

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND  
TECHNOLOGY**

**COLLEGE OF SCIENCE**

**FACULTY OF PHYSICAL AND COMPUTATIONAL  
SCIENCES**

**DEPARTMENT OF COMPUTER SCIENCE**

**Dr. ERIC OPOKU OSEI – SUPERVISOR**



**ADVANCED LOGISTICS AND DATA ANALYSIS SYSTEM**

**BY**

**KOOMSON PRINCE KWAKU - 4213420**

**ANANE HEISLER YEBOAH - 4193520**

## DECLARATION

KOOMSON PRINCE KWAKU and ANANE HEISLER YEBOAH declares that:

- A. Unless stated otherwise, the project work is the outcome of our own inquiry. A suitable citation and clear references are provided for each source utilized in the completion of this project, and they may be found in the attached references.
- B. We provide permission for this project work to be reproduced, if approved, and for entities outside of Kwame Nkrumah University of Science and Technology to get access to the title and summary.

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KOOMSON PRINCE KWAKU

ANANE HEISLER YEBOAH

### **Supervisor's Declaration:**

I declare that I have personally supervised the students in undertaking the project work submitted for examination with my full knowledge and confirm that they have permission to present for assessment:

DR. OPOKU ERIC OSEI

.....

.....

Signature

Date

## ACKNOWLEDGEMENT

We would like to take some time to express our sincere gratitude to the Divine Creator for his constant guidance on our path.

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## DEDICATION

We would like to extend this work as a dedication to the people of Ghana, the administration and students of Kwame Nkrumah University of Science and Technology, the Computer Science Department, and our parents, relatives, and friends. Their contributions and support were pivotal in ensuring the completion and success of this project.

## ABSTRACT

The objective of this study is to optimize supply chain operations through the design and deployment of a logistics and data analysis system. To give a thorough picture of logistics operations, the system combines inventory control, real-time tracking, and predictive analytics. It makes resource allocation, demand forecasting, and route planning more effective by evaluating data from several sources.

Moreover, the system has an intuitive user interface that enables stakeholders to analyze key metrics for performance and generate insights that can be put to use. In the long run, this strategy increases customer happiness by lowering expenditures, cutting down on delays, and improving operational efficiency.

Sales times, inventory turnover, and service levels have all significantly improved, according to test implementation results. The technology has the potential to change conventional logistics management operations, as these findings confirm.

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# Chapter 1

## Introduction

### 1.1 Background of study

Today, success in the dynamic world of international trade depends on efficient logistics management. Seamless integration of logistics and cutting-edge technologies is necessary to stay competitive. The goal of this project proposal is to develop and implement an Advanced Logistics and Data Analysis System. This innovative solution is being developed to update traditional logistics by utilizing the advantages of cutting-edge data analytic techniques.

A wide range of academic fields, including machine learning, operations research, optimization theory, and decision sciences, provide the theoretical foundation for advanced logistic and data analysis systems. Concepts like stochastic modeling, dynamic programming, Bayesian inference, and simulation approaches offer the groundwork for developing complex algorithms that can handle difficult logistical challenges (Rosenhead, 2006). Furthermore, prescriptive analytics and decision support systems work together to enable businesses to make data-driven decisions in real-time by leveraging insights from prediction models and historical data (Turban et al., 2019).

Thanks to powerful platforms and technologies that have recently revolutionized the data analysis and logistics sectors, large-scale data processing, analysis, and visualization are now feasible. Large datasets from several sources may now be handled and stored more easily because of the development of big data technologies, such as distributed computing frameworks like Apache Hadoop and real-time processing systems like Apache Spark (Chiang et al., 2012). Furthermore, intelligent systems that can adjust to changing surroundings and optimize intricate logistical operations are now possible because to developments in machine learning techniques like deep learning and reinforcement learning (Kaelbling et al., 1996).

As it happens, implementing cutting-edge data analysis and logistics systems has several advantages in a variety of industries, including manufacturing, retail, transportation, and healthcare. Tang et al. (2016) claim that these solutions help companies improve customer happiness, decrease transportation costs, boost demand prediction accuracy, and optimize inventory control. Businesses like Walmart use advanced analytics in their inventory replenishment processes to guarantee product availability and reduce excess inventory holding costs (Davenport, 2006).

Creating a sophisticated logistical and data analysis system gives businesses a significant opportunity to gain a competitive edge in today's data-driven industry. By using the power of advanced analytics, AI, and optimization techniques, businesses may get useful insights, streamline their supply chain operations, and promote sustainable growth.

### 1.2 Problem Statement

Conventional logistics systems must contend with problems including inefficiencies, delays, and the inefficient use of resources. As large industries and big data become more prevalent, there is a once-in-a-lifetime opportunity to innovate and enhance logistical operations. Standard logistics

systems offer the bare minimum of features for inventory and supply chain analysis. They are not equipped with the sophisticated analytical skills needed to deal with the intricacies of today's logistics networks.

Moreover, businesses have a huge chance to increase operational efficiency and obtain meaningful insights from the vast amounts of data created by the different devices they use, including sensors, IoT devices, and transactional records. Nevertheless, traditional data analysis methods are severely challenged by the sheer amount, diversity, and velocity of data, which prevents firms from realizing the full potential of this valuable resource.

In order to help enterprises overcome obstacles and take advantage of new chances for progress, it is necessary to design an advanced logistics and data analysis system that is integrated with cutting edge technologies like data analysis and optimization algorithms. Large amounts of heterogeneous data should be processed, analyzed, and visualized by such systems with ease in real-time, giving stakeholders useful information to optimize supply chain operations, improve resource allocation, save costs, and raise customer satisfaction.

Organizations may go from reactive to proactive logistics operations by tackling these issues and utilizing modern analytics tools. This will help them remain ahead of the competition, adjust to changing market circumstances, and reduce risks. The project's objective is to seize this opportunity by creating a system that will handle current logistical challenges and assist companies in thriving in the more data-driven future.

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### 1.3 Aim of the project

The project is an advanced logistics and data analysis system, which aims to assist novice entrepreneurs, administrators, managers and employees of an organization to keep track of sales of individual products produced and sourced by the organization, specify the most selling and sort after products and allow the organization keep track of available products in their various branches and provide transparency between branches pertaining to available products in store. It aims to provide a user-centered interface which is flexible, accommodating and easy to navigate through either for a novice or advanced entrepreneur.

### 1.4 Specific Objectives of the project

- ✓ Provide a flexible, accommodating and easy to navigate system for both novice and advanced entrepreneurs.
- ✓ Provide an avenue for entrepreneurs to break through geographical barriers.
- ✓ Tracking the most selling products for the individual branches using a backend database that stores real time sales input.
- ✓ Recommending products on shortages using log inventory system which keeps track of various products in the branches of the organization.

- ✓ Allowing transparency in the availability of products by the use of real-time log entries giving information about inventories in stores across various branches.
- ✓ Enhanced efficiency streamlining logistics processes through real-time data analytics to minimize delays, reduce costs, and optimize resource allocation.
- ✓ Utilizing real-time predictive and prescriptive analytics through artificial intelligence to forecast demand.

## 1.5 Justification of project

Effective logistics and data management are essential for businesses trying to stay competitive and adjust to shifting market conditions because of how dynamic international commerce is. An Advanced Logistics and Data Analysis System needs to be put in place in order to enhance decision-making, speed up processes, and make the most use of available resources. The Advanced Logistics and Data Analysis System is a complete system designed to address the intricate issues of modern logistics. By means of optimizing resource allocation, decision-making procedures, and operational efficacy, the company is positioned to sustain its competitiveness and thrive in the ever-evolving realm of international commerce. Acquiring such a technology demonstrates a strategic commitment to market responsiveness and operational effectiveness.

In the current digital era, the creation of a sophisticated logistics and data analysis system is not only a crucial and strategic idea, but also a fundamental facilitator of organizational performance. This project promises to yield measurable advantages in terms of operational efficiency, cost reduction, customer satisfaction, risk mitigation, competitive advantage, and future preparedness by aligning with corporate objectives and tackling important problems.

## 1.6 Motivation for undertaking Project

The Advanced Logistics and Data Analysis System project is being driven by the commitment and foresight to help organization stay competitive in the rapidly changing global business scene. This entails streamlining operations, utilizing data to inform choices, raising client happiness, reducing costs, lowering risks, and strategically establishing the business as a pioneer in the industry with a focus on long-term viability and worker empowerment.

The project's objectives are to meet market demands, fit with the strategic vision, accomplish business ideals, overcome operational obstacles, take advantage of technical advancements, and put the needs of the customer first.

## 1.7 Scope of project

The scope of the Advanced Logistics and Data Analysis system encompasses the design, development and implementation of a logistics system with a data analytics capability which

portrays a flexible, accommodating and easy to navigate user- centered interface with advanced features for modern entrepreneurs and businesses. The system is to enhance efficiency within the supply chain by leveraging data-driven insights to help a business and entrepreneurs reach and fulfil their business visions, missions and ideals. The project begins by collecting information and resources pertaining to necessary sales, products in stock and general inventory information with the goal of identifying inefficiency and optimizing processes. The project involves mapping current workflow to identify bottlenecks and areas where improvements can be made, as well as integrating technology like real-time reports and data management tools to provide better visibility and control over logistics processes. In response to the increasing need for cutting edge, real-time predictive and report generating logistics system, the Advanced Logistics and Data Analysis system seeks to provide a comprehensive and user centered solution.

### 1.7.1 Project limitations

The system would only encompass the logistics and data analytic duties required in the organization concerning products in stock. It would not provide end-user features to customers. It would provide information related to the availability, location and sales of products and not concerning with product production details and how production resources or manufacturing takes place.

## 1.8 Beneficiaries of the project

Our Logistics and Data Analysis system offers various benefits to different stakeholders involved. Here are some of the beneficiaries:

**Stakeholders and Administrators:** A significant portion of the company's stakeholders and administrators, including those at the operational, management, strategic and knowledge level will gain from the project as it will act as a cornerstone for any organization. It will provide them with data-driven insight to make well-informed decisions, expedite workflows, and spearhead strategic initiatives inside the enterprise with the system's substantial support and advantages. The system will combine large volumes of data from different branch sources, and provide a predictive insight into the workflow of the organization.

**Managers:** Managers at the various branch level will information, in terms of managing branch inventory, internal decision making and customer orders. It would provide real-time tracking and monitoring of acquired commodities at each branch, demand forecasting and optimal inventory and allocated resources would all be made possible by the system. All things considered, a sophisticated logistics and data analysis system gives operational teams the means and knowledge to maximize daily operations, better use resources, raise service standards, and promote operational excellence throughout the company.

**Employees:** The system would provide employees at the operational level insight into available products at the branch and provide alternative branches, which would possess products lacking at their specific branch. It provides them with an easy to navigate, flexible and compressive interface which increases the rate of customer service at each branch.

**Entrepreneurs:** The system aims to serve as a starting pivotal point for both emerging and advanced entrepreneurs. The system serves as a corner stone to aid entrepreneurs break geographical barrier to entry in their allocated target market by providing insight and predictive analysis by utilizing data and reports generated by the system.

## 1.9 Academic and practical relevance of the project

Because it addresses real-world problems and advances knowledge in the subject, the project is relevant from both an academic and practical standpoint.

**Academic Relevance:** By investigating cutting-edge methods for data analysis and logistics optimization, the initiative advances scholarly conversation. The implementation of advanced analytics in supply chain management can be better understood thanks to the opportunity it presents for theoretical advancement and empirical study. The project may be used by academic institutions to carry out research, write articles, and share discoveries that further our understanding of data analysis, logistics, and related subjects.

**Practical Relevance:** Practically speaking, the initiative tackles major obstacles that companies must overcome in order to maximize their logistical operations and make good use of data. Through the creation of an advanced logistics and data analysis system, the project will provide observable advantages including increased customer satisfaction, reduced costs, reduced risk, and better operational efficiency. The project's conclusions and recommendations may be immediately implemented by businesses to improve strategic decision-making, expedite workflow, and get a competitive advantage in the market.

In general, the initiative provides insightful analysis and useful solutions that both the academic community and industry stakeholders may benefit from, bridging the gap between scholarly research and real-world application. It illustrates the value and significance of scholarly research in solving practical problems and fostering innovation in data analysis and logistics.

## 1.10 Project activity planning and schedules

### PROJECT PLAN (TIMELINES):

#### Week 1

- Introduction to the project team.
- Presentation of project topic
- Overview of Project Aims, Objectives and Scope.

#### Week 2 (Requirement Analysis and Project Planning)

- Project Activity Planning and Schedules.
- Finalizing detailed project requirements.
- Structure of Report and Project Deliverables.
- Establishing Roles and Responsibility.

#### Week 3 – 4 (Review of Related Works)

- Literature Review of Related Works and Systems
- Proposed System, Conceptual, Architectural and Components Design.
- Overview of Development Tools

#### Week 5 (Methodology)

- Overview of Methodology
- Requirements Specifications.
- Overview of Functional and Non-Functional Requirements.
- Design of UML Diagrams
- Overview of Project Method and Model
- Overview of Project Logical Design

#### Week 6 – 13 (Software Development and Testing)

- Begin Logistics and Data Analysis System Development.
- Implementation and Results.
- Testing, Testing Plans and Results.

#### Week 14 -15

- Address any Issues, Errors or Bugs identified during Testing Phase
- Findings and Conclusions

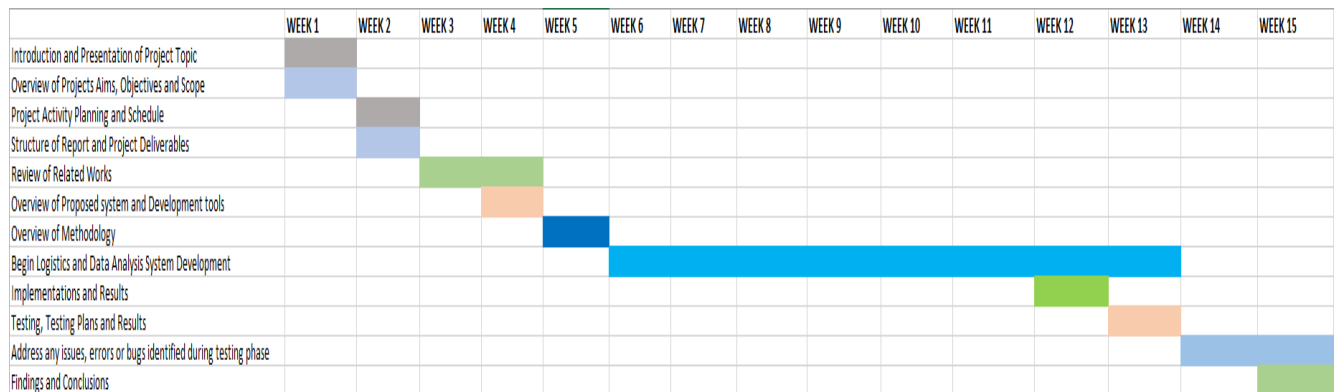


Figure 1: Project Plan Gantt Chart

### 1.11 Structure of report

The report or documentation has been structured into five main chapters which cover the entirety of the developmental process of the advanced logistics and data analysis system. The report begins with Chapter one which seeks to introduce the main relevance and brief insight into the project on it aims and purposes. Chapter one covers and elaborates on various topics such as:



- The problem statement, which defines the aim and motive behind the development of the project and why it's of any relevance.
- The aims and objectives that this project seek to thrive on and in a long run accomplish them. The aims and objectives set the standard and goal the system seeks to achieve.
- Justification and motivation for conforming or accepting to perform the particular project.
- Scope of the project that defines the boundaries, purpose of the project, key individuals involved in the project and the limitations associated with the project.
- The beneficiaries of the project
- The academic and practical relevance of the project, in the life of the customers.
- The planning, time allocation and the activities done to acquire or placed into the development and acquisition of the project in its current state.
- Finally, the deliverables or what is to be expected of a functioning project and its benefits to the stakeholders and customers.

The chapter two which is the literature review of related works, tries to see reason and importance in project chosen and its relativity to any already developed and existing projects.

The chapter two elaborates more firmly on:

- Processes of any existing systems, detailing its system features, advantages and disadvantage of the existing related system.
- The proposed system, establishing its dominance over the existing and already in use system.
- The conceptual frame work, which is the initial framework of how the system is to look like in the near future.
- The architecture of proposed system, that seeks to elaborate on the internal happening of the project or how the it operates internally.
- Components design and components description. These aspects elaborate on the various functions of the components in the architectural design.
- Proposed system features that differentiate it from its previous predecessors.
- The developmental tool and environment in which the project was built.

- Benefits of implementing or using the proposed system

Chapter three talks about the various methodology utilized in the development of the project and the needs and requirements put forward by both the stakeholders and consumers and various diagrams depicting and describing the functionality of the system giving a more pictorial look to the project in its developmental stage. Chapter three contains sub topics such as:

- Chapter overview, which gives a brief introduction into the content in the system.
- Requirement specifications handed down by the stakeholders.
- Highlights the various stakeholders involved in the development of the system.
- The process and strategies used in the gathering process of the various information and solutions relating to the requirements.
- Functional requirements involved or associated with the project.
- The UML Diagrams and its Description.
- Non-functional requirements.
- Security concepts defining the protection layers around the system.
- The project method used in the development of the system.
- Various software process models.
- Chosen modal and its justifications.
- The logical design of the project UI and DB design including E-R Diagram and SCHEMA.
- Developmental tools and how it was used in the development of the project.

Implementation placed down to achieve in the project and the various results obtained from them are defined in chapter four of this documentation. It defines and shows:

- Chapter overview, which elaborate on the various subtopics under the it.
- Mapping logical design onto a physical platform
- Testing
- Testing plan
- Results.

The last chapter details the findings and conclusion of the project stating:

- Chapter overview
- The findings
- Conclusion
- Challenges
- Lessons learnt
- Recommendations for future works
- Recommendation for project commercialization.
- Reference

### 1.12 Project Deliverables

- **Project documentation:** Detailed documentation highlighting the necessary steps and guidelines to the efficient utilization of the system.
- **Logistics and Data Analysis Software:** Complete software integrated with database for sales logistics and predictive analysis based on data- driven analytics.
- **User-friendly desktop application:** Complete PyQt5 user interactive interface for the administrator, Manager and Salesperson of the organization
- **PowerPoint Slides.**
- **Presentation Posters**

## Chapter 2

### Review of related works / Review of similar systems

#### 2.0 Introduction

The increasing number of data pertaining to supply chain businesses in modern enterprises and organizations has increased the need for an effective logistics and data analysis system. This chapter examines the research that has already been done on logistics and data analysis system, including its features, possible advantages, and effects in the supply chain industry and user experience at various operational level. This chapter also examines other existing systems which have similar functionalities as the Advance Logistics and Data Analysis system, and the challenges faced with these other systems.

#### 2.1 Processes of the existing system

##### **Inventory Management System**

Throughout the years, technological breakthroughs and shifting business requirements have had a substantial impact on the evolution of inventory management systems (IMS). A manual procedure that was prone to inefficiency and human mistake was inventory management in the past. Businesses can now control their stock levels more accurately and effectively thanks to the development of digital inventory systems. These solutions, which guarantee product availability when needed, are essential for businesses looking to save expenses while increasing customer satisfaction (Waller et al., 2016).

