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Inventory Management System using Django Framework, PostgreSQL and Server Rendered Approach

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ABSTRACT

This document details the creation of a comprehensive, web-based Inventory Management System (IMS) designed to address the vital need for effective stock control across multiple branches. The IMS aims to optimize inventory processes, decrease operational expenses, and improve decision-making through real-time tracking and streamlined management. Leveraging a robust technology stack that includes Django for the backend and Bootstrap for a responsive frontend, the IMS offers a user-friendly, scalable, and secure solution.

Keywords: Secure User Authentication, Role-Based Access Control, Personalized Dashboard, Real-Time Inventory Tracking, Integrated Stock Transfer Request System, Responsive Design, Robust Technology Stack

I. INTRODUCTION

In the rapidly changing business landscape of today, effective inventory management is crucial for organizations of all sizes. As the need to optimize operations, lower costs, and meet customer demands grows, businesses are adopting innovative solutions to stay competitive. A powerful Inventory Management System (IMS) tackles these challenges by offering a central platform for tracking, managing, and analyzing inventory in real-time.

A well-designed IMS simplifies inventory processes by incorporating features such as automated stock tracking, order management, supplier integration, and advanced data analytics. These capabilities enable businesses to make informed decisions, minimize errors, and boost overall operational efficiency. The incorporation of modern web technologies further ensures scalability, security, and ease of use, making the system accessible across various devices and suitable for diverse industries.

Developing an IMS requires a careful approach that balances intuitive design, strong functionality, and secure data handling. It must meet the specific needs of businesses, whether they are small businesses seeking better inventory control or large organizations optimizing complex supply chains. By utilizing

frameworks like Django, responsive design principles, and scalable databases, the IMS becomes a versatile tool for achieving inventory accuracy and operational excellence.

This document outlines the essential components, features, and technologies involved in the development of the IMS. It serves as a comprehensive guide for creating a solution that aligns with the dynamic requirements of businesses and supports their growth in an increasingly competitive market.

II. MOTIVATION

In the ever-evolving business environment, efficient inventory management is a fundamental element of operational success for businesses of all scales. However, many businesses still rely on outdated, manual processes that are susceptible to human error, delays, and inefficiencies. These limitations can result in missed opportunities, increased expenses, and customer dissatisfaction, highlighting an urgent need for a streamlined, modern solution.

The development of this Inventory Management System (IMS) is driven by a clear objective: to address these challenges by providing a simple yet effective platform for inventory control. By offering features such as real-time stock tracking, automated workflows, and role-based access, the IMS empowers businesses to eliminate inefficiencies, enhance accuracy, and improve decision-making.

The project's emphasis on accessibility and adaptability is particularly noteworthy. Small and medium-sized enterprises (SMEs) often face difficulties managing inventory due to limited resources or the high cost of available tools. Our IMS is designed to bridge this gap, providing an affordable, user-friendly solution that enables businesses to compete effectively with larger organizations. Ultimately, this project is motivated by the desire to create a significant impact by simplifying processes, reducing operational obstacles, and equipping businesses with the necessary tools to grow and succeed in an increasingly competitive global market.

III. RELATED WORKS

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IV. PROPOSED SYSTEM

This section describes the proposed system architecture Django Inventory management System (DIMS) as depicted in figure 1.

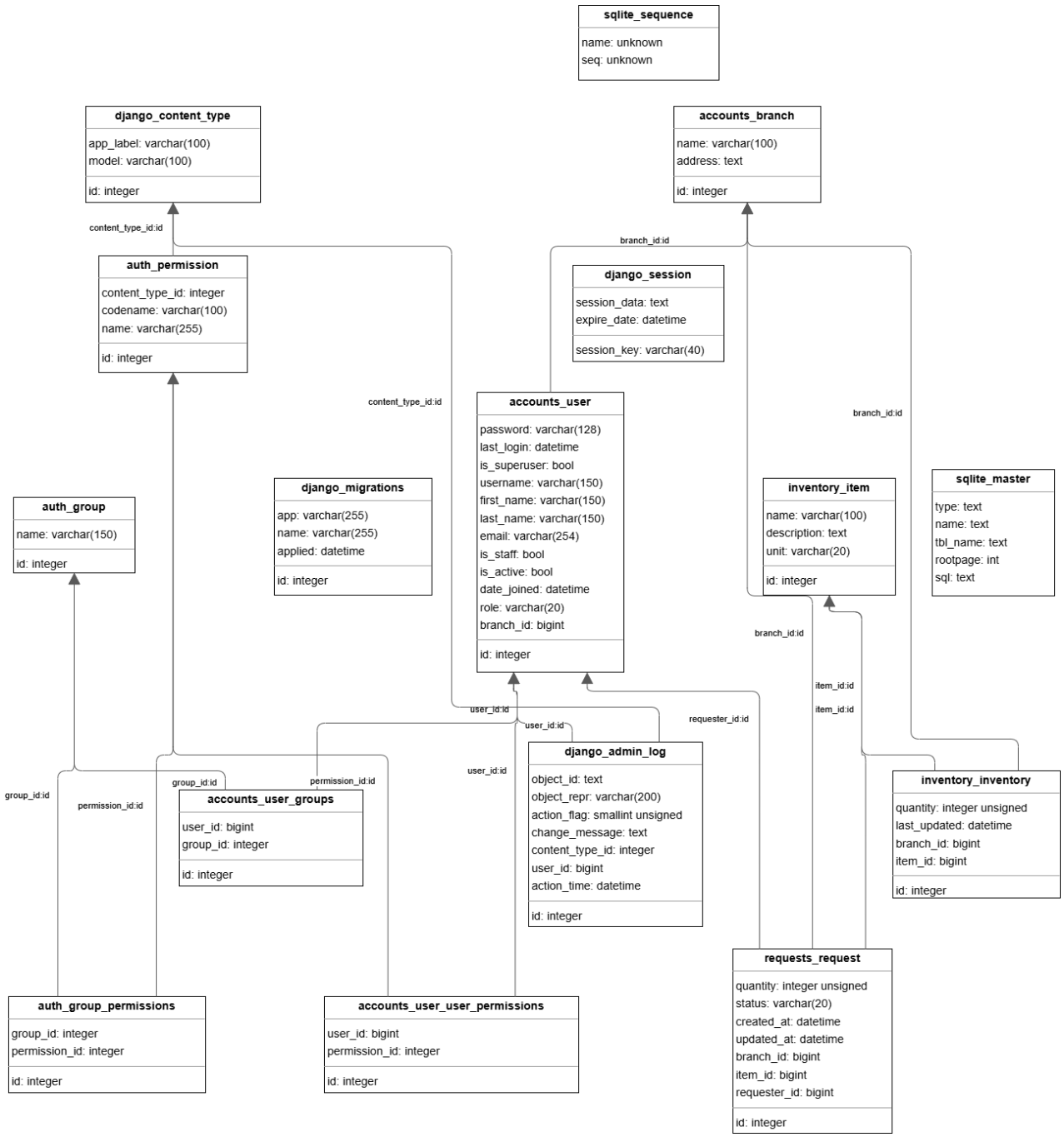

Figure 1: Relational database diagram for Django Inventory management System (DIMS)

1. System Architecture and Module Description:

The system architecture of the web-based inventory management system mainly focuses on data flow, security, and user interface.

