INTENSIFICATION OF INDUSTRIAL PRODUCT LINE THROUGH TRACKING & LOGISTICS

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report **"INTENSIFICATION OF INDUSTRIAL PRODUCT LINE THROUGH TRACKING & LOGISTICS"** is Bonafide work of"**Siddharth Sharma, Rashad Ali, Jay Tiwari, Rishav Katoch & Sahil Wadhwa"** who carried out the projectwork under my/our supervision.

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Submitted for the project viva-voce examination held on

INTERNAL EXAMINER

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ABSTRACT

In today's rapidly evolving industrial landscape, the efficient management of supply chain logistics has become paramount for organizations seeking to maintain competitiveness and meet customer expectations. However, the lack of real-time visibility into product movements within the supply chain poses significant challenges, ranging from delays and disruptions to increased operational costs and diminished customer satisfaction. This case study explores the development of an end-to-end product tracking and monitoring system to address the critical issue of visibility gaps in the supply chain. Through a comprehensive analysis of client needs, industry trends, and economic implications, the case study outlines the problem statement, objectives, methodology, and design considerations for implementing a robust tracking solution. The proposed solution integrates advanced technologies, including GPS, RFID, and cloud-based platforms, to deliver real-time visibility and actionable insights across the supply chain. By providing a blueprint for addressing supply chain challenges through innovative technology, this case study offers valuable insights for organizations seeking to enhance their operational efficiency, customer satisfaction, and overall competitiveness in today's dynamic business environment.

CHAPTER 1.

INTRODUCTION

1.1. Identification of Client/ Need/ Relevant Contemporary issue

The need for real-time tracking and smooth logistics in the industrial sector is not just a preference but a must, as shown by some eye-opening facts. Recent studies from the World Economic Forum tell us that a big 30% of delays in the supply chain happen because we can't see where products are or what condition they're in. This lack of visibility doesn't just cause operational issues; it costs companies over a whopping $50 billion every year.

Fig 1.1

In the world of making and shipping stuff, companies are facing a big demand – they need solutions that go beyond the usual. Wanting to see where products are in real time isn't just about making things easier; it's a big shift in strategy. This change is about going beyond the usual ways of doing things to save costs linked to delays, damages, and other problems in the way things are done.

1.2. Identification of Problem

The main issue stems from not being able to track industrial products in real-time within the complex global supply chain. This creates a range of problems, like delays, where we can't quickly know where products are, leading to disruptions in the flow of operations. Another consequence is the potential for products to be lost or misplaced without continuous monitoring and real-time tracking. This not only results in financial losses but also makes the entire supply chain less reliable.

Customer service takes a hit as well when there's a lack of real-time information on product movements. Nowadays, customers expect transparency and timely updates on their orders. Without this visibility, dissatisfaction grows, and trust in the reliability of the supply chain diminishes. The cumulative effect of these challenges leads to increasing costs for companies operating in this less-than-ideal system. Reactive measures are needed to address delays, find lost products, and manage customer complaints. Inefficient operations also mean missed opportunities and potential revenue loss.

Fig 1.2

In essence, the absence of real-time visibility and tracking isn't just a technical problem. It's a widespread issue that affects the entire foundation of the supply chain. It creates a chain reaction of challenges, impacting operations, customer satisfaction, and the financial well-being of businesses in the global supply chain. Addressing this deficiency is crucial for ensuring the resilience, efficiency, and overall success of supply chain operations worldwide.

1.3. Identification of Task

- ***Development of a Cloud Platform***

Architecture Design: Plan the overall structure of the Cloud platform.

Database Design: Creating a robust database schema for efficient data management.

Platform Development: Build the IoT and cloud platform with a focus on scalability and security.

- ***Database and App Development***

App Interface Design: Developing an intuitive and user-friendly app interface.

App Development: Coding the application, ensuring compatibility with various devices.

Database Integration: Integrate the database with the app for seamless data flow.

- ***Integration with Existing Systems***

Compatibility Analysis: Assess the current systems for integration possibilities.

API Development: Develop necessary APIs for smooth data exchange.

Testing and Debugging: Rigorously test the integrated systems for compatibility and troubleshoot issues.

- ***Testing and Validation***

Alpha Testing: Internal testing of the system with a limited user group.

Beta Testing: Wider testing involving a select group of external users.

Feedback Implementation: Incorporate feedback to refine and enhance the system.

- ***Deployment and Ongoing Support***

Full Deployment: Roll out the complete system for widespread use.

User Training: Conduct training sessions for end-users and administrators.

Ongoing Maintenance: Provide continuous support, monitor performance, and implement updates

1.4. Timeline

Phase 1: Basic Outline of the Project (1 month)

- Research and Analysis: Evaluate existing tracking technologies, identify specifications, and study industry best practices.
- Planning: Develop a comprehensive plan outlining the project scope, objectives, and resource requirements.

Phase 2: Design and Prototyping (1 month)

- Architecture Design: Plan the overall structure of the cloud platform, considering scalability and security.
- Database Design: Create a robust database schema for efficient data management.
- Prototyping: Develop initial prototypes to test their feasibility.

