Team Name : Lords of the Runtime

Team Leader Name : Parth Petkar

Problem Statement : Predictive Parking Place Management

MVP OVERVIEW

What It Does

- ParkHero helps drivers easily find and book available parking spots in real time — reducing search time, traffic congestion, and frustration.

How It Works

- Collects live data from traffic, weather, and local events to predict parking demand.
- Shows color-coded **heatmaps** of parking availability.
- Let's user's **book, pay, and navigate** to available spots via a simple app interface.
- Updates dynamically as parking conditions change.

MVP OVERVIEW

- 🔍 **Real-Time Availability** – Live heatmaps show open slots nearby.
- 💸 **Smart Pricing** – Dynamic pricing based on demand and congestion.
- 🧭 **Predictive Insights** – Forecasts parking trends during peak times and events.
- 🏠 **P2P Marketplace** – Homeowners and operators can list and monetize their spaces.
- 📊 **Operator Dashboard** – Manage spaces, track revenue, and view analytics`

Brief about the Idea:

Overview:

Park Hero is an AI-driven, IoT-enabled platform that lets users **find, book, and manage parking spaces** in real time through a React Native app and optional smart hardware.

🧍‍♂️ For Personal Users

- Instantly locate and reserve free or verified parking near any destination.
  Get live heatmaps of availability and dynamic pricing suggestions.
  Verify booking via **OTP / QR unlock** for a secure, contact-free experience.

For Commercial Users

- **Self-Managed Operators (Cafés, Restaurants, Offices)**
  - List and monetize their own parking spaces through the marketplace.
  - Manage bookings, payments, and analytics from a single dashboard.
- **Large-Scale Operators (Malls, Complexes)**
  - Deploy **Smart Parking Locks** (Raspberry Pi + SIM + Sensors + Servo) for fully automated control. Spaces lock automatically when booked and unlock on verified arrival.

Brief about the Idea:

AI Dynamic Pricing + Occupancy Forecasting

- XGBoost / Scikit-learn

API-driven microservices

- (FastAPI + Supabase + Redis + Docker)

Data fusion from traffic, weather, and events

- for accurate predictions

IoT Smart Lock

- ensures real-world automation and zero manual intervention

Result:
A **hybrid marketplace** connecting personal drivers and commercial operators, reducing search time, preventing unauthorized parking, and maximizing space utilization through **AI-powered, sensor-free scalability**.

Brief about the Idea:

1. Data Collection & Preprocessing

Tools: Mapbox API, OpenWeatherMap API, PredictHQ/Calendarific, Redis, RabbitMQ

- Collects **traffic congestion, speed, and high-demand zone data** via Mapbox & Geoapify.
- Integrates **weather** (rainfall, temperature) and **event data** (festivals, gatherings) to refine demand models.
- Uses **RabbitMQ Streams** for **real-time data ingestion**.
- **Redis caching** ensures fast access to frequently used live data.

Brief about the Idea:

2. Backend Architecture

Tools: FastAPI, Supabase, Docker, Redis, Nginx, Render

- Built as **modular microservices** for Heatmap, Booking, Parking, ML Prediction, and Auth.
- Each service runs **asynchronously**, fetching and processing data independently.
- **Supabase** stores normalized data; **Redis** handles caching for real-time responses.
- **Nginx API Gateway** manages routing, rate-limiting, and load balancing.
- **Dockerized deployment** on **Render** for scalability and portability.

FastAPI

supabase

redis

NGINX

Brief about the Idea:

3. Machine Learning & Prediction

Tools: Python, Scikit-learn, XGBoost, MLflow

- **Forecast parking occupancy** using historical traffic, weather, and event inputs.
- **Dynamic pricing model** adjusts rates based on congestion and demand trends.
- **MLflow** enables model tracking, versioning, and automated retraining.
- **Parking duration estimation** by vehicle type, day, and event for better slot turnover.

Brief about the Idea:

4. Marketplace System (P2P + Commercial)

Tools: FastAPI (Booking Service), Supabase, PayU API

- Allows **homeowners, institutions, and operators** to list, manage, and monetize parking spaces.
- **Booking API** manages reservations, calendars, and payments (PayU sandbox).
- Supports **FastTag** integration for future automation.
- Includes **ratings, reputation**, and **operator dashboards** with analytics and feedback modules.

