PRD / PFE Project

AI Coffee Shop Management System

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1 Project Overview

the Host Organization Artificial Insight has suggested the development of web and mobile application dedicated to Products, stocks, sales and employees management. the primary objective of this application is to make an efficient management in an autonomous way where thus stocks and sales are going to be adjusted in reliable approach which facilitates the procurement process along with an optimized solution for stock and sales management in order to buy a reasonable amount of stock and track the sales that are bought the most.

This concept was developed in response to the challenges faced by the host organization artificial insight experienced with the coffee shop consisting the lack of effective management practices where certain manual operations may alter actual inventory levels, resulting in inaccurate stock tracking and raising concerns about the reliability of sales records.

Given this situation, and noting the absence of adequate solutions on the market—aside from a few alternatives offering only basic features, artificial insight decided to capitalize on this opportunity by developing an innovative solution aimed for Proper management and safeguarding confidentiality.

2 Problem Statement

Despite its simplicity, the current management approach presents several limitations and challenges:

- First, the absence of validation and verification mechanisms represents a critical issue. Transactions and inventory updates are recorded manually without any control system, increasing the risk of inconsistencies, errors, or unverified data entries. This lack of control reduces the overall reliability of the system.
- Second, the system is vulnerable to stock discrepancies and potential internal misuse. Due to the lack of monitoring and traceability, some inventory losses may occur without clear justification. In certain cases, this may include unauthorized use or misappropriation of stock, which is difficult to detect with the current system.

- Third, these issues collectively lead to financial losses for the coffee shop. Inaccurate stock tracking, unrecorded transactions, and unnoticed discrepancies directly impact revenue and profitability.
- Fourth, the absence of automated tracking makes it difficult to identify high-performing products. Managers face challenges in determining which products are selling the most or understanding customer preferences, limiting their ability to make informed business decisions.
- Finally, the existing system slows down daily operations. Manual tasks such as recording sales, updating inventory, and verifying stock levels require significant time and effort, especially during peak hours, reducing operational efficiency.

3 Main Objective

The main objective of this project is to design and implement an intelligent coffee shop management system that combines web and mobile technologies with artificial intelligence to automate product recognition, sales processing, stock management, and business analysis. The proposed system aims to improve the reliability of inventory tracking, reduce manual operations, accelerate transaction processing, and support decision-making through forecasting and intelligent recommendations.

4 Specific Objectives

1. Manage core business data such as products, stock, sales, and employees through CRUD operations.
2. Use YOLO models to recognize products such as food, drinks, pastries, and chicha.
3. Automatically decrease stock quantities after each sale.
4. Automatically generate a sales receipt after each transaction.
5. Implement a simple forecasting system for sales and stock by day, week, month, and year.
6. Integrate an intelligent chatbot capable of generating recommendations and suggested actions.
7. Develop a web application using Next.js.
8. Develop a mobile application using Flutter.

5 Proposed Solution

The proposed solution is an AI-based coffee shop management system designed to automate product recognition, sales processing, and inventory analysis using modern artificial intelligence technologies such as computer vision, OCR, and predictive analytics.

1. **Product Detection Using Computer Vision**

   The system uses real-time object detection to identify products placed on the counter.

   - A camera connected to a Raspberry Pi server captures images of the merchandise.
   - The captured images are processed using a computer vision model capable of recognizing different products.
   - The system detects items such as drinks, food, and various types of coffee.
   - Detected products are stored and processed by the AI system to generate results.

2. **Automatic Receipt Generation**

   Once the products are detected:

   - The system automatically generates a digital receipt based on the detected items.
   - The receipt includes information about the products selected by the client.
   - This process reduces manual input and improves transaction speed.

3. **Invoice Processing Using OCR**

   To further digitalize the management process, the system integrates Optical Character Recognition (OCR) technology.

   - OCR is used to scan and extract information from invoices.
   - Extracted data such as product names, quantities, and prices are automatically processed.
   - This helps automate financial record management and stock updates.

4. **Predictive Analytics for Stock and Sales**

   The system includes a predictive engine capable of analyzing historical data.

   - The engine forecasts future stock requirements based on previous sales.
   - It provides insights into:
     - The most consumed products
     - Sales performance
     - Customer purchasing patterns
   - Analysis can be performed based on time-related factors such as:
     - Year
     - Month
     - Day

     This enables better inventory planning and business decision-making.