1) Item Management View:

- Core Item Operations: The system uses CRUD (Create, Read, Update, Delete) operations for inventory items.
- Item Listing(item_list):

This view is responsible for displaying the inventory items

1. Role-based access control: This is a critical security feature. It means that what a user can see depends on their role within the system. Superusers and admins use role-based access as they can view all items, while regular users can only see items in their branch.
2. Django's ORM(Object-Relational Mapping): Django uses ORM to interact with the database. Instead of writing raw SQL queries, developers use Python code to perform database operations. This makes the code cleaner and easier to maintain.This IMS uses Django's ORM (Object-Relational Mapping) with filtering based on branch relationships and distinct() to prevent duplicate items.

- **Item Creation(item_create):**
  1. In Django, decorators are used to add extra functionality to functions.Thepermission_required decorator ensures that only users with the necessary permissions can access the item creation functionality. It is protected by Django's permission_required decorator.
  2. Branch-specific logic for branch managers: This means that when a branch manager creates an item, the system automatically associates that item with their branch. This simplifies the process for the user and ensures data accuracy. It includes branch-specific logic for branch managers and integrates a notification system.
  3. Automatic creation of associated inventory records: When a new item is added to the system, it's not enough to just record the item's details (name, description, etc.). The system also needs to track the quantity of that item in each branch. This is done by creating "inventory records" that link the item to specific branches and store the quantity on hand. The system automates this process to ensure data consistency. It automatically creates associated inventory records.

2) Inventory Management View:

This module deals with tracking and managing actual stock of items.

- **Inventory Listing:**
  1. It has branch-specific visibility controls. Similar to item listing, this ensures that users only see the inventory levels for their own branch.
  2. It maintains a hierarchical access structure (superuser/admin vs. branch users). This refers to the different levels of access within the system (e.g., superuser, admin, branch user). Superusers or admins might have a complete view of inventory across all branches, while branch users only see their own branch's inventory.
  3. It directly maps to branch relationships.This ensures that inventory data is correctly tied to the appropriate branch preventing confusion and errors.
- **Inventory Updates:**
  1. It has permission-based access control which means only authorized users can change inventory levels.
  2. It has branch-specific validation means when updating inventory, the system checks if the changes are valid for that particular branch (e.g., preventing negative stock levels).
  3. It uses form-based quantity management where users use forms to enter and update inventory quantities, providing a user-friendly interface.

4. It automatically assigns branches for branch managers. It simplifies the process of updating inventory for branch managers.

3) Reporting Management System:

This module handles requests for stock transfers or other inventory-related actions

- **Request Creation:**
  1. It requires user authentication where only logged-in users can create requests, ensuring accountability.
  2. It automatically assigns the requester where the system automatically records who created the request. and uses form-based validation which ensures that request information is complete and accurate.
  3. It has permission-based access control. It controls who is allowed to create requests.
- **Request Processing:**
  1. It includes a status update workflow where it manages the different stages of a request (e.g., pending, approved, rejected, completed). and an approval process which defines who needs to approve a request.
  2. It has role-based access restrictions that determine who can process or approve requests. and branch-specific request handling which ensures requests are handled within the context of the relevant branch.
  3. It emphasizes the importance of a well-defined process for handling requests to ensure efficiency and transparency thus enhancing key workflow implementation.

4) Security Implementation Details:

This module focuses on the security measures built into the system.

- **Authentication:**
  1. Login is required for all views. Users must log in to access any part of the system.
  2. It uses permission-based access control which means it controls what actions users can perform. and role-based visibility restrictions. means it controls what data users can see.
- **Authorization:**
  1. It includes branch-level access control which means it isolates data between different branches.
  2. It has role-specific permissions that defines the actions each role is allowed to take.
  3. It has a hierarchical permission structure that supports different levels of access (e.g., user, manager, administrator).
- **Data Access Controls:**
  1. It has object-level permissions such that it controls access to individual data records.
  2. It has Branch-specific data filtering that ensures users only see data relevant to their branch.
  3. It has superuser override capabilities that allows administrators to access all data if necessary.

5) Data Flow and Relationships:

This module describes how data is organized and connected within the system.

- **Model Relationships:**
  1. Item to Inventory,(One-to-Many): One item can exist in multiple inventory records (e.g., in different branches).
  2. Branch to Inventory: One branch can have many inventory records (for different items).
  3. User to Request: One user can create multiple requests.

4. Branch to Request: One branch can be involved in many requests.

- **Data Validation:**
  1. Form-based validation: Validates data entered by users in forms.
  2. Model-level validation: Validates data at the database level.
  3. Permission=based validation: Validates if users have permission to perform certain actions.

6) Notification System Integration:

The system include email notifications for various events:

- New item creation alerts notify relevant personnel when a new item is added.
- Branch-specific notifications ensure that branch users receive relevant alerts.
- User action notifications provide feedback and confirmation to users for their actions.

2. Database Design:

The database design of the web-based Inventory Management System (IMS) is structured to efficiently manage and organize data related to inventory, users, branches, and requests. The design, as depicted in the Object-Relationship Diagram (ORD), employs a relational database model, where data is stored in tables, and relationships between these tables are established using foreign keys.

