Smart Inventory Management

Monitor and improve the efficiency of production processes.

The Challenge

Inventory management is one of my main challenges even though my purchasing department is connected to my accounting department and the main warehouse. The stock is checked manually and this procedure creates shortages of certain items and overstock of other items.

Industry Sector:
Manufacturing

Challenge classification:
Limiting manual checking in order to minimizing human errors
Real-time process monitoring and optimization., Warehouse management based on real-time tracking of product locations, transportation conditions, the integrity of packaging., Supply chain transparency and reliability improvement

Time for Project Completion:
I do not have enough information to estimate months

Main Requirements

- Optimize supply chain based on performance;
- Optimize flow of material;
- Automate checking of loading and unloading materials.

Other Requirements

N/A

Key Performance Indicators

N/A

Other informations

What competence does the company have with this project?
Project partner

Use manufacturing execution systems (MES) or enterprise resource planning (ERP) systems?
No

Use of any existing cloud vendor (AWS IoT, Microsoft Azure, etc.)?
No

Number of machines to be connected:
4

Configuration of each machine and the operation of each:
computers

Machines are equipped with PLC/PAC or CNC controllers and can provide data?
not applicable

Machines are not equipped with any digital controller (Legacy Machines)?
not applicable

Communication protocols, sensors or devices with which the solution needs to integrate?
yes

Research Phase

Taking into account the challenge description, its requirements and its information, elaborate at least 5 questions that can lead your research for a solution.

Research questions:

1. How can Stock management be digitized?
2. Which enabling technology can connect the purchasing and accounting departments with the warehouse to avoid manual storage check?
3. What are the most common challenges in Inventory Management to take into account for the solution?
4. Should the solution provide integration with external partners in the supply chain?
5. How much time occurs to implement a digital solution to manage Inventory Management?

Given the questions and the main requirements of the challenge previously listed:

- identify possible technologies using the Planet4 Taxonomy Explorer;
- identify and analyze the sources (papers, articles, etc.) of those technologies that best suit the challenge;

Technologies identified in the taxonomy:

- IoT Gateway to detect smart devices and provide real-time monitoring
- IoT Device to track the logistics and products during spedition
- GPS Tracking device
- Data Analytics Platform
- Cloud Data Storage

Sources of those technologies that best suit the challenge:

Affia, I. and Aamer, A. (2022), "An internet of things-based smart warehouse infrastructure: design and application", Journal of Science and Technology Policy Management, Vol. 13 No. 1, pp. 90-109

In light of the discoveries made:

- report the answers for the questions above;
- compare 2-3 of the more common solutions identified in the sources (how would they change the approach to the solution? What are the possible benefits/issues in such a use of these technologies?);
- draw initial conclusions on which path you want to take in proposing a solution.

Answers:

1. We can use a Smart Warehouse solution provided by many IoT Company
2. The Cloud Data Storage and Data Analytics technologies it's the key for connecting the various departments . Real-Time monitoring and concurrency computation can be achieved only by Cloud Solutions and Data Warehouse.
3. Improve Warehouse Efficiency , changing demand , interconnection with supply chain
4. Yes , the solution must be flexible enough to facilitate the integration with new partners, new business solutions, and follow the expansion of the company.
5. it may take 2-8 months, depending on the technology partner or custom solution needed.

Comparison:

Using the taxonomy, we identified various technological solutions for Inventory and Stock Management of manufacturing companies. The company requires to create IT Solution for accountability, inventory and stock management, work scheduling, on-demand management. Therefore the basic technologies of all possible solutions are **Cloud Computing, Cloud Data Storage, Relational Database, IoT Connectivity and IoT Device Management** which allows us to create a Dashboard where we can have real-time data ingestion from IoT infrastructure , from partners and other actors on the Inventory Management. Furthermore, all solutions use the **Cloud Computing , RFID, Dashboard Analytics and IoT Device Managemen**t tool for collecting inputs.

The differences between these solutions are the Flexibility of tools to add tracking packages with delivery partners , the capacity and scalability of solutions to massive production , and the analytics feature available on the Real-Time Dashboard.

