

Software Requirements Specification (SRS) for Milk Collection Logistics & Route Optimization System

1. Introduction

1.1 Purpose

The purpose of this document is to specify the complete functional and non-functional requirements for the **Milk Collection Logistics & Route Optimization System (MCLROS)**. This system aims to digitalize and optimize the milk collection process for the dairy processing industry by connecting farmers, collection centers, and transport logistics in a single integrated platform.

1.2 Document Conventions

Convention	Format/Example	Description
System Name	MCLROS	Milk Collection Logistics & Route Optimization System
User Roles	Farmer, Driver, Admin	Primary system users
Requirement ID	FR-A.1, NFR-P.2	Functional and Non-Functional Requirement IDs
Key Term	VRP	Vehicle Routing Problem

1.3 Intended Audience and Reading Suggestions

The primary audience includes the development team, project managers, system analysts, and stakeholders (milk company administrators).

- **Developers:** Sections 3 (Functional Requirements) and 4 (Non-Functional Requirements).
- **Project Manager:** Sections 2 (Overall Description) and 5 (Data Model Overview).
- **Stakeholders:** Section 2 (Overall Description) for project scope and objectives.

1.4 Project Scope (Refined from Proposal 1.0)

The MCLROS will be a web-based, multi-user platform focused on the **dynamic optimization of milk collection routes**. It includes interfaces for farmers to register production, an

administration dashboard for logistics management, and a mobile-friendly interface for drivers to follow optimized routes. The core of the system is the **Vehicle Routing Problem (VRP)** solver, which minimizes cost, distance, and time subject to real-world constraints (capacity, time windows).

Out-of-Scope: Payment processing, financial transaction systems

2. Overall Description

2.1 Product Perspective and System Context

The MCLROS is a standalone solution designed to replace manual, paper-based logistics and route planning. It will interface with external services for geospatial data, specifically using the **OpenStreetMap/OSRM Routing Stack** and potentially the **Google Maps Platform** for enhanced services like geocoding and real-time traffic.

2.2 User Characteristics (Refined from Proposal 1.0)

User Role	Access Level	Responsibilities	Technical Proficiency
Farmer	Low (Self-Service)	Production reporting, history tracking, collection monitoring.	Basic smartphone/web usage.
Driver	Medium (Mobile Focus)	Real-time navigation, pickup confirmation, route execution.	Moderate mobile application usage.
Admin	High (Full Control)	System configuration, fleet management, route generation, performance monitoring.	Moderate to High web application usage.

2.3 Operating Environment (Refined from Proposal 2.6)

- **Backend:** Node.js (Express.js)
- **Frontend:** React.js (Web-based for Admin/Farmer, mobile-optimized for Driver)
- **Database:** PostgreSQL (PostGIS for Geo-data) and/or MongoDB
- **Deployment:** Docker containers on Google Cloud Platform (GCP)
- **Routing:** OpenStreetMap (OSM) / Open-Source Routing Machine (OSRM)

2.4 General Constraints

- **Performance:** Route optimization must be completed and displayed within **1 second**.

- **Security:** System must employ **Role-Based Access Control (RBAC)**, **password hashing**, and **JWT** session management. **2FA** is required for Admin accounts.
- **Offline Capability:** The map service shall provide essential routing and navigation functionality in **offline mode** for drivers.

3. Functional Requirements (FR)

The functional requirements are grouped by the primary user roles and the core system function.

3.1 Farmer/Farm Requirements (FR-F)

ID	Description	Source
FR-F.1	Production Submission: The Farmer shall be able to register their daily milk production volume (in liters) and the desired collection time window through the platform.	Req 1
FR-F.2	Production History: The Farmer shall be able to view a chronological log of all submitted production details over a customizable date range.	Req 2
FR-F.3	Earnings History: The Farmer shall be able to view their calculated monthly income, showing the total volume sold and the total amount earned for the provided milk.	Req 3
FR-F.4	Live Truck Tracking: The Farmer shall be able to view the live geographical location of the assigned collection truck when it is en route for their scheduled pickup.	Req 4
FR-F.5	Pickup Confirmation: The Farmer shall receive an automated confirmation message (e.g., SMS/in-app notification) once their registered production is successfully picked up.	Req 5
FR-F.6	Feedback/Complaint Submission: The Farmer shall be able to submit structured feedback or a complaint directly to the System Admin via a dedicated interface.	Req 6

3.2 System Administration Requirements (FR-A)

ID	Description	Source
----	-------------	--------

FR-A.1	Production Overview: The admin shall be able to view a real-time list/card display of all available milk production entries, including farmer/farm name, location (map button), volume (liters), and registration time.	Req 5
FR-A.2	Fleet Management: The admin shall be able to register, remove, and update the status (Available/Unavailable) of collection trucks/lorries, including capacity (liters) and initial depot location.	Req 6
FR-A.3	Route Generation (Core): The System shall automatically calculate and display the globally optimized collection route (VRP solution) based on available milk production, truck capacities, depot locations, and service time constraints.	Req 7, Prop 2.5.4
FR-A.4	Driver Management: The admin shall be able to register, modify, and remove Driver accounts, including assigning a default username and password.	Req 10
FR-A.5	Pickup Notification Management: The Admin shall be able to configure and verify the automated confirmation messages sent to farmers upon pickup confirmation.	Req 8
FR-A.6	Route Analysis & Visualization: The Admin shall be able to visualize the generated routes on an interactive map, including the sequence of stops, estimated travel time, distance, and load per truck.	Prop 2.5.4
FR-A.7	Performance Dashboard: The Admin shall have access to an analytics dashboard showing key performance indicators (KPIs) such as total distance/time saved, fleet utilization, and spoilage rate metrics.	Prop 2.5.4

