SOFTWARE REQUIREMENTS SPECIFICATION

(SRS)

Cloudimart E-Commerce Platform

Geofenced Shopping for Mzuzu University Community

Version 1.0
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1. INTRODUCTION

1.1 Purpose

This Software Requirements Specification (SRS) document provides a comprehensive description of the Cloudimart E-Commerce Platform. It details the functional and non-functional requirements for a geofenced e-commerce system designed to serve the Mzuzu University community and surrounding areas in Malawi. This document serves as the primary reference for all stakeholders involved in the design, development, testing, and deployment of the Cloudimart platform.

The primary audience for this document includes:

- Development team members responsible for implementing the system
- Project stakeholders and management at Cloudimart Limited
- Quality assurance and testing personnel conducting verification and validation
- System administrators and DevOps engineers managing deployment and operations
- Future maintenance developers requiring system understanding
- External vendors and integration partners

This document establishes a mutual understanding between clients and developers regarding what the system shall and shall not do. It provides a baseline for project validation and verification activities.

1.2 Document Conventions

This document follows IEEE Standard 830-1998 for Software Requirements Specifications. The following conventions and formatting standards are used throughout:

Requirement Priority Levels: High (Critical - must be implemented), Medium (Important - should be implemented), Low (Desirable - may be implemented)

Requirement Identifiers: FR-XX for Functional Requirements, NFR-XX for Non-Functional Requirements, where XX represents a sequential number

Database Entities: Presented in monospace format (e.g., users, orders, products)

Technical Terms: Defined in Section 1.4 (Definitions and Acronyms)

Shall vs. Will: "Shall" indicates mandatory requirements, "will" indicates future intentions

Modal Verbs: "Must" indicates absolute requirement, "should" indicates recommendation

1.3 Project Scope

1.3.1 Project Vision

Cloudimart is a geofenced e-commerce platform specifically engineered to revolutionize the digital shopping experience for students, staff, and residents within predefined zones in Mzuzu,

Malawi. The platform addresses the unique challenges of e-commerce delivery in developing regions by restricting transactions to verified geographical locations, thereby reducing delivery disputes, minimizing operational costs, improving last-mile logistics efficiency, and building trust between vendors and customers.

Unlike traditional e-commerce platforms that operate without geographical restrictions, Cloudimart enforces delivery boundaries through GPS-based geofencing technology. This innovation ensures that orders are only placed by customers who are physically located within deliverable areas, eliminating the common problem of failed deliveries due to unreachable locations.

1.3.2 Problem Statement

Current e-commerce platforms operating in Malawi and similar developing markets face significant operational challenges that impact both vendors and customers:

Failed Deliveries: Inaccurate or incomplete address information, combined with the lack of standardized addressing systems in many African cities, leads to high rates of unsuccessful delivery attempts. This results in wasted resources, increased logistics costs, and customer dissatisfaction.

Location Disputes: The absence of standardized street addresses and building numbers causes frequent confusion between customers and delivery personnel regarding precise delivery locations. This leads to extended delivery times and conflicts.

Increased Operational Costs: Multiple delivery attempts, extended search times for customer locations, and fuel costs from unsuccessful trips significantly increase logistics expenses, making e-commerce financially unsustainable for many local vendors.

Limited Service Coverage: Vendors struggle to define and maintain consistent, enforceable service boundaries without technological support, leading to overextension and service quality degradation.

Trust and Verification Issues: Insufficient verification mechanisms for order handoff create opportunities for fraud, disputes about delivery completion, and misunderstandings between all parties involved in the transaction.

Infrastructure Limitations: Poor road conditions, inadequate signage, and limited internet connectivity in certain areas compound delivery challenges.

Cloudimart comprehensively addresses these challenges through a multi-faceted approach: (1) Enforced geofencing technology that validates customer location before checkout, (2) GPS-based location verification ensuring customers are within deliverable zones, (3) A two-factor delivery handshake system combining Order ID verification with customer phone number confirmation, (4) Automated notification system keeping all parties informed, and (5) A simplified interface optimized for low-bandwidth mobile networks.