Brief about the Idea:

5. Heatmap Generation & Visualization

Tools: Mapbox GL JS, Mapbox SDK

- Real-time, color-coded **heatmaps** show parking availability:
  🟢 High | 🟡 Moderate | 🔴 Full
- Uses **vector-based Mapbox GL JS** for smooth rendering.
- **WebSocket integration** via FastAPI ensures dynamic, real-time updates.
- Predictive overlays supported on **Mapbox SDK (Android/iOS)**.

6. Deployment

Tools: AWS EC2, Render, Docker, GitHub Actions

- **Containerized microservices** deployed on Render.
- **Static assets** (heatmaps, QR codes) stored in **AWS S3**.
- **CI/CD** via GitHub Actions for continuous integration and updates.

aws docker

HOW DIFFERENT IS IT FROM ANY OF THE OTHER EXISTING IDEAS?

Feature	Existing Solutions	Park Hero
Parking Discovery	Manual/Static	AI-based, real-time availability
Pricing	Fixed	Dynamic AI pricing
Hardware	None/Manual Gates	Smart IoT Lock (servo, magnetometer, MPU6050)
Connectivity	Wi-Fi / Bluetooth	GSM (SIM-based, always connected)
Verification	Manual / Camera	OTP / QR secure unlock
Car Detection	Camera / Manual	Sensor-based auto-detection
Users	Drivers only	Drivers + Property Owners
Automation	Partial	Fully automated (lock control + status)

HOW WILL IT BE ABLE TO SOLVE THE PROBLEM?

🧠 **1. Reduces Time & Traffic**
Predicts real-time parking availability using **AI + live data (traffic, weather, events)**.
Directs drivers to likely free spots, reducing **search time, congestion, and fuel waste**.

🔐 **2. Ensures Guaranteed & Secure Parking**
Booked spots are reserved with a **smart IoT lock** that blocks unauthorized vehicles.
Access granted only through **OTP/QR verification**, ensuring **reliable, contactless entry**.

⚙️ **3. Automates Management for Businesses**
Commercial owners can list and manage their spaces easily.
For large facilities, **smart locks** handle occupancy automatically — no human staff needed.

HOW WILL IT BE ABLE TO SOLVE THE PROBLEM?

💸 **4. Balances Demand with Dynamic Pricing**
AI-driven **dynamic pricing** adjusts rates based on demand, time, and events.
Optimizes space usage and revenue while ensuring fairness for users.

🌎 **5. Scalable, Sensor-Free, and City-Ready**
Uses public APIs (traffic, weather, events) instead of physical sensors → **low-cost, high coverage**.
Works anywhere via **SIM-based connectivity**, making deployment easy and scalable.

Park Hero eliminates parking chaos by combining AI intelligence, IoT automation, and secure digital booking, creating a seamless, reliable, and data-driven parking ecosystem for cities, businesses, and drivers alike.

USP OF PROPOSED SOLUTION

🚀 **1. End-to-End Smart Parking Ecosystem**
Unlike most apps that only *list* or *book* parking spots, Spot Hero provides a **complete solution** — from digital booking to physical space control using a **smart IoT lock**.
➡️ **Software + Hardware integration** = 100% reliability and automation.

🧠 **2. AI-Based Dynamic Pricing**
Spot Hero uses AI to predict demand and adjust prices automatically, similar to how Uber manages surge pricing.
➡️ Ensures **fair rates for users** and **maximum revenue** for commercial space owners.

🔐 **3. Secure, Verified Access (OTP / QR Unlock)**
Every booked parking spot can only be accessed by the verified user through **OTP or QR-based unlocking**, preventing unauthorized use.
➡️ Guarantees that the **booked spot is truly reserved** for the customer.

USP OF PROPOSED SOLUTION

⚙️ **4. Self-Automated Smart Lock**
The **servo-based parking lock** powered by **Raspberry Pi, magnetometer, and accelerometer** detects when a car arrives or leaves — automatically raising or lowering the barrier.
➡️ **No manual intervention**, **no guards needed**.