Key components and Tables:

- **accounts_user:** Stores user-specific details, including credentials (password, username), personal information (first name, last name, email), status flags (is_staff, is_active, is_superuser), date joined, role, and the branch the user is associated with.
- **auth_group & auth_permission:** Manages user groups and permissions, providing a mechanism for controlling user access and actions within the system. These tables are part of Django's authentication and authorization framework.
- **inventory_item:** This table stores the basic information about each item in the inventory, such as name, description, and unit of measurement.
- **inventory:** This is a crucial table that links items to branches and tracks the quantity of each item at each branch. It also includes a field for the last updated timestamp.
- **branch:** This table stores information about the different branches of the organization, such as name and address.
- **requests_request:** This table stores information about requests for inventory, including the quantity requested, status, creation and update timestamps, the branch involved, the item requested and the user who made the request.
- **django_session:** Django uses this table to store session data, which allows the system to remember user sessions.
- **django_admin_log:** This table keeps a log of actions performed in the Django admin interface, providing an audit trail.
- **django_content_type & django_migrations & sqlite_sequence & sqlite_master:** These tables are used internally by Django for its framework operations, content management, database migrations, and SQLite database management.

Relationships between Tables:

The tables are interconnected through relationships, primarily one-to-many, using foreign keys. For instance, a branch can have multiple inventory records, and an item can appear in multiple inventory records across different branches. These relationships are crucial for maintaining data consistency and enabling efficient data retrieval.The relational database schema is fundamentally defined by a set of

precisely articulated inter-table relationships, characterized predominantly by the one-to-many cardinality. These relationships are rigorously enforced through the strategic application of foreign key constraints, playing a pivotal role in upholding data consistency, ensuring referential integrity, and enabling efficient retrieval of related data sets via relational database operations.

Specific relationships and their implications:

- One-to-Many Relationship between branch and inventory: A single branch can be associated with multiple inventory entries, signifying that each branch can store and track multiple inventory items. The inventory table uses a foreign key (branch_id) referencing the primary key (branch_id) of the branch table.
- One-to-Many Relationship between inventory_item and inventory: A single inventory item can be associated with multiple inventory records, indicating that an item can be stocked at multiple branches. The inventory table incorporates a foreign key (item_id) referencing the primary key (item_id) of the inventory_item table.
- One-to-Many Relationship between accounts_user and requests_request: A single user can create multiple requests. The requests_request table includes a foreign key (user_id) referencing the primary key of the accounts_user table.
- One-to-Many Relationship between branch and requests_request: A single branch can be involved in multiple requests. The requests_request table uses a foreign key (branch_id) referencing the primary key (branch_id) of the branch table.
- One-to-Many Relationship between inventory_item and requests_request: A single inventory item can be the subject of multiple requests. The requests_request table incorporates a foreign key (item_id) referencing the primary key (item_id) of the inventory_item table.

3. User Interface:

Dashboard page

The image displays the dashboard of the Inventory Management System, welcoming the user "sayan." It presents a summary of key information, including "User Information" (username, email, role, join date) and "Branch Information" (name and address). The dashboard also features statistical overviews of "Item Statistics," "Inventory Statistics" (by branch), and "Request Statistics" (by status), providing a quick snapshot of the system's current state.

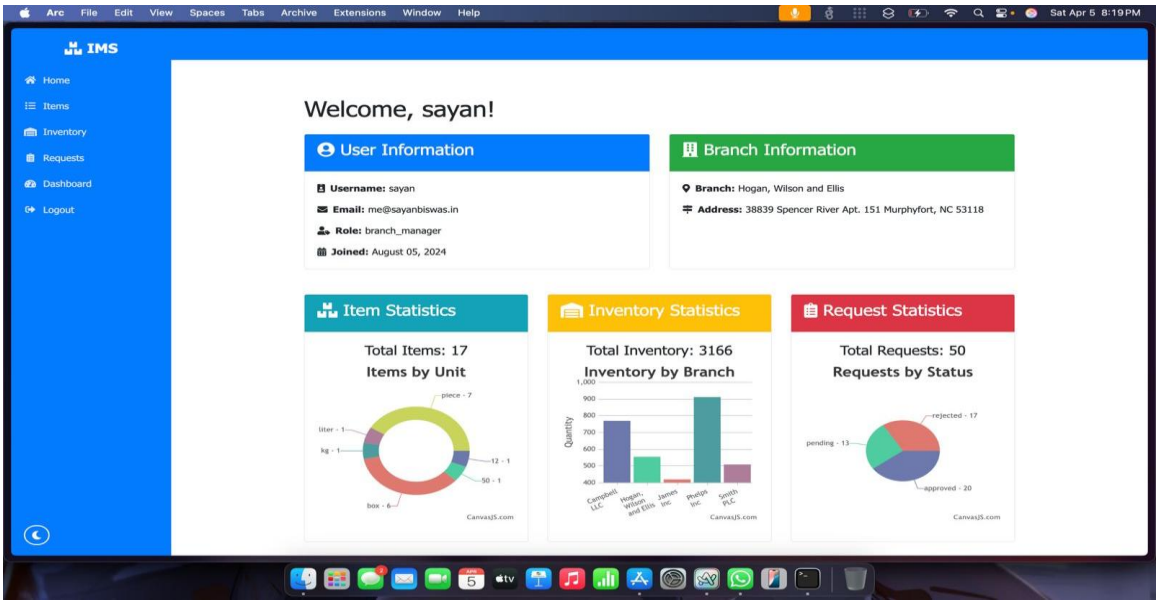

Figure 2: Dashboard of Django Inventory management System (DIMS) welcoming the user "sayan"

Homepage

The image is the homepage of an Inventory Management System. It highlights key features like "Inventory Management" for tracking stock across branches, "Request Processing" for streamlining approvals, and "Insightful Reports" for data-driven decisions. The page also offers a "Go to Dashboard" button for quick access and provides an "About Our System" and "Key Benefits" section detailing the system's purpose and advantages.