1.3.3 Target Service Area

The initial deployment phase targets specific, well-defined geographical zones within Mzuzu, Malawi. These areas were selected based on population density, internet connectivity, smartphone penetration, and delivery infrastructure readiness:

- Mzuzu University main campus, including all academic buildings, libraries, and administrative offices
- Student accommodations both on-campus (hostels) and off-campus (approved student residences)
- Mzuzu Central Hospital and associated medical facilities
- Luwinga residential area, a high-density residential zone with good road access
- Area 1B (Chibanja), an established residential and commercial district
- KAKA trading center, a key commercial hub in northern Mzuzu
- Adjacent approved delivery zones as configured and validated by administrators

Each service zone is defined by precise GPS polygon coordinates stored in the system database. Administrators can add, modify, or deactivate zones through the administrative interface, allowing for flexible service expansion as infrastructure and demand evolve.

1.3.4 Product Categories

The MVP focuses on two primary product categories essential to the student and resident population:

Stationery: Academic and office supplies including hardcover books, college notebooks, plain paper rims, calculators, pens, pencils, markers, folders, binders, and related items.

Dairy Products: Fresh and packaged dairy items including Lilongwe Dairy milk, cheese, yogurt, butter, and related refrigerated products requiring careful handling and timely delivery.

Future phases will expand to include additional categories such as groceries, household items, electronics, and personal care products based on market demand and vendor partnerships.

1.4 Definitions, Acronyms, and Abbreviations

The following terms, acronyms, and abbreviations are used throughout this document:

Term/Acronym	Definition/Explanation
Geofencing	A location-based technology that creates virtual geographical boundaries using GPS or RFID coordinates. Actions are triggered when a mobile device enters or exits these defined areas.
Order ID	A unique alphanumeric identifier generated for each order in the standardized format ORD-YYYYMMDD-XXX, where YYYY is the year, MM is the month, DD is the day, and XXX is a sequential number starting from 001 each day.
Delivery Handshake	A two-factor authentication process for delivery verification requiring both the unique Order ID and the customer's registered phone number to confirm successful delivery and prevent fraudulent confirmations.
MVP	Minimum Viable Product - the initial version of the platform containing core features necessary for basic operations, serving as the foundation for iterative development.
MVC	Model-View-Controller - an architectural design pattern that separates application logic (Model), user interface (View), and input control (Controller) to improve modularity and maintainability.
API	Application Programming Interface - a set of protocols, tools, and definitions for building and integrating software applications, enabling communication between different system components.
REST	Representational State Transfer - an architectural style for designing networked applications using stateless, cacheable communications and standard HTTP methods.
GPS	Global Positioning System - a satellite-based navigation system providing location and time information anywhere on Earth with precision typically within 5-10 meters.
SMS	Short Message Service - a text messaging service component of most telephone, internet, and mobile device systems, using standardized communication protocols.
SMTP	Simple Mail Transfer Protocol - an internet standard communication protocol for electronic mail transmission across networks.
Point-in-Polygon	A computational geometry algorithm that determines whether a given point (GPS coordinates) lies inside, outside, or on the boundary of a polygon defined by vertex coordinates.
RBAC	Role-Based Access Control - a security approach that restricts system access to authorized users based on their assigned role (e.g., Customer, Admin, Delivery Staff).
CRUD	Create, Read, Update, Delete - the four basic functions of persistent storage and database operations.
Eloquent ORM	Laravel's Object-Relational Mapping implementation that provides an elegant ActiveRecord interface for working with databases using PHP object-oriented syntax.
Laravel Sanctum	A lightweight authentication system for SPAs (Single Page Applications) and mobile applications, providing token-based API authentication.
Next.js	A React-based framework that enables server-side rendering and static site generation, optimizing performance and SEO for web applications.
TLS	Transport Layer Security - cryptographic protocols designed to provide communications security over a computer network, successor to SSL.