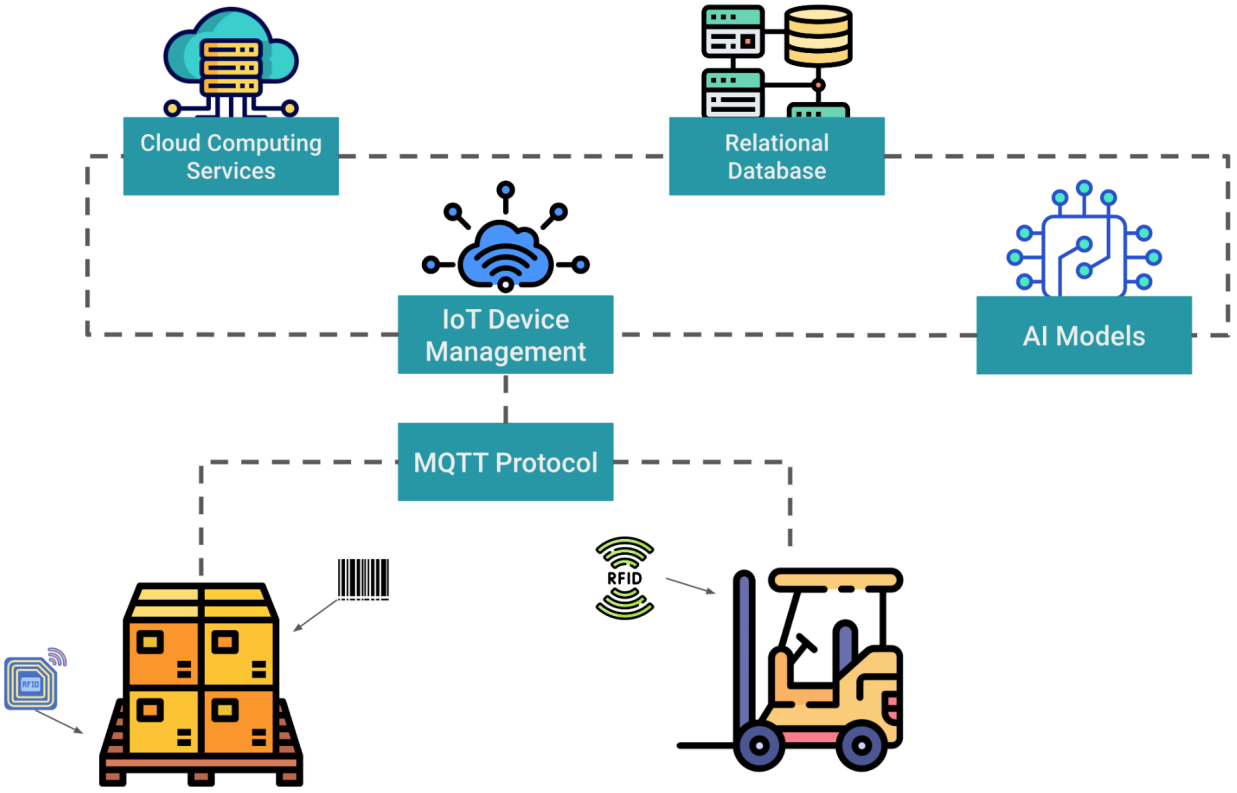
Conclusions:

To add more features to the solution we can use GPS technology for monitoring and tracking the stocks and the delivery. It depends on whether the delivery is outsourced or handled by an internal department. The analytics and optimization of logistics is a key feature that can reduce costs and grow productivity . It's recommended to implement custom Machine Learning solutions to optimize the scheduling and the stock management. Also Scheduling Optimization algorithms can be created from a custom Data Analytics partner.

Proposed Solution

Making use of the technologies identified after the analysis of the sources, describe a possible solution to the challenge. Also, do not forget the constraints (time, number of devices to produce/connect, etc.): the solution must be applicable to the real context of the company that commissioned the challenge.

Solution Summary



The proposed solution for inventory management involves implementing BarCode labels on boxes and RFID tags on pallets for accurate detection and recognition of inventory objects. The system combines BarCodes and RFID technology to capture data such as delivery dates and customer information. MQTT protocol is chosen for IoT device communication due to its energy efficiency and suitability for remote connectivity. AWS IoT Core is utilized to securely connect and collect data from devices, with AWS EC2 hosting the application for inventory management, data analysis, and insight generation. AWS RDS ensures secure storage of IoT data, providing data integrity and high performance. The cloud-based components enable the development of a user-friendly dashboard offering real-time visibility into inventory, key metrics, and delivery information. Comprehensive reports and analytics are generated to derive insights into supply chain performance. AWS Sagemaker, a cloud-based ML platform, is employed to develop AI models that continuously adapt and optimize over time, providing predictive insights for work scheduling, material flow, and decision-making processes.