The importance of real-time data in inventory management has been highlighted by recent research. Businesses can lower the danger of stockouts or overstock situations by using real-time tracking to help them make intelligent decisions about stock replenishment (Wild, 2021). Inventory systems have a number of important disadvantages and difficulties despite their benefits. Conventional methods of inventory management are frequently labor-intensive and prone to human error, which can result in inaccurate stock levels and higher operating expenses. It can also be time-consuming and expensive to conduct frequent audits and continual human entry into inventory records in order to maintain accuracy. Acquiring consistent and trustworthy inventory data can be challenging due to the intricacy of maintaining inventory across several locations or handling a high volume of things. According to Rao et al. (2020), inventory systems that primarily rely on manual procedures or antiquated technology may find it difficult to keep up with the rapidly changing needs of the market, which might lead to inefficiencies and possible interruptions to corporate operations.

##### **System Features of an Inventory System**

1. **Real-time Inventory Tracking:** Gives immediate stock level updates, which is crucial for keeping the right amount of goods in different places (Waller et al., 2016).

2. **Inventory Forecasting:** Predicts future inventory demands utilizing past sales data, enabling companies to foresee demand and adjust stock levels appropriately (Wild, 2021).
3. **Multi-Location Management:** Ensures that each location has the right amount of goods by enabling firms to monitor and manage inventory across different locations (Waller et al., 2016).
4. **Complex User Interfaces:** User mistakes, lost productivity, and inefficiencies in inventory management procedures can all be caused by challenging-to-use interfaces. This may have a detrimental influence on the operational performance and overall efficacy of the system (Brown & Wilson, 2021).

## Pros and Cons of an Order Management System

### Pros:

1. **Increased Efficiency:** Significant time savings are achieved by using inventory systems, which shorten the time needed to track and manage goods (Rao et al., 2020).
2. **Cost Savings:** As a result of waste reduction and decreased holding costs, effective inventory management helps businesses save money overall (Waller et al., 2016).
3. **Better Customer Satisfaction:** Customer satisfaction and loyalty can increase when items are made available when needed (Wild, 2021).
4. **Improved Accuracy:** These systems reduce the possibility of human mistake by automating data entry and inventory tracking, which results in more precise stock levels (Wild, 2021).

### Cons:

1. **Complexity:** There may be an initial learning curve associated with advanced inventory systems due to their complexity and the need for specialist staff training (Waller et al., 2016).
2. **Data Security Risks:** As inventory systems often store sensitive data, they are vulnerable to cybersecurity threats if not properly secured (Rao et al., 2020).
3. **Dependence on Technology:** Due to the heavy reliance on technology, any interruptions or malfunctions in the system can have a big effect on how business is conducted (Wild, 2021).
4. **Initial Implementation Cost:** An inventory management system's setup and integration can be costly, especially for small enterprises (Rao et al., 2020).

## Sales Tracking System

With the ability to track and evaluate sales performance in great detail, sales tracking systems have become essential to contemporary corporate operations. Sales tracking was formerly done by hand using spreadsheets and paper records, which required a lot of effort and were prone to errors (Miller, 2018). Technology has advanced, and as a result, sales monitoring systems have developed to provide increasingly advanced capabilities for trend analysis, data analysis, and strategy optimization (Smith & Brown, 2020).

As evidenced by recent research, sales monitoring systems are critical for offering up-to-date information on sales performance and activities. According to Jones et al. (2021), these systems facilitate the tracking of key performance indicators (KPIs) that are essential for strategic decision-making, such as sales volume, revenue, and conversion rates.

### System Features:

1. **Real-Time Sales Data Monitoring:** Provide current data on sales transactions, such as revenue, performance indicators, and daily sales numbers. Based on current sales data, it facilitates prompt analysis and decision-making (Jones et al., 2021).
2. **Sales Forecasting and Analytics:** Aids companies in successfully allocating resources, adjusting sales tactics, and forecasting demand (Smith & Brown, 2020).
3. **Customizable Reporting:** Gives consumers the ability to create customized reports depending on particular sales KPIs and data.
4. **Sales Performance Metrics:** Helps to find opportunities for growth by offering insights on both individual and team performance (Williams & Davis, 2022).

## Pros and Cons of an Order Management System

### Pros:

**Enhanced Data Accuracy:** Produces more dependable sales data by automating data gathering and reporting, which lowers human error (Smith & Brown, 2020).

**Improved Sales Performance:** Aids in developing plans to improve sales performance, monitoring advancement, and defining reasonable sales targets (Jones et al., 2021).

**Efficient Resource Allocation:** Makes it possible to plan and anticipate more accurately, which improves resource allocation and budgeting (Williams & Davis, 2022).

**Informed Decision-Making:** Facilitates strategic decision-making and corporate planning by offering comprehensive reports and actionable insights (Smith & Brown, 2020).

## **Cons:**

**Implementation Costs:** For small enterprises in particular, the initial setup and integration of sales monitoring systems can be expensive (Miller, 2018).

**Complexity and Learning Curve:** There might be a high learning curve associated with certain systems due to their complicated interfaces, which call for substantial training to operate properly (Jones et al., 2021).

**Dependence on Data Accuracy:** Since inaccurate data might result in false insights and bad decision-making, the efficacy of sales monitoring systems depends on the quality of the input data (Williams & Davis, 2022).

**Potential for Data Overload:** Effective interpretation of the vast amount of data created may necessitate the use of advanced analysis techniques and expertise (Smith & Brown, 2020).

## **Order Management System**

Streamlining the complete customer order lifecycle, from initial placing to final delivery, is made possible in large part by Order Management Systems (OMS). Order administration was formerly done by hand or with crude software, which frequently resulted in errors and inefficiencies (Brown, 2017). Thanks to technological breakthroughs, contemporary OMS now offer complete solutions that boost customer satisfaction, increase operational effectiveness, and interface with other company systems with ease (Johnson & Smith, 2019).

Current research emphasizes how crucial OMS is for handling the complexity of contemporary supply networks. Maintaining high levels of customer satisfaction and operational success requires organizations to manage order fulfillment, track inventory, and handle returns effectively (Davis, 2020). Businesses are now able to offer a more unified and responsive service thanks to the integration of OMS with other systems, including Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP) systems (Williams et al., 2021).

## **System Features of an Order Management System**

- 1. Order Processing and Tracking:** Oversees the processing, tracking, and updating of orders throughout their whole lifespan, from placing to delivery. makes ensuring orders are handled quickly and gives businesses and customers access to real-time order progress information (Johnson & Smith, 2019).
- 2. Inventory Management Integration:** integrates with inventory management systems to provide real-time inventory management and stock level checks. provide reliable inventory data, which helps avoid stockouts and overstock situations (Davis, 2020).

3. **Returns and Exchanges Management:** Manages authorization, processing, inventory adjustments, and client swaps and returns. simplifies the return procedure while keeping precise stock levels (Williams et al., 2021).
4. **Reporting and Analytics:** Produces reports and offers insights into order performance, customer happiness, and fulfillment rates. gives information for making data-driven judgments and streamlining order management procedures (Davis, 2020).

### Pros and Cons of an Order Management System

#### Pros:

1. **Improved Efficiency:** reduces human mistake and expedites order fulfillment by automating and streamlining order processing operations (Williams et al., 2021).
2. **Enhanced Customer Experience:** Faster order processing and real-time order tracking increase customer satisfaction (Johnson & Smith, 2019).
3. **Better Inventory Control:** Complies with inventory management systems to give precise stock levels and stop overstock or stockouts (Davis, 2020).
4. **Unified Order Management:** One integrated picture of orders and operations is provided by the integration with other business systems and support for numerous sales channels (Williams et al., 2021).

#### Cons:

1. **High Implementation Costs:** It can be expensive to set up and integrate an OMS initially, especially for small firms (Brown, 2017).
2. **Complexity and Learning Curve:** Certain OMSs might be difficult to set up and operate, necessitating in-depth training and perhaps creating problems during the transition phase (Johnson & Smith, 2019).
3. **Dependence on System Reliability:** The dependability and uptime of an OMS determine its efficacy. System malfunctions can interfere with order fulfillment and have a detrimental effect on client satisfaction (Davis, 2020).
4. **Maintenance and Upgrades:** Maintaining the system at its best requires continuous updates and on-going maintenance, which may be expensive and need specialized IT staff (Williams et al., 2021).

### Point of Sale System

Point of Sale (POS) systems have revolutionized the way businesses are handled and transactions are completed, making them a necessary part of today's retail and service sectors. With the development of technology, point-of-sale (POS) systems have undergone substantial evolution from their traditional status as basic cash registers that logged sales transactions. These days,



point-of-sale (POS) systems are complex, multipurpose platforms that include inventory control, sales processing, and other features (Smith & Johnson, 2019).

The importance of POS systems in raising customer satisfaction and corporate efficiency has been brought to light by recent research. Modern point-of-sale (POS) systems, for example, provide real-time data analytics that let firms monitor sales patterns, control inventory levels, and come to wise conclusions (Davis, 2021). Additionally, POS systems' connection with other company technologies, has produced a smooth operating environment that enhances productivity and lowers human mistakes (Williams, 2020).

POS systems do have several drawbacks, despite their many advantages. The research highlights many drawbacks, including the initial implementation cost, the difficulty of integrating with current systems, and the requirement for continual maintenance and updates (Brown, 2018).

### **System Features of a Point of System**

1. **Sales Processing and Payment Handling:** Offers quick and effective transaction processing, cutting down on client wait times and enhancing the general shopping experience (Smith & Johnson, 2019).
2. **Inventory Management:** An integrated inventory management system is often found in point-of-sale (POS) systems. It can check stock levels in real-time, update inventory automatically after each sale, and send out notifications when stock levels are low. Gives precise, up-to-date inventory data, which helps avoid stockouts and overstock scenarios (Davis, 2021).
3. **Reporting and Analytics:** POS systems produce comprehensive analytics and reporting on sales, including insights into consumer behavior, staff productivity, and sales trends. provides meaningful insights into many business areas, enabling data-driven decision-making (Smith & Johnson, 2019).
4. **Multi-Store Management:** A POS system may be used to manage all of a company's stores by virtue of this functionality. Data about sales, inventory, and staff performance are centralized from several businesses. Helps to maintain uniformity and efficiency across all stores by offering a single perspective of operations, which makes managing several locations easier.

### **Pros and Cons of a Point of System**

#### **Pros:**

1. **Increased Efficiency:** Minimizes mistakes and the necessity for manual input by automating a variety of operations such inventory management, reporting, and sales processing (Williams, 2020).

2. **Data-Driven Decision-Making:** POS systems' reporting and analytics features give companies insightful information that they may use to improve sales tactics, optimize operations, and make well-informed decisions (Davis, 2021).
3. **Improved Inventory Management:** Businesses may improve overall inventory management by lowering the risk of stockouts or overstock by using real-time inventory tracking to assist maintain ideal stock levels (Brown, 2018).

#### Cons:

1. **High Implementation and Maintenance Costs:** Especially for small firms, the upfront costs associated with acquiring and setting up a POS system can be high. Furthermore, the total cost may increase due to software upgrades and continuous maintenance (Brown, 2018).
2. **Complexity and Learning Curve:** Complex to set up and operate, advanced point-of-sale (POS) systems may need staff training and can cause operational delays while they are being transitioned (Miller, 2020).
3. **System Downtime:** Because of our reliance on technology, technical problems or system failures may cause disruptions to sales activities, which might result in lost revenue and disgruntled clients (Miller, 2020).

## 2.1 The proposed system

The suggested solution makes use of conventional logistics systems and adds data analysis capabilities. It incorporates an inventory management system, sales tracking system, order management system and point of sale system. The proposed system aims to provide an avenue where upcoming entrepreneurs and business driven individual can establish enterprises and have real time data insights to help them build a competitive advantage within a particular market niche. The proposed project provides accommodation for flexibility and ease of use by possessing features which can be modified to suit the preferences and ideals of the stakeholders.

The system is built to provide predictive capabilities with the help of artificial intelligence, which helps businesses and organizations plan and have foresight into the future prospects pertaining to the organization by generating real-time reports based on actual sales and inventory information. The system is built with three distinct, yet interactive user interfaces (administrator, manager and sales person) which provides role-based information to respective stakeholders to facilitate effective business functionality.

The proposed system utilizes a point-of-sale functionality at the various salesperson's endpoint, which does not need a physical establishment to function. Salespersons could use the system to facilitate sales duties which feeds the system with sales data to generate reports for to administrators and managers to help monitor prospective growth of each fragmented branch and perpetual growth of the organization at large.

## Pros:

1. **Enhanced Efficiency:** The system's real-time monitoring and predictive analytics capabilities enable logistics operations to be more agile and responsive to changing demands, leading to improved efficiency in supply chain management.
2. **Role-based information access:** Is a security and management strategy used in organizations to control access to information and resources based on the roles assigned to individuals or groups within the organization.
3. **Improved Decision Making:** Data-driven insights provided by the system empower decision-makers with valuable information for strategic planning, resource allocation, and risk management, leading to better-informed decisions.
4. **Greater Visibility:** The system offers end-to-end visibility across the supply chain, allowing stakeholders to track sales, monitor inventory levels, and identify bottlenecks in real-time, leading to greater transparency and control.
5. **Adaptability:** With artificial intelligence and predictive analytics, the system can adapt to changing market conditions and operational needs, continuously improving its performance over time.
6. **Competitive Advantage:** Companies adopting this advanced system gain a competitive edge by leveraging data-driven insights to optimize their logistics operations, differentiate their services, and meet evolving customer expectations.

## Cons:

1. **Technical Challenges:** Maintaining and troubleshooting complex software systems can present technical challenges, including software bugs, system failures, and compatibility issues, which may disrupt operations and require ongoing support and maintenance.
2. **Dependency on Data Quality:** The effectiveness of the system relies heavily on the accuracy and reliability of the data inputted into the system. Poor data quality or incomplete data sets can undermine the system's performance and decision-making capabilities.
3. **High Cost of customization:** The cost of designing a user- friendly but distinct interactive interface specified to suit each stakeholder would depend on the preferences and needs of the organization or goals aimed to be achieved.
4. **Maintenance and upkeep challenges:** Regular maintenance, such as software updates, security patches, and system upgrades, is necessary for sales logistics systems. It takes constant attention and money to keep the system functioning properly.

## 2.3 Conceptual Design

The conceptual design outlines the core functionalities and user experience of the Smart Extension board

Target Audience:

- Entrepreneurs seeking to manage inventory, collect sales data and report and fore sales and inventory using predictive analysis.
- Managers needing sales and order report to analysis branch growth.
- Salespersons providing point-of-sales services.

**Key Outcomes:** Better inventory control, efficient sales tracking, more efficient logistical processes, and better decision-making through real-time data analysis.

**Logistics Management Module:**

- **Inventory Management Subsystem:** Handles sales tracking, predictive analysis, and demand forecasting.
- **Order Management Subsystem:** Processes orders, tracks fulfillment, and manages returns.
- **Purpose:** To manage the core logistics operations, ensuring efficient flow of goods from suppliers to customers.

**Data Analysis and Insights Module:**

- **Data Processing Engine:** Aggregates and processes raw data for analysis.
- **Analytics Tools:** Supports both descriptive and predictive analytics, including trend analysis and demand forecasting.
- **Machine Learning Models:** Predictive models for optimizing inventory levels, order management, and demand forecasting.
- **Purpose:** To transform raw data into actionable insights that drive decision-making and operational improvements.

**User Interface and Reporting Module:**

- **Customizable Dashboards:** Real-time visualization of key performance indicators (KPIs) for logistics operations.
- **Reporting Tools:** Automated generation of reports for different stakeholders, with the ability to drill down into specific data points.
- **User Access Controls:** Role-based access to ensure users only see data relevant to their responsibilities.

- **Purpose:** To provide users with easy access to critical data and insights, supporting informed decision-making.

### User Interface Design

- **Inventory Dashboard:** Displays current stock levels, alerts for low stock, and predictions for future inventory needs.
- **Order Management Interface:** Tracks the status of orders from placement to delivery, with options for managing returns.
- **Analytics Dashboard:** Provides users with customizable charts and graphs showing trends, forecasts, and other insights.

