**Inventory Management System**

**GitLink:** [**https://github.com/V939271/CapstoneProject-Venkat-**](https://github.com/V939271/CapstoneProject-Venkat-)

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**System Description**

A comprehensive **Inventory Management System** built with **.NET Core Web API** backend and **React.js** frontend, featuring role-based authentication, real-time inventory tracking, and advanced reporting capabilities.

**Technology Stack**

* **Backend**: ASP.NET Core 8.0, Entity Framework Core, SQL Server
* **Frontend**: React 18, Redux Toolkit, Tailwind CSS
* **Authentication**: JWT-based authentication with role-based authorization
* **Database**: SQL Server with Entity Framework Code-First approach
* **State Management**: Redux Toolkit with RTK Query for API calls

**Key Stakeholders**

* **Admin**: Full system access, user management, comprehensive reporting
* **Manager**: Inventory oversight, reporting, limited user operations
* **Staff**: Basic inventory operations, product viewing, movement recording

**1. Core Features Implementation**

**1.1 Authentication & Authorization System**

*// JWT-based authentication with role-based authorization*

[Authorize(Roles = "Admin,Manager,Staff")]

**public** **class** ProductsController : ControllerBase

{

[HttpPost]

[Authorize(Roles = "Admin")]

**public** **async** Task<IActionResult> CreateProduct(ProductCreateDto dto)

{

*// Admin-only product creation logic*

}

[HttpPut("{id}")]

[Authorize(Roles = "Manager,Admin")]

**public** **async** Task<IActionResult> UpdateProduct(**int** id, ProductUpdateDto dto)

{

*// Manager and Admin can update products*

}

}

**Features Implemented:**

* ✅ **Multi-role Authentication**: Admin, Manager, Staff roles with specific permissions
* ✅ **JWT Token Management**: Secure token generation and validation
* ✅ **Role-based Access Control**: Different UI and API access based on user roles
* ✅ **Session Management**: Automatic token refresh and logout functionality

**1.2 Product Management System**

*React component for product management with role-based UI*

**const** Products = () => {

**const** user = useSelector(selectCurrentUser);

**const** { data: products = [], isLoading, refetch } = useGetProductsQuery();

**return** (

<div className="grid grid-cols-1 md:grid-cols-2 lg:grid-cols-3 gap-6">

{products.map((product) => (

<ProductCard key={product.id} product={product}>

{*/\* Role-based action buttons \*/*}

{user?.role === 'Admin' && <DeleteButton />}

{(user?.role === 'Manager' || user?.role === 'Admin') && <EditButton />}

<ShowCodeButton /> {*/\* Barcode/QR code generation \*/*}

</ProductCard>

))}

</div>

);

};

**Features Implemented:**

* ✅ **CRUD Operations**: Create, Read, Update, Delete products with proper validation
* ✅ **Product Images**: Dynamic image system using external CDN with category-based fallbacks
* ✅ **Barcode & QR Code Generation**: On-demand code generation with download functionality
* ✅ **Low Stock Alerts**: Automatic low stock detection and notifications
* ✅ **Category Management**: Product categorization with filtering capabilities

**1.3 Inventory Movement Tracking (7 Points)**

*// Inventory movement tracking with audit trail*

**public** **class** InventoryMovement

{

**public** **int** Id { **get**; **set**; }

**public** **int** ProductId { **get**; **set**; }

**public** **int** UserId { **get**; **set**; }

**public** MovementType Type { **get**; **set**; } *// Stock In, Stock Out, Adjustment, etc.*

**public** **int** Change { **get**; **set**; }

**public** **int** PreviousQuantity { **get**; **set**; }

**public** **int** NewQuantity { **get**; **set**; }

**public** **string** Reason { **get**; **set**; }

**public** DateTime Timestamp { **get**; **set**; }

**public** **string** Notes { **get**; **set**; }

}

**Features Implemented:**

* ✅ **Movement Types**: Stock In, Stock Out, Adjustment, Sale, Return, Damage
* ✅ **Audit Trail**: Complete history of all inventory changes with user tracking
* ✅ **Real-time Updates**: Instant inventory quantity updates across all user sessions
* ✅ **Movement Logs**: Detailed logging with timestamps, reasons, and user information

**1.4 Dashboard & Analytics (5 Points)**

*// Role-based dashboard with different metrics for different users*

**const** Dashboard = () => {

**const** user = useSelector(selectCurrentUser);

*// Different data fetching based on user role*

**const** { data: allLogs = [] } = useGetAdminLogsQuery(**undefined**, {

skip: user?.role === 'Staff'

});

**const** { data: staffLogs = [] } = useGetStaffMovementsQuery(**undefined**, {

skip: user?.role !== 'Staff'

});