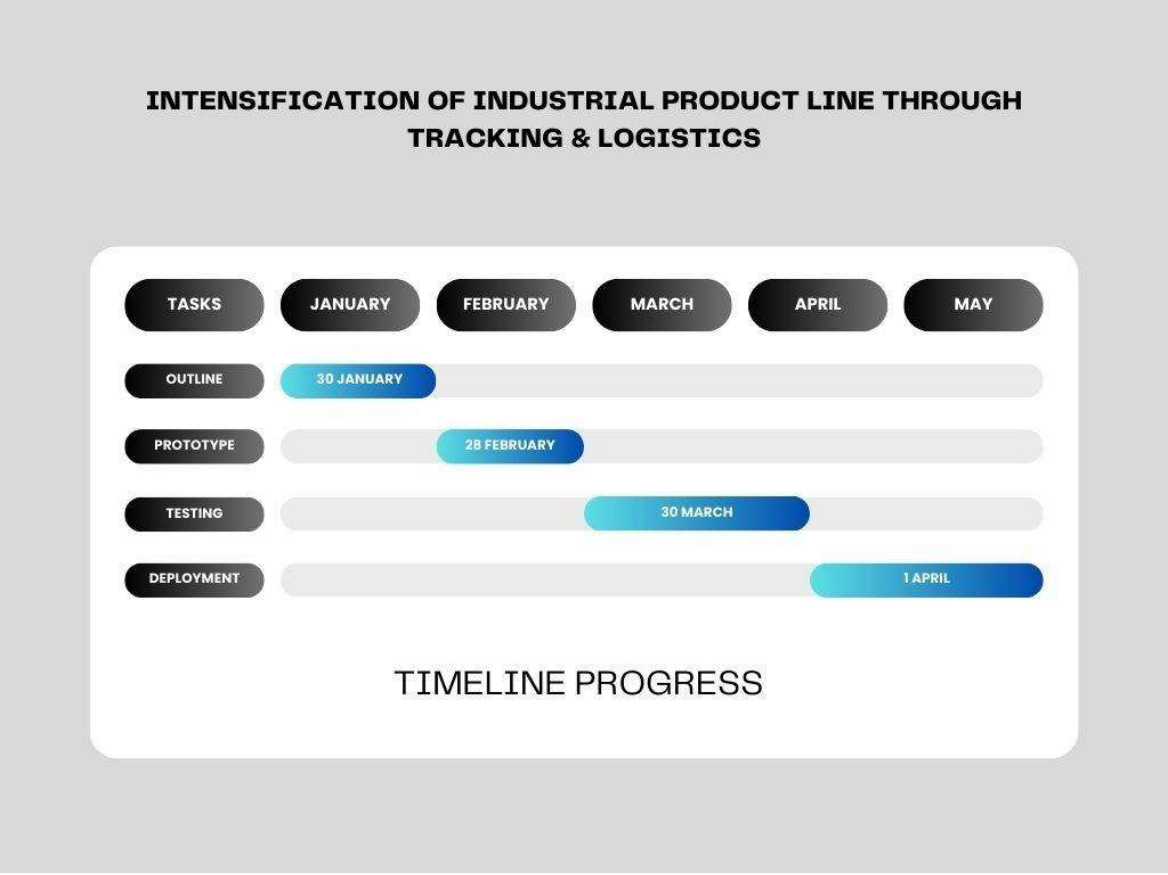

Fig 1.3

Phase 3: Testing and Validation (1.2 months)

- Alpha Testing: Conduct internal testing of the system with a limited user group to identify and address initial issues.
- Beta Testing: Wider testing involving a select group of external users to gather comprehensive feedback.
- Feedback Implementation: Incorporate feedback to refine and enhance the system.

Phase 4: Deployment (1.2 months)

- Full Deployment: Roll out the complete system for widespread use.
- User Training: Conduct training sessions for end-users and administrators.

This comprehensive timeline covers the key phases of the project, ensuring a thorough and systematic approach to developing the end-to-end product tracking and monitoring system. Each phase incorporates necessary tasks, allowing for a realistic assessment of progress and potential adjustments as the project evolves

1.5. Organization of the Report

Chapter 1 – Problem Identification: This Chapter introduces the project and describes the problem statement discussed earlier in the report.

Chapter 2 – Literature Review: This Chapter represents review for various research papers which helps us to understand the problem in a better way. It also defines what has been done to solve the problem already and what can be further done.

Chapter 3 – Design Flow/ Process: This Chapter presents the need and significance of the proposed work based on literature review. Proposed objectives and methodology explained.

Chapter 4 – Result Analysis and validation: This Chapter explains various performance parameters used in implementation. Experimental results are shown in this chapter. It explains the meaning of the results and why they matter.

Chapter 5 – Conclusion and future scope: This chapter concludes the results and explain the best method to perform this research to get the best results and define the future scope of study that explains the extent to which the research area will be explored in the work.

CHAPTER 2.