## 2.4 Architecture of the proposed system

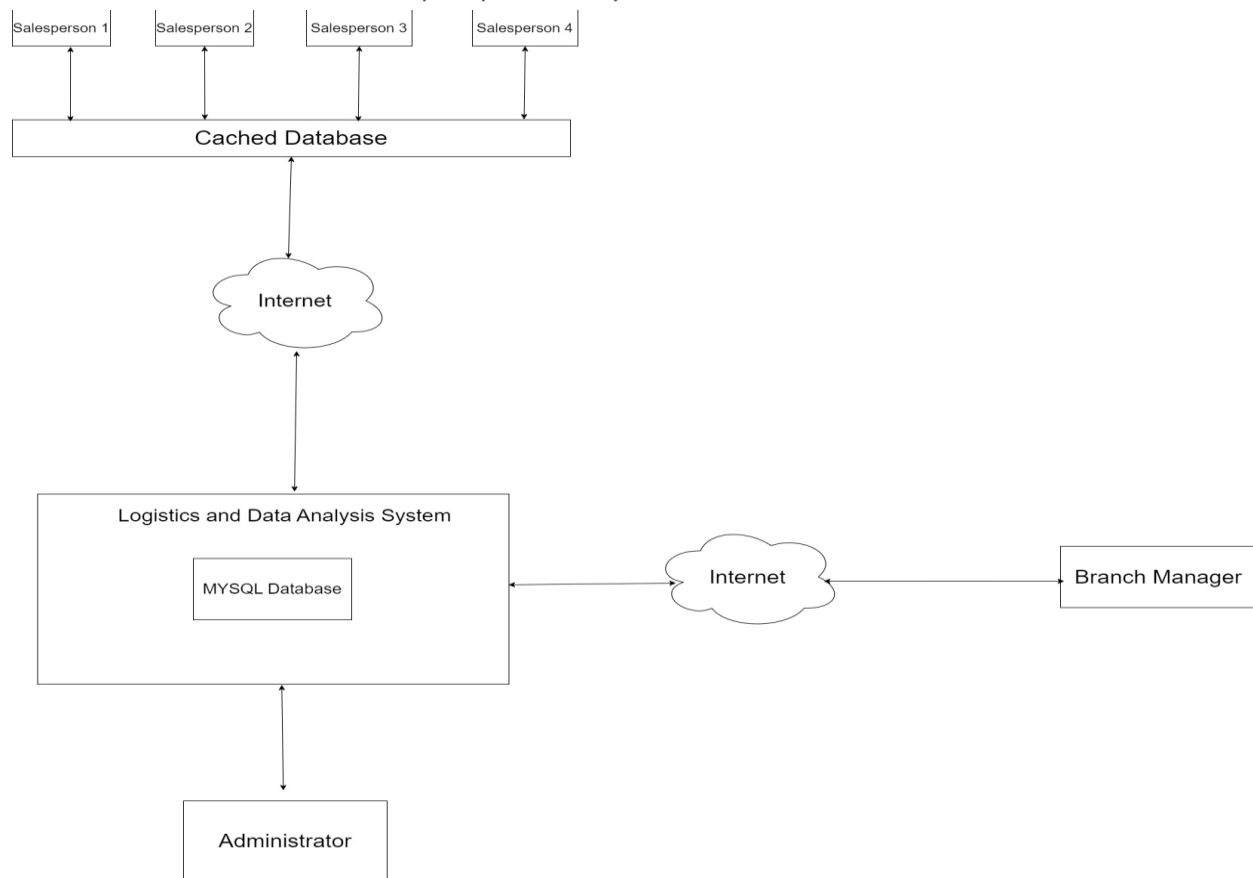


Figure 2: Architectural design of Proposed System

## 2.5 Components Designs and Components descriptions.

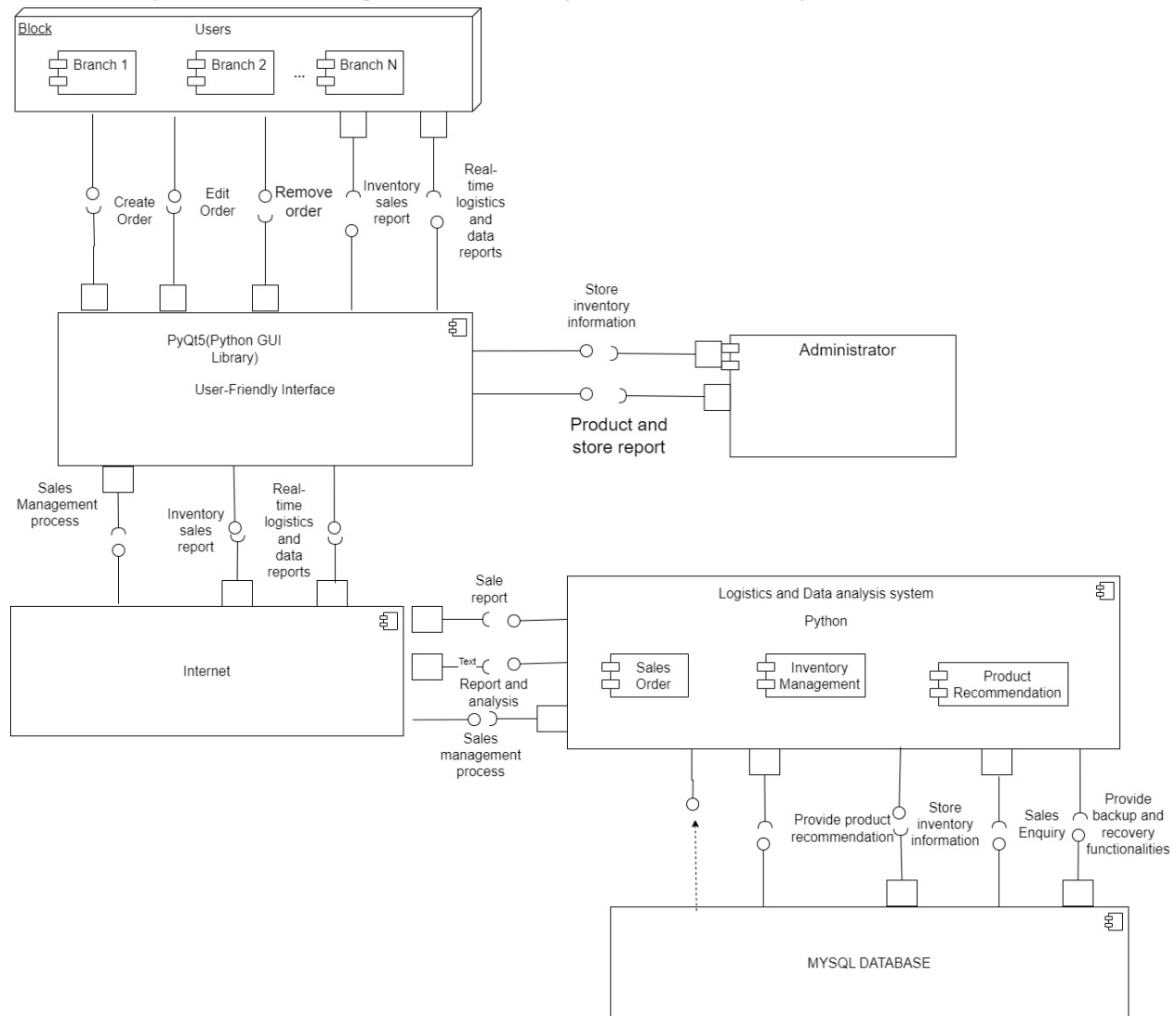


Figure 3:Component Design of Proposed System

### 2.5.1 Component Design Description

#### Branches (Branch 1, Branch 2, ... Branch N)

These stand for various real or virtual places where the system is set up. Salespeople and a manager comprise each branch. Depending on the needs of operations, each branch has the ability to add, modify, or delete orders. The branches are also in charge of producing real-time logistics and data reports, as well as inventory sales reports.

Branches utilize an intuitive interface to communicate with the central system. Order and inventory data are exchanged between them, processed, and stored in the system.

#### 2. Salespersons:

In order to keep correct inventory records, users at every branch level must manage orders and communicate with the system. They make sure that changes in sales and inventory are reflected in real time in the system.

To carry out operations such as adding, modifying, and deleting orders, users use the PyQt5 interface. In order to make decisions, they also create and evaluate a variety of reports.

### **3. PyQt5 (Python GUI Library) – User-Friendly Interface:**

This part functions as the primary graphical user interface that allows people to communicate with the system. PyQt5 is a collection of Python bindings for the Qt application framework, which facilitates the development of intricate and dynamic graphical user interfaces.

Users may access the real-time data analysis, inventory monitoring, and sales management operations through the interface. Order management, report viewing, and logistics tracking are all made simpler for users by breaking down complicated processes into simple, actionable steps.

### **4. Administrator:**

Overall authority over the system rests with the administrator. In addition to creating product and store reports and maintaining store inventory data, this position also oversees system security and integrity.

Using the PyQt5 interface, the administrator may access the system and has extra permissions to manage and change system settings. They make certain that all branches run efficiently and that data is regularly backed up and kept safely.

### **5. Internet:**

The central logistics and data analysis system and each branch's local system communicate with each other over the internet. Real-time data transport and remote access are made possible by it. Sales reports, inventory information, and other vital data are transferred from branches to the central database via the internet using the system. This guarantees that every component of the system is current and synchronized.

### **6. Logistics and Data Analysis System:**

All logistical activities and data analysis take place in this central component. It consists of many smaller modules:

- **Sales Order:** Oversees the monitoring and handling of sales orders from every branch.
- **Inventory management:** Analyzes data pertaining to inventory, keeps track of stock levels, and aids in estimating stock requirements.
- **Product Recommendation:** This method makes recommendations for items based on consumer demand and sales patterns using data analytics.

For storing and retrieving data, this system communicates with the MySQL database. It interprets the incoming data (orders, inventory levels, etc.) and produces insights that are sent back to the branches and users through dashboards and reports.

### **7. MySQL Database:**

The system's storage foundation is the MySQL database. It keeps track of every relevant piece of information, such as product details, inventory levels, and sales orders.

For data archiving and retrieval, the database communicates with the Logistics and Data Analysis System. In order to guarantee data continuity and integrity in the event of a system breakdown, it also offers backup and recovery features.

### **8. Sales Management Process:**

Data management, tracking, and analysis are all part of this process. It guarantees proper recording of all sales actions and the use of data to enhance subsequent sales tactics.

After being gathered from the branches, sales data is handled by the Logistics and Data Analysis System and kept in a MySQL database. Reports that are available to administrators and other users are created using the processed data.

### **9. Real-time Logistics and Data Reports:**

Current data on inventory levels, sales results, and logistical activities may be found in these reports. They are essential for maximizing logistical operations and making prompt judgments. The Logistics and Data Analysis System gathers data from all branches, processes it, and then uses the PyQt5 interface to show the results to administrators and users.

### **10. Product and Store Report:**

Data on the success of the products and general shop operations are combined in this report. It facilitates trend identification, inventory control, and enhanced retail performance.

These reports are viewed by the administrator and pertinent users to help with strategic decision-making. They are produced by the Logistics and Data Analysis System.

### **11. Report and Analysis**

Based on the data that the Logistics and Data Analysis System processes, this component manages the creation of several reports. It offers information that helps improve sales and logistical plans.

Various users, ranging from branch managers to administrators, utilize the generated reports to make well-informed decisions based on data analysis.

### **12. Backup and Recovery Functionalities**

In the event of data loss or corruption, these features guarantee that all information kept in the MySQL database is constantly backed up and recoverable.

All-important data is regularly backed up by the system. The backup system guarantees the uninterrupted functioning of the business in case of a breakdown by enabling the recovery of lost data.



## 2.6 Proposed system/software features

- **Interactive user interface:** An interactive user interface which is designed for specific stakeholders depending on their role in the organization and the username and password entered. This ensure that each user is provided a distinct user interface which provides role-based information pertaining to the user needs.
- **Caching Database:** A caching database that stores data about sales temporally and uploads them to the main database to prevent sales query loss in times of network loss.
- **Messaging feature:** This allows the needed parties to share and transmit information in real time in times of urgency and importance. This aims to improve communication and seamless transmission of vital information and commands.
- **Login interface:** First step of security which ensures role-based access control after login with specified username and password.
- **Sales report generator:** Generation of report to view the performance of all branches and the actual sales are made available to the administration in real-time. To ensure integrity and trust in each fragmented branch.
- **Predictive capabilities with AI:** Utilizing real-time data on sales and sales tracking, predictive and data-driven insights could be used to forward sales and check inventory and sales levels at each branch.
- **Generation of sales receipt:** Generation of report to curb non-repudiation at each branch. To ensure integrity and trust in each fragmented branch.

## 2.7 Development tools and environment

- **Integrated Development Environment: Vscode Visual Studio Code**

Visual Studio Code (VSCode) is a versatile and highly popular source code editor developed by Microsoft. Launched in 2015, it quickly gained traction among developers due to its robust features, ease of use, and extensive customization options. VSCode supports a wide range of programming languages and offers features such as syntax highlighting, code completion, debugging, and version control integration.

One notable aspect of VSCode is its rich ecosystem of extensions, which allows developers to enhance and tailor their coding environment to suit their specific needs. From language support extensions to productivity tools and themes, the VSCode marketplace offers thousands of extensions contributed by the community.

- **Programming Language: Python**

Python is a versatile and widely-used programming language known for its simplicity, readability, and versatility. Created by Guido van Rossum and first released in 1991, Python has since become one of the most popular languages for a variety of applications, including web development, data science, artificial intelligence, and automation.

One of Python's key strengths is its clear and concise syntax, which makes it easy to learn and understand for both beginners and experienced developers alike. Its readability is often compared to plain English, allowing programmers to express concepts in fewer lines of code compared to other languages.

Python's extensive standard library provides a wide range of modules and functions for tasks ranging from basic file operations to complex networking protocols, reducing the need for external dependencies and simplifying development workflows. Python's versatility, readability, and extensive ecosystem of libraries and frameworks make it an excellent choice for a wide range of programming tasks, from simple scripting to complex software development projects.

- **Database Management System: MySQL**

MySQL is an open-source relational database management system (RDBMS) renowned for its reliability, performance, and ease of use. Developed by MySQL AB (now owned by Oracle Corporation), MySQL has become one of the most widely used database systems globally, powering numerous web applications, content management systems, and enterprise solutions.

Launched in 1995, MySQL quickly gained popularity due to its robustness, scalability, and cost-effectiveness. It adheres to the SQL (Structured Query Language) standard, making it compatible with a vast ecosystem of tools and frameworks. MySQL's architecture is designed for high performance, with features such as indexing, caching, and replication, enabling efficient handling of large volumes of data.

One of MySQL's key strengths is its active community and extensive documentation, which provide ample resources for developers and administrators. Additionally, MySQL offers various storage engines, each optimized for specific use cases, such as InnoDB for transactional applications and MyISAM for read-heavy workloads.

MySQL's versatility, performance, and extensive community support make it a preferred choice for developers and organizations seeking a reliable and scalable database solution for their applications and services.

- **User Interface Development: PyQt5(Python GUI Library)**

PyQt5 is a powerful Python library for creating graphical user interfaces (GUIs) with Qt, a cross-platform application framework. PyQt5 allows developers to build interactive and visually appealing desktop applications using Python, leveraging Qt's extensive set of widgets and tools.

Released in 2016, PyQt5 provides bindings for Qt 5, enabling developers to access Qt's features directly from Python code. It offers a wide range of widgets for creating buttons, menus, dialogs, and other UI elements, as well as support for advanced features such as multimedia, OpenGL integration, and web content rendering.

One of the key advantages of PyQt5 is its integration with Qt Designer, a graphical tool for designing UI layouts visually. Developers can use Qt Designer to create UI designs using a drag-and-drop interface and then seamlessly integrate them into their PyQt5 applications, reducing development time and effort.

PyQt5's combination of Python's simplicity and Qt's power and versatility makes it an excellent choice for developers looking to create cross-platform desktop applications with rich and responsive user interfaces.

## 2.8 Benefits of implementation of the proposed system

- Improved customer service
- Easy access to inventory information
- Flexibility in sales management
- Access to branch inventory
- Recommendation of alternative products
- Real-time sale tracking
- Predictive ability of system.

## Chapter 3

### Methodology

#### 3.1 Chapter Overview

This chapter of the documentation provides details required in the development and understanding of the project methodology. The project methodology, elaborates on the key elements such as requirement specification, stake holders of system, the requirement gathering process, functional requirements, UML diagrams, non-functional requirements, security concepts, project method, project design consideration and the developmental tools that goes a long way to describe the details provided by the stake holders, the various stake holders involved in the system, the process used in gathering information concerning the requirement, the specific functionalities and capabilities a system must possess to meet the needs and expectation of the stakeholders, UML diagram to display the flow of logic within the project and Use Case Description to give details of the logic used, security properties of the project, project method and design considerations and the developmental tools used in the creating the project.

#### 3.2 Requirement specification

Requirement specifications—often simply known as requirements—are comprehensive descriptions of the features, functions, constraints, and prerequisites that a product or system must satisfy. These specifications give a clear and unambiguous understanding of what needs to be accomplished, which forms the basis for the design and development process. The gap between the client's expectations and the real execution of a system is lessened with the aid of requirement specifications.

Good requirement specifications are essential to development and project management success. They lessen the possibility of misunderstandings and increase the likelihood of producing a product that satisfies the required requirements by assisting in ensuring that all stakeholders have a common knowledge of the project's objectives and expectations.

#### 3.3 Stake holders of system

- Strategic level management or stake holders (Entrepreneurs and Administrators)
- Knowledge level management
- Operational level management (Managers)
- Employees (Salespersons)

### 3.4 Requirement Gathering process

Requirement gathering defines the processes in which various information concerning the acquisition of requirements needed from the system were gathered. The process involves identifying stakeholders, gathering requirements, documenting, and validating the system's needs through:

#### 1. Project Initiation and Stakeholder Identification

- **Initial Project Meeting:** Initiate the project with project partner to outline and identify the various needs of the project, the workflow of project, tools required and pinpoint the stakeholders to be involved in the project.
- **Stakeholder Identification:** Identify primary and secondary stakeholders, understanding their roles, responsibilities, and expectations for the system including viable stakeholders

#### 2. Requirement Elicitation

- **Interviews:** Conduct one-on-one or group interviews with key stakeholders to understand their specific needs and pain points.
- **Brainstorming:** Facilitate brainstorming sessions to gather collective inputs and identify potential solutions.
- **Document Analysis:** Review existing sales, logistics, and data analysis processes and systems, documents, and reports pertaining with our needs and goals.
- **Site Visits:** Observe the sales logistics and data analysis systems of various organizations to understand workflows and identify areas for improvement.

#### 3. Requirement Documentation

- **Create a Requirement Document:** Develop a comprehensive document outlining the system's goals, objectives, and functional requirements.
- **Use Cases:** Develop use cases to describe how users interact with the system.
- **User Scenarios:** Create user scenarios to capture user needs and expectations in a clear and concise manner.
- **Data Flow Diagrams (DFDs):** Visualize the flow of data through the system.
- **Entity-Relationship Diagrams (ERDs):** Model the data entities and their relationships and how to better improve them.

#### 4. Requirement Prioritization

- **Requirements Prioritization:** The various requirements were ranked based on their importance, urgency, and dependencies for use to know our every step and have a clear view of the project and its improvements.
- **Create a Prioritized Requirement List:** Based on the urgency of the various requirements, a list was created to know which ones were immediate importance or

needed urgent responses. This led to the easy flow of development and code programming.

## 5. Requirement Validation

- **Review and Feedback:** Share the requirements document with stakeholders for review and feedback. And to identify areas of improvement, alterations and add-ons.

## 6. Continuous Improvement

- **Regular Review:** Continuously evaluate the effectiveness of the requirement gathering process.
- **Feedback Incorporation:** Incorporate feedback from stakeholders to refine the process.
- **Adaptation:** Adapt the process to suit the specific needs of each project.

## 3.5 Functional requirements

These are statements of services the system should provide, how the system should react to provide to react to particular inputs and how the system should behave in a particular situation. In some cases, the functional requirement may also explicitly state what the system should not do.

### 3.5.1 User Requirements

#### ADMINISTRATOR

- ✓ User shall login with the required username and password.
- ✓ User shall be able to view all products in stock in the inventory
- ✓ User shall be able to add inventory, manage and delete stocks from inventory.
- ✓ User should be able to view all stores associated with the organization and the various products in stock at each branch.
- ✓ User should be able to view all the necessary information pertaining to employees in the organization.
- ✓ User shall be able to view, add, and delete products sold by the organization from the organizations database.
- ✓ User should be able to view and make informed and required decisions based on reports generated from sales.
- ✓ User should be able to send and reply messages to and from the branch managers in times of urgency.
- ✓ User should be able to logout of the system without difficulty.

## **BRANCH MANAGER**

- ✓ User shall enter with the required username and password.
- ✓ User shall be able to view products sold in the branch.
- ✓ User shall be able to change the credentials of employees in case it is forgotten.
- ✓ User shall be able to view reports pertaining to sales in their store.
- ✓ User should be able to send and reply messages to and from the administrator in times of urgency.
- ✓ User should be able to logout of the system.

## **SALESPERSON**

- ✓ User shall login with the required username and password.
- ✓ User shall be able to search products.
- ✓ User shall place an order specified by the customer.
- ✓ User should be able to accommodate certain specifications required by the customer.
- ✓ User should be able to verify and remove unneeded orders by customers.
- ✓ User should be able to confirm or cancel order placed by a customer.
- ✓ User should be able to logout of the system.

### **3.5.2. System Requirements**

#### **ADMINISTRATOR**

- ✓ The system shall allow users (Administrator, Manager, Salesperson) to log into the system with a username and password.
- ✓ The system shall validate the user login.
- ✓ The system shall display the appropriate user-friendly interface (Administrator, Manager or Salesperson) pertaining to the username and password entered.
- ✓ The system shall display the administrator interface upon successful login.
- ✓ The system shall query the inventory table from the database to display the current inventory information.
- ✓ The system shall display the queried inventory information on the user interface.
- ✓ The system shall allow the Administrator to add, manage or delete items in the inventory table.
- ✓ The system shall validate the add, manage and delete operations performed by the Administrator.
- ✓ The system shall validate modification done by administrator.
- ✓ The system shall store modifications in database.
- ✓ The system shall allow the Administrator to select the store button.
- ✓ The system shall validate the action performed.
- ✓ The system shall query the branch table from the database to display current branch information.