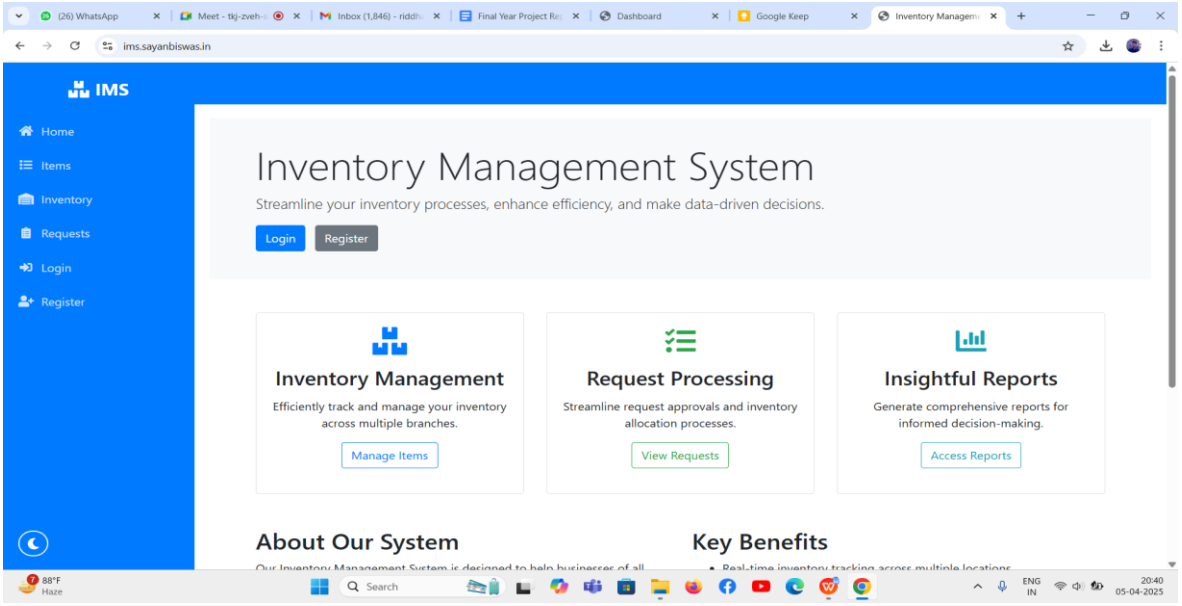

Figure 3: Homepage of Django Inventory management System (DIMS)

Register page

The image shows the registration page for an Inventory Management System (IMS). New users can create an account by filling in fields for username (up to 15 characters, letters, digits, and -/_./+ only), email, password (with specific complexity requirements), password confirmation, and branch. After filling the form, users can click the "Register" button to create their account.

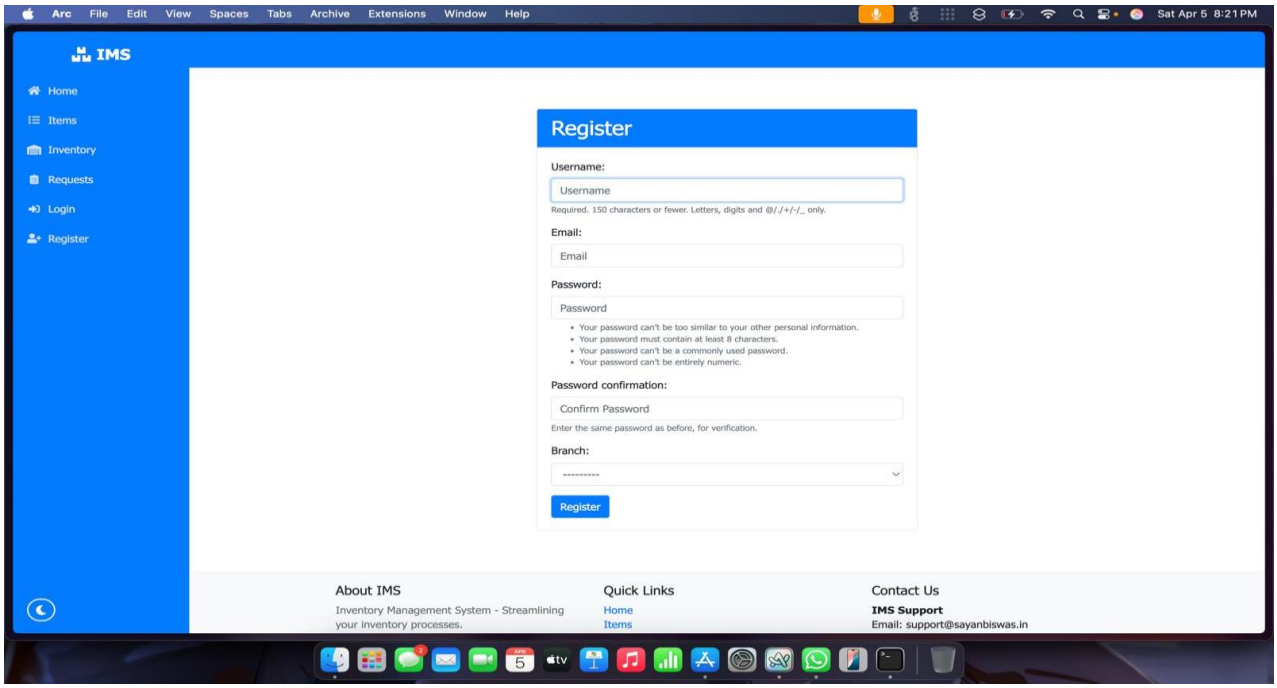

Figure 4: Registration page of Django Inventory management System (DIMS)

Login Page

The image displays the login screen for an Inventory Management System (IMS). Users are prompted to enter their username and password to access the system, which appears to offer features for managing items, inventory, and requests, as indicated by the left sidebar navigation. The footer provides information about the IMS, quick links, contact details, and copyright information.