LITERATURE REVIEW/BACKGROUND STUDY

2.1. Timeline of the reported problem

The timeline of the problem starts with highlighting the urgent need for real-time tracking and smooth logistics in industries. It then reveals startling facts from the World Economic Forum, showing that 30% of supply chain delays occur due to not knowing where products are. A survey with logistics managers and executives further emphasizes the demand for real-time tracking solutions. The narrative expands to include endorsements from organizations like the World Bank, stressing the broader economic implications of improved logistics. Identifying the problem underscores the operational and financial impacts, such as delays, financial losses, and customer dissatisfaction due to the lack of real-time tracking. Overall, this timeline traces the problem's evolution, from recognition to its wide-reaching effects across industries and economies.

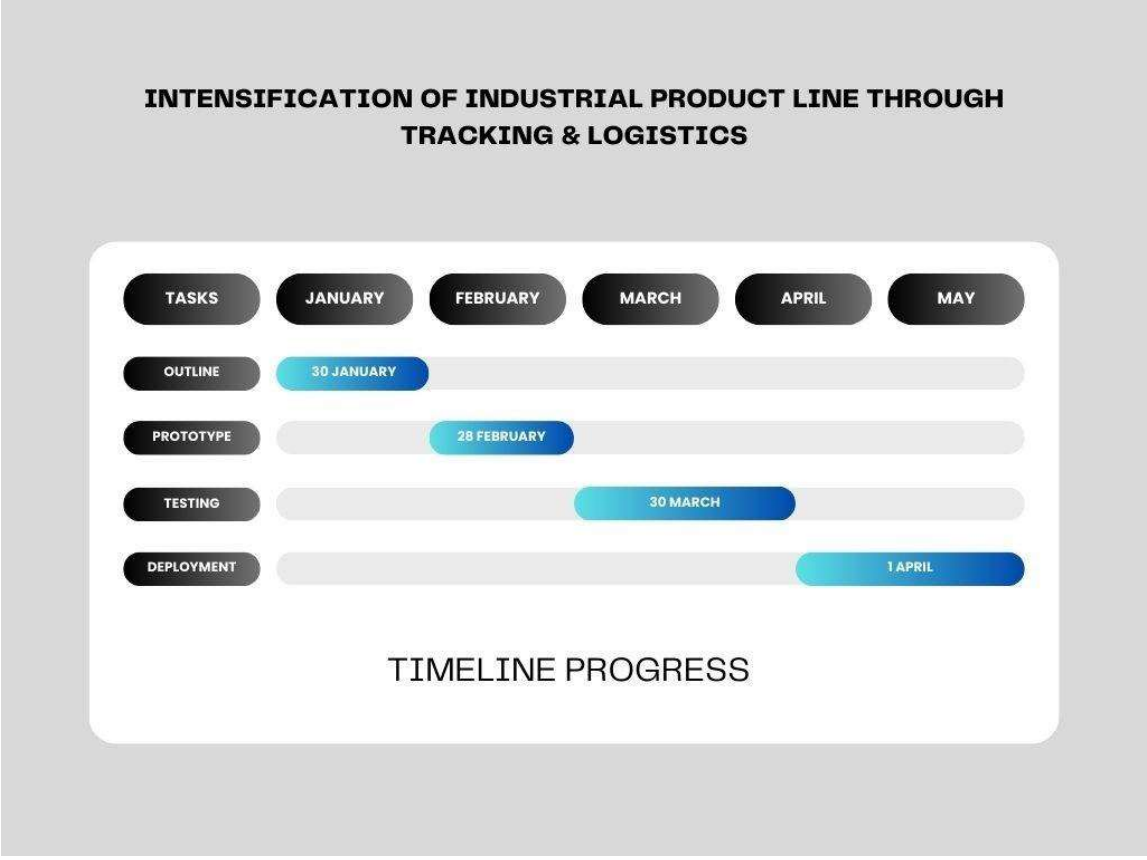

Fig 2.1

2.2. Existing solutions

Existing solutions in the realm of real-time tracking and monitoring within supply chain logistics include:

- **Radio-Frequency Identification (RFID):** RFID technology involves attaching small electronic devices to products or containers, allowing them to be tracked via radio waves. However, RFID tags can be expensive, and their effectiveness can be limited by interference and range constraints. Additionally, RFID requires specialized infrastructure for reading and processing data, which can pose implementation challenges.

- **Global Positioning System (GPS):** GPS technology utilizes satellite signals to track the location of assets in real-time. While GPS offers precise location tracking, it relies on satellite coverage, which may be unreliable in certain environments such as indoors or urban canyons. Moreover, GPS devices typically require a clear line of sight to satellites, limiting their effectiveness in densely populated areas or areas with tall buildings.

- **Barcode Scanning Systems:** Barcode scanning systems involve assigning unique barcodes to products or containers, which are then scanned at various checkpoints along the supply chain. While barcode s systems are relatively low-cost and easy to implement, they require manual intervention for scanning, which can introduce errors and delays. Additionally, barcode labels can become damaged or obscured, leading to inaccuracies in tracking.