📶 **5. Always Connected (SIM-Based Communication)**
Each lock uses a **SIM module**, meaning it can operate without Wi-Fi — even in open lots or basements.
➡️ Enables **deployment anywhere**, making it scalable across cities.

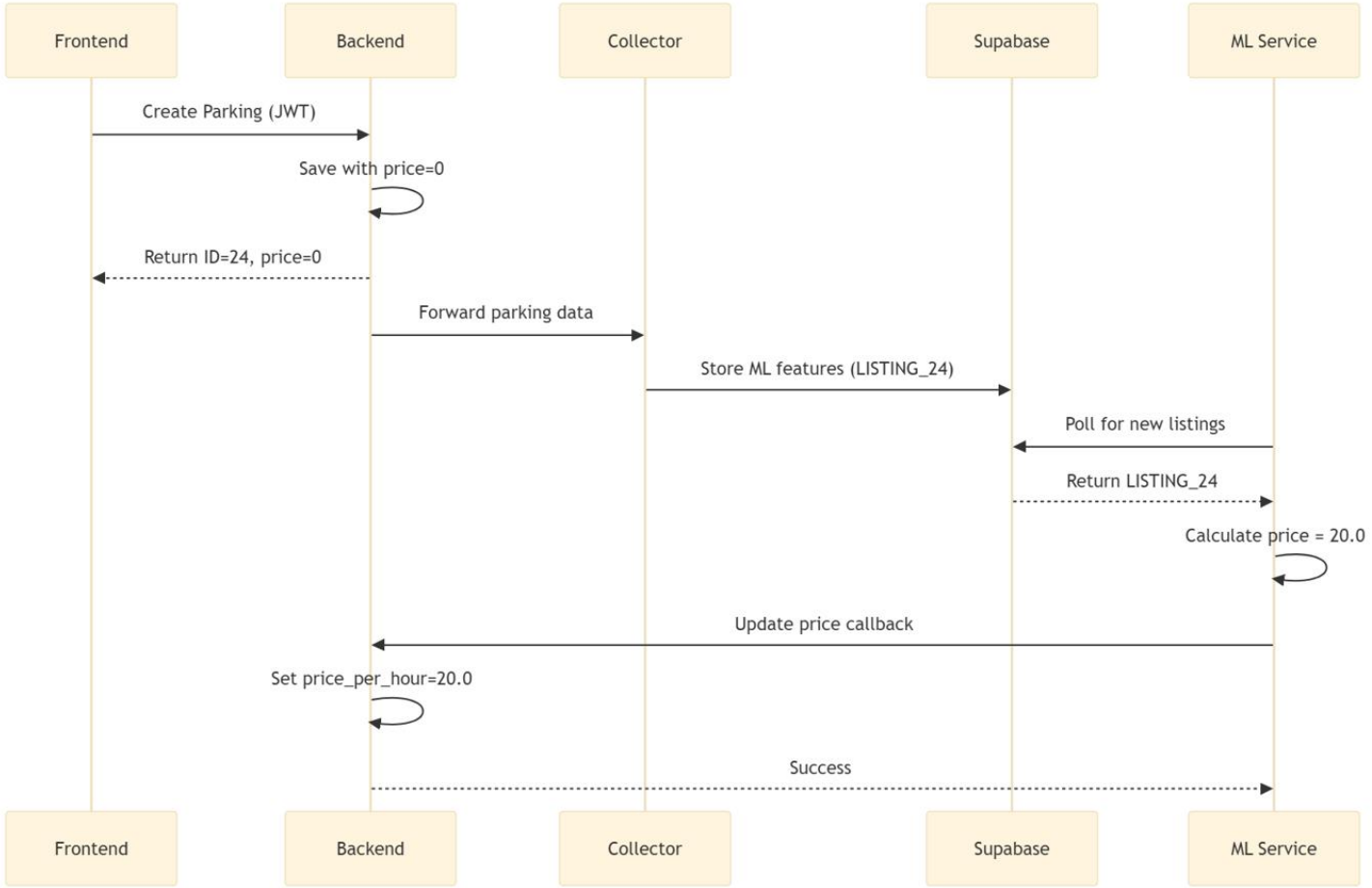
🧩 **6. Dual-Use Ecosystem (B2C + B2B):**
Serves **individual users** looking for parking and **business owners** who want to monetize idle parking spaces.
Creates a connected network of verified parking zones.