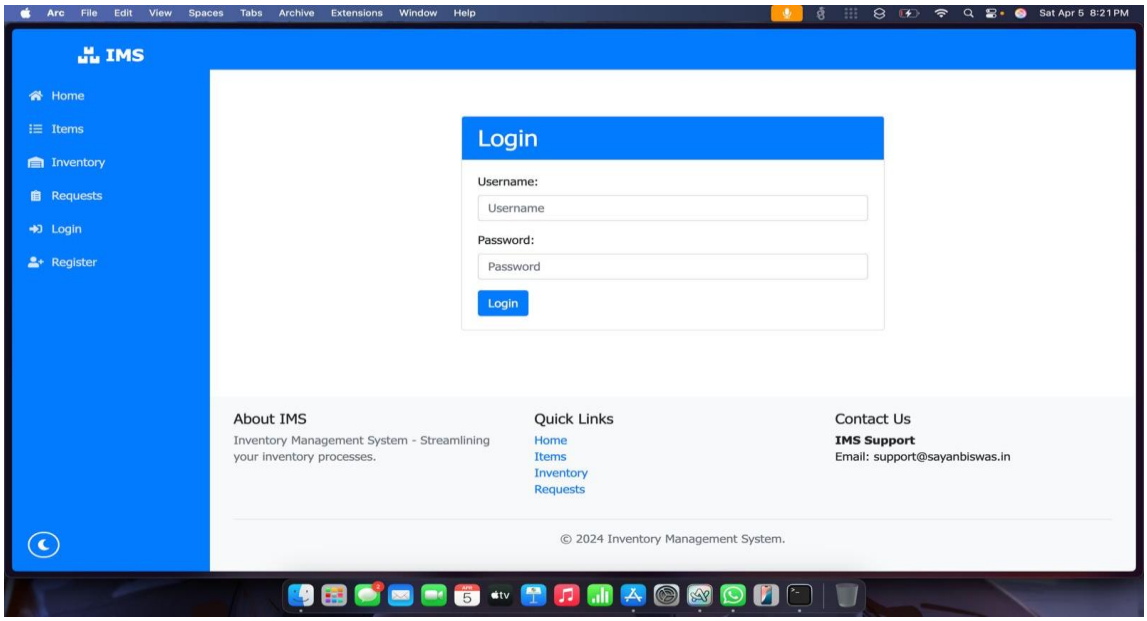

Figure 5: Login screen of Django Inventory management System (DIMS)

Item page

The image presents the "Items" interface within the Inventory Management System. It displays a table listing different inventory items, such as "Printer Paper," "Ballpoint Pens," and "Staplers." For each item, the table provides details like the name, a brief description, and the unit in which it's measured (e.g., "box," "piece," "liter"). On the right side, "Actions" allow users to "View" more details, "Edit" the item's information, or "Delete" it from the system. Additionally, a "+ Add New Item" button in the top right corner enables users to introduce new products into the inventory.

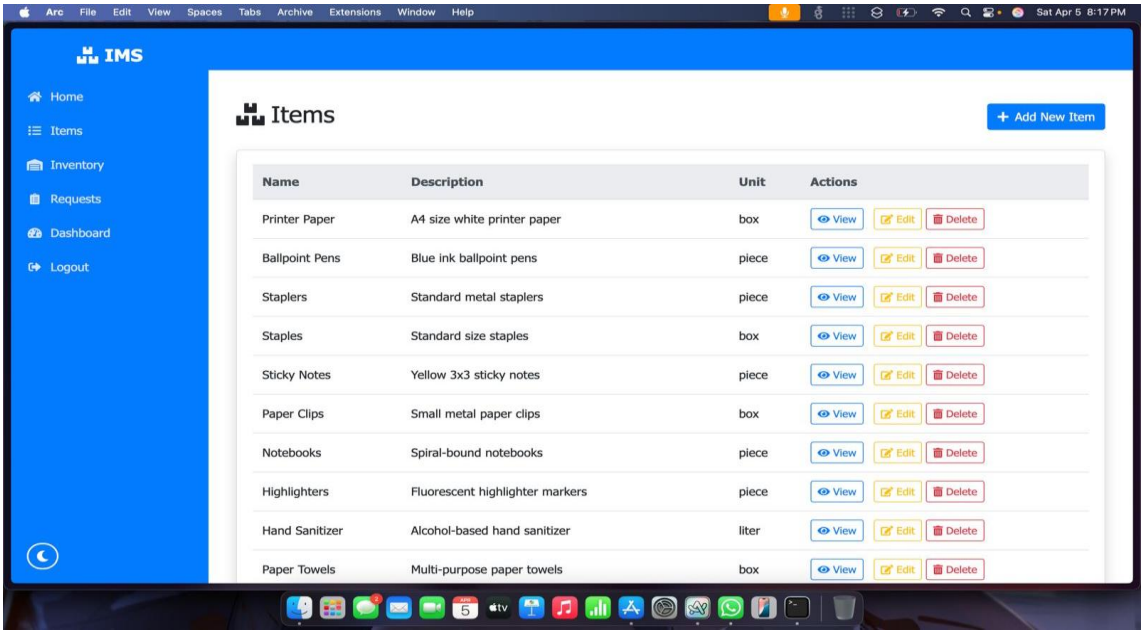

Figure 6: "Items" interface within the Django Inventory management System (DIMS)

Item detail page

The image shows the "Item Detail" page for "Printer Paper" within the Inventory Management System. It displays the item's unit ("box") and description ("A4 size white printer paper"). The "Current Inventory" section shows the quantity of Printer Paper available across different branches: James Inc. (5), Campbell LLC (77), Smith PLC (41), and Phelps Inc. (0). Users can also "Edit" the item details or go "Back to List" of all items.

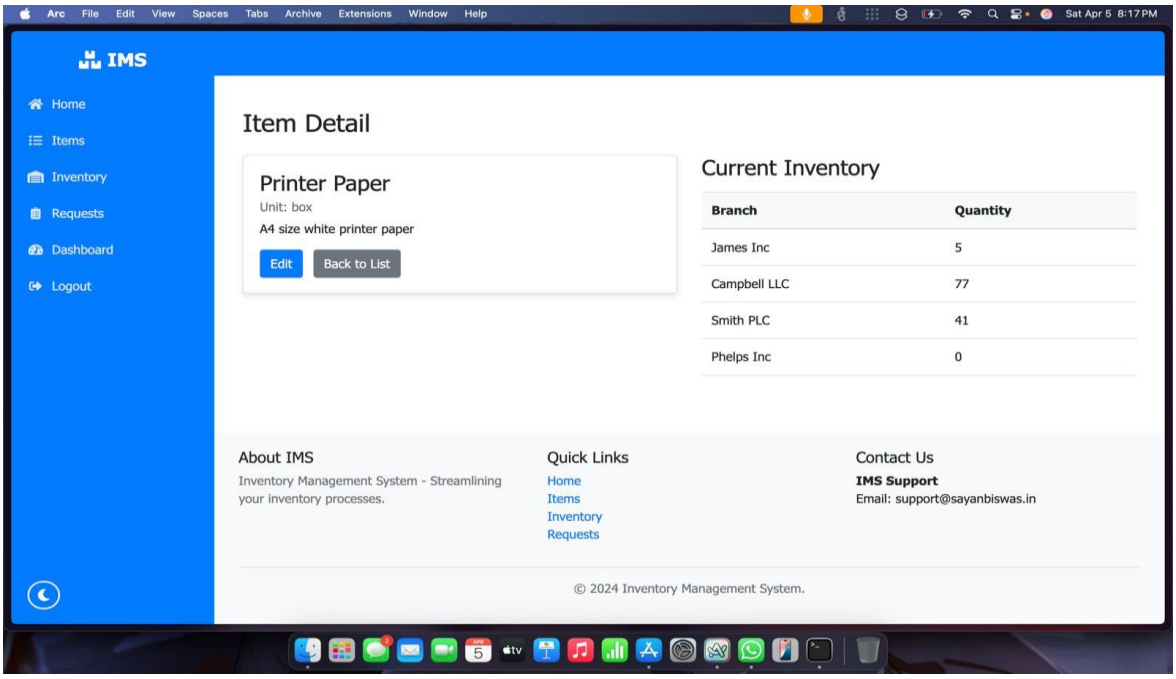

Figure 7: "Item Detail" page within the Django Inventory management System (DIMS)

Inventory page

The image displays the "Inventory" section of the Inventory Management System. It shows a list of items and their current quantities specifically at the "James Inc" branch. For each item, such as "Staples," "Markers," and "Printer Paper," the listed quantity represents the stock level at this particular branch. The "Actions" column provides an "Update" button, likely allowing users to modify the inventory levels for each item at James Inc.