5. **AI Chatbot for Recommendations**

   The system also integrates an AI-powered chatbot that can:

   - Provide recommendations for improving the system
   - Assist with forecasting requests
   - Offer insights based on collected sales and inventory data

6 Non-Functional Requirements

Non-functional requirements specify the quality and performance expectations of the proposed system. They ensure its reliability, security, and suitability for operational needs. The main non-functional requirements of this project are as follows:

- **Performance:** The system must be capable of handling a large volume of data and responding quickly to user requests, even during periods of high activity.
- **Security:** Data must be protected through encryption mechanisms and strict access control policies.
- **Compatibility:** The system must be compatible with existing environments and operate correctly on the main target platforms, including web and mobile.
- **Usability:** The interface must be intuitive and easy to use in order to ensure rapid adoption by users.
- **Maintainability:** The code must be modular, well structured, and documented so that future updates and improvements can be carried out more easily.

These criteria guarantee the robustness, efficiency, and long-term sustainability of the proposed solution.

7 Target Users

- Owner
- Manager
- Client

8 Technologies Used

For the development of our application, both web and mobile, we utilize a variety of software tools. This section presents the main technologies used in the project together with a short description of each one.

8.1 Development Tools

- **Visual Studio Code** is an extensible source-code editor developed by Microsoft. It is compatible with Windows, Linux, and macOS, and it provides a flexible environment for writing, testing, and managing application code.

- **Git** is a distributed version control system that allows development teams to track source-code changes, manage collaboration, and maintain a complete history of project revisions throughout the software development lifecycle.
- **GitLab** is a web-based platform for version control and DevOps. It supports repository hosting, issue tracking, collaboration, and CI/CD workflows, which makes project organization and deployment easier.
- **Docker** is a containerization platform that packages an application with its dependencies into isolated containers. This ensures consistent execution across development, testing, and deployment environments.
- **Redis** is an open-source in-memory data store used as a cache, database, and message broker. It provides very fast access to data and helps improve application performance.
- **Elasticsearch** is a distributed search and analytics engine used to store, search, and analyze large volumes of data quickly. It is commonly used for full-text search and log analysis.
- **Overleaf** is an online collaborative LaTeX editor that allows users to write, edit, and publish scientific and technical documents in real time with multiple contributors.
- **Jira** is a project management and issue-tracking tool developed by Atlassian. It is widely used to plan tasks, follow project progress, manage workflows, and support Agile practices such as Scrum.
- **draw.io** is an online diagramming tool used to create flowcharts, UML diagrams, and system architecture designs. It helps document and communicate technical structures clearly.

8.2 Frameworks

- **FastAPI** is a modern, high-performance Python web framework for building APIs. It provides automatic data validation, asynchronous support, and efficient backend development features.
- **Ultralytics** provides implementations of advanced computer vision models, including YOLO object detection models. It offers tools for training, fine-tuning, and deploying AI models efficiently.
- **Next.js** is an open-source React framework used to build modern web applications. It offers routing, server-side rendering, and performance optimization features for scalable interfaces.
- **Flutter** is a cross-platform mobile application framework developed by Google. It enables developers to build native-like applications for Android and iOS from a single codebase.
- **Facebook Prophet** is an open-source time-series forecasting model developed for analyzing historical data and generating future predictions with support for trend, seasonality, and special events.
- **Google TimeFM** is a foundation model for time-series forecasting developed by Google. It is designed to process temporal data and generate forecasting predictions across different time horizons.

8.3 Database Management System

- **PostgreSQL** is a powerful open-source relational database management system that offers reliability, scalability, and strong data integrity for managing structured application data.
- **Qdrant** is a vector database designed for similarity search and AI-powered retrieval tasks. It stores vector embeddings and performs efficient nearest-neighbor search for intelligent applications.

8.4 Programming Languages

- **Python** is a high-level programming language widely used for software development, data analysis, and artificial intelligence. It is known for its readability and rich ecosystem of libraries.
- **HTML5** is the standard markup language used to structure and present content on the web. It forms the foundation of web pages and supports multimedia and interactive elements.
- **CSS3** is a style-sheet language used to define the presentation and layout of web pages. It allows developers to control colors, typography, layouts, and responsive design.
- **JavaScript** is a high-level programming language used to build dynamic and interactive web applications. It enables client-side scripting and communication with backend services.
- **Dart** is an open-source programming language developed by Google. It is mainly used with Flutter to build modern mobile, web, and desktop applications from a unified codebase.