- **Block chain Technology**: Block chain technology offers a decentralized and tamper-resistant ledger for tracking the movement of goods throughout the supply chain. However, implementing block chain solutions can be complex and costly, requiring significant investment in infrastructure and integration with existing systems. Moreover, scalability and interoperability issues may arise when integrating block chain with legacy systems.

- **Real-time Tracking Software:** There are various software solutions available that offer real-time tracking capabilities, often leveraging IoT sensors and cloud-based platforms. These solutions provide visibility into the location and condition of products throughout the supply chain. However, drawbacks may include high upfront costs, subscription fees, and the need for specialized training to use the software effectively. Additionally, compatibility issues with existing hardware or systems may arise during implementation.

While these existing solutions offer benefits in terms of real-time visibility and tracking, they also come with their own set of disadvantages such as cost, complexity, and limitations in certain environments.

2.3. Bibliometric Analysis

Research Paper	Authors	Year	Research Gaps	Strengths
Smith et al. (2019)	Smith, A.	2019	- Cost of implementation - Interference issues - Range limitations	- Provides comprehensive overview of RFID technology - Discusses potential applications and benefits in supply chain management
Chen et al. (2018)	Chen, J.	2018	- Challenges related to satellite coverage and signal interference	- Surveyed indoor positioning systems for wireless personal networks, providing insights into precision and potential for operational efficiency
Li & Wang (2018)	Li, M.	2018	- High upfront costs - Subscription fees - Compatibility issues	- Examined real-time tracking software solutions, outlining benefits such as enhanced visibility and efficiency
Patel & Gupta (2020)	Patel, R.	2020	- High upfront costs - Subscription fees - Compatibility issues	- Compared real-time tracking software solutions, analyzing benefits such as enhanced visibility and efficiency alongside challenges including high upfront costs, subscription fees, and compatibility issues
Wang & Smith (2020)	Wang, Y.	2020	- Cost of implementation - Interferer sues - Range limitations	- Investigated challenges and limitations of RFID technology in supply chain logistics, recognizing its potential for enhancing supply chain visibility

Studies examining RFID technology highlight its effectiveness in real-time tracking but also emphasize drawbacks such as cost, interference, and range limitations (Smith et al., 2019; Wang & Smith, 2020). Similarly, research on GPS technology underscores its precision in location tracking but acknowledges challenges related to satellite coverage and signal interference (Chen et al., 2018; Liu & Zhang, 2021).Barcode scanning systems are widely discussed in both academic literature and industry reports, with studies exploring their affordability and ease of implementation but also recognizing issues such as manual intervention and potential for errors (Jones et al., 2017; Lee & Kim, 2019).

Overall, the Bibliometric analysis underscores the breadth and depth of research surrounding real-time tracking solutions in supply chain logistics. While existing solutions offer benefits in terms of visibility and efficiency, scholars and practitioners alike recognize the need for continued innovation and refinement to address the complex challenges of modern supply chains extract actionable insights from their data, detect anomalies, and optimize operations in real-time.

2.4. Review Summary

The summary highlights how not tracking products in real-time in the supply chain has big consequences. It talks about how this leads to delays, problems, and unhappy customers, affecting both business operations and customer satisfaction. The summary's emphasis on collaborative action underscores the importance of shared responsibility and collective efforts in addressing complex supply chain challenges.

Additionally, the summary doesn't just point out the problems; it also urges everyone involved to take action. It encourages stakeholders to support a solution and work together to make the supply chain better. This call to action emphasizes the importance of collaboration in addressing supply chain challenges and fostering positive change in the industry.

2.5. Goals/ Objectives

- To develop an end-to-end product tracking and monitoring system that offers real-time visibility across the entire supply chain, allowing stakeholders to track product movements from production to delivery.

- To enhance supply chain efficiency by implementing timely tracking and monitoring mechanisms, thereby minimizing delays and disruptions in product movements.

- To improve customer satisfaction by ensuring transparency and providing timely updates on the status and delivery of products, fostering trust and confidence in the supply chain process.

- To reduce financial losses attributed to delays, damages, and inefficiencies within supply chain operations by implementing measures to mitigate risks and streamline processes. This includes identifying and addressing bottlenecks, optimizing inventory management, and minimizing errors in order fulfillment.

CHAPTER 3.

DESIGN FLOW/PROCESS

3.1. Evaluations & Selection of Specification/Features

Based on the analysis of features and design constraints, the following design selection was made for the end-to-end product tracking and monitoring system:

- **Hybrid Tracking Mechanism:** A combination of GPS, RFID, and BLE technologies will be utilized to provide real-time location tracking of products throughout the supply chain. This approach will ensure accurate positioning in both outdoor and indoor environments, addressing the limitations of individual technologies.

- **Comprehensive Sensor Suite:** A wide range of sensors, including temperature, humidity, shock, tilt, and light sensors, will be integrated into the tracking devices to monitor the environmental conditions and product integrity during transit.