**return** (

<div>

{*/\* Role-based metrics display \*/*}

{user?.role !== 'Manager' && <InventoryMovementsChart />}

{user?.role !== 'Manager' && <UserManagementStats />}

<RecentActivityFeed /> {*/\* Visible to all users \*/*}

</div>

);

};

**Features Implemented:**

* ✅ **Role-based Dashboards**: Different views and metrics for Admin, Manager, and Staff
* ✅ **Real-time Notifications**: Combined notification system for low stock and pending users
* ✅ **Recent Activity Tracking**: Last 5 inventory movements visible to all users
* ✅ **Quick Action Buttons**: Context-sensitive actions based on user permissions

**1.5 Reporting & Export System**

*// Advanced reporting with date range selection and direct downloads*

**const** ExportSystem = () => {

**const** downloadLogsCSV = **async** () => {

**const** token = localStorage.getItem('token');

**const** response = **await** fetch('https://localhost:7273/api/Manager/reports/logs.csv', {

headers: { 'Authorization': `Bearer ${token}` }

});

*// Handle CSV download*

};

**return** (

<div>

<ExportReportsModal /> {*/\* Date range selection \*/*}

<DirectDownload /> {*/\* One-click downloads \*/*}

</div>

);

};

**Features Implemented:**

* ✅ **CSV Export**: Inventory logs and product data export functionality
* ✅ **Date Range Reports**: Custom date range selection for targeted reporting
* ✅ **Direct Download**: One-click download buttons for common reports
* ✅ **Role-based Access**: Export functionality available only to Manager and Admin roles

**2. User Stories Alignment**

**2.1 Admin User Stories**

**Story**: *"As an Admin, I want to manage users and have full control over the system"*

* ✅ **Implementation**: Complete user management interface with role assignment
* ✅ **Features**: Create, approve, delete users; assign roles; view all system activities

**Story**: *"As an Admin, I want to see comprehensive analytics and reports"*

* ✅ **Implementation**: Full analytics dashboard with user statistics, inventory trends
* ✅ **Features**: User status tracking, role distribution, comprehensive movement logs

**2.2 Manager User Stories**

**Story**: *"As a Manager, I want to oversee inventory without seeing administrative data"*

* ✅ **Implementation**: Filtered dashboard hiding user management and detailed system logs
* ✅ **Features**: Product oversight, inventory value tracking, export capabilities

**Story**: *"As a Manager, I want to generate reports for inventory analysis"*

* ✅ **Implementation**: Export functionality with date range selection
* ✅ **Features**: CSV downloads, inventory reports, movement tracking

**2.3 Staff User Stories**

**Story**: *"As Staff, I want to view products and see recent inventory activity"*

* ✅ **Implementation**: Read-only product access with recent activity visibility
* ✅ **Features**: Product viewing, recent activity feed, movement history access

**Story**: *"As Staff, I want to see product codes for inventory operations"*

* ✅ **Implementation**: Barcode and QR code generation for all products
* ✅ **Features**: On-demand code generation, download functionality

**3. Code Quality & Best Practices (10 Points)**

**3.1 Code Structure & Modularity (5 Points)**

**Backend Structure:**

InventoryManagement.API/

├── Controllers/

│ ├── ProductsController.cs

│ ├── AuthController.cs

│ ├── ManagerController.cs

│ └── StaffController.cs

├── Data/

│ └── ApplicationDbContext.cs

├── Models/

│ ├── Product.cs

│ ├── User.cs

│ └── InventoryMovement.cs

├── Dtos/

│ ├── ProductCreateDto.cs

│ ├── ProductUpdateDto.cs

│ └── ProductResponseDto.cs

└── Services/

├── IAuthService.cs

└── AuthService.cs

**Frontend Structure:**

src/

├── components/

│ ├── ui/

│ │ ├── Button.jsx

│ │ └── Card.jsx

│ ├── ProductCard.jsx

│ └── ProductCodeModal.jsx

├── pages/

│ ├── Dashboard.jsx

│ ├── Products.jsx

│ └── Analytics.jsx

├── store/

│ ├── authSlice.js

│ └── store.js

├── services/

│ └── api.js

└── utils/

└── productImages.js

**Best Practices Implemented:**

* ✅ **Separation of Concerns**: Clear separation between controllers, services, and data layers
* ✅ **Component Reusability**: Modular UI components with consistent styling
* ✅ **State Management**: Centralized state management using Redux Toolkit
* ✅ **API Organization**: RTK Query for efficient data fetching and caching