HTTPS	Hypertext Transfer Protocol Secure - an extension of HTTP using encryption via TLS/SSL for secure communication over networks.
JSON	JavaScript Object Notation - a lightweight data-interchange format that is easy for humans to read and write and for machines to parse and generate.

2. OVERALL DESCRIPTION

2.1 Product Perspective

Cloudimart is a standalone, self-contained e-commerce platform specifically designed for geographically restricted markets. Unlike traditional e-commerce systems that operate globally or nationally without location restrictions, Cloudimart operates within predefined geographic boundaries and enforces delivery trust through location-based verification mechanisms.

The system architecture consists of three primary, interconnected components:

Frontend Application: A responsive web application built with Next.js 14, providing the customer-facing interface accessible via modern web browsers on desktop computers, tablets, and mobile devices. The frontend handles user interactions, product browsing, cart management, geolocation capture, and order placement.

Backend API: A RESTful API developed using Laravel 10 framework, following the Model-View-Controller (MVC) architectural pattern. The backend processes business logic, enforces geofence validation, manages authentication and authorization, handles order processing, and coordinates with external services.

Database Layer: A relational database management system (MySQL 8.0+) providing persistent storage for all system data including user accounts, product catalog, orders, delivery zones, transactions, and audit logs. The database ensures data integrity through foreign key constraints and maintains performance through strategic indexing.

The platform integrates with several external systems and services:

- Geolocation API (Browser-based navigator.geolocation) for capturing user GPS coordinates
- SMS Gateway (TNM API) for sending order notifications and delivery confirmations
- Email Service (SMTP/Mailgun) for detailed order communications
- Payment Gateway (Airtel Money/TNM Mpamba - planned integration, simulated in MVP)
- Hosting Infrastructure (Docker-compatible cloud or on-premise servers)

2.2 Product Functions

The Cloudimart platform provides comprehensive e-commerce functionality with specialized features for geofenced operations. Major system functions are organized into six functional modules:

2.2.1 Product Management

- Browse products organized by hierarchical categories (Stationery, Dairy, with subcategories)
- View detailed product information including high-resolution images, descriptions, prices, stock availability
- Search products using keyword-based search with autocomplete suggestions
- Filter and sort products by category, price range, availability, popularity

- Administrative CRUD operations for products: create new products, update existing information, manage inventory, set pricing, upload images, archive discontinued items

2.2.2 Shopping Cart Management
- Add products to persistent shopping cart with quantity selection
- Modify product quantities using increment/decrement controls
- Remove individual items or clear entire cart
- View real-time cart total with itemized price breakdown
- Save cart state across sessions for registered users
- Cart validation before checkout (stock availability, minimum order value)

2.2.3 Geofenced Checkout
- Automatic GPS coordinate capture with user permission request
- Real-time validation of coordinates against configured delivery zones using point-in-polygon algorithm
- Clear visual feedback indicating whether user is within deliverable area
- Prevention of checkout completion for users outside approved zones with informative error messages
- Fallback manual location selection from dropdown for cases with poor GPS accuracy
- Simulated payment processing interface (preparing for actual payment gateway integration)
- Order summary review before final confirmation

2.2.4 Order Processing
- Automatic generation of unique Order ID following format ORD-YYYYMMDD-XXX
- Comprehensive order record creation with timestamp, user details, items, amounts, delivery location
- Inventory adjustment reflecting ordered quantities
- Multi-channel order confirmation via email and SMS
- Order status tracking through defined lifecycle (pending → processing → out_for_delivery → delivered)
- Order history access for customers showing past and current orders
- Administrative order management dashboard with filtering and search
- Order cancellation within defined timeframe