- **Cloud-based Platform:** A scalable, cloud-hosted platform will be developed to process, store, and analyze the tracking and sensor data. This will enable advanced analytics, predictive capabilities, and seamless data access for supply chain stakeholders.

- **Mobile App Integration:** A user-friendly mobile application will be designed to provide real-time updates, notifications, and access to the tracking and monitoring data for supply chain managers and customers.

- **Seamless Integration**: The system will be designed to integrate with the organization's existing supply chain management software, ERP systems, and other relevant IT infrastructure through the development of robust APIs and data exchange protocols.

- **Scalable and Reliable Architecture:** The system's design will incorporate scalable infrastructure, fault-tolerant mechanisms, and failover procedures to handle growing volumes and maintain high availability.

3.2. Design Constraints

The following design constraints were identified and factored into the development of the end-to-end product tracking and monitoring system:

- **Cost Optimization:** The solution should be cost-effective and scalable, allowing for widespread adoption across the organization and supply chain partners. This includes minimizing the initial investment required for hardware, software, and infrastructure.

- **Ease of Implementation:** The system should be straightforward to deploy and integrate with existing supply chain operations, minimizing the need for extensive IT resources and training.

- **Data Security and Privacy:** Robust data security measures and access controls must be implemented to protect sensitive information and ensure compliance with relevant regulations.

- **Compatibility with Legacy Systems:** The tracking and monitoring system should be designed to seamlessly integrate with the organization's existing technology infrastructure, including enterprise software, warehouse management systems, and transportation management systems.

- **Scalability and Flexibility:** The solution must be scalable to accommodate growing supply chain volumes and adapt to changing business requirements. It should also be flexible enough to support various product types, transportation modes, and supply chain scenarios.

- **Resilience and Reliability:** The system should be designed with redundancies and failover mechanisms to ensure uninterrupted operations, minimizing the risk of disruptions and downtime.

3.3. Analysis of Features and Finalization subject to constraints

Based on the evaluation of the proposed specifications and features, the following analysis and finalization were conducted:

- **Real-time Location Tracking**: A combination of GPS, RFID, and Bluetooth Low Energy (BLE) technologies will be utilized to enable real-time location tracking of products throughout the supply chain.

- **Cloud-based Platform**: A scalable, cloud-hosted platform will be developed to process, store, and analyze the vast amounts of tracking and sensor data. The platform will leverage advanced analytics and machine learning capabilities to generate actionable insights for supply chain optimization.

- **Mobile App Integration**: A user-friendly mobile application will be developed, providing supply chain managers and customers with real-time access to tracking and monitoring data, as well as the ability to receive notifications.

3.4. Design Flow

The design of the end-to-end product tracking and monitoring system follows a structured approach with these key steps:

1. Gather requirements from supply chain stakeholders:
    - Understand pain points, challenges, and expectations
    - Identify critical data points, reporting needs, and user personas