- ✓ The system shall display the queried branch information on the user interface.
- ✓ The system shall allow the Administrator to add, edit or delete information in the store table.
- ✓ The system shall validate the modifications performed.
- ✓ The system shall store the modification in the branch table.
- ✓ The system shall allow the Administrator to select the employee button.
- ✓ The system shall validate the action performed.
- ✓ The system shall query the employee table from the database to display current employee information.
- ✓ The system shall display the queried employee information on the user interface.
- ✓ The system shall allow the Administrator to add, edit or delete information in the employee table.
- ✓ The system shall validate the modifications performed.
- ✓ The system shall store the modification in the employee table.
- ✓ The system shall allow the Administrator to select the product button.
- ✓ The system shall validate the action performed.
- ✓ The system shall query the product table from the database to display current product information pertaining to each branch.
- ✓ The system shall display the queried products information on the user interface.
- ✓ The system shall allow the Administrator to add, edit or delete information in the product table.
- ✓ The system shall validate the modifications performed.
- ✓ The system shall store the modification in the products table.
- ✓ The system shall allow the Administrator to select the report button.
- ✓ The system shall validate the action performed.
- ✓ The system shall query the sales table from the database to display current reports information.
- ✓ The system shall display the generated report information in a graphical form on the user interface.
- ✓
- ✓ The system shall allow the Administrator to select the message button.
- ✓ The system shall validate action performed
- ✓ The system shall provide a messaging platform for the Administrator to interact with the Manager.
- ✓ The system shall validate and deliver messages between the Administrator and the Manager.
- ✓ The system shall store the exchanged messages in the database for record-keeping.
- ✓ The system shall allow users to log out of the system securely.
- ✓ The system shall validate the logout action performed by the user.
- ✓ The system shall successfully log out the user and end their session.



## **Branch Manager**

- ✓ The system shall allow users (Administrator, Manager, Salesperson) to log into the system with a username and password.
- ✓ The system shall validate the credentials entered by the user.
- ✓ The system shall display the appropriate user-friendly interface (Administrator, Manager or Salesperson) pertaining to the username and password entered.
- ✓ The system shall query the product table from the database and display current branch product information.
- ✓ Display the queried products information from database.
- ✓ The system shall allow the Manager to select the employee button.
- ✓ The system shall validate the action performed.
- ✓ The system shall query the employee table from the database to display current branch employee information.
- ✓ The system shall display the queried employee information on the user interface.
- ✓ The system shall allow the Manager to add, edit or delete information in the employee table pertaining to branch employees.
- ✓ The system shall validate the modifications made to the employee table.
- ✓ The system shall store the modifications into the database
- ✓ The system shall allow the Manager to select the report button.
- ✓ The system shall validate the action performed.
- ✓ The system shall query the sales table from the database to display current branch sales report information.
- ✓ The system shall display the graphically generated sales report information on the user interface.
- ✓
- ✓ The system shall allow the Manager to select the message button.
- ✓ The system shall validate the action performed.
- ✓ The system shall provide a messaging platform for the Manager to interact with the administrator.
- ✓ The system shall validate and deliver messages between the Manager and the Administrator.
- ✓ The system shall store the exchanged messages in the database for record-keeping.
- ✓ The system shall allow users to log out of the system securely.
- ✓ The system shall validate the logout action performed by the user.
- ✓ The system shall successfully log out the user and end their session.

## **Salesperson**

- ✓ The system shall allow users (Administrator, Manager, Salesperson) to log into the system with a username and password.
- ✓ The system shall validate the credentials entered by the user.

- ✓ The system shall display the appropriate user-friendly interface (Administrator, Manager or Salesperson) pertaining to the username and password entered.
- ✓ The system shall query the product table from the database to display current branch product information.
- ✓ The system shall display the queried product information on the user interface pertaining to each branch.
- ✓ The system shall allow the salesperson to search for preferred products using the search combo box functionality.
- ✓ The system shall validate the search activity.
- ✓ The system shall query the products database for the specified product.
- ✓ The system shall display the specified product from the database based on the query entered.
- ✓ The system shall allow the salesperson to initiate the sales process by selecting required products.
- ✓ The system shall display the necessary information pertaining to the selected products.
- ✓ The system shall validate the various sales orders initiated by the Salesperson.
- ✓ The system shall allow the salesperson to add selected products to the cart.
- ✓ The system shall validate and add the selected products to the cart.
- ✓ The system shall allow the sales person to select the cart button.
- ✓ The system shall validate the action performed.
- ✓ The system shall display the cart interface with added products specified by customer.
- ✓ The system shall allow the salesperson to view and make needed modification to selected products.
- ✓ The system shall validate the modifications performed by the user.
- ✓ The system shall allow the salesperson to confirm the products in the cart.
- ✓ The system shall validate the confirmation action and proceed to generate a sales receipt.
- ✓ The system shall generate a receipt for the completed sales transaction.
- ✓ The system shall save the generated sales receipt in a cached database.
- ✓ The system shall upload the sales receipt information to the main database upon the availability of a network connection.
- ✓ The system shall allow users to log out of the system securely.
- ✓ The system shall validate the logout action performed by the user.
- ✓ The system shall successfully log out the user and end their session.

## 3.6 UML Diagrams

### USE CASE DIAGRAMS

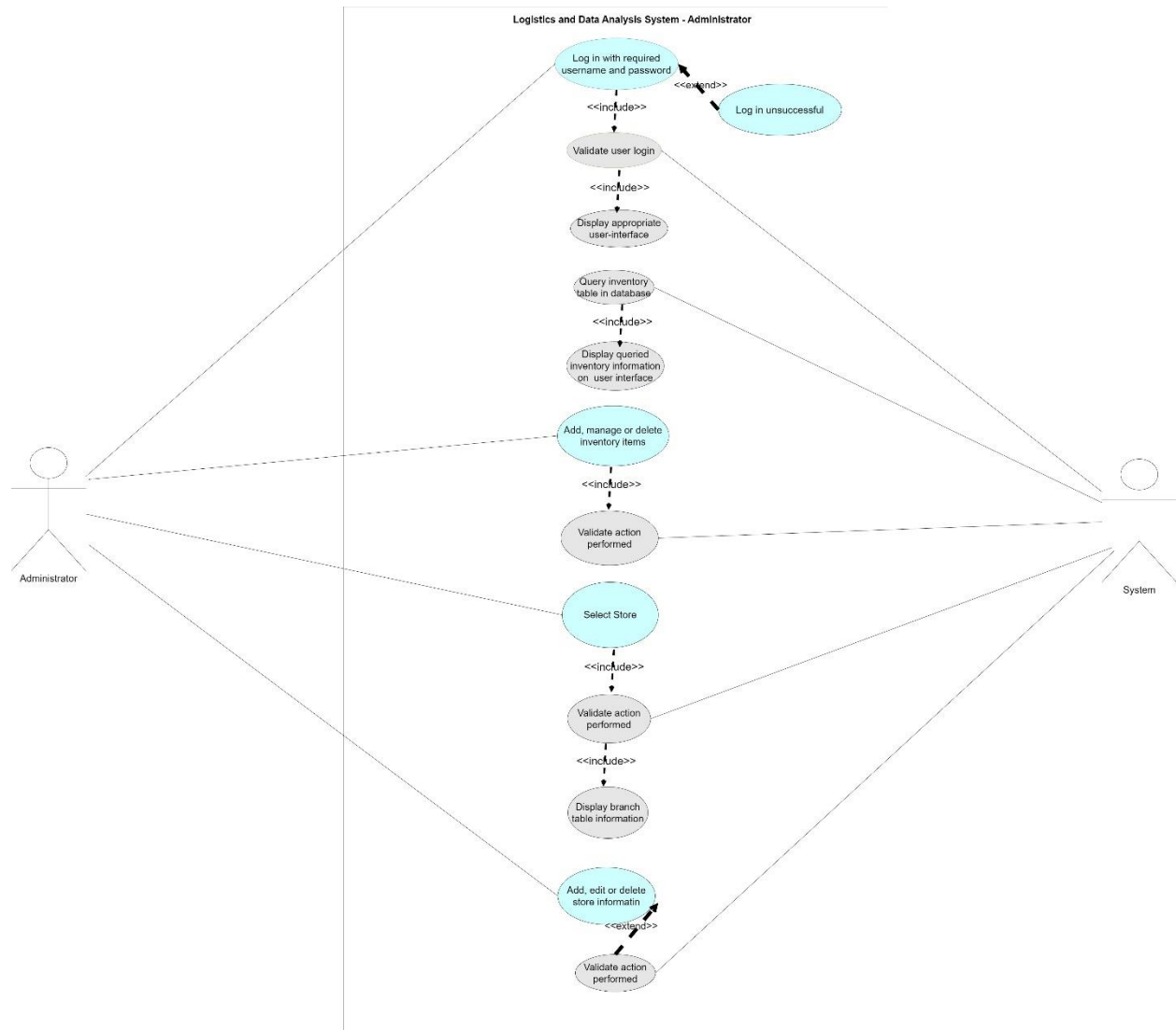


Figure 4: Use case Diagram for Administrator

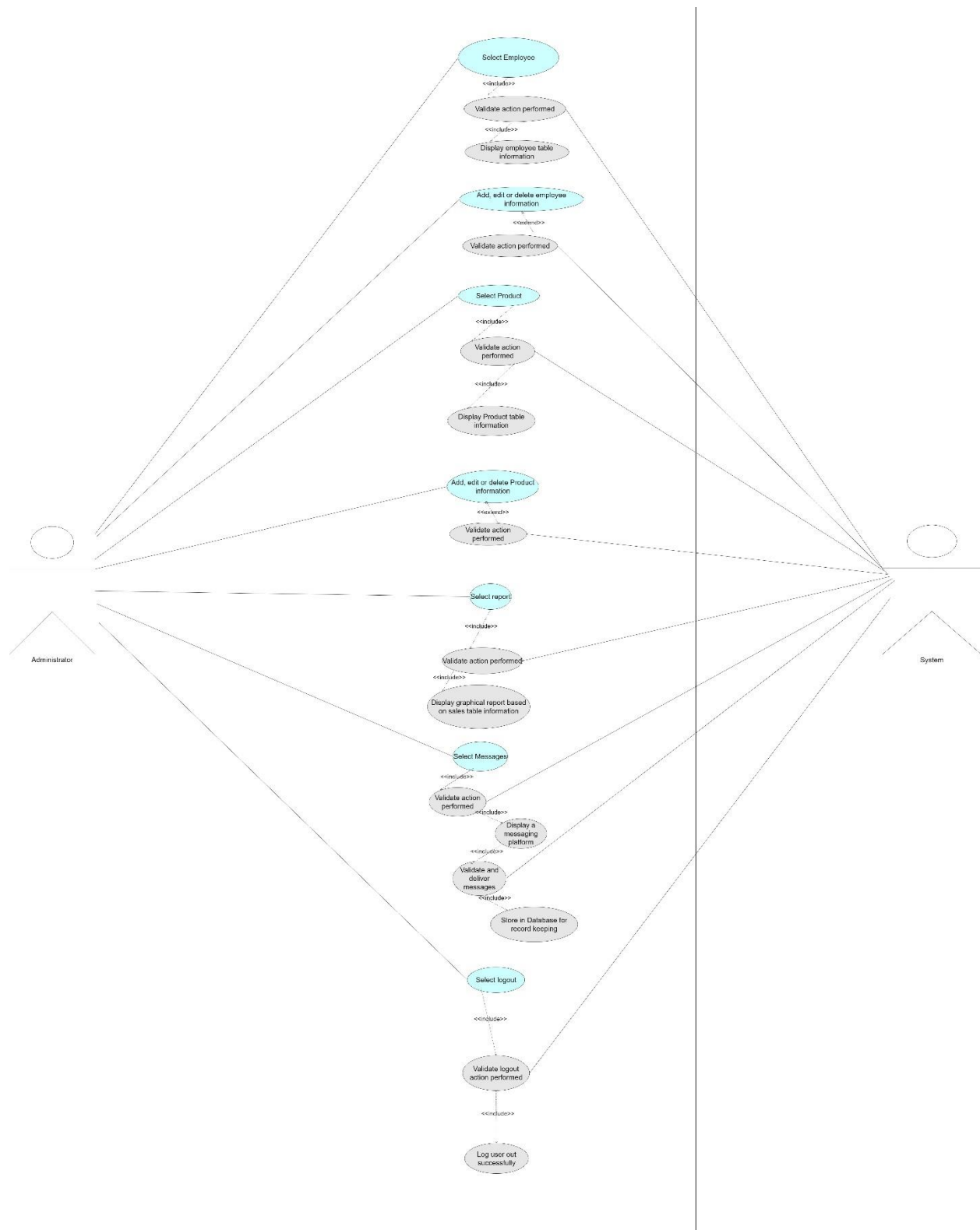


Figure 5: Use Diagram for Administrator

## USE CASE DESCRIPTION

**Primary Actor: Administrator**

**System:** Logistics and Data Analysis System

### 1. Log in to System

- **Goal:** The Administrator logs into the system using a valid username and password.
- **Preconditions:** The Administrator must have a registered account.
- **Main Flow:**
  1. The Administrator inputs the username and password.
  2. The system validates the credentials.
  3. Upon successful validation, the system displays the appropriate user interface.
  4. If validation fails, the system displays an error message.
- **Postconditions:** The Administrator gains access to the system.

### 2. Manage Inventory

- **Goal:** To add, edit, or delete inventory items.
- **Preconditions:** The Administrator must be logged into the system.
- **Main Flow:**
  1. The Administrator selects the inventory management option.
  2. The system queries and displays the inventory data.
  3. The Administrator chooses to add, edit, or delete an inventory item.
  4. The system validates the performed action.
- **Postconditions:** The inventory data is updated accordingly.

### 3. Manage Stores

- **Goal:** To add, edit, or delete store information.
- **Preconditions:** The Administrator must be logged into the system.
- **Main Flow:**

1. The Administrator selects the store management option.
  2. The system displays the current store information.
  3. The Administrator performs the desired operation (add, edit, delete).
  4. The system validates the performed action.
- **Postconditions:** The store information is updated in the system.

#### 4. Manage Employees

- **Goal:** To manage employee records by adding, editing, or deleting information.
- **Preconditions:** The Administrator must be logged into the system.
- **Main Flow:**
  1. The Administrator selects the employee management option.
  2. The system displays the employee records.
  3. The Administrator performs the desired operation (add, edit, delete).
  4. The system validates the performed action.
- **Postconditions:** Employee records are updated in the system.

#### 5. Manage Products

- **Goal:** To add, edit, or delete product information.
- **Preconditions:** The Administrator must be logged into the system.
- **Main Flow:**
  1. The Administrator selects the product management option.
  2. The system displays the product data.
  3. The Administrator performs the desired operation (add, edit, delete).
  4. The system validates the performed action.
- **Postconditions:** Product information is updated in the system.

#### 6. Generate Reports

- **Goal:** To generate and view reports based on sales data.

- **Preconditions:** The Administrator must be logged into the system.
- **Main Flow:**
  1. The Administrator selects the report generation option.
  2. The system generates and displays a graphical report based on the sales table information.
- **Postconditions:** The Administrator views the generated report.

## 7. Messaging

- **Goal:** To send and view messages within the system.
- **Preconditions:** The Administrator must be logged into the system.
- **Main Flow:**
  1. The Administrator selects the messaging option.
  2. The system displays a messaging interface.
  3. The Administrator sends or views messages.
  4. The system validates and stores the messages in the database.
- **Postconditions:** Messages are stored in the system's database for record-keeping.

## 8. Logout

- **Goal:** To securely log out of the system.
- **Preconditions:** The Administrator must be logged into the system.
- **Main Flow:**
  1. The Administrator selects the logout option.
  2. The system validates the logout action.
  3. The Administrator is logged out of the system.
- **Postconditions:** The Administrator is securely logged out, ending the session.

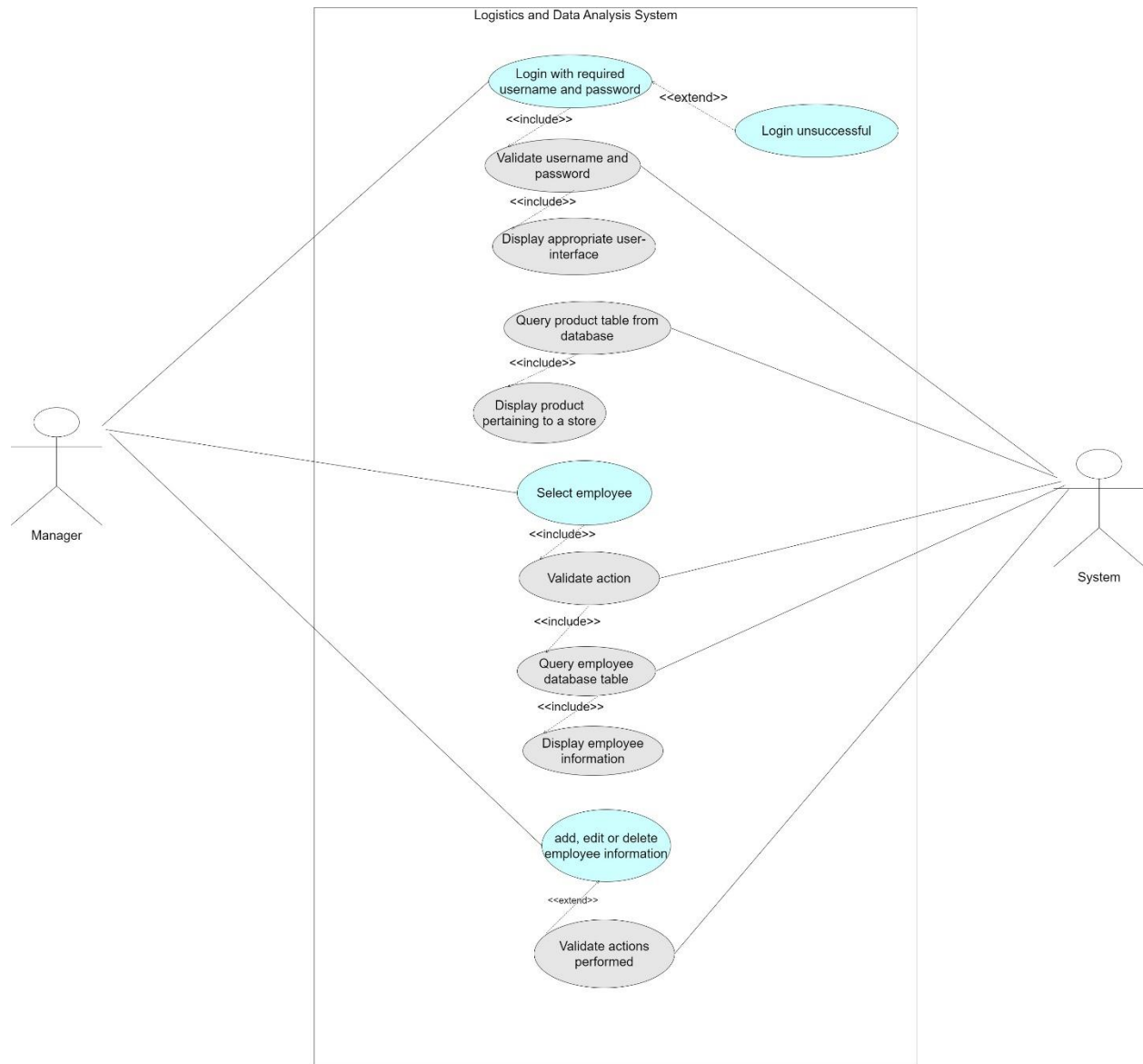


Figure 6: Use Case Diagram for Manager





Figure 7: Use case Diagram for Manager

## USE CASE DESCRIPTION

**Primary Actor: Manager**

**System:** Logistics and Data Analysis System

### 1. Log in to System

- **Goal:** The Manager logs into the system using a valid username and password.
- **Preconditions:** The Manager must have a registered account.