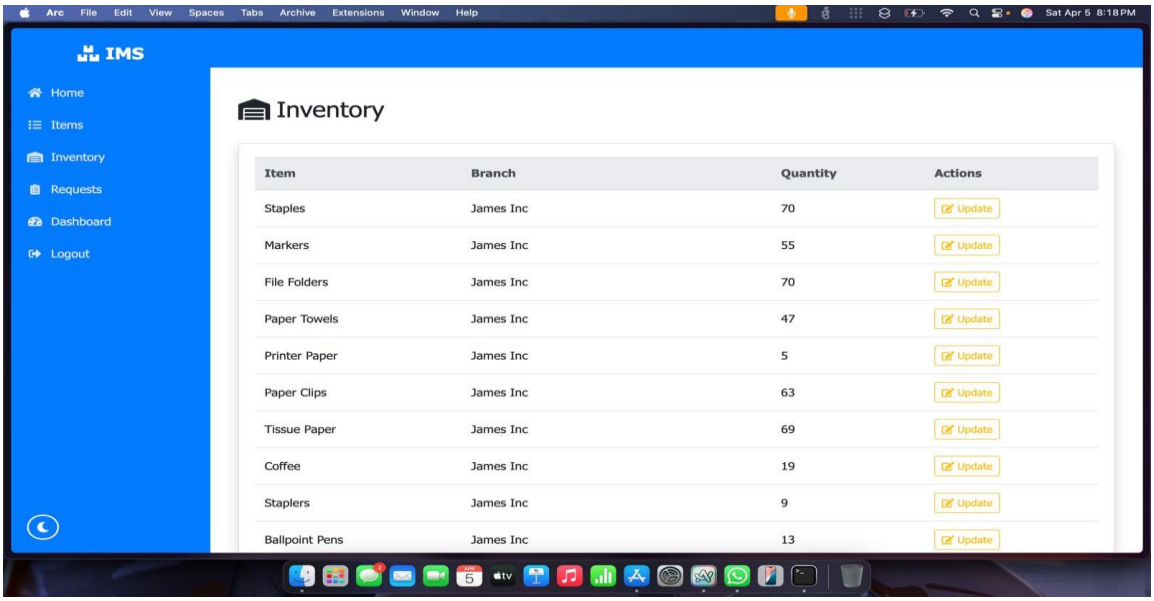

Figure 8: "Inventory" section of the Django Inventory management System (DIMS)

Request page

The image shows the "Requests" section of the Inventory Management System. It displays a list of requests made by different users ("Requester") for various items and quantities. The "Status" column indicates whether each request has been "Approved," "Rejected," or is still "Pending." Users can view the details of each request through the "View" action, and there's an option to "+ New Request."

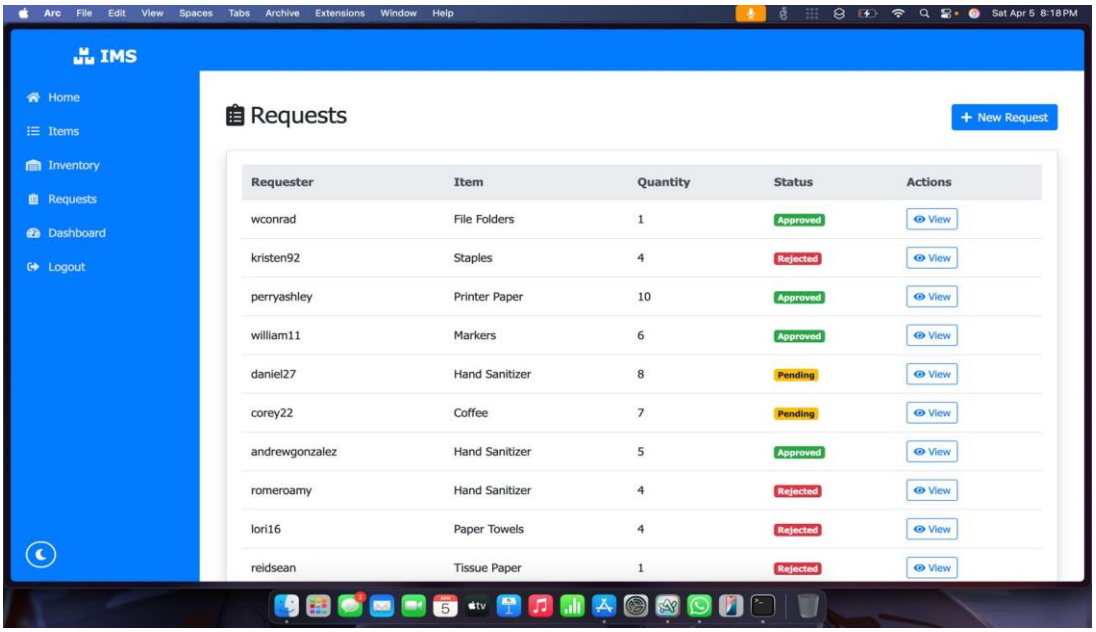

Figure 9: "Request" section of the Django Inventory management System (DIMS)

Request detail page

The image shows the "Request Detail" page for "Request #9" in the Inventory Management System. This request was made by "pervashley" on December 30, 2024, for 10 units of "Printer Paper" to be fulfilled by the "Phelps Inc" branch. The request's status is currently "Approved," and there are options to "Update Status" or go "Back to List" of all requests.