**3.2 Naming Conventions & Documentation (2.5 Points)**

**Consistent Naming Conventions:**

*// Backend - PascalCase for classes and methods*

**public** **class** ProductsController : ControllerBase

{

**private** **readonly** ApplicationDbContext \_context;

**public** **async** Task<IActionResult> GetProducts()

{

*// Method implementation*

}

}

jsx

*// Frontend - camelCase for variables, PascalCase for components*

**const** ProductCard = ({ product, onClick }) => {

**const** [isLoading, setIsLoading] = useState(false);

**const** handleProductClick = () => onClick(product);

**return** <Card onClick={handleProductClick} />;

};

**Documentation Standards:**

* ✅ **Inline Comments**: Clear explanations for complex business logic
* ✅ **API Documentation**: Comprehensive endpoint documentation
* ✅ **Component Documentation**: PropTypes and usage examples
* ✅ **README Files**: Setup instructions and project overview

**5. UI/UX Design & Frontend Implementation (10 Points)**

**5.1 Responsive UI & Design Consistency (5 Points)**

**Responsive Design Implementation:**

*// Tailwind CSS responsive grid system*

<div className="grid grid-cols-1 md:grid-cols-2 lg:grid-cols-3 xl:grid-cols-4 gap-6">

{products.map((product) => (

<ProductCard key={product.id} product={product} />

))}

</div>

*// Mobile-first responsive navigation*

<div className="flex flex-col sm:flex-row justify-between items-start sm:items-center gap-4">

<h1 className="text-2xl font-bold text-gray-900">Products</h1>

<Button className="w-full sm:w-auto">Add Product</Button>

</div>

**Design System:**

* ✅ **Consistent Color Palette**: Unified color scheme across all components
* ✅ **Typography Scale**: Consistent font sizes and weights
* ✅ **Component Library**: Reusable UI components (Button, Card, Modal)
* ✅ **Responsive Breakpoints**: Mobile-first design with proper breakpoints
* ✅ **Accessibility**: ARIA labels, keyboard navigation, color contrast compliance

**Visual Features:**

*// Smart image system with fallbacks*

**const** getProductImage = (product) => {

**const** { name, category, sku } = product;

*// Priority 1: Specific product image*

**if** (productImageMap[sku]) **return** productImageMap[sku];

*// Priority 2: Category-based image*

**if** (categoryImageMap[category]) **return** categoryImageMap[category];

*// Priority 3: Default placeholder*

**return** defaultPlaceholderImage;

};

**5.2 State Management (5 Points)**

**Redux Toolkit Implementation:**

*// Centralized store configuration*

**export** **const** store = configureStore({

reducer: {

auth: authSlice.reducer,

[inventoryApi.reducerPath]: inventoryApi.reducer,

},

middleware: (getDefaultMiddleware) =>

getDefaultMiddleware().concat(inventoryApi.middleware),

});

*// RTK Query API service*

**export** **const** inventoryApi = createApi({

reducerPath: 'inventoryApi',

baseQuery: fetchBaseQuery({

baseUrl: 'https://localhost:7273/api/',

prepareHeaders: (headers, { getState }) => {

**const** token = localStorage.getItem('token');

**if** (token) headers.set('authorization', `Bearer ${token}`);

**return** headers;

},

}),

tagTypes: ['Product', 'Movement', 'User'],

endpoints: (builder) => ({

getProducts: builder.query({

query: () => 'products',

providesTags: ['Product'],

}),

createProduct: builder.mutation({

query: (newProduct) => ({

url: 'products',

method: 'POST',

body: newProduct,

}),

invalidatesTags: ['Product'],

}),

}),

});

**State Management Features:**

* ✅ **Centralized State**: Redux Toolkit for predictable state management
* ✅ **API Caching**: RTK Query for intelligent data fetching and caching
* ✅ **Optimistic Updates**: Immediate UI updates with rollback on failure
* ✅ **Error Handling**: Comprehensive error state management
* ✅ **Loading States**: Proper loading indicators throughout the application

**6. Performance Optimization & Benchmarking (10 Points)**

**6.1 Performance Benchmarking & Load Handling (5 Points)**

**Database Optimization:**

csharp

*// Efficient database queries with projections*

**public** **async** Task<IActionResult> GetProducts()

{

**var** products = **await** \_context.Products

.Select(p => **new** ProductResponseDto(

p.Id, p.Name, p.Description, p.Quantity,

p.Price, p.LowStockThreshold, p.Category,

p.SKU, p.IsLowStock, p.CreatedAt, p.UpdatedAt

))

.ToListAsync(); *// Projection to avoid loading full entities*

**return** Ok(products);

}

*// Indexed database columns for faster queries*

**protected** **override** **void** OnModelCreating(ModelBuilder modelBuilder)

{

modelBuilder.Entity<Product>()

.HasIndex(p => p.SKU)

.IsUnique();

modelBuilder.Entity<InventoryMovement>()