- **Main Flow:**
  1. The Manager inputs the username and password.
  2. The system validates the credentials.
  3. Upon successful validation, the system displays the appropriate user interface.
  4. If validation fails, the system displays an error message.
- **Postconditions:** The Manager gains access to the system.

## 2. Manage Products

- **Goal:** To view products related to a specific store.
- **Preconditions:** The Manager must be logged into the system.
- **Main Flow:**
  1. The Manager selects the option to view products.
  2. The system queries the product table from the database.
  3. The system displays the products pertaining to a specific store.
- **Postconditions:** The Manager views the product information.

## 3. Manage Employees

- **Goal:** To manage employee records by adding, editing, or deleting information.
- **Preconditions:** The Manager must be logged into the system.
- **Main Flow:**
  1. The Manager selects the employee management option.
  2. The system queries the employee database table.
  3. The system displays the employee records.
  4. The Manager performs the desired operation (add, edit, delete).
  5. The system validates the performed action.
- **Postconditions:** Employee records are updated in the system.

## 4. Generate Reports

- **Goal:** To generate and view reports based on sales data.
- **Preconditions:** The Manager must be logged into the system.
- **Main Flow:**
  1. The Manager selects the report generation option.
  2. The system queries the sales table to generate a report.
  3. The system displays a graphical representation of the report.
- **Postconditions:** The Manager views the generated report.

## 5. Messaging

- **Goal:** To send and view messages within the system.
- **Preconditions:** The Manager must be logged into the system.
- **Main Flow:**
  1. The Manager selects the messaging option.
  2. The system displays a messaging platform.
  3. The Manager sends or views messages.
  4. The system validates the action and delivers the message.
  5. The system stores the messages in the database for record-keeping.
- **Postconditions:** Messages are stored and managed within the system.

## 6. Logout

- **Goal:** To securely log out of the system.
- **Preconditions:** The Manager must be logged into the system.
- **Main Flow:**
  1. The Manager selects the logout option.
  2. The system validates the logout action.
  3. The Manager is logged out of the system.
- **Postconditions:** The Manager is securely logged out, ending the session.

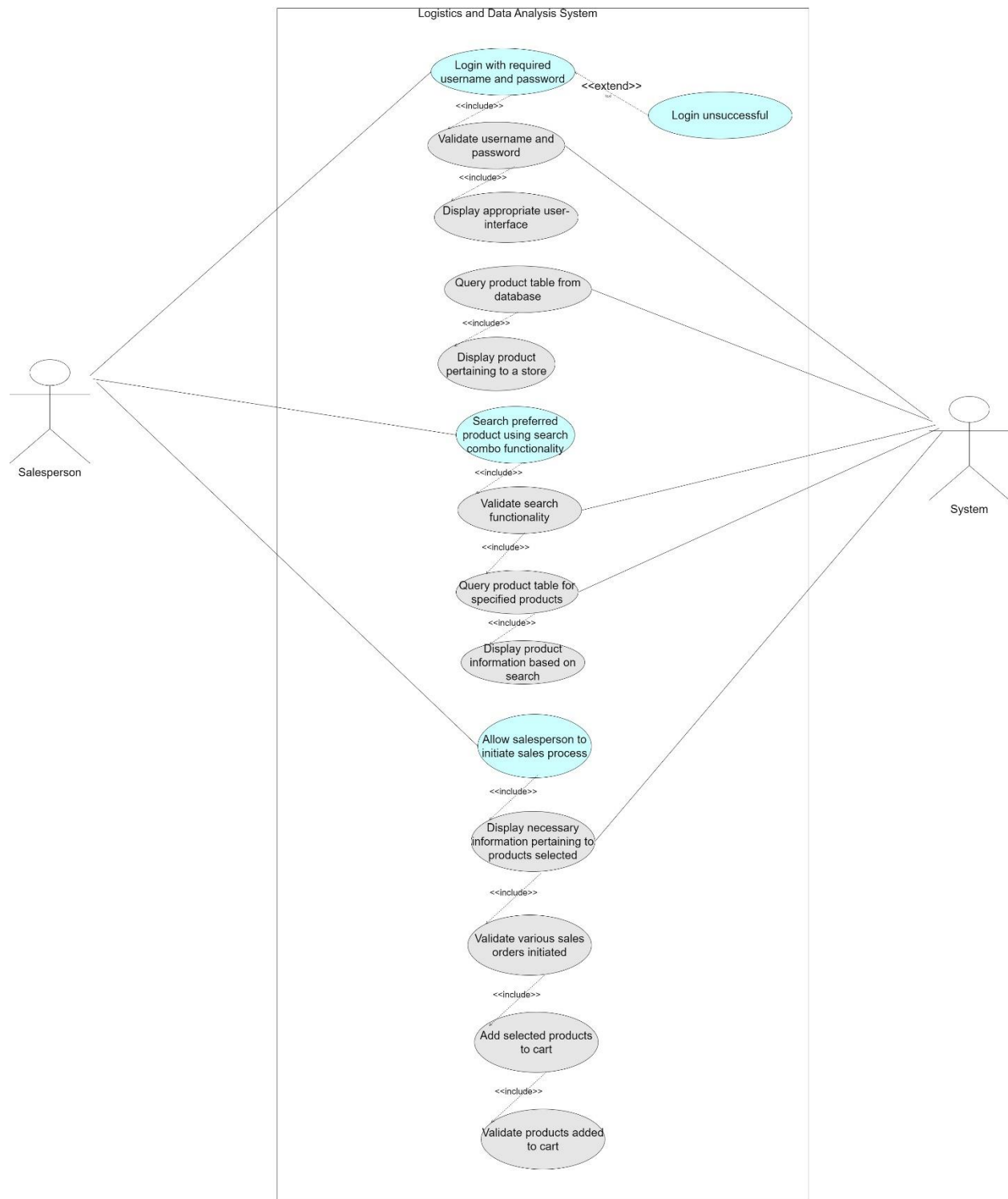


Figure 8: Use Case Diagram for Salesperson

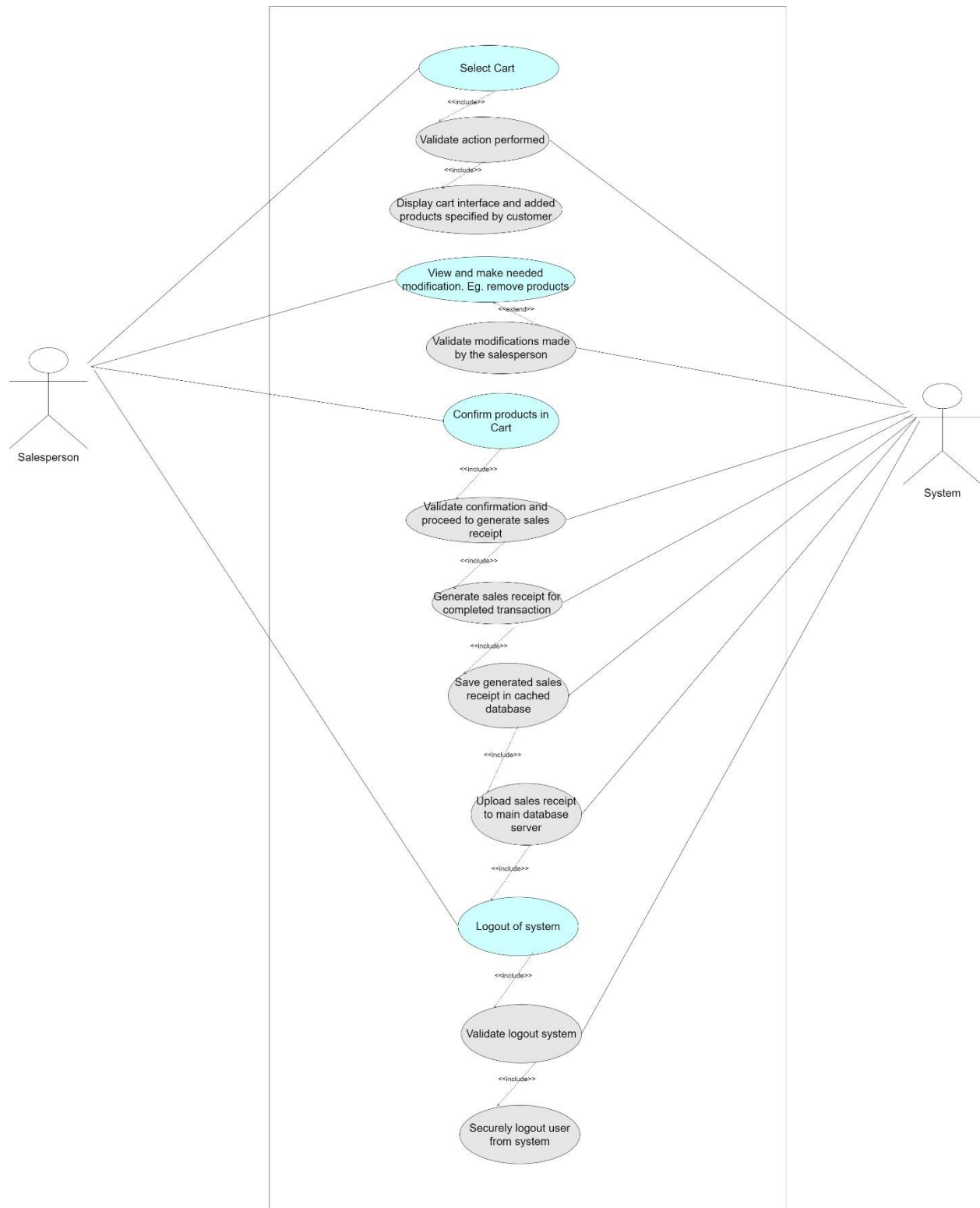


Figure 9: Use Case Diagram for Salesperson

## USE CASE DESCRIPTION

**Primary Actor: Salesperson**

**System:** Logistics and Data Analysis System

### 1. Log in to System

- **Goal:** The Salesperson logs into the system using a valid username and password.
- **Preconditions:** The Salesperson must have a registered account.
- **Main Flow:**
  1. The Salesperson inputs the username and password.
  2. The system validates the credentials.
  3. Upon successful validation, the system displays the appropriate user interface.
  4. If validation fails, the system displays an error message.
- **Postconditions:** The Salesperson gains access to the system.

### 2. Search for Preferred Products

- **Goal:** To search for specific products using the search combo functionality.
- **Preconditions:** The Salesperson must be logged into the system.
- **Main Flow:**
  1. The Salesperson uses the search combo functionality to search for preferred products.
  2. The system validates the search criteria.
  3. The system queries the product table based on the search.
  4. The system displays the product information based on the search results.
- **Postconditions:** The Salesperson views detailed product information.

### 3. Initiate Sales Process

- **Goal:** To initiate the sales process for the selected products.
- **Preconditions:** The Salesperson must have searched and selected products.

- **Main Flow:**
  1. The Salesperson initiates the sales process for the selected products.
  2. The system displays necessary information pertaining to the selected products.
  3. The system validates the sales orders initiated by the Salesperson.
  4. The Salesperson adds the selected products to the cart.
  5. The system validates the products added to the cart.
- **Postconditions:** The selected products are added to the cart, and the sales process is initiated.

### **Select Cart and Modify Products**

- **Goal:** The Salesperson selects the cart and makes necessary modifications to the products.
- **Preconditions:** The Salesperson must have added products to the cart.
- **Main Flow:**
  1. The Salesperson selects the cart to view added products.
  2. The system validates the action performed.
  3. The system displays the cart interface along with the products specified by the customer.
  4. The Salesperson views and makes needed modifications (e.g., removes products).
  5. The system validates the modifications made by the Salesperson.
- **Postconditions:** The cart is updated with the necessary modifications.

### **5. Confirm Products in Cart and Generate Sales Receipt**

- **Goal:** To confirm the products in the cart and generate a sales receipt.
- **Preconditions:** The Salesperson must have completed any necessary modifications to the cart.
- **Main Flow:**
  1. The Salesperson confirms the products in the cart.
  2. The system validates the confirmation and proceeds to generate a sales receipt.
  3. The system generates a sales receipt for the completed transaction.

4. The sales receipt is saved in the cached database.
  5. The sales receipt is uploaded to the main database server.
- **Postconditions:** The sales receipt is generated and stored securely in the system.

## 6. Logout of System

- **Goal:** To securely log out from the system after completing the sales process.
- **Preconditions:** The Salesperson must have completed the sales transaction.
- **Main Flow:**
  1. The Salesperson initiates the logout process.
  2. The system validates the logout request.
  3. The system securely logs out the Salesperson.
- **Postconditions:** The Salesperson is logged out of the system, and the session is securely terminated.