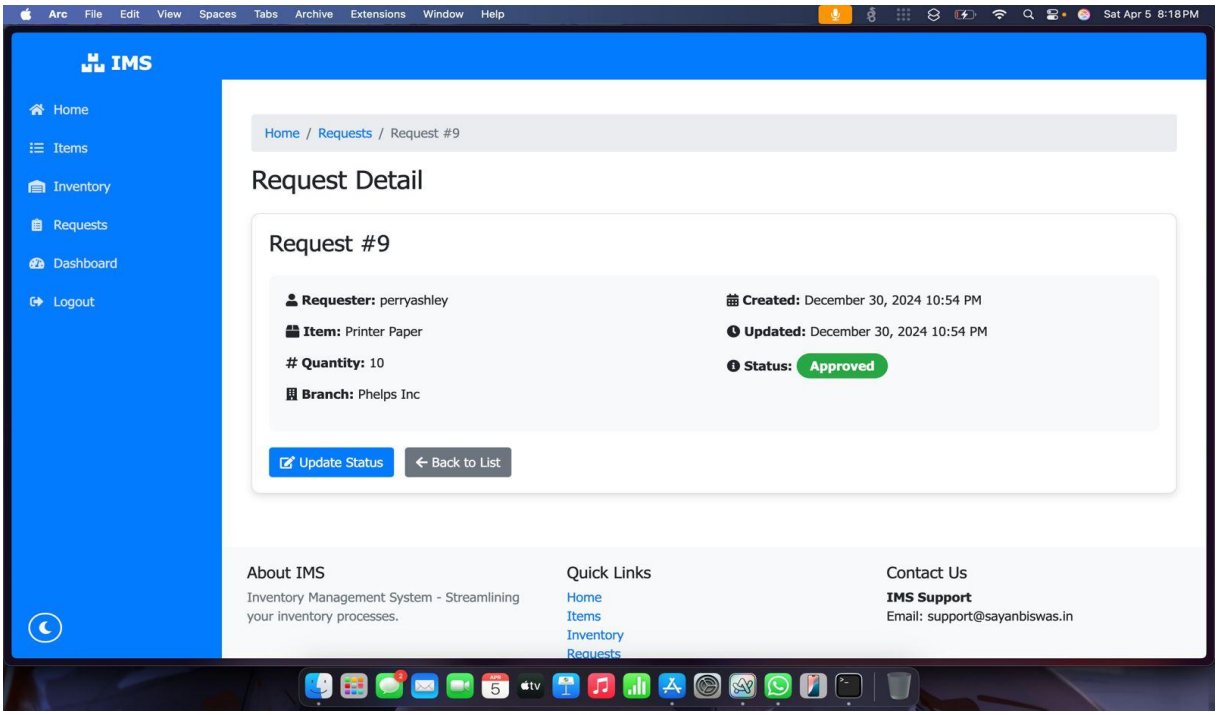

Figure 10: "Request Detail" page for "request" in the Django Inventory management System (DIMS)

Update page

The image shows a pop-up window titled "Update Request Status" overlaid on the "Request Detail" page for Request #9. The pop-up presents a dropdown menu with three status options: "Pending," "Approved" (currently selected with a checkmark), and "Rejected." Users can choose a different status for the request and then click the "Update Status" button to save the changes, or "Close" the window without making any modifications.

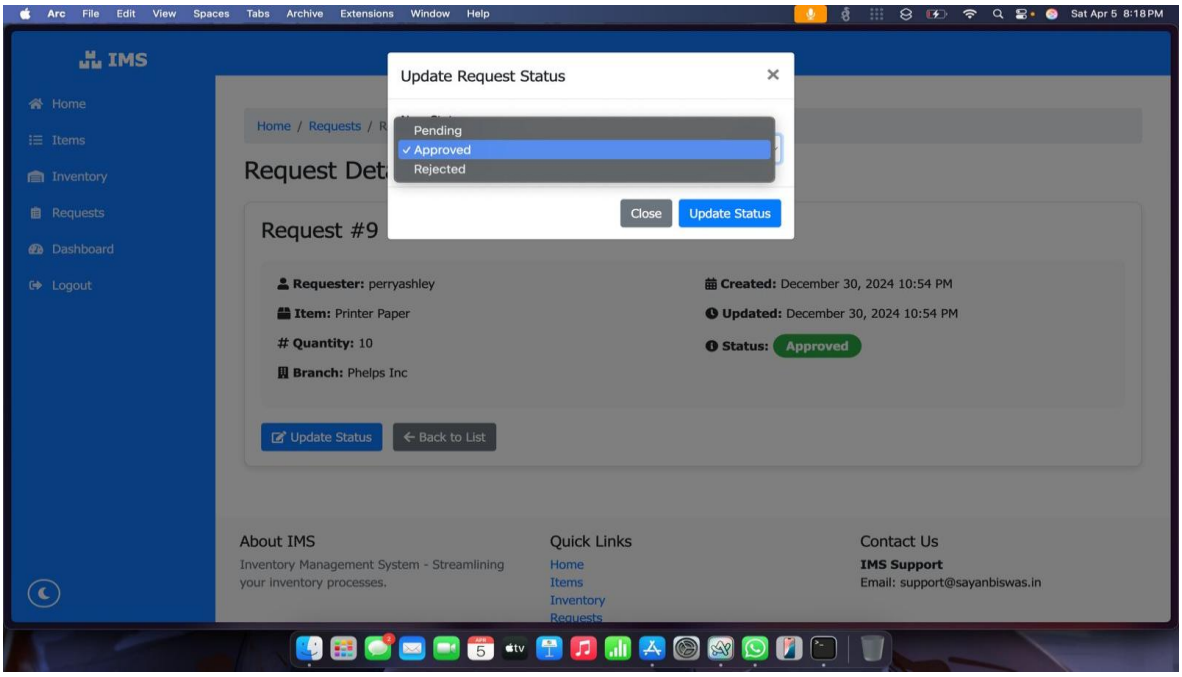

Figure 7: A pop-up window titled "Update Request Status" overlaid on the "Request Detail" page for request in the Django Inventory management System (DIMS)

V. COMPARATIVE STUDY

1. Security and Access Control

Feature	Traditional Systems	Enterprise Systems	DIMS
Role Based Access	Basic user/admin roles [6]	Complex role matrix [7]	Branch-specific with hierarchical control [5]
Permission Granularity	Module-level only [9]	Field-level [10]	Field-level + Branch-level [8]
Authentication	Basic authentication [12]	SSO + Advanced auth [13]	Django's robust auth + Custom roles [11]
Audit Trail	Basic logging [15]	Comprehensive audit [16]	Built-in admin logs + Custom tracking [14]
Branch Isolation	Often mixed data [18]	Configurable isolation [19]	Complete data isolation [17]