2.2.5 Delivery Verification
- Dedicated delivery staff portal with mobile-optimized interface
- Secure authentication for delivery personnel
- View assigned deliveries with customer details and order summaries
- Two-factor handshake verification requiring Order ID and customer phone number
- Real-time validation against order database
- Automatic order status update to "delivered" upon successful verification
- Delivery confirmation notification sent to customer
- Complete audit trail of delivery events with timestamps

2.2.6 Administrative Functions

- Comprehensive product catalog management with bulk operations
- Category hierarchy management (create, edit, reorganize categories)
- Delivery zone configuration using interactive map interface for polygon drawing
- User account management (create, modify, deactivate user accounts)
- Role and permission assignment (Customer, Admin, Delivery Staff roles)
- Order monitoring dashboard with real-time statistics
- Sales analytics and reporting (revenue, popular products, delivery success rates)
- System configuration management (business rules, notification templates, operational hours)

2.3 User Classes and Characteristics

The Cloudimart platform serves three distinct user classes, each with unique characteristics, needs, and interaction patterns:

2.3.1 Customer

Description: Students enrolled at Mzuzu University, university staff, and residents living within the defined service zones who purchase groceries, stationery, and other essential items.

Demographics: Primarily ages 18-45, with majority being university students (18-25). Mix of male and female users with varying income levels.

Technical Expertise: Basic to intermediate technology skills. Comfortable with smartphone usage, web browsing, and mobile applications. May have limited experience with e-commerce platforms.

Device Usage: Primarily access via smartphones (80%), with some desktop/laptop usage (20%). Devices range from budget Android phones to modern smartphones.

Frequency of Use: Weekly to bi-weekly shopping patterns, with peak usage during weekends and month-start (pay days). Session duration typically 10-20 minutes.

Primary Functions: Browse products, search for specific items, manage shopping cart, complete geofenced checkout, track order status, view order history, update account information.

User Goals: Quick, convenient shopping without physical store visits; reliable delivery within specified timeframes; transparent pricing; easy order tracking; secure transactions.

Pain Points: Limited internet connectivity in some areas, concerns about delivery reliability, price sensitivity, preference for cash-on-delivery (future feature).

Success Metrics: Time to complete purchase < 5 minutes, successful deliveries > 95%, user retention rate > 60%, repeat purchase rate > 40%.

2.3.2 Administrator

Description: Cloudimart staff members responsible for managing the platform, including product managers, operations managers, and system administrators.

Demographics: Professional staff members, typically ages 25-50, with business or technical backgrounds.

Technical Expertise: Intermediate to advanced technical skills. Comfortable with content management systems, data entry, basic analytics, and administrative interfaces. Some may have programming knowledge.

Device Usage: Primarily desktop/laptop computers (70%) for extensive administrative tasks, mobile devices (30%) for monitoring and quick updates.

Frequency of Use: Daily usage throughout business hours. Average session duration 2-4 hours with multiple concurrent tasks.

Primary Functions: Manage product catalog (add/edit/remove products), configure delivery zones using map tools, monitor order flow and statuses, generate sales and performance reports, manage user accounts and permissions, configure system settings and business rules, respond to customer issues.

User Goals: Efficient catalog management, accurate delivery zone configuration, real-time operational visibility, data-driven decision making, streamlined workflows, minimal system downtime.

Success Metrics: Product upload time < 2 minutes, geofence configuration time < 10 minutes per zone, report generation time < 30 seconds, zero data entry errors.

2.3.3 Delivery Staff

Description: Personnel responsible for fulfilling orders, transporting products, and completing deliveries to customers using the two-factor verification system.

Demographics: Ages 20-40, mix of full-time and part-time workers, may include motorcycle/bicycle delivery riders.

Technical Expertise: Basic smartphone literacy. Able to use simple mobile forms and interfaces. May have limited experience with apps but can follow clear visual instructions.

Device Usage: Exclusively mobile devices (smartphones) for on-the-go delivery operations. Budget to mid-range Android devices common.

Frequency of Use: Multiple times daily during delivery shifts (typically 8-12 deliveries per day). Short session duration (1-2 minutes per delivery verification).