List of features offered by the solution

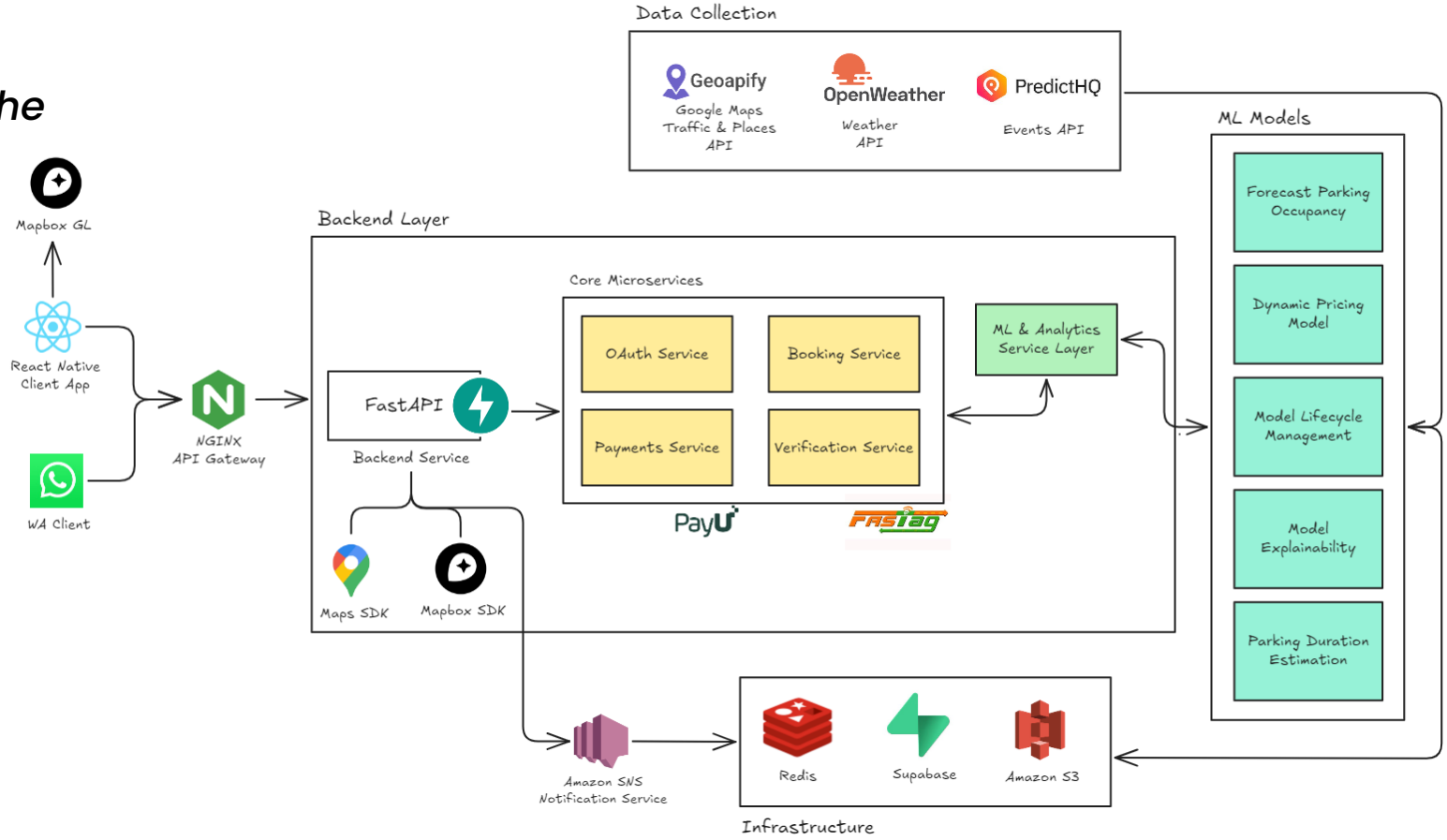
- Predictive, color-coded heatmap with confidence indicators.
- P2P listing & booking (calendar, pricing, images, reviews).
- Commercial operator onboarding & inventory management.
- Booking lifecycle: reserve → pay (sandbox) → check-in/checkout (QR / FastTag / OTP).
- Dynamic pricing engine & operator dashboard (revenue, occupancy analytics).
- Crowdsourced reporting (one-tap free/occupied with optional photo).