Key Advantages:

- Branch-specific permission system prevents data leakage between locations
- Custom role implementation allows for flexible access control
- Built-in audit trail through Django admin provides accountability
- Hierarchical access control enables multi-level management

2. Architecture and Scalability

Aspect	Traditional Systems	Enterprise Systems	DIMS
Framework	Often PHP/Basic frameworks [21]	Various frameworks [22]	Django (High performance) [20]
Database Design	Often denormalized [24]	Highly normalized [25]	Normalized with proper relations [23]
Scalability	Usually, vertical only [27]	Full scalability [28]	Horizontal + Vertical [26]
Modularity	Monolithic [30]	Microservices [31]	Component based [29]
API Support	Limited API support [33]	Full API support [34]	Built-in REST capability [32]

Notable Strengths:

- Django's ORM provides efficient database operations
- Properly normalized database prevents data redundancy
- Component-based architecture allows for easy expansion
- Built-in scalability through Django's architecture

3. Inventory Management Features

Feature	Traditional Systems	Enterprise Systems	DIMS
Real-time Tracking	Basic tracking [32]	Advanced tracking [33]	Yes (Per branch) [31]
Stock Alerts	Fixed thresholds [35]	AI-based predictions [36]	Customizable thresholds [34]
Multi-location	Limited support [38]	Full support [39]	Native support [37]
Request Workflow	Basic requests [41]	Complex workflows [42]	Full workflow system [40]
Batch Operations	Limited support [44]	Full support [45]	Supported [43]

Unique Benefits:

- Branch-specific inventory tracking provides accurate local stock levels
- Integrated request system streamlines stock transfers
- Custom workflow supports complex business processes
- Real-time updates across all branches

4. User Experience and Interface

Aspect	Traditional Systems	Enterprise Systems	DIMS
UI Framework	Basic HTML/CSS [47]	Advanced UI frameworks [48]	Modern Django templates [46]
Response Time	Variable [50]	Highly optimized [51]	Optimized queries [49]
Mobile Support	Limited [53]	Full mobile support [54]	Responsive design [52]
Offline Capability	Usually none [56]	Full offline support [57]	Configurable [55]

Advantages:

- Clean, modern interface through Django templates
- Optimized database queries ensure fast response times
- Mobile-friendly design supports field operations
- Intuitive workflow reduces training needs

5. Integration and Extensibility

Feature	Traditional Systems	Enterprise Systems	DIMS
Email Notifications	Basic notifications [59]	Advanced notifications [60]	Built-in system [58]
API Integration	Limited APIs [62]	Full API suite [63]	Django REST framework [61]
Custom Extensions	Limited extensibility [65]	Full extensibility [66]	Plug-and-play [64]
Third-party Support	Limited support [68]	Extensive support [69]	Wide ecosystem [67]

Key Capabilities:

- Easy integration with external systems through APIs
- Flexible notification system for various events
- Extensible architecture for custom modules
- Strong third-party package support

6. Cost and Implementation Comparison

Aspect	Traditional Systems	Enterprise Systems	DIMS
Initial Cost	Low [71]	Very High [72]	Medium [70]
Maintenance Cost	Medium [74]	High	Low [73]
Customization Cost	High	Very High	Medium
Training Required	Low	High	Medium

Cost Benefits:

- Lower long-term maintenance costs due to clean architecture
- Reduced customization costs through modular design
- Moderate training requirements due to intuitive interface
- Scalable licensing model

Technical Superiority

Key Technical Advantages

1. Database Design
    - Properly normalized tables ensure data integrity and reduce redundancy.
    - Efficient relationships are established between tables for logical data connections.
    - Optimal index usage is implemented by selecting appropriate indexing techniques (e.g., B-trees, hash tables) to significantly enhance query performance and data retrieval speed [1, 2].
    - Transaction support ensures data consistency during database operations.
2. Code Organization
    - Clear separation of concerns is maintained, isolating different functionalities for better maintainability [3, 4].
    - A modular architecture, potentially incorporating component-based or micro-frontend principles, enhances scalability and simplifies development workflows [3, 4].
    - Reusable components are utilized to improve developer productivity and ensure consistency across the application [3].
    - Clean code practices are followed for readability and ease of maintenance.
3. Security Implementation
    - Multiple security layers are implemented as part of a balanced architecture, recognizing the interplay between security, performance, and usability [4].
    - A custom permission system regulates user access to specific features and data.
    - Secure data access controls are enforced, protecting sensitive information and building user trust within the scalable system [4].
    - Audit capabilities allow for tracking and reviewing system activities.
4. Performance Optimization
    - Efficient queries are achieved through careful design and the application of optimized indexing strategies, minimizing execution time [1, 2].

- Effective caching support, potentially leveraging client-side, server-side, or CDN strategies, improves application responsiveness and reduces load times [3, 4].
- A scalable architecture is designed using modern methodologies (like component-based approaches, SSR, or others) to handle increasing loads efficiently while maintaining reliability [3, 4].
- The system is ready for load balancing, a key strategy for distributing traffic and ensuring high availability in scalable web architectures [4].

VI. CONCLUSION & FUTURE SCOPE

The proposed Inventory Management System (IMS) provides a comprehensive solution for modern inventory challenges by incorporating advanced features like FIFO-based stock sorting, ERP system integration, and BPMN for process optimization. The system's automated and centralized design minimizes human error, improves operational efficiency,and enhances decision-making capabilities.

By adopting the IMS, businesses can achieve better control over their inventory, reduce costs, and ensure customer satisfaction through efficient resource management. The real-time monitoring capabilities and scalability of the system make it a practical choice for businesses
of all sizes.

VII.FUTURE SCOPE

The proposed IMS lays the foundation for further advancements and improvements in inventory management systems. Some potential future developments include:

- Artificial Intelligence (AI) Integration: Incorporating AI algorithms to predict demand trends and optimize stock levels based on historical data.
- IoT Integration: Utilizing IoT devices, such as smart sensors, for real-time tracking of stock conditions like temperature or humidity.
- Mobile Accessibility: Developing a mobile application to provide users with on-the go access to inventory data and management tools.
- Advanced Analytics: Providing predictive analytics and detailed reporting to support strategic decision-making.

The IMS will continue to evolve with advancements in technology, enabling businesses to maintain a competitive edge in an ever-changing market environment.

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