Primary Functions: View assigned delivery list, access customer delivery addresses, navigate to delivery locations, perform delivery handshake verification (enter Order ID and customer phone), confirm successful delivery, report delivery issues.

User Goals: Complete deliveries quickly and accurately, minimize verification errors, receive clear navigation instructions, efficient interface requiring minimal data entry.

Success Metrics: Delivery verification time < 60 seconds, verification error rate < 2%, successful deliveries per shift > 90%.

2.4 Operating Environment

The Cloudimart platform operates in a distributed computing environment with specific hardware, software, and network requirements:

2.4.1 Client-Side Environment

Web Browsers: Google Chrome 90+, Mozilla Firefox 88+, Safari 14+, Microsoft Edge 90+, or equivalent modern browsers supporting HTML5, CSS3, JavaScript ES6, and Geolocation API.

Operating Systems: Windows 10/11, macOS 10.15+, Linux (Ubuntu 20.04+), Android 8.0+, iOS 13+.

Hardware Requirements: Minimum 2GB RAM, 1GHz processor, 100MB available storage, GPS-enabled device for location-based features, screen resolution minimum 360x640 pixels.

Network Connectivity: Minimum 2G/3G mobile network or broadband internet connection. System optimized for low-bandwidth scenarios (< 1 Mbps) common in Malawi.

2.4.2 Server-Side Environment

Web Server: Nginx 1.20+ or Apache 2.4+ with mod_rewrite enabled, supporting HTTPS/TLS 1.2+.

Application Server: PHP 8.2+ with required extensions (OpenSSL, PDO, Mbstring, Tokenizer, XML, Ctype, JSON, BCMath), Laravel 10 framework.

Database Server: MySQL 8.0+ or MariaDB 10.6+, with InnoDB storage engine, configured for UTF-8mb4 character encoding.

Operating System: Ubuntu Server 20.04 LTS/22.04 LTS or equivalent Linux distribution, or Docker-compatible containerized environment.

Hardware Requirements: Minimum 2 CPU cores, 4GB RAM, 50GB SSD storage. Recommended: 4 CPU cores, 8GB RAM, 100GB SSD for production deployment.

Backup Infrastructure: Automated daily backup system with 30-day retention, geographically separate backup storage location.

2.4.3 Third-Party Services

SMS Gateway: TNM Mpamba API for sending SMS notifications to Malawi mobile numbers. Requires active API account and sufficient credit balance.

Email Service: SMTP server (Mailgun recommended) for transactional emails. Requires configured sender domain and authentication credentials.

Payment Gateway (Future): Airtel Money and/or TNM Mpamba payment integration. Currently simulated in MVP.

2.5 Design and Implementation Constraints

The following constraints impact the design and implementation of the Cloudimart platform:

2.5.1 Technical Constraints

- Must use Laravel 10 framework for backend development (client requirement)
- Must use Next.js 14 for frontend development (client requirement)
- Must follow MVC architectural pattern as per organizational standards
- Database must be MySQL-compatible for existing infrastructure compatibility
- Must support deployment on Docker containers for DevOps workflow
- API must follow RESTful design principles
- All user-facing text initially in English (Chichewa localization planned for future)
- Must function on 2G/3G networks due to connectivity limitations in target area

2.5.2 Business Constraints

- MVP must be completed by February 18, 2026 for stakeholder presentation
- Initial deployment limited to Mzuzu University community and immediate surroundings
- Product categories limited to Stationery and Dairy for MVP launch
- Payment integration deferred to post-MVP phase (simulated in initial release)
- Budget constraints limit third-party service usage (prefer open-source solutions)
- Must comply with Malawi data protection regulations when enacted
- Delivery operations limited to Monday-Saturday, 8:00 AM - 6:00 PM
- Minimum order value of MWK 2,000 required for sustainable delivery economics

