Department of **Computer Science & Engineering**
Independent University, Bangladesh

System Analysis and Design

CSE 307 (SEC – 02)

Summer – 2025

Assignment - 1

"Group Project"

Project Name: A Smart Inventory Management System for Small Businesses Using RFID

Group Members

ID	Name	Section	Question No
2030525	Md Labib Islam	02	4
2010170	Nusrat Jahan	02	3
1822119	Syed Mostafa Parvez	02	N/A
2320087	Sanjida Akter Jui	02	1
2110418	Rifah Tasfia	02	2

Faculty: Dr. Razib Hayat Khan

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1.

Project Goal:

The goal of this project is to develop a **smart, reliable, and cost-effective RFID-based inventory management system tailored specifically for small businesses** to streamline and automate their inventory processes. By leveraging RFID technology, the system aims to provide **real-time visibility of stock movements, accurate inventory counts, and automated tracking of item locations within storage areas**. This project seeks to reduce manual workload, minimize human error, and empower small business owners with actionable insights into their inventory patterns, thereby enhancing operational efficiency, reducing losses due to stock discrepancies, and supporting data-driven decision-making for inventory planning and business growth.

Objectives:

- **Design and implement a comprehensive RFID-based system** capable of automatically tracking the inflow and outflow of inventory items in real time, ensuring continuous and accurate stock visibility.

- **Develop an intuitive, user-friendly software interface** that clearly displays current stock levels, generates automated low-stock and overstock alerts, and shows precise item locations within the store or warehouse.

- **Minimize human error and reduce manual labor** by replacing traditional inventory counting and record-keeping with automated RFID tracking, ensuring data accuracy and operational efficiency.

- **Enable rapid and precise inventory audits** by utilizing RFID handheld and fixed readers, allowing small businesses to conduct regular stock checks with minimal disruption to daily operations.

- **Generate actionable business insights from inventory data**, such as identifying fast-moving and slow-moving products, to support data-driven decisions for restocking and shelf space optimization.

- **Implement item-level location tracking within storage areas**, enabling quick retrieval of products and reducing time spent searching for items during sales or audits.

- **Ensure scalability of the RFID system architecture** so it can seamlessly adapt to business growth and inventory expansion while remaining cost-effective for small businesses.

- **Integrate security protocols to protect inventory data**, ensuring the confidentiality, integrity, and availability of stock information from unauthorized access or data loss.

- **Provide customizable reporting and analytics features** to help business owners monitor sales trends, inventory turnover rates, and seasonal demand patterns effectively.

- **Test and evaluate the system's reliability, usability, and cost-effectiveness** in a real small-business environment to validate its practical benefits and readiness for implementation.

2.

History Leading to Project Request:

For small firms, inventory management frequently determines sustainability and profitability, making it an essential component of any corporate operation. Small firms have always relied on manual tracking methods like Excel sheets, handwritten logs, and simple barcode scanning. These approaches are time-consuming, prone to errors, and provide little insight into real-time inventory data, despite their apparent cost-effectiveness at first. Because RFID (Radio Frequency Identification) devices may provide automated, real-time inventory tracking without the need for manual scanning, larger businesses have effectively incorporated them into their operations. However, due to perceived complexity, hefty upfront expenses, and a lack of technical know-how, small enterprises have been slow to adopt these technologies. RFID technology has become much more affordable in recent years, opening it up to smaller players. In the meantime, inventory-related issues including theft, stockouts, and overstocking still hinder small business productivity. Scalable, user-friendly, and reasonably priced smart inventory systems are becoming more and more necessary. This study suggests an RFID-based intelligent inventory management system that is tailored to small firms' requirements and constraints.

The essential historical factors necessitating this effort are detailed below:

- **Conventional inventory techniques are antiquated and prone to mistakes.**
  Handwritten logs or spreadsheets are frequently used by small organizations, which can lead to errors, missing data, and delayed updates.

- **Barcode systems are not without restrictions.**
  Barcode scanning is faster than manual entry, but it still requires line-of-sight and human labor, which slows down the process and raises labor expenses.