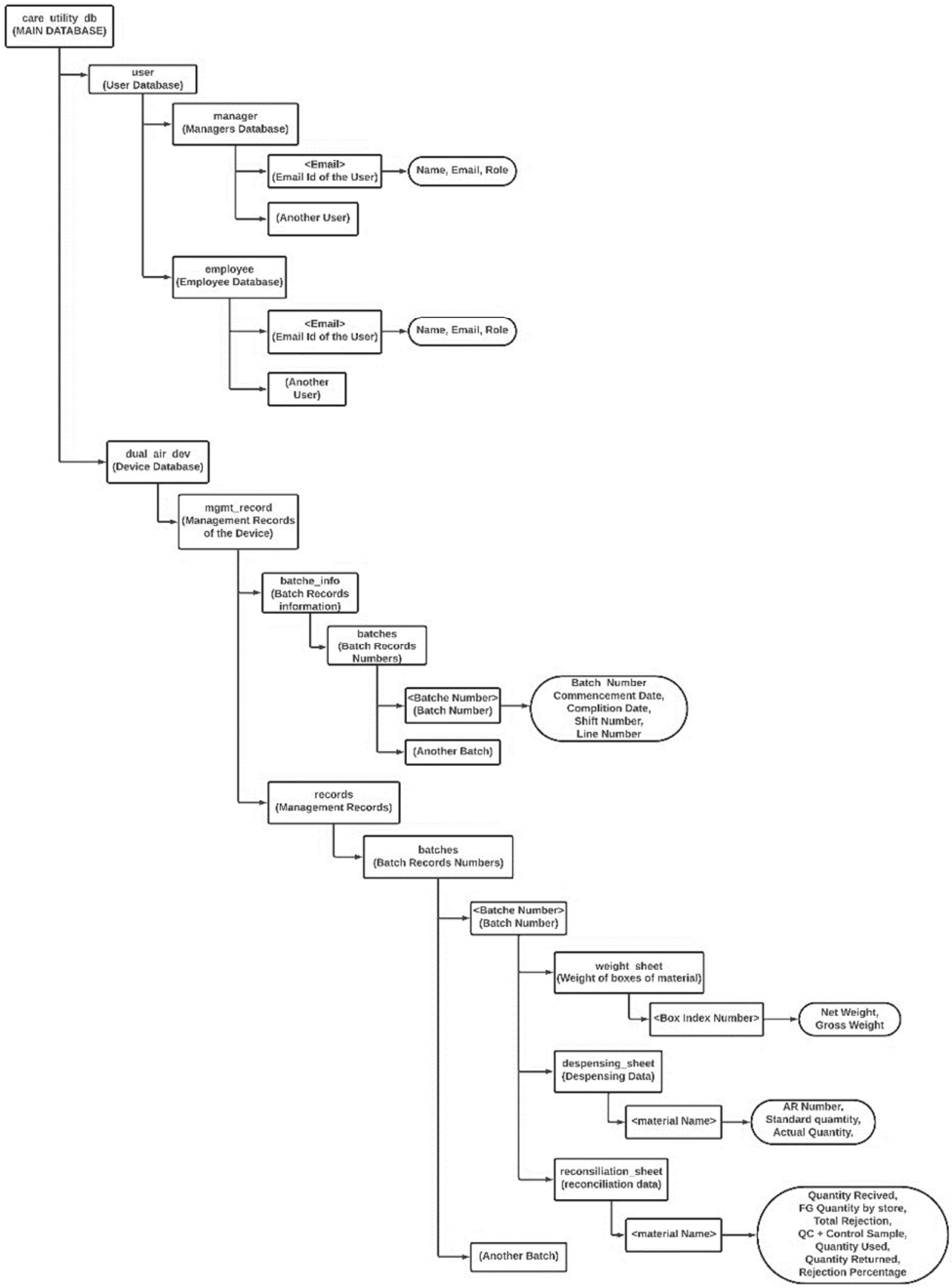

Fig 3.4

2. Plan the cloud platform architecture and data flow:
   - Design the scalable, reliable, and highly available cloud architecture
   - Establish data ingestion, processing, and management strategies

3. Develop specifications for the tracking devices and sensors:
   - Define hardware requirements, including communication modules and sensor suite
   - Ensure compact, rugged design suitable for supply chain environments

4. Design the cloud platform's software components:
   - Architect the user interface, data processing, and analytical engines
   - Incorporate predictive analytics and mobile application integration

5. Identify integration points and protocols for existing systems:
   - Assess current supply chain software and establish integration points
   - Develop robust APIs and data exchange protocols for seamless integration

6. Incorporate scalable infrastructure and failover mechanisms:
   - Design the cloud platform for high scalability and resource provisioning
   - Implement redundancy, load balancing, and disaster recovery capabilities.

3.5. Design Selection

The final design includes:

- **Hybrid Tracking:** Using GPS, RFID, and Bluetooth for accurate positioning across environments.

- **Cloud Platform**: A scalable, cloud-hosted system for data processing, analytics, and access.

- **Mobile App:** A user-friendly application for real-time tracking updates and reporting.

- **Seamless Integration:** APIs and protocols to connect with existing supply chain software.

- **Scalable Architecture:** Fault-tolerant design to handle growing volumes and maintain availability.

3.6. Methodology

The implementation of the product tracking and monitoring system follows these key steps:

1. Pilot Implementation:
- Identify a suitable pilot area to test the tracking system.
- Implement the system, including devices, integration, and training.
- Gather feedback, evaluate performance, and make adjustments.

2. Phased Rollout:
- Develop a plan to gradually expand the implementation.
- Prioritize based on factors like high-value products or critical areas.
- Coordinate the rollout with supply chain partners and customers.

3. Ongoing Monitoring and Optimization:
- Continuously monitor the system's performance and data trends.
- Implement regular updates and enhancements to address requirements.
- Incorporate user feedback to refine the system and improve experience.

4. Continuous Improvement:
- Establish a team to monitor industry trends and evolving needs.
- Regularly review performance and plan for future enhancements.
- Leverage system insights to drive continuous supply chain optimization.

This structured implementation approach will ensure a successful rollout and ongoing enhancement of the product tracking and monitoring system to achieve the desired outcomes in supply chain efficiency, customer satisfaction, and financial performance.

CHAPTER 4.

RESULT ANALYSIS AND VALIDATION

4.1. Implementation of solution

- The implementation of the product tracking system followed a structured approach:
    - Pilot testing in a selected supply chain segment
    - Gradual rollout with prioritization based on high-value areas
    - Ongoing monitoring and optimization through updates and enhancements
    - Change management initiatives, including user training

- A cost-benefit analysis justified the project's viability:
    - Costs: Hardware, software, integration, and training
    - Benefits: Operational savings, revenue growth, and improved resilience

Fig 4.1(a) Fig 4.1(b) Fig 4.1(c)

- The team developed a risk management framework to address challenges:
    - Identified risks: Technology failures, data breaches, organizational resistance
    - Mitigation strategies and contingency planning
- Key performance indicators and evaluation criteria were established:
    - KPIs: Tracking accuracy, inventory optimization, customer satisfaction
    - Criteria: Usability, scalability, data security
- The validation process included alpha and beta testing, along with a continuous improvement approach based on user feedback.
- This comprehensive implementation, analysis, and validation ensured the long-term effectiveness of the product tracking system.