2.5.3 Regulatory and Legal Constraints

- Must obtain explicit user consent for location data collection and processing
- Must provide clear privacy policy and terms of service
- Must implement data protection measures for personally identifiable information (PII)
- Must provide users with ability to request data deletion
- Must maintain transaction records for minimum 7 years for tax compliance
- Must clearly disclose all pricing including taxes and fees before checkout

2.5.4 Environmental Constraints

- GPS accuracy may be degraded in areas with dense building coverage or poor satellite visibility
- Internet connectivity may be intermittent or low-bandwidth in certain service zones
- Power outages common in Malawi requiring robust session management and data persistence
- Road infrastructure varies significantly across delivery zones affecting delivery times
- Limited availability of street addresses requiring GPS-based location identification

3. SYSTEM FEATURES

This section describes the functional requirements organized by system features. Each feature includes a description, priority rating, and detailed functional requirements with unique identifiers.

3.1 Feature: Geofence Validation

3.1.1 Description and Priority

Priority: HIGH

The geofence validation feature is the core differentiating capability of the Cloudimart platform. It ensures that only users physically located within predefined geographical boundaries can complete purchases, directly addressing the primary problem of failed deliveries and location disputes. This feature combines GPS coordinate capture with sophisticated polygon-based validation algorithms.

3.1.2 Functional Requirements

FR-01: GPS Coordinate Capture

- The system shall request user permission to access device location services through browser Geolocation API
- The system shall capture user latitude and longitude coordinates with precision to at least 5 decimal places (approximately 1-meter accuracy)
- The system shall retrieve and display GPS accuracy level (in meters) provided by the device
- The system shall handle permission denial gracefully with clear user messaging
- The system shall provide manual location selection fallback if GPS permission is denied or unavailable

FR-02: Geofence Polygon Validation

- The system shall store delivery zone boundaries as GeoJSON polygon coordinates in the delivery_locations table
- The system shall validate user GPS coordinates against all active delivery zones using ray-casting point-in-polygon algorithm
- The system shall return validation result containing: (a) Boolean indicating inside/outside status, (b) Matched zone name if inside, (c) Nearest zone name if outside
- Validation process shall complete within 2 seconds for typical network conditions
- The system shall log all geofence validation attempts with timestamp, coordinates, and result for audit purposes

FR-03: Checkout Restriction Enforcement

- The system shall prevent checkout if user location is outside all approved delivery zones

- The system shall display user-friendly error message indicating: (a) User is outside delivery area, (b) Nearest approved zone name, (c) Suggestion to move closer or try manual selection
- The system shall allow manual location selection from dropdown list of approved zones if GPS accuracy exceeds 50 meters
- Manual location selection shall require user confirmation with disclaimer about delivery responsibility
- The system shall store selected delivery zone with order record for delivery routing

3.2 Feature: Order ID Generation and Management

3.2.1 Description and Priority

Priority: HIGH

Unique order identification is critical for tracking, delivery verification, customer communication, and system integrity. The Order ID serves as the primary reference for all order-related operations and must be guaranteed unique, easily communicable (verbal and written), and human-readable.

3.2.2 Functional Requirements

FR-04: Order ID Format and Generation

- The system shall generate Order ID in standardized format: ORD-YYYYMMDD-XXX where: YYYY = year, MM = month (01-12), DD = day (01-31), XXX = sequential number (001-999)
- Sequential number shall reset to 001 at start of each calendar day (00:00 local time)
- The system shall guarantee uniqueness of Order ID through database unique constraint on orders.order_id field
- Order ID generation shall be atomic operation to prevent race conditions in concurrent checkouts
- The system shall handle sequential number overflow (>999) by appending additional digit (XXX becomes XXXX)

FR-05: Order Record Creation

- The system shall create order record only after successful payment confirmation (or simulated payment in MVP)
- Order record shall include mandatory fields: order_id (unique), user_id (foreign key), delivery_location_id (foreign key), total_amount (decimal), status (enum), payment_status (enum), created_at (timestamp), updated_at (timestamp)
- The system shall create associated order_items records linking products with quantities and prices at time of purchase
- Initial order status shall be set to "pending" upon creation
- The system shall implement database transaction wrapping order and order_items creation to ensure atomic operation