- **RFID is advantageous for large businesses.**
  Automatic, quick, and precise inventory tracking is made possible by RFID technology, which aids larger companies in supply chain optimization.

- **RFID has several important benefits.**
  In contrast to barcodes, it does not require direct line-of-sight, permits bulk item recognition, lowers human error, and permits real-time tracking.

- **Adoption hurdles affect small firms.**
  RFID adoption by small enterprises has been hindered by high startup costs, a lack of technical expertise, and complicated infrastructure requirements.

- **The cost of RFID technology is dropping.**
  RFID has become more affordable and widely available due to advancements in both hardware and software, opening up new economic options for small enterprises.

- **Ineffective inventory management techniques lead to serious issues.**
  In small enterprises, problems including overstocking, stockouts, outdated items, and theft result in losses and have an impact on customer satisfaction.

- **The market is in need of intelligent inventory solutions.**
  More and more small businesses are looking for cost-effective, scalable, and user-friendly stock management systems.

- **Inventory systems in small businesses can be revolutionized by RFID.**
  RFID contributes to waste reduction, time savings, and precise insights for improved corporate decision-making by automating inventory tracking.

- **This initiative fills a void in the real world.**
  Advanced inventory tracking is now feasible and accessible for small organizations thanks to the suggested RFID-based smart inventory management system.

3.

Identify Problem, Issues, Concerns, Opportunities:

Problems & Issues:

- **Manual Inventory Tracking**:
  Most small businesses still rely on manual methods such as paper records or spreadsheets to manage inventory. This often leads to mistakes, outdated information, and inefficiencies

- **Lack of Real-Time Updates:**
  Inventory data is not updated in real-time, causing delays in decision-making and potential overstocking or stockouts.

- **Theft and Misplacement:**
  Without an automated tracking system, products can be misplaced or stolen without immediate detection.

- **Limited Staff Expertise:**
  Small business employees may not have technical expertise to manage complex systems, leading to poor data handling and inefficiency.

- **Inventory Shrinkage:**
  Due to human error, theft, or damage, businesses face unnoticed losses in stock, which directly affects profitability.

Concerns:

- **Cost of Implementation:**
  Small businesses often operate on tight budgets. The cost of installing RFID technology and required hardware/software could be a concern.

- **Technology Adaptation Resistance:**
  Employees and owners may resist adopting new technology due to lack of awareness or fear of complexity.

- **Maintenance & Downtime:**
  Technical issues with RFID systems or software could cause downtime, affecting day-to-day operations.

- **Privacy and Data Security:**
  As the system involves tracking and data collection, protecting that data becomes critical.

Opportunities:

- **Improved Accuracy and Efficiency:**
  RFID technology allows for automatic, real-time, and accurate tracking of stock, reducing human error significantly.

- **Cost Saving Over Time:**
  Though initial investment may be high, automated inventory systems reduce long-term operational costs by minimizing errors and optimizing stock.

- **Better Decision-Making:**
  Real-time data allows business owners to make informed decisions on reordering, promotions, and stock clearance.

- **Scalability for Growth:**
  A smart system allows small businesses to scale easily without a proportionate increase in manual workload.

- **Competitive Advantage:**
  Adopting modern technology gives small businesses a competitive edge in customer service and operational excellence.

4. Product/Solution Description:

a. Describe the Solution:

The proposed system is a **Smart Inventory Management System** designed specifically for **small businesses** utilizing **RFID (Radio Frequency Identification)** technology. The system automates inventory tracking and monitoring processes to enhance accuracy, reduce manual labor, minimize theft/loss, and provide real-time inventory status.

Core Components:

Component	Description
RFID Tags	Attached to individual inventory items for identification.
RFID Readers	Installed at key checkpoints (e.g., entry/exit points, shelves) to scan items.
Arduino/Raspberry Pi	Used as a microcontroller to integrate hardware with the software system.
Database	Stores inventory data, history, and reports. (e.g., MySQL or Firebase)
Web-based Dashboard	For user-friendly inventory monitoring, alerting, and reporting.
Cloud Integration	Enables access from multiple devices and locations for remote management.