Process Flow:

Creating a new paid parking listing

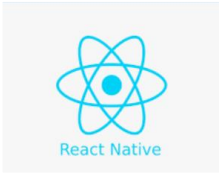


Architecture Diagram Of The Proposed Solution



Technologies to be used in the solution:

- React Native
- MapBox GL
- Scikit Learn, Numpy, Pandas
- FastAPI
- Redis
- OpenWeather
- Supabase
- Render

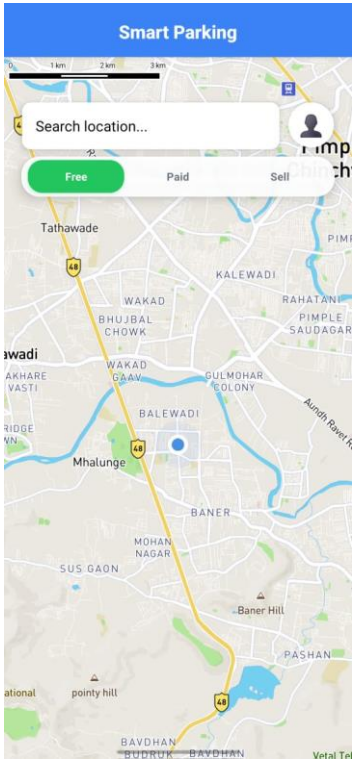


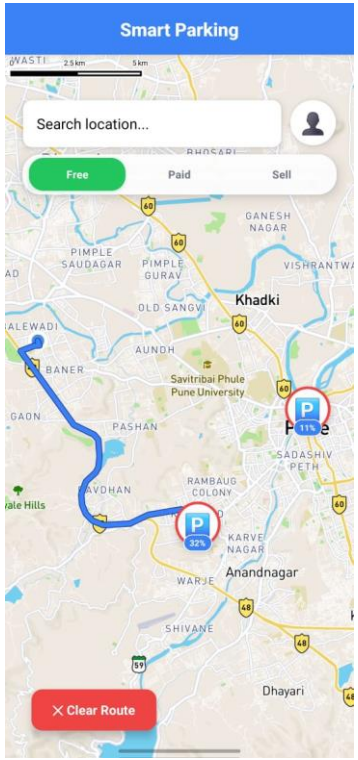
Estimated implementation cost (optional):

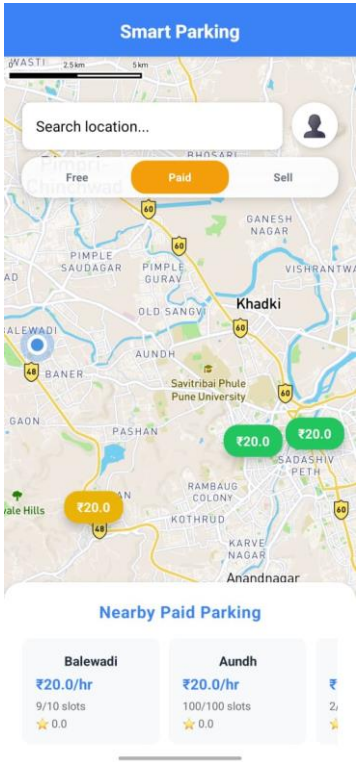
- Software implementation is **FREE OF COST**; however, server hosting and maintenance expenses may arise as the system scales.
- For users opting for the IoT-enabled smart parking solution, the hardware cost is approximately ₹8,000 per unit. When produced at an industry scale cost will decrease to ₹3000-3500.

