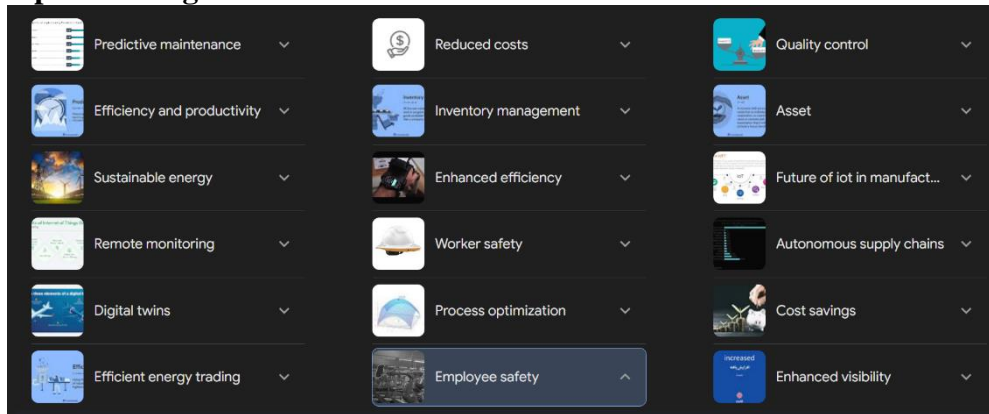


Advantages of Introducing IoT to the shop floors:

1. **Operational Efficiency:** Automation and data-driven processes.
2. **Downtime Prevention:** Minimized unplanned machine stoppages.
3. **Quality Improvement:** Real-time defect detection.
4. **Enhanced Safety:** Monitoring hazardous conditions.
5. **Cost Reduction:** Predictive maintenance and optimization.
6. **Scalability:** Easy expansion across facilities.
7. **Energy Efficiency:** Reduced consumption.
8. **Predictive Maintenance:** Anticipate failures.
9. **Supply Chain Optimization:** Streamlined logistics.
10. **Asset Tracking:** Monitor equipment location.
11. **Remote Monitoring:** Control from anywhere.
12. **Data-Driven Decisions:** Informed choices.
13. **Customization:** Tailor products dynamically.
14. **Waste Reduction:** Optimize resource usage.
15. **Inventory Management:** Accurate tracking.
16. **Productivity Boost:** Automation benefits.
17. **Condition-Based Maintenance:** Service when needed.

Source: Hakuna matata org

18. **Product Lifecycle Management:** End-to-end monitoring.
19. **Collaborative Robots (Cobots):** Efficient teamwork.
20. **Smart Warehousing:** Efficient storage.
21. **Process Visibility:** Real-time monitoring.
22. **Time-to-Market Reduction:** Faster development.
23. **Customer Experience Enhancement:** Better products.
24. **Compliance Adherence:** Meeting standards.
25. **Competitive Edge:** Innovate with IoT.



Advantages of IoT devices in industrial automation

Dis-advantages of IoT devices in shopfloor management:

1. **Security Risks:** External attacks can compromise machines.
2. **High Implementation Cost:** Significant expenses for IoT deployment.
3. **Connectivity Challenges:** Dead spots disrupt productivity.
4. **Lack of Standardization:** Diverse hardware and protocols.
5. **Legacy System Integration:** Adapting IoT to older machinery.
6. **Data Overload:** Managing vast amounts of generated data.
7. **Dependency on Connectivity:** Network disruptions affect real-time monitoring.
8. **Scalability Complexity:** Expanding IoT across facilities.
9. **Interoperability Issues:** Different equipment protocols hinder adoption.
10. **Privacy Concerns:** Protecting sensitive data from breaches.

Addressing the Dis-Advantages:

1. **Security of Data Management:**
 - o **Challenge:** As IoT systems interconnect and communicate over networks, external attacks can compromise machines.
 - o **Solution:** Proper network SSL encryption is crucial for secure communication and data exchange.
2. **High Implementation Cost:**



- **Challenge:** Implementing IoT involves significant expenses.
- **Impact:** Costs include software updates and maintenance.
- 3. **Connectivity Outages:**
 - **Challenge:** Large manufacturing buildings may have dead spots, disrupting machine productivity due to intermittent connections.
 - **Mitigation:** Ensuring robust connectivity infrastructure is essential.
- 4. **Lack of Standardization:**
 - **Challenge:** Diverse hardware and protocols make IoT solutions complex.
 - **Issue:** Each machine “speaks” a different language, hindering seamless integration.
- 5. **Integration with Legacy Systems:**
 - **Challenge:** Older machinery lacks inherent IoT compatibility.
 - **Customization:** Adapting IoT sensors to legacy systems can be time-consuming and costly.
- 6. **Data Overload:**
 - **Challenge:** IoT generates vast amounts of data.
 - **Management:** Handling and analyzing this data efficiently are a challenge.
- 7. **Dependence on Connectivity:**
 - **Challenge:** IoT relies on continuous network connectivity.
 - **Risk:** Downtime or network disruptions affect real-time monitoring and decision-making.
- 8. **Scalability Concerns:**
 - **Challenge:** Expanding IoT deployments across multiple sites or facilities requires careful planning.
 - **Complexity:** Ensuring scalability without compromising performance is essential.
- 9. **Interoperability Issues:**
 - **Challenge:** Different equipment protocols hinder seamless adoption of Industrial IoT.
 - **Solution:** Efforts to standardize protocols can ease interoperability challenges.
- 10. **Privacy and Data Security:**
 - **Challenge:** Protecting sensitive data from breaches and unauthorized access.
 - **Mitigation:** Robust security measures, encryption, and access controls are crucial.

Conclusion:

The IIoT revolution, fueled by visionaries like Kevin Ashton, promises a data-driven renaissance. McKinsey estimates its economic value at \$11.1 trillion by 2025. However, security concerns loom large, with Bruce Schneier cautioning against surveillance and control. The symbiosis of humans and machines, augmented by AR and VR, reshapes factories. Ethical dilemmas arise, demanding transparency and privacy safeguards. Standardization efforts by bodies like the IIC pave the way for seamless integration. Resilience becomes imperative, ensuring robustness against disruptions. As we navigate this journey, let’s heed Einstein’s wisdom: “The only source of knowledge is experience.” The true potential of IIoT lies in collective learning, adaptation, and harmonizing ones and zeros. While IoT plays a major role in enhancing overall equipment efficiency, jobs per hour and 4M efficiency, it also suffers from data breaches and require skilled set of IoT engineers.

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