Key Features:

- Real-time inventory tracking and status updates
- Low-stock alerts and restocking suggestions
- Product movement logs and loss/theft alerts
- Dashboard with analytics (most sold items, idle stock, etc.)
- Role-based access control (Admin, Employee)
- Report generation (daily, weekly, monthly)
- Barcode/RFID tag generation and printing support
- Integration with POS (optional)

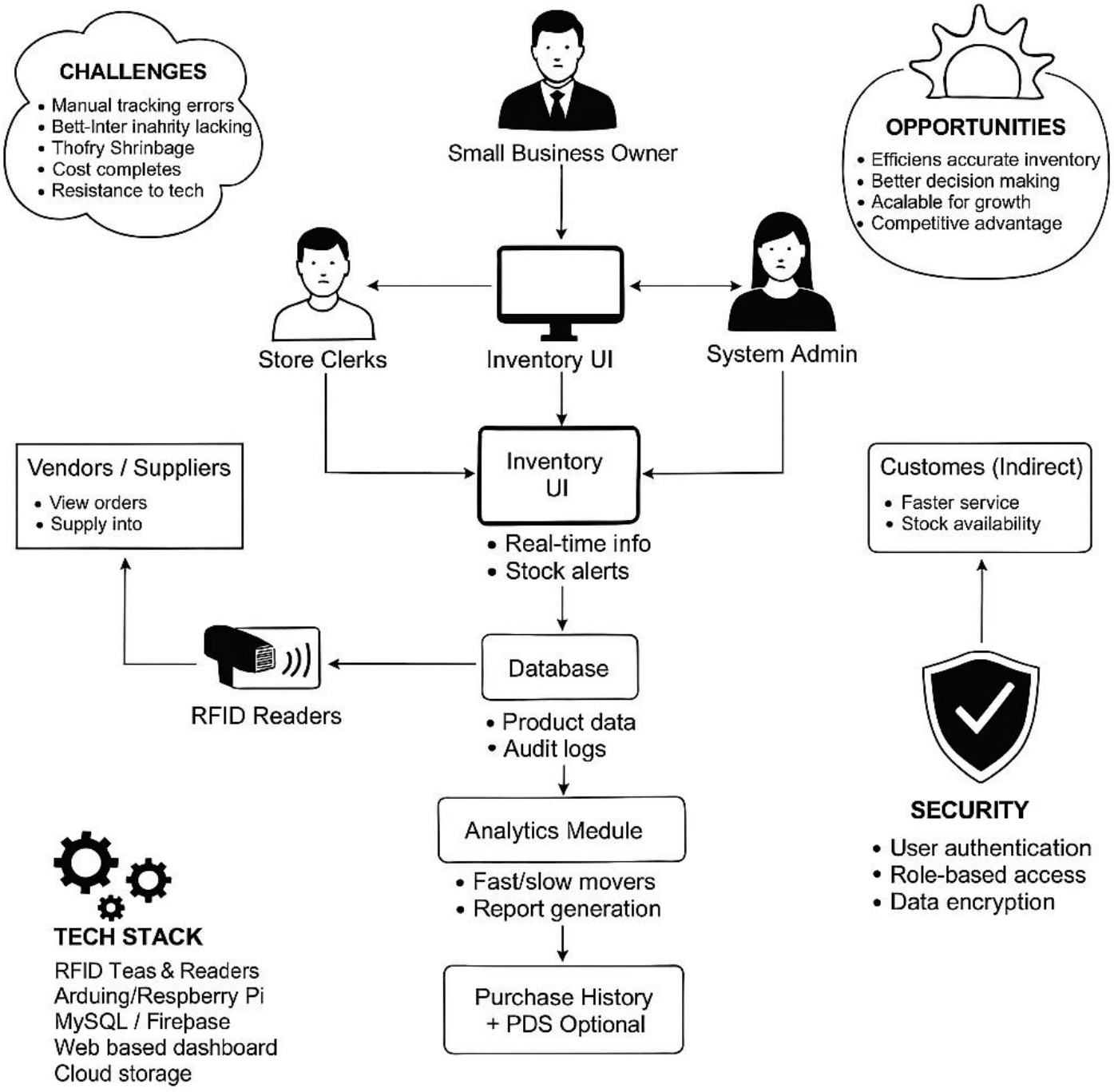
Benefits:

- Reduces human errors in manual inventory logging
- Saves time and operational cost
- Improves product availability and customer satisfaction
- Scalable and cost-effective for small businesses
- Provides actionable business intelligence

b. Product Stakeholders:

Stakeholder	Role/Responsibility
Small Business Owners	Primary users; oversee inventory, sales, and decision-making using insights.
Employees (Storekeepers/Clerks)	Use the system for stock entry, checking availability, and updates.
System Administrator	Maintains the system (hardware/software), ensures uptime and performance.
Suppliers/Vendors	May access certain modules to see purchase orders or supply requirements.
Developers/System Integrators	Responsible for designing, deploying, and maintaining the system.
Customers (Indirect Stakeholder)	Benefit from improved stock availability and reduced waiting time.

c.


CHALLENGES
• Manual tracking errors
• Bett-Inter inahrity lacking
• Thofry Shrinbage
• Cost completes
• Resistance to tech
Small Business Owner
OPPORTUNITIES
• Efficiens accurate inventory
• Better decision making
• Acalable for growth
• Competitive advantage
Store Clerks
Inventory UI
System Admin
Vendors / Suppliers
• View orders
• Supply into
Inventory UI
• Real-time info
• Stock alerts
Customes (Indirect)
• Faster service
• Stock availability
RFID Readers
Database
• Product data
• Audit logs
SECURITY
• User authentication
• Role-based access
• Data encryption
Analytics Medule
• Fast/slow movers
• Report generation
TECH STACK
RFID Teas & Readers
Arduing/Respberry Pi
MySQL / Firepase
Web based dashboard
Cloud storage
Purchase History
+ PDS Optional

d. Hardware and Software Details (Tabular Format):

Component	Description
Hardware Components	
RFID Reader	Device to read RFID tags attached to inventory items
RFID Tags	Passive or active tags attached to products for identification
Microcontroller/Processor	Arduino, Raspberry Pi, or similar to process data from RFID reader
Communication Module	Wi-Fi, Bluetooth, or GSM module for data transmission
Inventory Storage System	Shelving or bins equipped with RFID readers for automatic detection
Power Supply	Batteries or mains power supply for hardware components
Optional Sensors	Temperature, humidity sensors for environment monitoring
Software Components	
Inventory Management Software	Backend system for tracking inventory data, product details, and transactions
Database System	SQL/NoSQL database to store inventory and transaction records
User Interface (UI)	Web or mobile app interface for users to interact with the system
Middleware/API	Software layer connecting RFID hardware data with the inventory system
Analytics Module	For generating reports, alerts, and stock-level predictions

e. Software Key Technical Features (Functional Requirements):

Feature	Description
Real-time Inventory Tracking	Automatically update stock levels as items are added/removed using RFID scans
Automated Stock Alerts	Notify users when stock is low or out of stock
Product Identification	Use RFID tag data to identify products uniquely
Check-in and Check-out	Track movement of inventory in/out of storage
User Authentication	Secure login and role-based access control
Data Synchronization	Sync inventory data across devices and cloud storage
Reporting and Analytics	Generate reports on sales, stock trends, and inventory turnover
Search and Filter	Search inventory by product name, category, or RFID tag ID
Purchase History	Maintain a detailed log of transactions for auditing
Multi-user Support	Allow multiple users with different permission levels to access the system
Integration with POS Systems	Optional integration with Point-of-Sale systems for seamless sales updates
Offline Mode	Support for offline scanning and sync when back online
Environmental Monitoring	Optional tracking of storage conditions (temperature, humidity) affecting inventory