## ACTIVITY DIAGRAMS

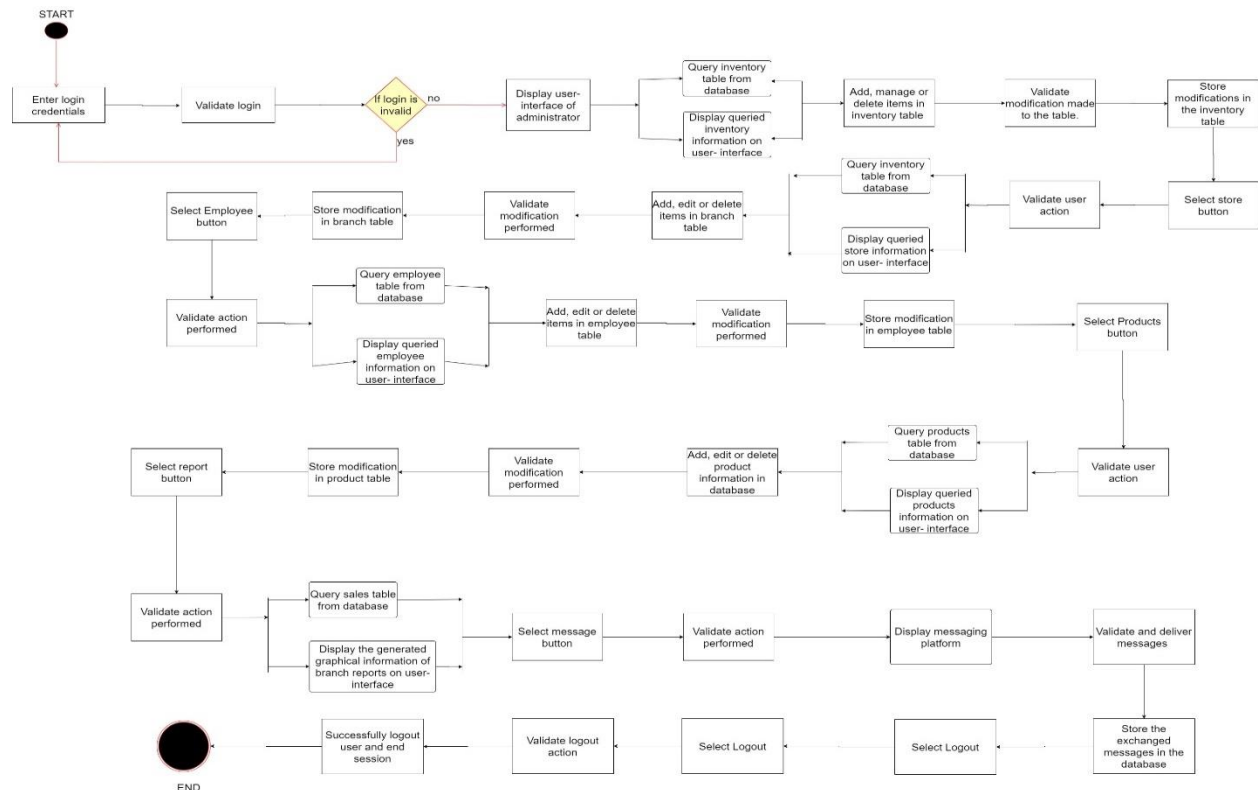


Figure 10: Activity Diagram for Administrator



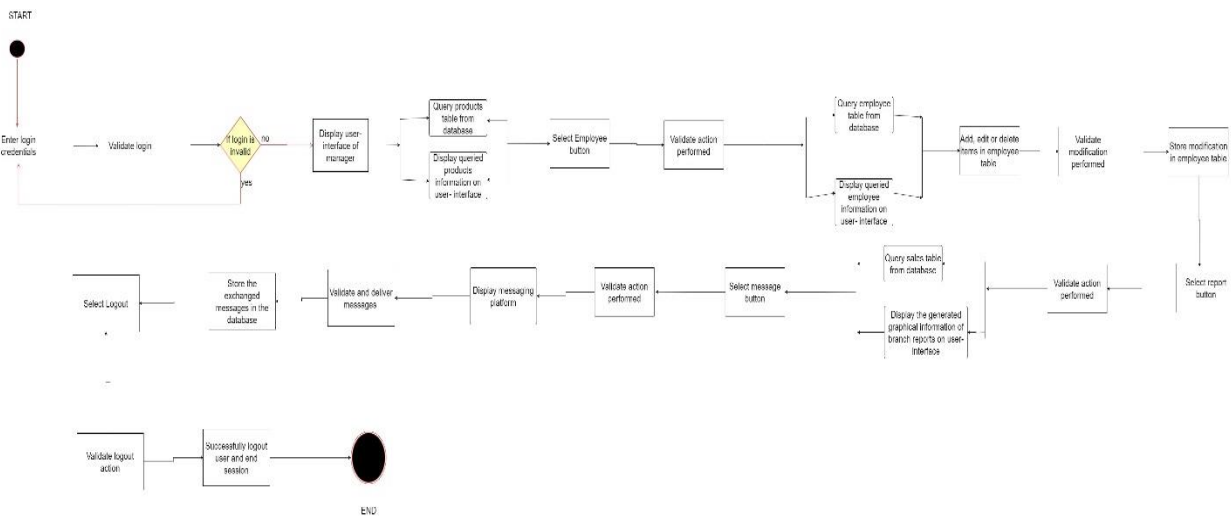


Figure 11: Activity Diagram for Manager

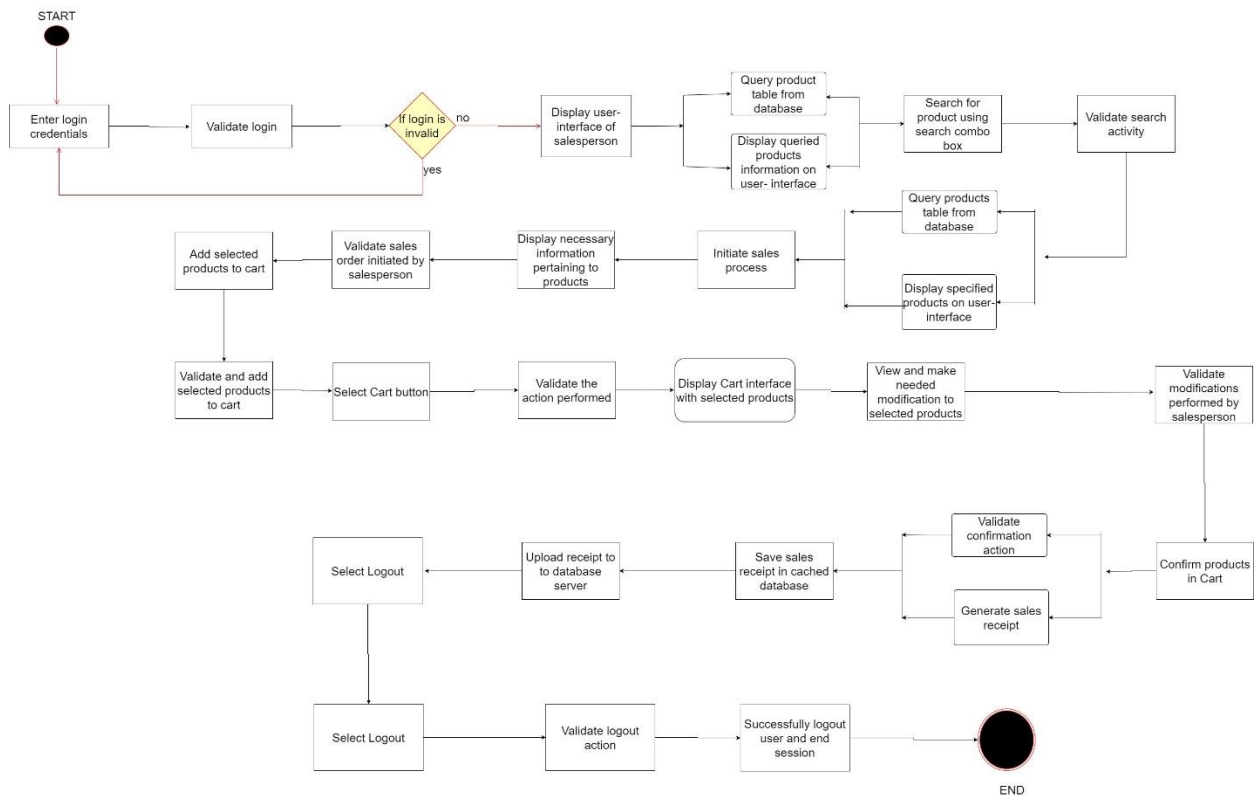


Figure 12: Activity Diagram for Salesperson

## SEQUENCE DIAGRAMS

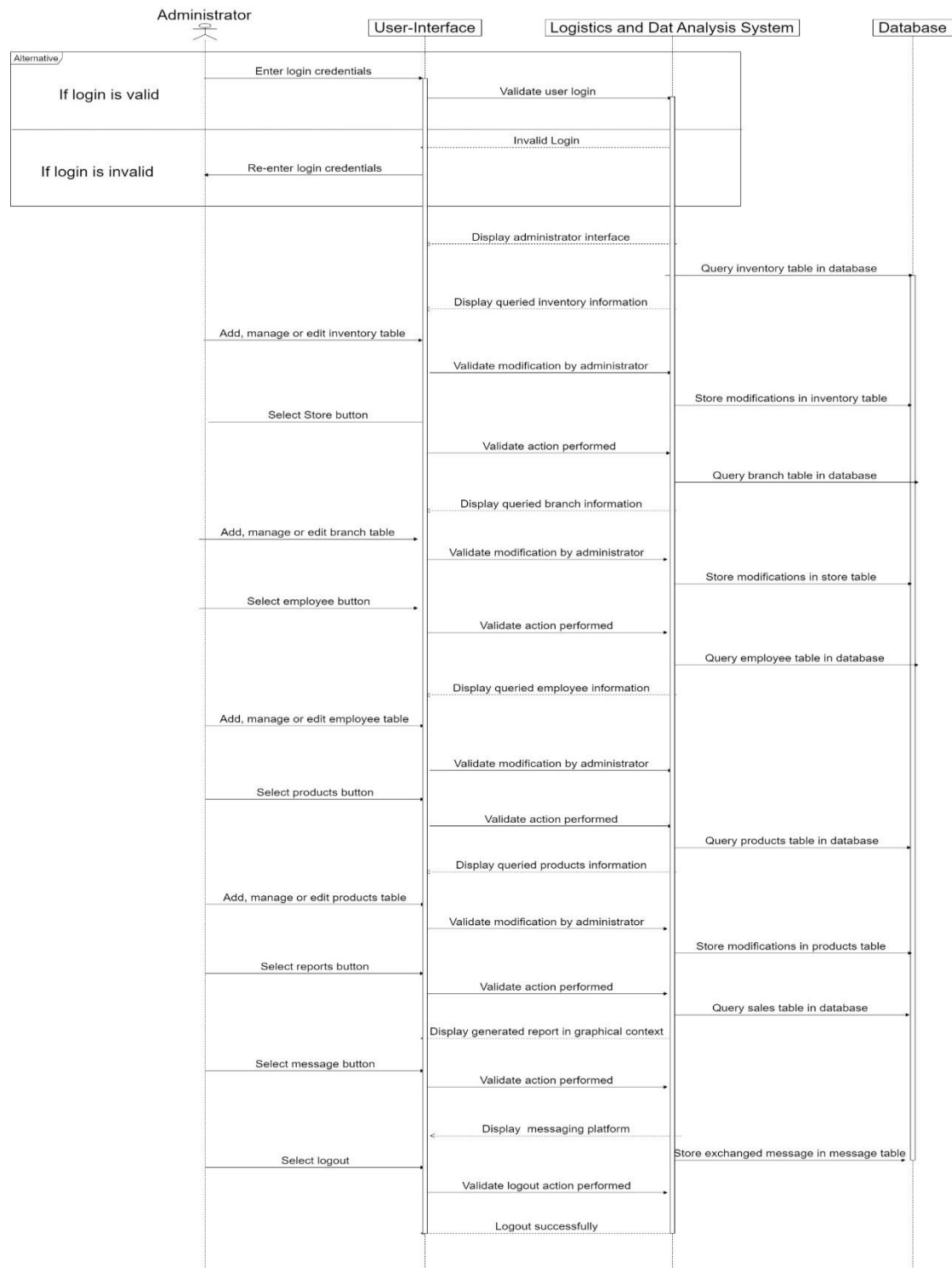


Figure 13: Sequence Diagrams for Administrator

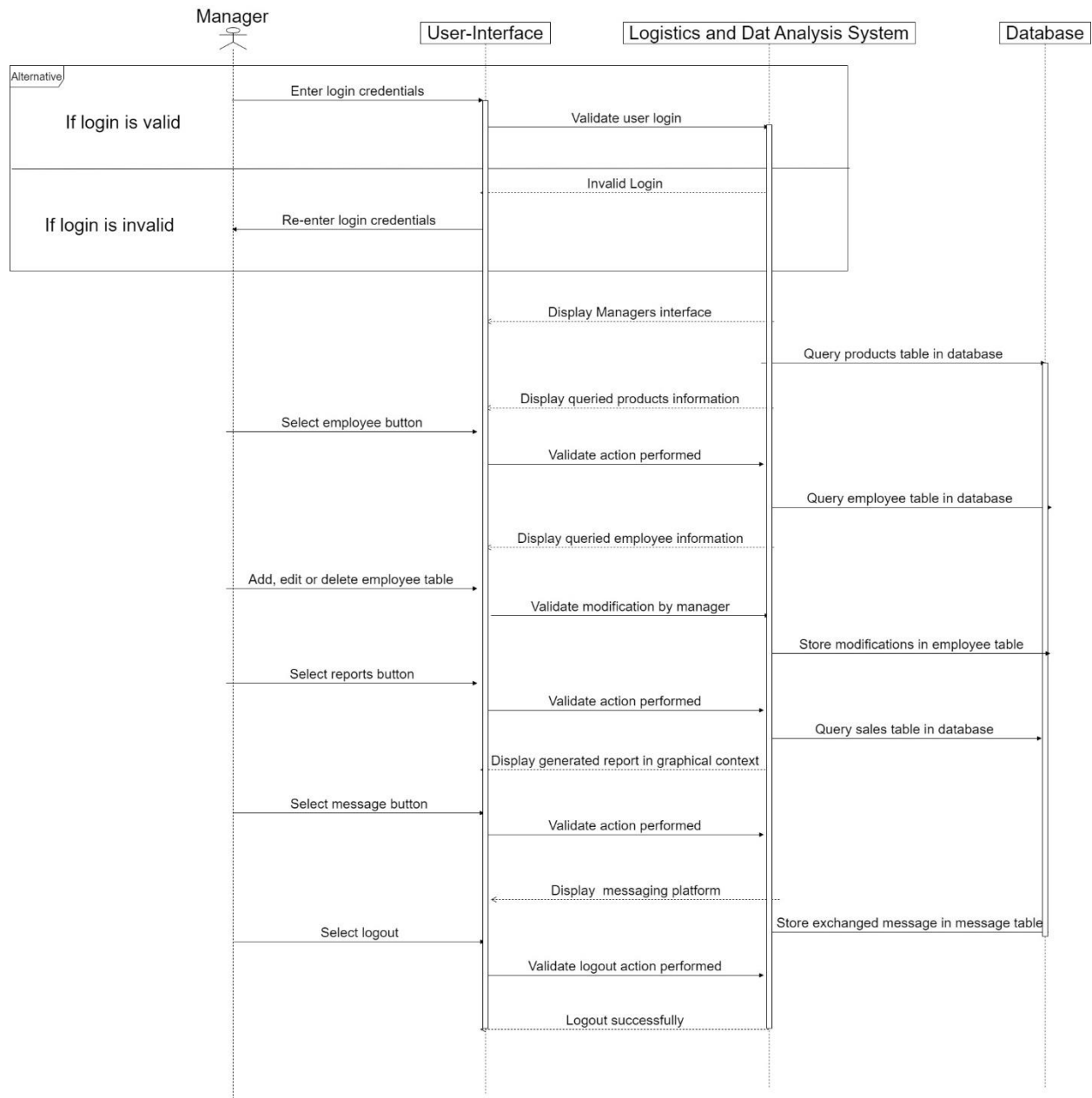


Figure 14: Sequence Diagram for Manager

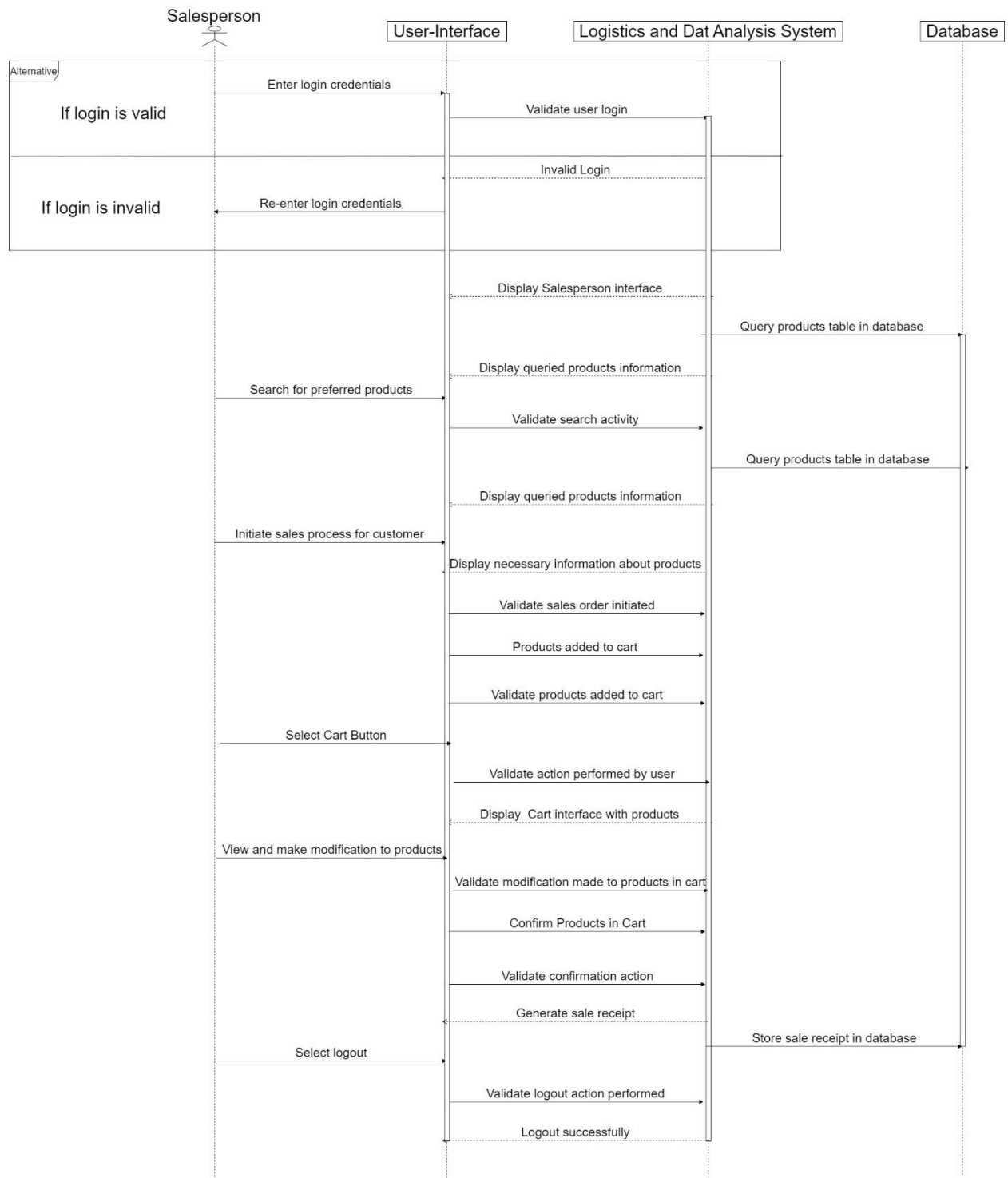


Figure 15: Sequence Diagram for Salesperson

## Class Diagram

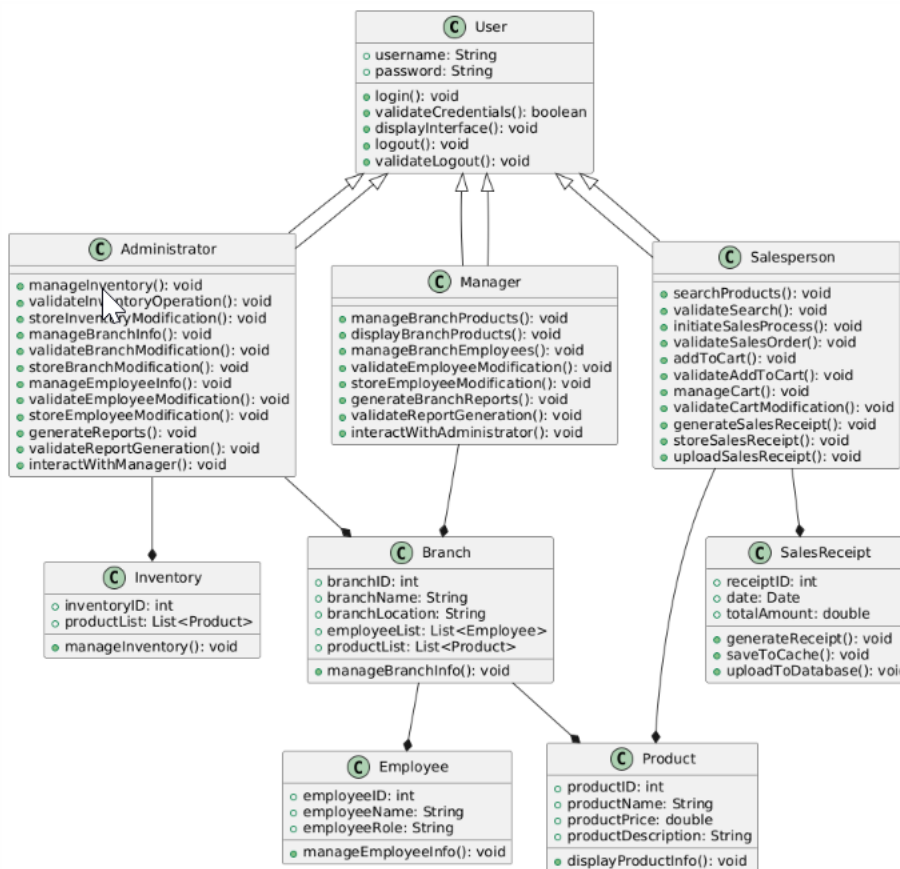


Figure 16: Class Diagram for logistics and data analysis system

### 3.7 Non – functional requirements

These are constraints on the services or functions offered by the system. They include timing constraint, constraints on the development process and constraints imposed by standards. They often apply to the system as a whole, rather than individual system feature or services. Non-functional requirements associated to the system include:

- **Performance:** The system should be able to handle a large volume of transactions and user requests efficiently to minimize response times and ensure smooth operation.
- **Usability:** The system shall provide an intuitive interface that is easy to navigate for users of all technical skills.
- **Efficiency:** Th system should have the ability to perform tasks and processes in a timely manner while utilizing resources effectively.

- **Relevance:** The system's ability to provide accurate and meaningful results and insight, recommendations, and actions based on the specific inputs entered into the system.
- **Response time:** The system should provide timely feedback or execute actions within predetermined time limits.
- **Reliability:** The system should be dependable, operational and available at all times to ensure uninterrupted access to required functionality and service, with less down time to facilitate a constant operational status.
- **Scalability:** As inventory and customer services increases exponentially, the system should be able to accommodate increasing data volumes and data loads without sacrificing system performance.
- **Security:** Given the sensitive nature of the company's sales records, customer order details and inventory information, the system must implement robust security measures to protect data confidentiality, integrity and availability.

### 3.8 Security concepts

- **Encryption of credentials:** Securing sensitive data within a sales logistics and data analysis system is paramount. Encryption plays a crucial role in protecting confidential information, such as customer order data, sales transactions information, and employee credentials. By employing robust one-way hashing and encryption algorithms and secure key management practices, organizations can safeguard against unauthorized access, data breaches, and identity theft. This aligns with the confidentiality pillar of the CIA triad. Integrating encryption into the PyQt5-based system involves using secure hashing algorithms for passwords, encrypting sensitive data at rest within the MySQL database, and implementing secure communication channels between the PyQt5 frontend and the backend. By prioritizing encryption and data protection, businesses can build trust with customers and comply with relevant data privacy regulations.
- **Dedicated user interfaces:** Dedicated user interfaces for distinct user roles enhance security and efficiency within a sales logistics and data analysis system. By implementing separate interfaces for administrators, managers, and employees, organizations can tailor access to specific functionalities and data, mitigating unauthorized access and data breaches. Role-based access control (RBAC) further reinforces security by granting permissions based on user roles and responsibilities. This approach not only safeguards sensitive information but also streamlines workflows by providing each user group with the tools and information they need to perform their tasks effectively.
- **Receipt with salesperson and branch name:** Production of a receipt with the branch and salesperson's name ensures non-repudiation in the various branches. This ensures that both the salesperson and the employee cannot deny the process of buying and selling at the various branches. It also ensures accountability and traceability, which helps to

identify the various branches making specific sales and the salesperson's attending to each sale.