FR-06: Order ID Communication

- The system shall display Order ID prominently on order confirmation screen immediately after successful checkout
- The system shall send Order ID via email to user's registered email address within 60 seconds of order creation
- The system shall send Order ID via SMS to user's registered phone number within 60 seconds of order creation
- Email notification shall include: Order ID, order summary with items and quantities, total amount, estimated delivery time, delivery address/zone
- SMS notification shall be concise (< 160 characters) containing: Order ID, total amount, delivery zone, customer service contact
- The system shall store Order ID in user account order history for future reference and reordering

3.3 Feature: Order Status Tracking

3.3.1 Description and Priority
Priority: MEDIUM

Order status tracking provides transparency to customers, enables efficient operations management for administrators, and guides delivery staff in fulfillment activities. The status lifecycle reflects the physical journey of the order from placement through delivery.

3.3.2 Functional Requirements
FR-07: Order Status States

The system shall support the following order status states with defined meanings:

> **pending:** Order created and payment confirmed, awaiting preparation and fulfillment assignment

> **processing:** Order is being prepared for delivery, items are being gathered and packaged

> **out_for_delivery:** Order has been dispatched and is currently with delivery staff en route to customer

> **delivered:** Order has been successfully delivered and verified through two-factor handshake

> **cancelled:** Order has been cancelled before delivery (by customer request or administrative action)

4. EXTERNAL INTERFACE REQUIREMENTS

4.1 User Interfaces

The Cloudimart platform provides distinct user interfaces optimized for each user class while maintaining consistent branding, navigation patterns, and interaction paradigms across all interfaces.

4.1.1 General UI Principles

- Mobile-First Design: Primary interface designed for mobile devices (320px-768px width) with responsive adaptation to tablet (769px-1024px) and desktop (1025px+) screens
- Accessibility Compliance: Minimum WCAG 2.1 Level AA conformance including keyboard navigation, screen reader compatibility, sufficient color contrast (4.5:1 for normal text, 3:1 for large text)
- Progressive Enhancement: Core functionality available on all browsers; advanced features (e.g., offline mode) enabled on modern browsers
- Loading States: Clear visual feedback during asynchronous operations using skeleton screens, progress indicators, or loading spinners
- Error Handling: User-friendly error messages avoiding technical jargon, providing actionable guidance for resolution
- Consistent Navigation: Persistent header with logo, cart icon, menu; sticky footer with contact information
- Touch-Friendly: Minimum 44x44px touch targets for buttons and interactive elements (iOS Human Interface Guidelines)
- Performance: Page load time < 3 seconds on 3G networks, Time to Interactive < 5 seconds

5. NON-FUNCTIONAL REQUIREMENTS

5.1 Performance Requirements

NFR-01: Response Time: Product browsing pages shall load within 2 seconds on 3G mobile networks (minimum 384 kbps). Geofence validation shall complete within 2 seconds. Checkout process shall complete within 5 seconds after payment confirmation. API endpoints shall respond within 500ms for 95% of requests.

NFR-02: Throughput: System shall support minimum 50 concurrent user sessions without performance degradation. System shall process minimum 100 orders per day. Database shall handle 1,000 queries per minute during peak hours.

NFR-03: Scalability: System architecture shall support horizontal scaling to 500 concurrent users through load balancing. Database design shall efficiently handle 100,000+ products and 1,000,000+ orders.

5.2 Security Requirements

NFR-04: Authentication: User passwords shall be hashed using Bcrypt with minimum cost factor of 10 or Argon2id. Password minimum length of 8 characters with complexity requirements. Session tokens shall expire after 24 hours of inactivity. Failed login attempts limited to 5 per 15-minute window per IP address.