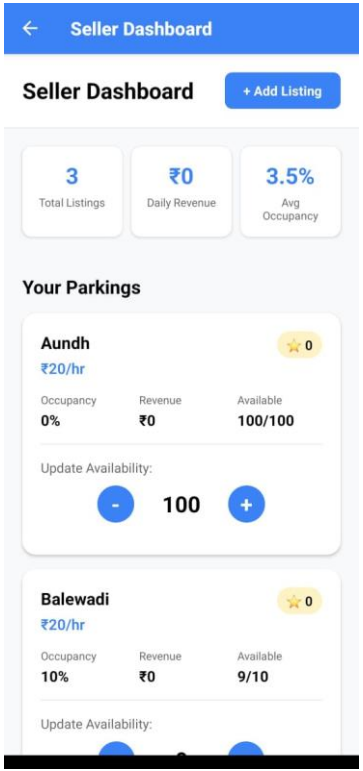
Components	Estimated Cost
Electronics + Sensors + Pi	₹6,000
Mechanics + Casing + Power	₹2,000
Total (per unit)	**₹8,000**

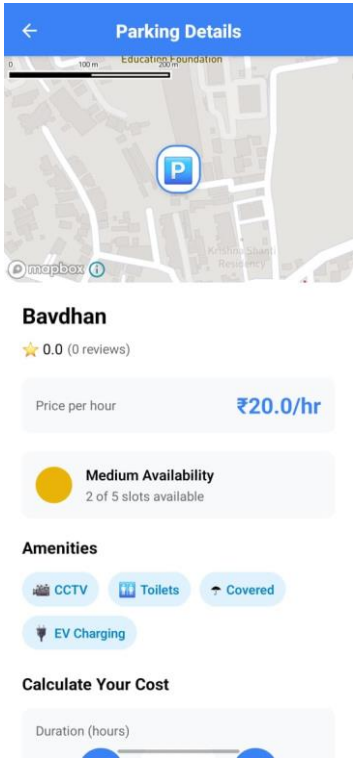
Snapshots of the Prototype



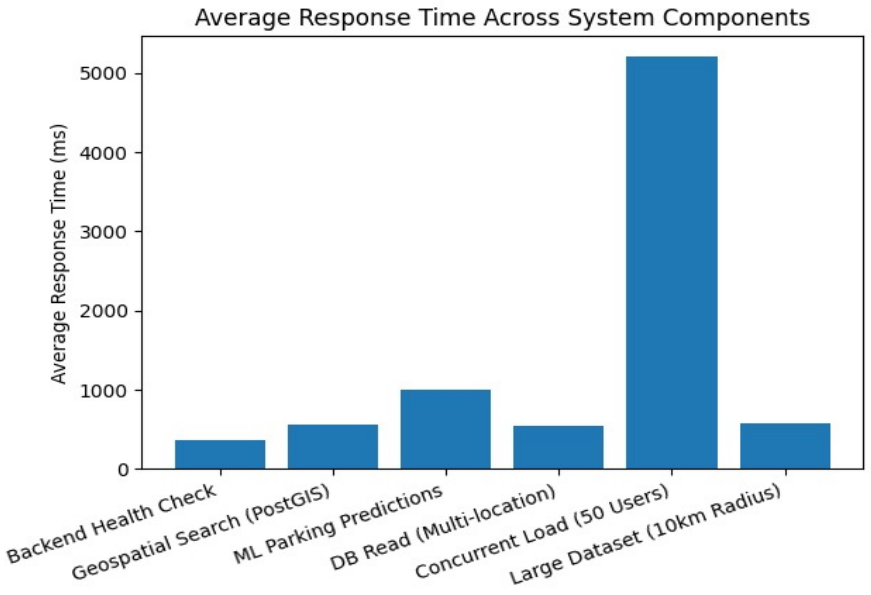