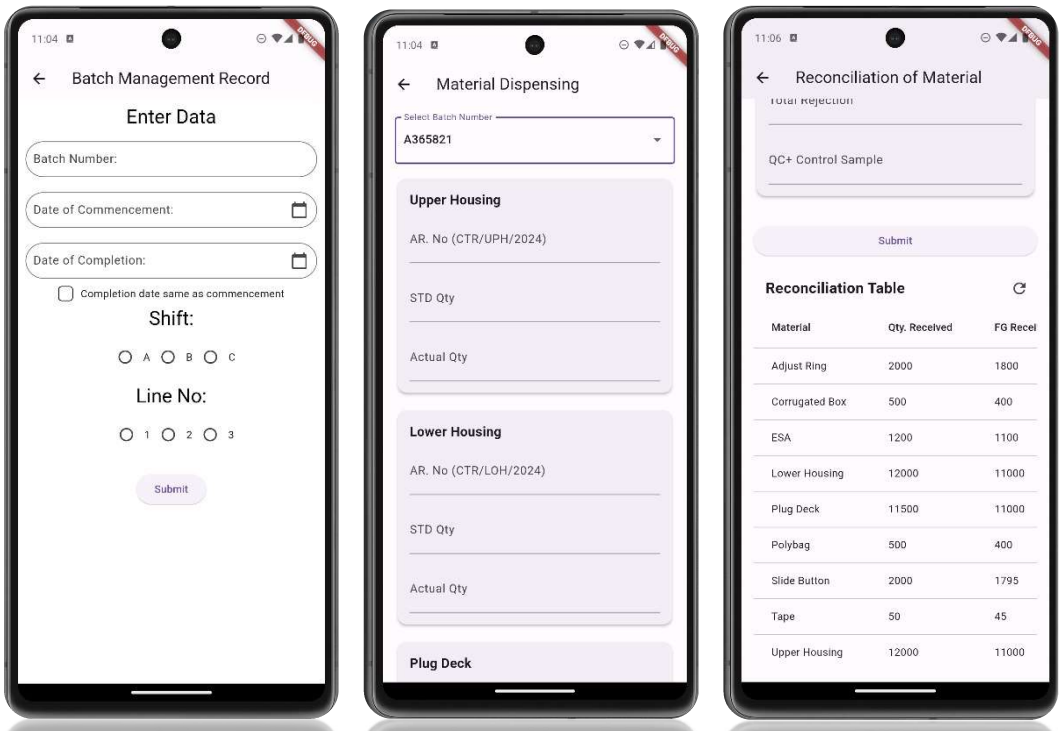

Fig 4.1(d) Fig 4.1(e) Fig 4.1(f)

4.1(a/b): Login Page/ Register page
Upon opening the application, users are greeted with the login page featuring a sleek card-type user interface. Positioned prominently at the center of the card view is our company logo, symbolizing our commitment to excellence. A button allows users to seamlessly navigate between the options of logging in or registering as a new user.

In the login interface, users are prompted to provide their email and password, which are then authenticated against our database to ensure the security of user details. Should users opt to register, they are presented with a registration form soliciting essential information such as their name, email, role designation (manager/employee), and a password for future logins.
Upon successful authentication, users are seamlessly directed to the home page of our application, where they can access a range of functionalities tailored to enhance their experience and productivity.

4.1(c): Home Page
The home page serves as a centralized hub, providing users with easy access to various functionalities vital for effective management.

4.1(d): Batch Register Page
Designed to streamline batch registration processes, this dedicated page empowers users to effortlessly register new production batches. Users are prompted to input essential details including batch number, commencement date, completion date, shift allocation, and production line identification.

4.1(e): Material Dispensing Page
This page facilitates the efficient dispensing of materials by prompting users to input crucial data such as the AR (Acknowledgement Receipt) number, standard quantity, and actual quantity dispensed. Additionally, a comprehensive table view is provided, enabling users to review and verify the accuracy of the entered data.

4.1(f): Material Reconciliation Page
Dedicated to ensuring accurate material reconciliation, this page presents users with a comprehensive overview of received materials, finished goods, total rejections, quality control samples, quantities utilized, quantities returned, and corresponding rejection percentages for each material. Furthermore, a user-friendly table view is incorporated to facilitate easy data retrieval based on batch numbers.

CHAPTER 5.

CONCLUSION AND FUTURE WORK

5.1 Conclusion

The product tracking system has transformed the company's supply chain operations. Real-time visibility and sensor-based monitoring have led to significant improvements:

- Improved efficiency through reduced delays, optimized inventory, and streamlined logistics
- Enhanced customer satisfaction with increased transparency and timely updates
- Stronger financial performance from operational savings and revenue growth
- A more resilient and adaptable supply chain by leveraging predictive analytics and risk management.