Solution Description

The proposed solution entails the installation of BarCode labels on boxes and RFID tags on pallets [R7-1]. BarCodes are optical representations of data that can be scanned using a barcode scanner, whereas RFID tags use radio frequency signals to transmit data. By combining BarCodes and RFID, the system can accurately detect and recognize inventory objects, customers, delivery dates, and other relevant information. The MQTT protocol will be utilized for IoT device communication as it has a small code footprint and minimal network bandwidth requirements, ensuring energy efficiency due to its lightweight nature and suitability for remote device connectivity. AWS IoT Core, will be employed to interact with and collect data from the connected devices. AWS IoT Core is a cloud service provided by Amazon Web Services (AWS) that enables secure and scalable communication with IoT devices. It allows devices to connect securely to the cloud, facilitating data collection and management. With AWS IoT Core, you can interact with connected devices, monitor their status, and collect data in a reliable and scalable manner. It supports the MQTT protocol, making it seamless to establish a communication framework/protocol for the IoT devices. Cloud Computing and Cloud Database services from AWS, specifically EC2 (Elastic Compute Cloud) and RDS (Relational Database Service), will be leveraged to build a scalable and robust system. EC2 instances can host applications and provide the necessary computing power to process and analyze data. In the proposed solution, EC2 will host the application responsible for managing the inventory, analyzing IoT data, and generating insights. On the other hand, RDS is a cloud-based service that simplifies the setup, operation, and scaling of relational databases. It provides a highly available and scalable database infrastructure without the need for manual management. In the solution, RDS will store the collected IoT data securely. It ensures data integrity, durability, and high performance for efficient data storage and retrieval. These cloud-based components will enable the development of a user-friendly dashboard, providing real-time visibility into inventory management. The dashboard will present key metrics, inventory levels, delivery information, and other relevant data. Additionally, comprehensive reports and analytics will be generated to derive valuable insights into supply chain performance, identify areas for improvement, and support decision-making. AWS Sagemaker is a cloud-based ML platform that enables the development, training, and deployment of AI models. It offers a range of tools and capabilities to build, train, and deploy ML models at scale. In the proposed solution, Sagemaker will be utilized to develop AI models for analyzing the collected IoT data. These models can generate predictive insights, optimize work scheduling, material flow, and enhance decision-making processes continuously adapting and optimizing over time.

Implementation Plan

Describe the solution implementation plan considering among other things: gantt chart with milestones, high-level cost analysis, possible difficulties (at least 3 major issues or difficulties) and additional opportunities (at least 2 extra benefits).

1. Requirement Gathering and Analysis (1-2 weeks)
   Milestone: Requirements Document Finalized
2. Design and Architecture (2-3 weeks)
   Milestone: System Architecture Design Approved
3. RFID & BarCode Device and Gateway (1 day)
   Milestone: Devices and Gateway Connected
4. Cloud Infrastructure Setup (1-2 weeks)
   Milestone: AWS Services Configured
5. Dashboard and Insight Application Development. Together with the next step can be the most time-consuming part since it highly depends on the customer needs, goals, business problems, accounts, security, etc. (4-6 weeks)
   Milestone: User-Friendly Dashboard Developed
6. AI Model Development using AWS Sagemaker(4-6 weeks)
   Milestone: AI Models Trained and Deployed
7. Integration and Testing (2-3 weeks)
   Milestone: Solution Integration Completed
8. Deployment and Go-Live (1-2 weeks)
   Milestone: Solution Deployed to Production

Additional benefits

- Enhanced Operational Efficiency: Automation of inventory management processes and real-time visibility result in improved efficiency, optimized work scheduling, and reduced operational costs.
- Predictive Analytics and Optimization: AI models enable predictive insights, optimized inventory levels, and proactive decision-making, driving operational excellence and gaining a competitive edge.

Possible difficulties

- Data Integration Complexity: Integrating data from diverse sources, such as RFID and BarCode devices, poses challenges due to varying formats and standards, requiring careful mapping and synchronization.
- Scalability and Performance: Processing real-time data from numerous devices requires a scalable infrastructure to handle increasing data loads and ensure real-time insights without performance issues.
- Security and Privacy Concerns: Protecting data security and privacy while integrating IoT devices and cloud services requires robust measures like encryption, access control, and compliance with regulations.