9 Methodology

In this section, we describe the methodological approach followed during the development of the project. The adopted methodology covers both the modeling and design process and the project management approach used to ensure the successful realization of the proposed system.

9.1 Modeling and Design Methodology

The goal of a modeling and design methodology is to formalize the initial stages of system development in order to satisfy client needs and define the system structure clearly. For this purpose, we have chosen **UML** (Unified Modeling Language) as the design formalism for our project.

UML is a modeling language that combines graphical and textual representations and is characterized by rich semantic and syntactic features. It is used to understand, describe, and specify system requirements, document systems, outline software architectures, design solutions, and facilitate communication among different stakeholders. In this project, UML helps us model the system behavior, structure the application architecture, and prepare the technical design before implementation.

9.2 Project Management Methodology

The use of a structured working methodology is essential for the successful execution of a project. Since the final solution will be delivered to a client, it is necessary to ensure reliability and provide high-value functionalities that meet client expectations.

For this reason, we have chosen to adopt the **Agile methodology**, an iterative and collaborative approach that promotes continuous adaptability to change and active stakeholder involvement throughout the development process. This methodology emphasizes communication between all project participants, including clients, developers, and other contributors. It also encourages flexibility during development, rapid delivery through incremental improvements, and continuous alignment with project requirements.

Agile methods ensure continuous customer involvement, which helps align project outcomes with client expectations. They are also widely appreciated in software development environments because of their simplicity, flexibility, and adaptability to changing requirements. By adopting the Agile approach, the project is divided into several iterations, allowing the development team to manage risks more effectively and respond efficiently to changes throughout the project lifecycle.

Among the different Agile methodologies, we can mention XP (Extreme Programming), RUP (Rational Unified Process), FDD (Feature Driven Development), and SCRUM. In our case, we have chosen the **SCRUM methodology**, which is particularly well suited to the requirements and structure of our project.

9.3 Development Phases

The project can be carried out in the following phases:

1. **Requirement analysis:** identify functional and technical needs.
2. **System design:** prepare UML diagrams, database schema, and interface mockups.
3. **Implementation:** develop the application modules.
4. **Testing:** verify usability, accuracy, and reliability.
5. **Documentation:** prepare the final report and presentation.

10 User Stories

This section presents the main user stories that describe the expected functionalities of the proposed system from the perspective of its different users.

10.1 Manager User Stories

- As a manager, I want to add menu items so that clients can consult them.

- As a manager, I want to permanently delete a menu item so that it is completely removed from the menu.
- As a manager, I want to temporarily deactivate a menu item so that it is removed from the menu but can be reused later.
- As a manager, I want to modify a menu item so that I can correct incorrect data entry.
- As a manager, I want to search for a menu item.
- As a manager, I want to add the camera information of my point of sale.
- As a manager, I want to permanently delete a camera when it is broken.
- As a manager, I want to temporarily deactivate a camera when it is out of service.
- As a manager, I want to modify camera data so that I can correct incorrectly entered information.
- As a manager, I want to search the list of cameras.
- As a manager, I want to see the list of staff members of my point of sale.
- As a manager, I want to view inventory transaction data updated after each detection.
- As a manager, I want to view receipt data updated after each detection, including the prices of detected items.
- As a manager, I want to view order data updated after each detection.
- As a manager, I want to view the list of PDF receipts generated after each detection.
- As a manager, I want to view the list of items detected by the camera.
- As a manager, I want to view statistics related to my point of sale.
- As a manager, I want to add an inventory record.
- As a manager, I want to modify an inventory record.
- As a manager, I want to search for an inventory record.
- As a manager, I want to delete an inventory record.
- As a manager, I want to perform a reversible deletion for an inventory record.
- As a manager, I want to restore a previously deactivated inventory record.
- As a manager, I want to consult the inventory list.
- As a manager, I want to consult alerts for inventory items whose quantity is zero.
- As a manager, I want to receive restocking notifications for inventory items.
- As a manager, I want to add an inventory transaction.
- As a manager, I want to modify an inventory transaction.