3.3 Driver Requirements (FR-D)

ID	Description	Source
FR-D.1	Secure Login: The Driver shall be able to log in to the system using a unique username and password assigned by the Admin.	Req 1
FR-D.2	Assigned Routes View: The Driver shall be able to view a list of all collection routes assigned to their specific truck for the current day.	Req 2
FR-D.3	Route Selection: The Driver shall be able to select and activate one of the assigned routes for execution.	Req 4

FR-D.4	Interactive Navigation: Upon route activation, the Driver shall be presented with an interactive map visualizing the optimized path and turn-by-turn navigation instructions for the selected route.	Req 5, Prop 2.5.4
FR-D.5	Offline Route List: If the map service is unavailable (e.g., no internet), the Driver shall still be able to view the list of pickup locations in sequential order, including the farmer's name and address.	Req 6
FR-D.6	Pickup Confirmation: At each stop, the Driver shall be able to confirm the milk collection by scanning a QR code provided by the farmer or collection center, or by manually confirming the collected volume.	Req 7

4. Non-Functional Requirements (NFR)

4.1 Performance Requirements (NFR-P)

ID	Description	Priority
NFR-P.1	Route Calculation Time: The VRP optimization algorithm shall calculate and display the optimal route for a typical collection run (up to 50 stops) within 1 second under normal load conditions.	High
NFR-P.2	Scalability: The system shall support up to 100 concurrent farmers submitting data and 10 concurrent drivers tracking routes without degradation of service response time (> 95% availability).	Medium
NFR-P.3	Map Load Time: Interactive map visualization (route and live tracking) shall load within 2 seconds on a standard mobile network connection (3G/4G).	High

4.2 Security Requirements (NFR-S)

ID	Description	Priority
NFR-S.1	Authentication: All user credentials must be stored using a strong, industry-standard hashing algorithm (e.g., Argon2 or bcrypt).	High
NFR-S.2	Access Control: The system shall strictly enforce Role-Based Access Control (RBAC) to ensure users can only access features and data appropriate for their role (Farmer, Driver, Admin).	High
NFR-S.3	Admin 2FA: Administrative accounts must be secured with mandatory Two-Factor Authentication (2FA) .	High

NFR-S.4	Session Management: User sessions shall be managed using JSON Web Tokens (JWT) with a defined expiration and renewal mechanism.	High
----------------	---	------

4.3 Operational and Quality Requirements (NFR-Q)

ID	Description	Priority
NFR-Q.1	Offline Navigation: The Driver interface must allow pre-downloaded map tiles and the generated route data to provide basic turn-by-turn navigation without an active internet connection.	High
NFR-Q.3	Maintainability: The codebase shall be modular and adhere to modern coding standards to facilitate easy updates and maintenance.	Medium

5. Preliminary Data Model and VRP Constraints

5.1 Key Data Entities

Entity	Attributes	Description
Farmer/Farm	ID, Name, Contact, Location (Geo-Coordinates) , Login Credentials.	Stores farmer registration and fixed location data.
Production Entry	ID, FarmerID, Volume (Liters) , Submission Time , Desired Pickup Window , Status (Pending/Picked Up).	Daily data submitted by farmers.
Truck/Lorry	ID, Plate No., Capacity (Liters) , Current Location, Status (Available/Unavailable).	Fleet details and logistics constraints.
Route	ID, TruckID, DriverID, Date, Optimized Stop Sequence , Total Distance, Total Time, Status (Pending/In Progress/Completed).	Output of the VRP solver.
Driver	ID, Name, Contact, Login Credentials, Assigned TruckID.	Driver details for authentication and route assignment.

5.2 Core VRP Constraints (Vehicle Routing Problem)

The route optimization algorithm (FR-A.3) must specifically address the following constraints:

1. **Truck Capacity:** The sum of milk volumes from all stops assigned to a single truck must not exceed its maximum carrying capacity.
2. **Time Windows:** The arrival time at a farm/collection center must fall within the farmer's **Desired Pickup Window** (or the defined depot operating hours).
3. **Maximum Route Duration:** The total time of a single route (travel + service time) must not exceed a company-defined limit (e.g., 8 hours).
4. **Service Time:** A defined time allowance (e.g., 5-15 minutes) must be added at each pickup location for loading the milk.
5. **Load Balancing:** The solver should strive to distribute the total collection volume as evenly as possible across the available fleet to maximize fleet utilization.