- **Hierarchical access control:** The system implements a role-based access control, where access rights are based on the roles within the organization. The system gives the needed rights and privileges, where the administrator has the sole right to add new managers for each branch within the organization by providing them with a unique username and password hashed with the database for access security control. The managers at each branch also have the required right to add employees at each branch to help facilitate sales. This ensures confidentiality, integrity and availability throughout the system.

### 3.9 Project methods (either agile or plan driven)

The development and implementation will follow an agile approach, involving close collaboration with stakeholders. The project will incorporate agile methodologies, ensuring flexibility to adapt to evolving requirements and technological advancements. This will ensure rapid development and adaptation to changes during the course of developmental progress and modification. Utilizing various feedback from the testing stage of the agile process further modification could be made by incremental documentation process.

Agile approaches place more emphasis on software process activity of the development i.e. Design and Coding, at the center of the other software process activity. Agile method incorporates activities of requirements elicitation and testing into design implementation(coding). It combines a philosophy and a set of development guidelines. The philosophy places emphasis on satisfying a customer by creating and delivering software products quickly as increments.

The development guideline stresses on ensuring the delivery of software over a prolonged strict analysis of requirement before undertaking the other software process activities. Agile method also stresses on active and continuous communication between the developers and customers. Agile methods are iterative and flexible approaches to software development that prioritize collaboration, adaptability, and delivering value to customers. Rapid development and delivery are the hallmark of agile methods. Examples of agile methods are incremental model and scrum model.

The agile method has two renowned means of handling changes which occur in the software process activity:

- **Change Avoidance:** The process whereby the software process includes activities that can anticipate possible changes before significant rework is required.
- **Change Tolerance:** Occurs when the process is designed so that changes can be accommodated at relatively low cost.

## Characteristics Of Agile method

- Agile system emphasizes continual stake holder interaction throughout the development process.
- Agile focus on producing a working software over production of comprehensive documentations.
- Agile method seeks to respond rapidly to change over following laid down plan.
- Iterations occur between software process activities simultaneously.
- The system design is generally obtained from the programming environment.
- Communication is informal.
- Produces software rapidly in increments and hence may trade in software quality for faster delivery.
- The user requirement documents only define the most essential character (they are the Must requirements (MOSCOW)).

## 3.10 The various software process models

- **Waterfall model:** This model is called the waterfall model or the software life cycle because of the cascade from one phase to another. The waterfall model is an example of a plan-driven process. In principle, the waterfall process model should only be used when the requirements are well understood and unlikely to change radically during system development. The principal stages of the waterfall model directly reflect the fundamental development activities: requirement analysis and definition, System and software design, Implementation and unit testing, Integration and system testing, Operation and maintenance.
- **Incremental development model:** Incremental development is based on the idea of developing an initial implementation, exposing this to user comment and evolving it through several versions until an adequate system has been development. Specification, development and validation activities are interleaved rather than separate, with rapid feedback across activities.
- **Reuse – oriented software engineering:** In majority of software project, there is some software reuse. This often happens informally when people working on the



project know designs or code that are similar to what is required. They look for these, modify them as needed, and incorporate them into their system. Although the initial requirements specification stage and the validation stage are comparable with other software processes, The intermediate stages in a reused-oriented process are different. These stages are: component analysis, requirement modification, system design with reuse and development and integration.

- **Boehm's spiral model:** This software process is represented as a spiral, rather than a sequence of activities with some backtracking from one activity to another. Each loop represents a phase of the software process. The innermost layer might be concerned with the system feasibility, the next loop with requirement definition, next loop with system design and so on. It combines change avoidance and tolerance. Each loop in the spiral is split into four sectors. These sectors are objective setting, risk assessment and reduction, development and validation and planning.
- **Prototyping model:** This is a model in which a version of the system or part of the system is developed quickly to check the customer's requirement and feasibility of some design decisions. This supports change avoidance as it allows users to experiment with the system before delivery and so refine their requirements. The number of requirements change proposals made after delivery is therefore likely to be reduced.

### 3.11 Chosen model and justification

The chosen model for the development of the system is the incremental development process due to its acceptance and accommodation to change. The incremental development process is well-suited for creating an advanced logistics and data analysis system due to its flexibility, early delivery of value, risk mitigation capabilities, support for continuous feedback, and effective management of complexity. By adopting this approach, stakeholders can expect a more adaptable, efficient, and ultimately successful development process. The users(employees) of the system are given an avenue to use and critique the system providing important and informative feedback for further improvement and adjustment to the system. This helps the developer make the necessary changes in future released versions through interleaved and concurrent activities which involves the specification, development and validation processes of the system, which will accommodate the necessary changes required for the smooth operation of the system.

The incremental development model is the most suitable for the development of the system based on the following justifications:

- Accommodation of future changes and recommendations.  
Incremental development model gives avenues for the implementations of new changes as the systems evolves. This ensure that the system meets user recommendations and stakeholder specifications.

- **Flexibility and Adaptability:** Incremental development allows for flexibility in accommodating changes and additions as the project progresses. In the case of a logistics and data analysis system, requirements may evolve as stakeholders gain a deeper understanding of their needs or as market conditions shift. Incremental development enables the incorporation of these changes without disrupting the entire development cycle.
- **Early Delivery of Value:** With incremental development, usable increments of the system are delivered iteratively. This means that stakeholders can start benefiting from the system's functionalities sooner rather than later. In the context of logistics and data analysis, even partial implementations can provide valuable insights and optimizations that can be immediately utilized to improve operations and decision-making.
- **Risk Mitigation:** By breaking down the project into smaller, manageable increments, the overall risk associated with development is reduced. Each increment is treated as a mini-project, allowing for focused risk assessment and mitigation strategies. This approach ensures that any potential issues or challenges can be addressed early in the development process, minimizing their impact on the overall project.
- **Continuous Feedback Loop:** Incremental development promotes continuous feedback from stakeholders, end-users, and other relevant parties. This feedback loop is invaluable for refining requirements, identifying areas for improvement, and validating the effectiveness of implemented features. In the context of a logistics and data analysis system, this feedback can help ensure that the system aligns closely with the needs and expectations of its users.
- **Complexity Management:** Developing a comprehensive logistics and data analysis system can be complex, involving various interconnected components and functionalities. Incremental development allows for the gradual implementation and integration of these components, making it easier to manage complexity and dependencies. It also enables developers to focus on one aspect of the system at a time, ensuring thorough testing and optimization before moving on to the next increment.

### 3.12 PROJECT DESIGN CONSIDERATION (LOGICAL DESIGNS)

#### UI Design

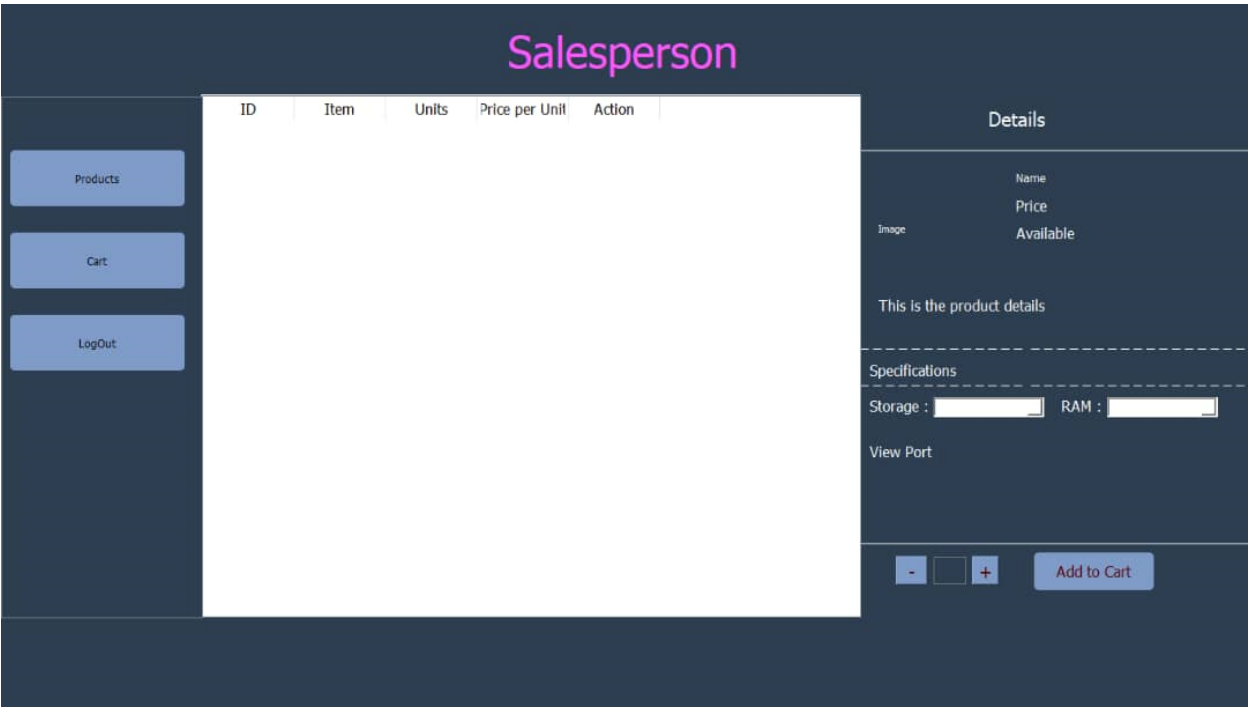


Figure 17:Salesperson UI

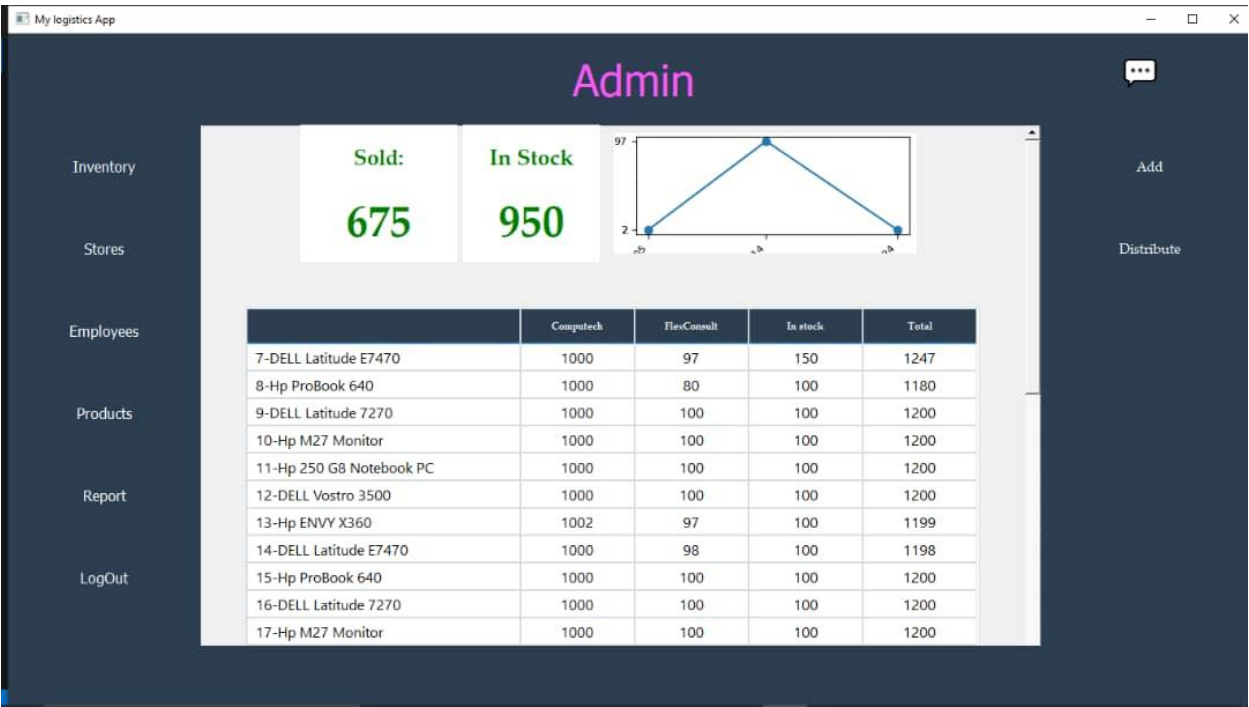
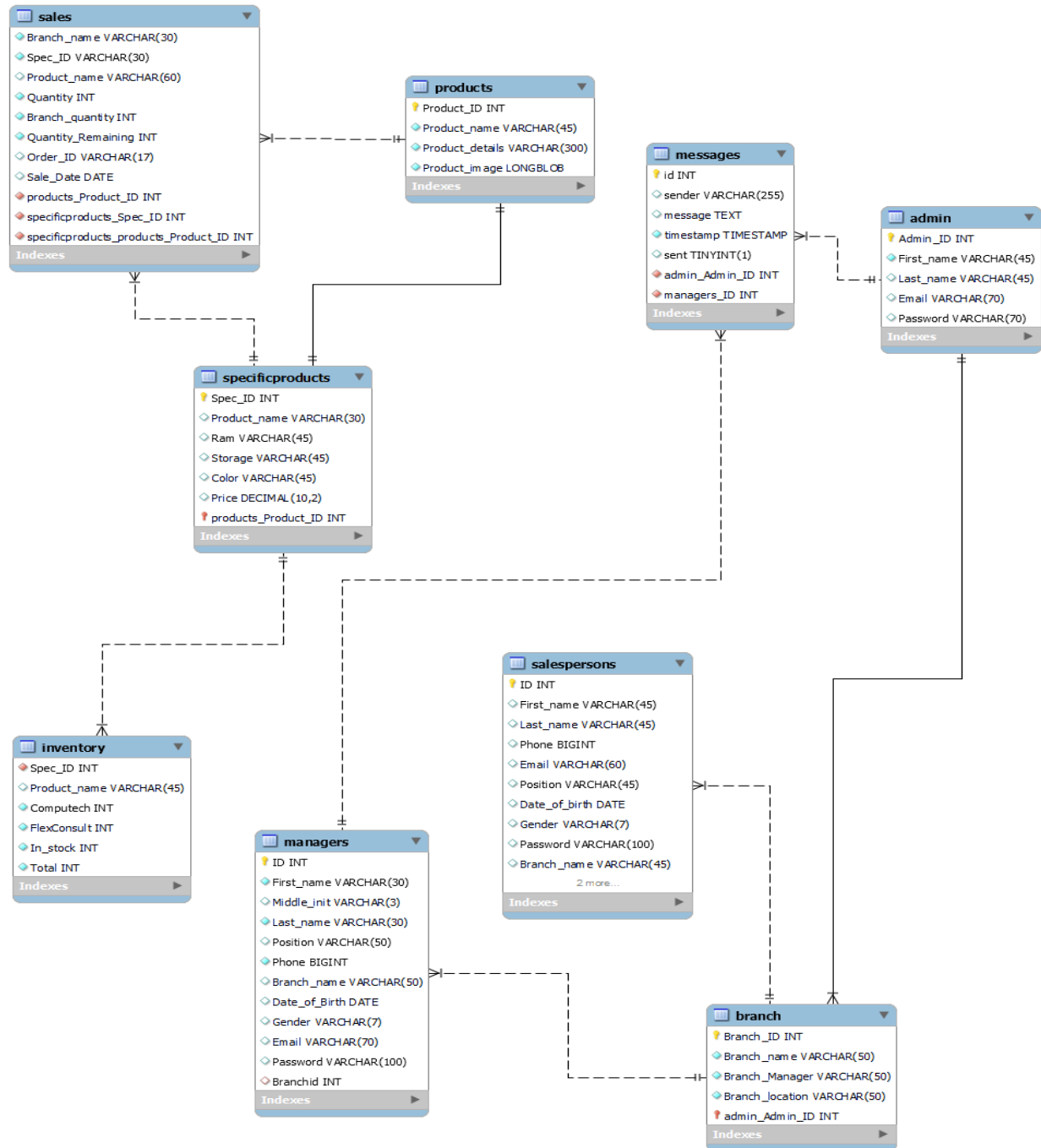


Figure 18: Administrator UI



Figure 19:Manager UI

### 3.13 DB Design



### 3.13 Developmental tools

- ✓ **Integrated Development Environment (VS code: Visual Studio Code):** Visual Studio Code (VS Code) has emerged as a popular Integrated Development Environment (IDE) for a wide range of programming languages, including Python, and is particularly well-suited for developing applications that involve PyQt5 and MySQL.

## Development Workflow with VS Code

### Project Setup:

- Created a new project folder and initialized a Git repository for version control.
- Install required Python packages (PyQt5, mysql-connector-python) using pip.
- Configure VS Code settings for Python and PyQt5 development.

### Code Editing:

- Write Python code for PyQt5 UI components, database interactions, and application logic.
- Leverage VS Code's IntelliSense and code completion features for efficient development.
- Use debugging tools to identify and fix errors.

### Database Interactions:

- Establish connections to the MySQL database using Python libraries.
- Execute SQL queries to retrieve, insert, update, or delete data.
- Utilize VS Code's extensions for database management (if available) to simplify database interactions.

### UI Development:

- Design and implement PyQt5 user interfaces using the provided widgets.
- Connect UI elements to Python functions for event handling and data manipulation.
- Visually design UI elements using Qt Designer and integrate them into our project.

### Testing and Debugging:

- Utilize VS Code's debugging features to step through code, set breakpoints, and inspect variables.
- Write unit and integration tests to ensure code quality and reliability.

### Version Control:

- Commit code changes regularly to the Git repository to track progress and collaborate with team members.

### ✓ **Programming Language (Python):**

Python's versatility, readability, and extensive libraries make it an excellent choice for building the backend of a sales logistics and data analysis system. It excels in handling complex business logic, managing databases, and integrating with various systems.

## Data Management:

- Python interacts seamlessly with the MySQL database to store and retrieve instrumental data unto the user interface.
- Libraries within python programming language made it possible to utilize the various widgets used within pyqt5 for effective interaction and correlation.
- Efficient data handling and manipulation are crucial for analysis and reporting.

## Business Logic:

- Python's clear syntax allowed for writing clean and maintainable code to implement core business rules and calculations.
- Functions can be defined to handle order processing, inventory management, sales calculations and reporting, and other business logic.
- Complex algorithms and data processing tasks were implemented efficiently.

## ✓ Database Management System (MySQL):

MySQL, a popular open-source relational database management system (RDBMS), serves as the backbone for storing and managing critical data in a sales logistics and data analysis system. Its role encompasses various aspects of the system's functionality:

## Data Storage

- **Product Information:** Stores details about products, including product ID, name, description, price, inventory levels, and categories.
- **Employee Data:** Maintains customer profiles with information like name, address, contact details, purchase history, and preferences.
- **Sales Management:** Tracks sales orders, including order details, customer information, shipping address, payment status, and order history.
- **Inventory Management:** Manages product inventory levels, stock locations, reorder points, and supplier information.
- **Branch Data:** Stores shipping information, carrier details, tracking numbers, delivery dates, and route optimization data.

## Data Retrieval and Analysis

- **Querying Data:** Enables efficient retrieval of data through SQL queries to support sales analysis, inventory reports, and performance metrics.
- **Data Aggregation:** Aggregates data for summary reports and analysis, such as total sales, top-selling products, and customer order segmentation.

- **Data Integration:** Combines data from different sources (e.g., sales, inventory, product) for comprehensive analysis.

### System Integration

- **Backend Integration:** Serves as the data layer for the system's backend, providing data access to application logic.
- **Frontend Integration:** Supports data display and interaction through the system's user interface (e.g., PyQt5).