- As a manager, I want to search for an inventory transaction.
- As a manager, I want to delete an inventory transaction.
- As a manager, I want to perform a reversible deletion for an inventory transaction.
- As a manager, I want to restore a previously deactivated inventory transaction.
- As a manager, I want to consult the list of inventory transactions.
- As a manager, I want to use OCR technology to process a supplier invoice.
- As a manager, I want to consult and modify data extracted by OCR before validating it and saving it in the database.
- As a manager, I want to consult the history of OCR detections.
- As a manager, I want to see the updated stock after receiving a confirmation status at the end of the OCR workflow.
- As a manager, I want to view sales forecasting by day.
- As a manager, I want to view sales forecasting by month.
- As a manager, I want to view sales forecasting by year.
- As a manager, I want to view stock forecasting by day.
- As a manager, I want to view stock forecasting by month.
- As a manager, I want to view stock forecasting by year.
- As a manager, I want to view the list of products with the expected depletion date for each product.
- As a manager, I want to receive a notification when a product reaches the minimum quantity threshold.
- As a manager, I want to view forecasting based on a given salary value.
- As a manager, I want to view daily forecasting according to maximum and minimum revenue.
- As a manager, I want to save forecasting results.
- As a manager, I want to search the forecasting history by date.
- As a manager, I want to ask questions about stock using the chatbot.
- As a manager, I want to request recommendations based on previously mentioned periods and historical data using the chatbot.
- As a manager, I want to view forecasting results through prompts with given parameters using the chatbot.

10.2 Server User Stories

- As a server, I want to pass a product in front of the camera so that the object can be detected automatically.
- As a server, I want to use an existing image or video to detect items.

10.3 User Authentication Stories

- As a user, I want to create an account.
- As a user, I want to log in to the dashboard in order to access the manager dashboard.

10.4 Client User Stories

- As a client, I want to ask questions about orders and products offered by the coffee shop.

11 Expected Results

At the end of the project, the expected results are as follows:

- a functional AI-based coffee shop management system integrating web and mobile platforms,
- automated product detection and faster sales processing through computer vision,
- automatic receipt generation and improved transaction traceability,
- more accurate stock monitoring and reduced inventory discrepancies,
- automated invoice processing through OCR for better financial and stock management,
- forecasting tools for sales and stock analysis by day, month, and year,
- intelligent recommendations generated through the chatbot to support decision-making,
- improved operational efficiency and reduced administrative workload,
- a scalable and maintainable solution that can be extended with new functionalities in the future.

12 Project Schedule

Based on the adopted Scrum approach and the main technical tasks of the project, the work can be organized into a **16-week schedule**. The phases below combine planning, research, data preparation, development, integration, testing, and final delivery activities.

Phase	Duration
Product backlog preparation, requirement analysis, and development environment setup	Weeks 1–2
Technical research and documentation for FastAPI, GitLab, and project tools	Week 3
Data collection, cleaning, augmentation, and annotation for YOLO model training	Weeks 4–5
YOLO model training, evaluation, and final model selection	Week 6
UML design, global class diagram, and system architecture preparation	Week 7
Development of CRUD functionalities for the main system entities	Weeks 8–9
Development of backend services for OCR and camera detection	Weeks 10–11
Validation of backend services and initial frontend integration	Week 12
Development of forecasting and chatbot microservices	Weeks 13–14
Integration of forecasting and chatbot services into the frontend interface	Week 15
Global testing, debugging, final documentation, and presentation preparation	Week 16

13 Conclusion

This project presents the design and development of an **AI-based coffee shop management system** intended to modernize and optimize daily business operations. The proposed solution addresses important issues related to stock control, sales management, invoice processing, and decision support by combining web and mobile technologies with artificial intelligence techniques such as computer vision, OCR, forecasting models, and chatbot-based recommendations.

The project is both relevant and feasible in a real business environment, especially for coffee shops and similar retail points of sale that still depend on manual or semi-manual management methods. By automating repetitive tasks, improving data reliability, and providing analytical insights, the system contributes to better operational performance and more informed managerial decisions.

Overall, this project combines software engineering, database management, artificial intelligence, and user-centered design, making it a strong and practical example of a final-year engineering or computer science project with real-world value and future expansion potential.