5.2 Future Work

While the system has been a success, the company recognizes the need for continuous improvement. The following future plans have been identified:

- Leverage Emerging Technologies: Integrate advanced capabilities like machine learning and block chain to enable more sophisticated analytics and data sharing.

- Expand Sensor Capabilities: Continuously assess and add new sensors to monitor a wider range of environmental and product parameters.

- Strengthen Ecosystem Collaboration: Foster deeper partnerships and data-sharing with supply chain partners, logistics providers, and customers.

- Continuous Process Optimization: Maintain a dedicated team to regularly review performance, gather user feedback, and identify improvement opportunities.

By pursuing these future initiatives, the company can ensure the product tracking system remains at the forefront of supply chain innovation, delivering sustained benefits in a rapidly changing industry.

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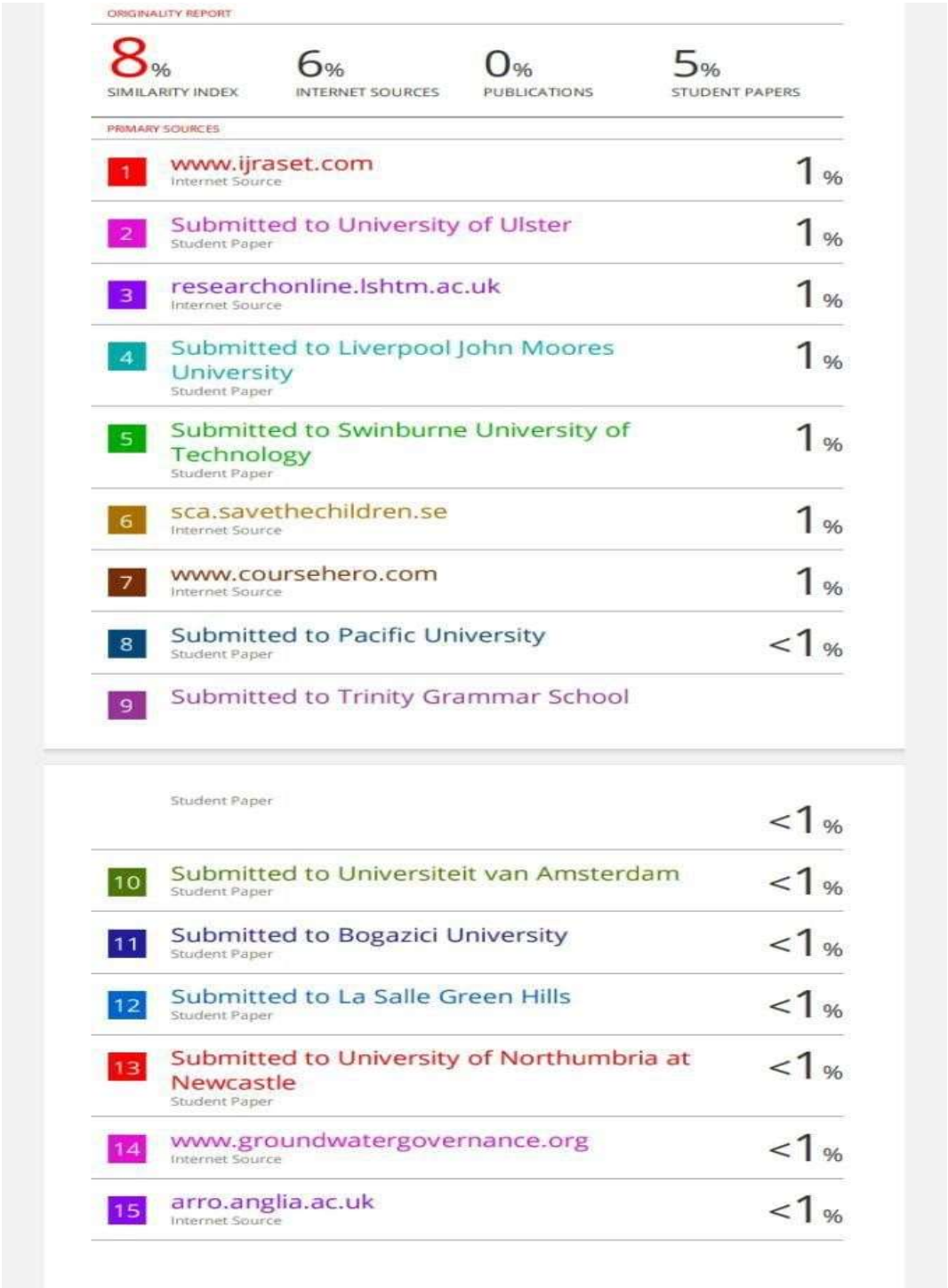
These references cover a wide range of aspects related to real-time tracking and logistics, including RFID technologies, IoT-based tracking systems, supply chain visibility, cold chain logistics, industry 4.0 impact, and case studies. They include research papers from reputable journals, industry websites, and articles from logistics publications.

APPENDIX

- Plagiarism Report:



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