### ✓ **PyQt5(Python GUI Library):**

PyQt5 is a crucial component in developing a user-friendly interface for a sales logistics and data analysis system. It provides a robust framework for building cross-platform applications with rich graphical elements.

### User Interface Development

PyQt5 offered a wide range of widgets and layouts to create intuitive and visually appealing user interfaces. This includes elements like buttons, text boxes, tables, charts, and more.

### Data Visualization

PyQt5 can be used to create interactive visualizations based on data retrieved from the MySQL database. Libraries like Matplotlib can be integrated to enhance data representation.

### User Interaction

PyQt5 enables handling user input through events, allowing users to interact with the system effectively.

### Integration with Backend

It acts as a bridge between the user and the system's backend, facilitating data exchange and updates.



## Chapter 4

### IMPLEMENTATION AND RESULTS

#### 4.1 Chapter Overview

This chapter elaborates on the various implementations used in designing the project and results gotten from various text and analysis. The aim of this chapter is to outline the implementations, results of applying them, testing of the application, the testing plan which is categorized into component testing and system test and mapping of the logical design onto physical platforms.

#### 4.2 Implementation

The project implementation phase included key steps to help in achieving the required and desired results. These steps typically included:

- **Task Assignment:** Specific tasks had to be assigned in order to achieve the required results complete on deadline. Task such as requirement gathering, scheduling time to implement codes and analyze growth of project and research to gather the latest information to use in my project to help acquire the needed and desired results.
- **Resource Allocation:** The allocation of resources such as time, money and human resources etc. had to be put in play to achieve results. The time resource was the number of hours used in writing code, implementing features, analyzing achieved project with requirements in hand. The human resource was the effort made to gather the needed information using various interview methods and money in terms of data bundle for various upgrades in system, research and running numerous tests.
- **Monitoring and Control:** Continuously monitoring the rapid growth and progress of the system and quickly addressing any issues promptly and accurately.
- **Quality Control and Assurance:** Having predefined aims, objectives and requirements serve as a guide in the development of the project having in mind the required and final outcome of the project.
- **Testing and Validation:** Conducting thorough testing and validation of the project deliverables to ensure they meet the requirement and expectation.

## 4.4 Testing

Testing is a critical phase in the software development lifecycle (SDLC) of our project that involved verifying and validating the software product to ensure it meets specified requirements and functions correctly. It's a systematic process of evaluating the software's functionality, performance, reliability, usability, and compatibility. The program testing, where the system is executed using simulated test data, was used for validation conformity to the user requirements. The process of testing was therefore an iterative one with information being fed back from later stages to earlier parts of the process. The testing of the system involved three major stages:

### Component testing

The components making up the system were tested independently, without other system components. The system components comprising of the various user interfaces (i.e. Administrator, Managers and Employees) and system background databases.

### System testing

System components are integrated to create a complete system. This process is concerned with finding errors that result from unanticipated interactions between components and component interface problems. It is also concerned with showing that the system meets its functional and non-functional requirements, and testing the emergent system properties. For large systems, this may be a multi-stage process where components are integrated to form subsystems that are individually tested before these sub-systems are themselves integrated to form the final system.

### Acceptance testing

This is the final stage in the testing process before the system is accepted for operational use. The system is tested with data supplied by the system customer rather than with simulated test data. Acceptance testing may reveal errors and omissions in the system requirements definition, because the real data exercise the system in different ways from the test data. Acceptance testing may also reveal requirements problems where the system's facilities do not really meet the user's needs or the system performance is unacceptable.

## 4.5 Testing plan

--components testing (algorithm for testing UI, algorithm for testing DB)

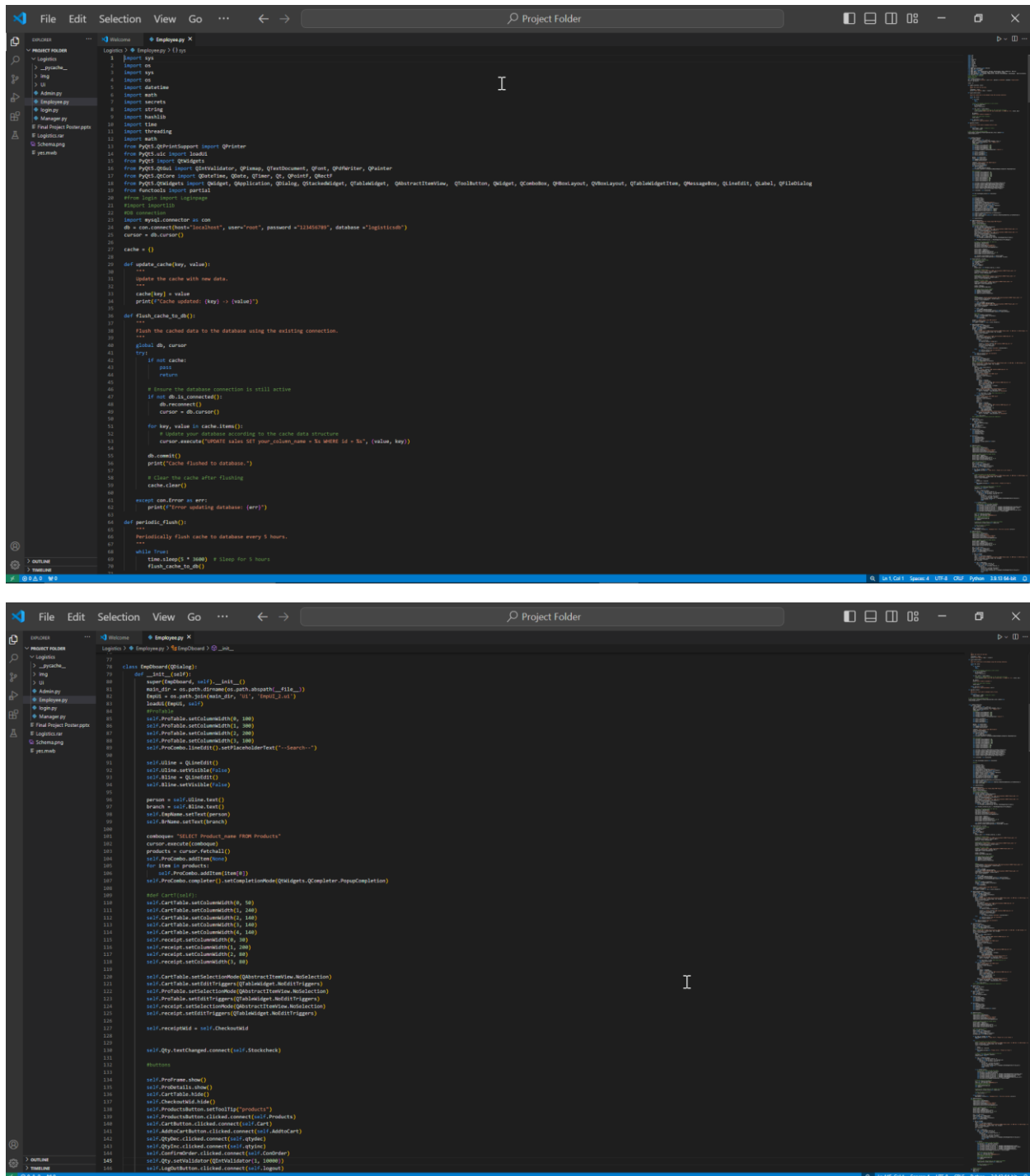
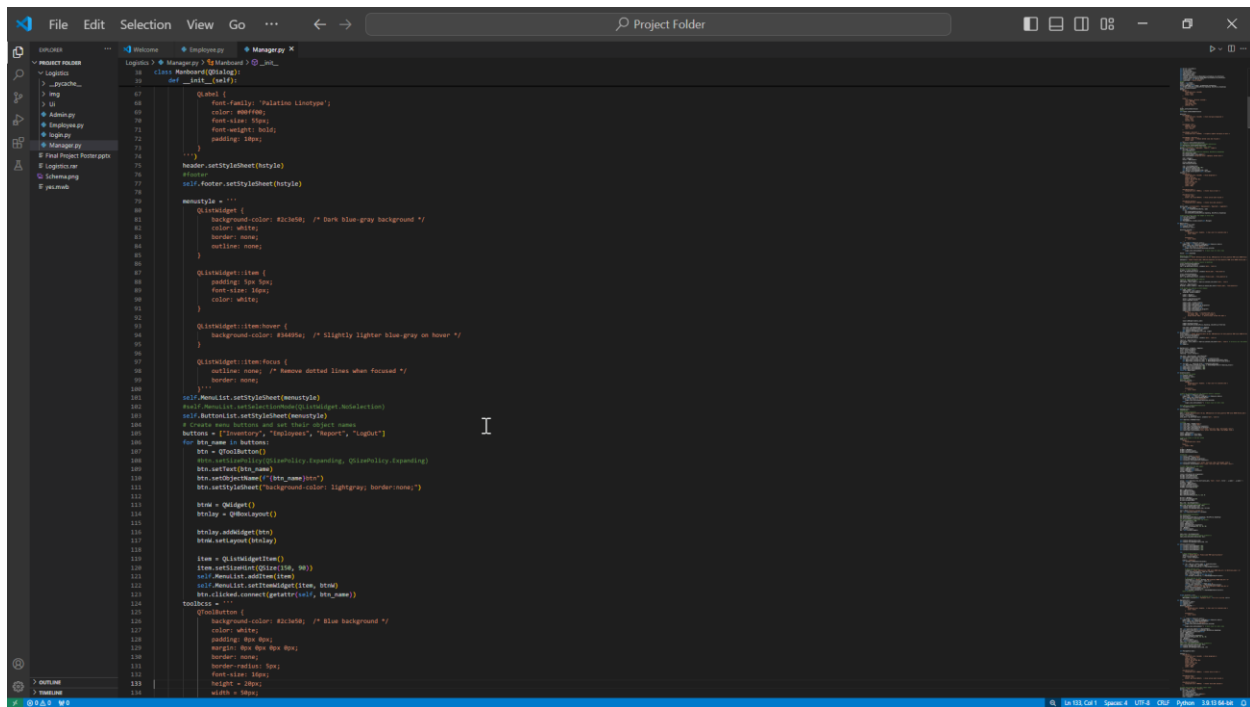


Figure 20: Algorithm for testing Salesperson UI





[illegible]

Figure 23: Algorithm for implementing a login interface

## Results

The proposed system provided the following feedbacks upon completion and after iterative testing processes:

- 1. Improved Operational Efficiency:** Operational efficiency would preserve a notable boost with the introduction of the sophisticated logistics and data analysis system. Enterprises will achieve supply chain process optimization by utilizing advanced optimization algorithms and real-time data processing. As a result, there will be fewer delays, better use of resources, and improved coordination across various logistical tasks. Operations will run more smoothly and with less downtime because to the system's capacity to anticipate and alleviate any bottlenecks.
- 2. Enhanced Decision-Making:** Better informed decision-making processes were made possible by the use of modern data analytics. Stakeholders may improve supply chain management overall, optimize inventory levels, and increase demand forecasting by using real-time data and predictive insights to inform their decisions. The prescriptive analytics feature of the system will offer practical suggestions that may assist businesses in anticipating shifts in the market, modifying their approaches, and lowering risks.
- 3. Cost Reduction:** A notable and observable advantage was the decrease in operating expenses. Better resource allocation, waste reduction, and a reduction in needless expenses were made possible by the system's optimization capabilities. Businesses achieved significant cost savings by reducing holding costs, eliminating surplus inventory, and optimizing route planning through improvements in inventory management and sales logistics.
- 4. Scalability and Flexibility:** The data analysis and logistics system demonstrated remarkable scalability and flexibility in meeting the expanding requirements of enterprises. Because of the architecture of the system, speed could not be compromised when adding additional data sources or managing larger amounts of data. This flexibility made sure that even if company needs changed, the system could keep up its effectiveness and offer insightful information.
- 5. Future Insights and Predictive Capabilities:** Not only did the sophisticated system solve the logistical issues of the present, but it will also give businesses the predictive power they need to prepare forward. With the use of trend analysis and past data analysis, the system will be able to predict demand, spot possible threats, and suggest demand measures. Thanks to this insight, businesses will be able to maintain long-term growth, adapt to changes in the market, and improve their supply chains to meet future needs.

## Chapter 5

### FINDINGS AND CONCLUSION

#### 5.1 Chapter Overview

This chapter discusses about the various finding and conclusion from the project in order to improve upon it in the future. Ways in which these finding can impact a lot of people are listed here with suitable recommendations and references, used in the development and life cycle of the application. The findings capture the various observations made during the life cycle of the project development and the conclusion talks about the end results and what was conceived and taken into consideration.

#### 5.2 Findings

- **User Authentication and Access Control:** The system must use a robust authentication mechanism that allows users to securely log in using a username and password. User roles are very important in determining the interface and functionalities available to the user. System must provide appropriate user interface to the user.
- **Inventory Management:** The system needs to support full create, read, update, delete operations on the inventory database. This includes adding, managing and deleting inventory items.
- **Sales Process Management:** Salespersons require the ability to search for products, add them to a cart and initiate the sales process. System must validate each step, from product selection to cart management, ensuring accuracy and efficiency.
- **Reporting and Data Analysis:** Strong reporting features must be included in the system, particularly for the Administrator and Branch Manager positions. This entails running queries on sales data and producing graphical reports that provide clear insights into sales success.
- **Messaging and Communications:** To facilitate communication between Branch Managers and Administrators, an integrated messaging platform is necessary. Secure, real-time communications with appropriate validation and storage for record-keeping has to be enabled by the system.
- **Security and Data Security:** Security must be applied to every aspect of system functioning to avoid data breaches or unwanted access. All user activities must be



validated by the system, and it must guarantee that important operations—like changing data and logging out—are done securely. A secure logout mechanism that efficiently terminates user sessions and guards against potential unauthorized use is another essential component of the system.

### 5.3 Conclusions

To conclude, the creation and execution of the sophisticated logistics and data analysis system constitute a notable advancement in managing the intricacies of contemporary supply chain administration. The system has demonstrated its capacity to increase operational efficiency, improve decision-making, and save costs by combining state-of-the-art technologies including real-time data processing, predictive analytics, and optimization algorithms. In addition to addressing the logistical issues that businesses are now facing, the initiative also provides them with the tools they need to adjust to changing market conditions and maintain their long-term development and competitiveness. This technology is a significant breakthrough in the logistics industry, providing companies with the chance to go from reactive to proactive operations, which will eventually result in long-term success in a world that is data-driven and changing quickly.

### 5.4 Challenges/ limitations of the system

- **Customization and Flexibility:** The system needs to be adaptable enough to meet the particular needs of various jobs or branches while also providing a uniform user experience.
- **Data Synchronization Issues:** A cached database is used to temporarily store sales receipts before they are synced with the main database; this requires data consistency to be ensured by the system.
- **Complexity of Role-Based Access Control:** It is difficult to implement a strong role-based access control (RBAC) system that guarantees every user (salesperson, administrator, and branch manager) has the right access to system functions without creating security flaws.
- **Scalability Concerns:** The underlying infrastructure and database design must expand to manage greater demand without performance deterioration as the system grows, especially with the addition of new branches or users. Performance bottlenecks may occur in the system, especially when managing several user tasks at once or searching big databases.
- **Data Access:** With any disruption in the access to the main database, real-time access to information to enable reporting and predictive capabilities become an issue. Which will result in loss of a competitive edge.

## 5.5 Lesson learnt

- **Importance of Data Integration and Quality:** One of the most important things the project taught us is how important quality and data integration are to the functioning of modern logistics systems. Ensuring precise, timely, and cohesive data from several sources is crucial for well-informed decision-making and optimal supply chain operations. Data gaps and inconsistencies might result in less-than-ideal results, which emphasizes the need of having strong data management procedures.
- **Value of Real-Time Analytics:** The endeavor emphasized how important real-time analytics are to logistics management. Real-time data processing helps firms react proactively to shifts in demand, inventory levels, and market circumstances by giving instant insights and facilitating rapid decision-making. This capacity helps businesses remain competitive in ever-changing contexts by increasing overall agility and operational efficiency.
- **Scalability and Flexibility Are Crucial:** Throughout the project, it became clear that logistics solutions needed to be flexible and scalable. The system has to be able to incorporate new technologies and handle bigger datasets without compromising performance as organizations expand and their data requirements change. Developing a scalable and adaptable system guarantees that it will continue to be useful and efficient in the face of shifting market conditions and corporate needs.
- **Collaboration Across Disciplines:** The project's success served as a reminder of how crucial it is for experts in data science, operations research, and logistics management to collaborate with one another. Developing a complete system that could handle challenging logistical situations required integrating information from several domains. A more solid and efficient solution was made possible by this multidisciplinary approach.
- **Continuous Improvement and Adaptation:** The project ultimately illustrated the necessity of ongoing adaptation and development. With new technology and methods appearing on a regular basis, the logistics industry is always changing. Updating and improving the system on a regular basis and using new tools and approaches as they become available are essential to maintaining effectiveness and competitiveness. In logistics management, long-term success is largely dependent on this attitude of constant learning and change.

## 5.6 Recommendations for future works

- **Implementations of a cloud-based database:** Adopting a cloud-based database system would go along way revolutionize the focus on data database optimization and scalability. Scalable and optimized databases will be able to handle the organization's

expanding requirements while maintaining high system uptime and quick query replies despite rising data volumes and user loads.

- **Focus on Database Optimization and Scalability:** Invest in query optimization, indexing, and partitioning to improve database performance. Take into account implementing a distributed database or sharding as a scalable database design.
- **Advanced Reporting and Data Visualization:** Improve the reporting capabilities of the system by adding more sophisticated data visualization tools and individualized reports that let users focus on particular metrics or time periods.
- **Implementations of a barcode scanning:** This will improve sales rate, cut on customer waiting time at each branch and increase the rate of data absorption into the system. This improves the rate of decisions pertaining to sales and the predictive ability of the system.
- **Enhanced Security Measures:** The various data generated by the system for the organization are sensitive for the competitive edge the organization wants to maintain. Therefore, as technology advances and hacking methods change, so does the security measures protecting the data assets and integrity of the organization has to change.

## 5.7 Recommendations for project commercialization

- **Market Research and Target Audience Identification:** Pay attention to small to medium-sized retail and wholesale companies that need integrated solutions for managing employees, inventory, and sales reporting. These companies frequently look for affordable ways to improve the efficiency of their processes.
- **Multi-Branch Businesses:** Businesses with many locations will find your system perfect since it can handle branch-specific data like personnel management and inventory. Aim for organizations that require both localized management skills and centralized control.
- **Sales Strategy:** Showcase the system's capabilities through in-person or virtual demos using direct sales tactics, particularly for decision-makers in targeted organizations. Emphasizing the system's capacity to lower operating costs and increase efficiency will be crucial.
- **Data Security and Compliance:** Highlight the security features of the system, such as encrypted communications, secure login procedures, and adherence to pertinent data protection laws, when it comes to features concerning employee and inventory data.
- **Feedback and Continuous Improvement:** Incorporate a feedback loop to gather user experiences, especially with reference to the cloud-based system's connection with

barcode scanning. Utilize these comments to create ongoing enhancements and promptly resolve any problems.

- **Marketing and Branding:** Develop marketing campaigns that are specifically tailored to your target market, highlighting the system's capabilities to improve workflow, lower mistakes through predictive analysis, and provide real-time data access via sales tracking.

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