NFR-05: Authorization: Role-based access control (RBAC) enforcing Customer, Admin, and Delivery Staff permissions. API endpoints shall validate user roles and permissions before executing operations. Delivery verification requires authenticated delivery staff account.

NFR-06: Data Encryption: All HTTP communications shall use HTTPS/TLS 1.2 or higher. Passwords encrypted at rest using bcrypt. Sensitive data fields (payment info when implemented) encrypted using AES-256. Database connections encrypted using SSL/TLS.

NFR-07: Input Validation: All user inputs sanitized to prevent SQL injection using parameterized queries. Cross-Site Scripting (XSS) prevention through output encoding. CSRF protection on all state-changing operations using Laravel CSRF tokens. File upload restrictions by type, size (max 5MB), and virus scanning.

5.3 Software Quality Attributes

NFR-08: Reliability: System uptime target of 99% (maximum 7.2 hours downtime per month) excluding planned maintenance. Mean Time Between Failures (MTBF) target of 720 hours. Graceful degradation if GPS accuracy exceeds 50 meters allowing manual location selection.

NFR-09: Maintainability: Code shall follow PSR-12 coding standards for PHP and ESLint Airbnb style for JavaScript. Minimum 70% code coverage for unit tests. Comprehensive API documentation using OpenAPI 3.0 specification. Database migrations versioned for schema change tracking.

NFR-10: Usability: New users shall complete first purchase within 5 minutes without external assistance. Error messages shall provide clear explanation and remediation steps. Interface shall support English with provision for Chichewa localization.

6. OTHER REQUIREMENTS

6.1 Business Rules

- BR-01: Deliveries operate Monday-Saturday, 8:00 AM - 6:00 PM (Malawi local time)
- BR-02: Minimum order value of MWK 2,000 required for processing
- BR-03: Orders can be cancelled within 30 minutes of placement if status is still "pending"
- BR-04: Products with zero stock shall not appear in customer product listings
- BR-05: Maximum 20 items per cart to ensure delivery vehicle capacity
- BR-06: Dairy products limited to 2-day shelf life from order placement

6.2 Assumptions and Dependencies

System Assumptions:

- Users have smartphones with GPS capability and internet connectivity
- Users grant location permissions to the application
- Malawi mobile network infrastructure provides adequate coverage in service areas
- Users have access to email or SMS for order notifications

External Dependencies:

- TNM SMS gateway availability and reliability
- Email service provider (Mailgun/SMTP) uptime
- Browser Geolocation API support and functionality
- Hosting infrastructure availability (99.9% SLA)
- MySQL database server stability

APPENDIX A: GLOSSARY

ACID: Atomicity, Consistency, Isolation, Durability - properties guaranteeing database transaction reliability

API Key: Secret token used to authenticate API requests

Atomic Operation: Database operation that completes entirely or not at all, preventing partial updates

Ray-casting Algorithm: Method for determining point-in-polygon by counting intersections with polygon edges

Session Token: Cryptographic string identifying authenticated user session

UTC: Coordinated Universal Time - global time standard

APPENDIX B: REQUIREMENTS TRACEABILITY MATRIX

This matrix maps functional requirements to system features, test cases, and priority levels, ensuring comprehensive coverage and traceability throughout the development lifecycle.

Req ID	Requirement Name	Feature Module	Priority
FR-01	GPS Coordinate Capture	Geofence Validation	HIGH
FR-02	Polygon Validation	Geofence Validation	HIGH
FR-03	Checkout Restriction	Geofence Validation	HIGH
FR-04	Order ID Generation	Order Management	HIGH
FR-05	Order Record Creation	Order Management	HIGH
FR-06	Order ID Communication	Notification System	MEDIUM
FR-07	Order Status States	Order Tracking	MEDIUM
NFR-01	Response Time	Performance	HIGH
NFR-04	Authentication	Security	HIGH
NFR-06	Data Encryption	Security	HIGH

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