.HasIndex(m => m.ProductId);

}

**Frontend Performance:**

jsx

*// Lazy loading and code splitting*

**const** ProductCodeModal = React.lazy(() => **import**('./ProductCodeModal'));

**const** Analytics = React.lazy(() => **import**('../pages/Analytics'));

*// Memoized components to prevent unnecessary re-renders*

**const** ProductCard = React.memo(({ product, onClick }) => {

**return** <Card onClick={onClick}>{*/\* Product details \*/*}</Card>;

});

*// Efficient data fetching with RTK Query caching*

**const** { data: products = [], isLoading } = useGetProductsQuery(**undefined**, {

refetchOnMountOrArgChange: 300, *// Cache for 5 minutes*

});

**6.2 Performance Optimization & Scalability (5 Points)**

**Backend Scalability:**

csharp

*// Async/await patterns for non-blocking operations*

**public** **async** Task<IActionResult> CreateProduct(ProductCreateDto dto)

{

**await** **using** **var** transaction = **await** \_context.Database.BeginTransactionAsync();

**try**

{

**var** product = **new** Product { */\* properties \*/* };

\_context.Products.Add(product);

**await** \_context.SaveChangesAsync();

*// Log the creation asynchronously*

\_ = Task.Run(**async** () => **await** LogProductCreation(product.Id));

**await** transaction.CommitAsync();

**return** CreatedAtAction(**nameof**(GetProduct), **new** { id = product.Id }, product);

}

**catch**

{

**await** transaction.RollbackAsync();

**throw**;

}

}

**Optimization Strategies:**

* ✅ **Database Indexing**: Strategic indexes on frequently queried columns
* ✅ **Query Optimization**: Entity Framework projections to reduce data transfer
* ✅ **Caching Strategy**: RTK Query caching with intelligent invalidation
* ✅ **Code Splitting**: Lazy loading for non-critical components
* ✅ **Memory Management**: Proper disposal of database contexts and resources

**7. Project Directory Structure (5 Points)**

**Backend Structure**

InventoryManagement.API/

├── Controllers/ # API Controllers

│ ├── ProductsController.cs

│ ├── AuthController.cs

│ ├── ManagerController.cs

│ └── StaffController.cs

├── Data/ # Database Context

│ ├── ApplicationDbContext.cs

│ └── Migrations/

├── Models/ # Entity Models

│ ├── Product.cs

│ ├── User.cs

│ ├── InventoryMovement.cs

│ └── Enums/

├── Dtos/ # Data Transfer Objects

│ ├── ProductCreateDto.cs

│ ├── ProductUpdateDto.cs

│ └── ProductResponseDto.cs

├── Services/ # Business Logic Services

│ ├── IAuthService.cs

│ └── AuthService.cs

├── Middleware/ # Custom Middleware

│ └── ExceptionHandlingMiddleware.cs

├── Extensions/ # Extension Methods

│ └── ServiceCollectionExtensions.cs

├── appsettings.json # Configuration

├── Program.cs # Application Entry Point

└── InventoryManagement.API.csproj

**Frontend Structure**

inventory-frontend/

├── public/

│ ├── index.html

│ └── favicon.ico

├── src/

│ ├── components/ # Reusable Components

│ │ ├── ui/

│ │ │ ├── Button.jsx

│ │ │ ├── Card.jsx

│ │ │ └── Modal.jsx

│ │ ├── ProductCard.jsx

│ │ ├── ProductCodeModal.jsx

│ │ └── NotificationBell.jsx

│ ├── pages/ # Page Components

│ │ ├── Dashboard.jsx

│ │ ├── Products.jsx

│ │ ├── Analytics.jsx

│ │ └── Login.jsx

│ ├── store/ # Redux Store

│ │ ├── store.js

│ │ ├── authSlice.js

│ │ └── api.js

│ ├── services/ # API Services

│ │ └── api.js

│ ├── utils/ # Utility Functions

│ │ ├── productImages.js

│ │ └── helpers.js

│ ├── hooks/ # Custom Hooks

│ │ └── useAuth.js

│ ├── styles/ # CSS Files

│ │ └── index.css

│ ├── App.jsx # Main App Component

│ └── index.js # Application Entry Point

├── package.json

├── tailwind.config.js

└── README.md

**Conclusion**

This Inventory Management System demonstrates a comprehensive understanding of modern web development practices, combining robust backend architecture with an intuitive frontend experience. The implementation showcases advanced features like role-based authentication, real-time notifications, barcode generation, and comprehensive reporting, while maintaining high code quality and performance standards.

The system is designed for scalability and maintainability, with clear separation of concerns, comprehensive error handling, and thorough documentation. The role-based approach ensures that each user type has access to appropriate functionality while maintaining security and data integrity.