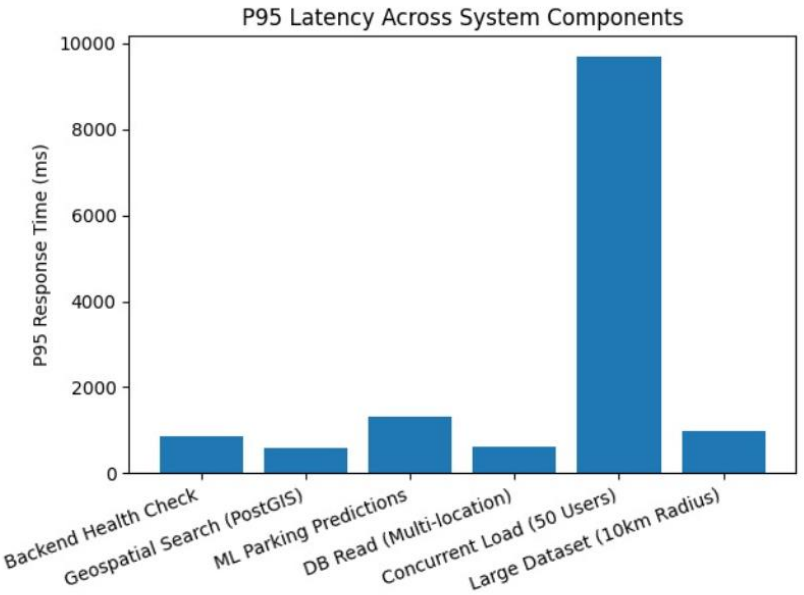




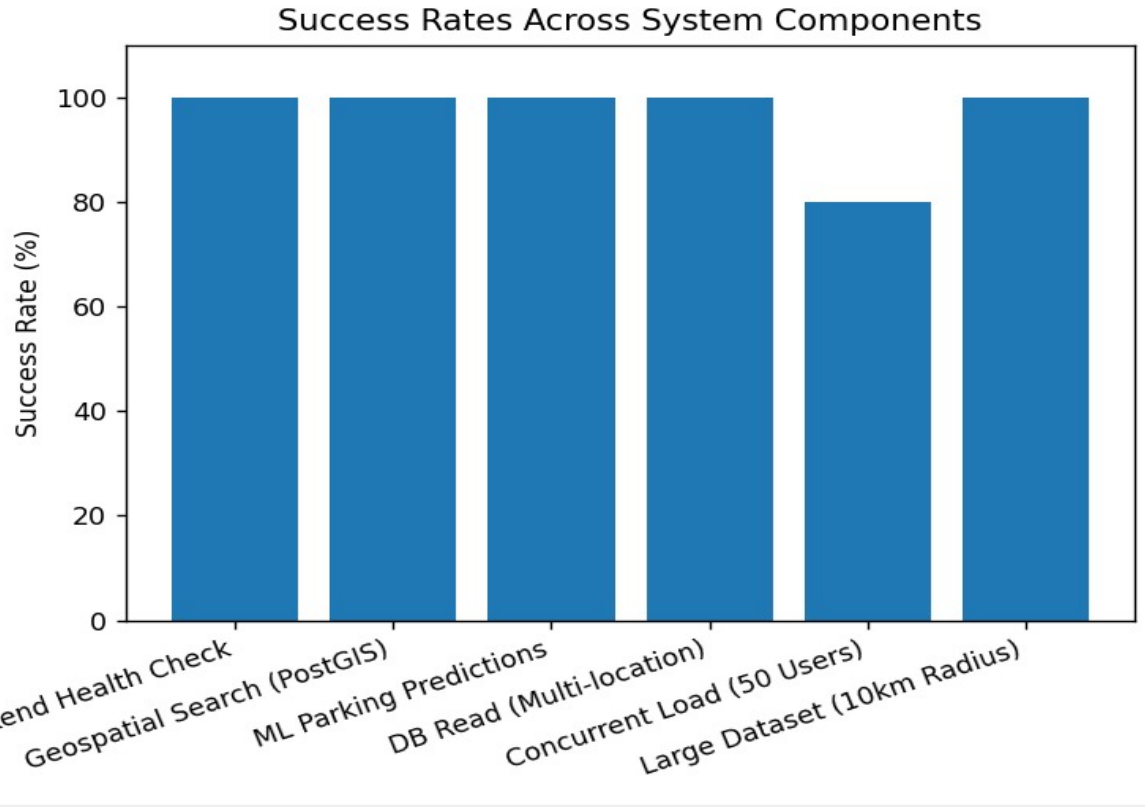


Prototype Performance report/Benchmarking





Prototype Performance report/Benchmarking



Additional Details/Future Development (if any)

PayU: Seamless, secure, one-click payments & dynamic billing.

360° Parking View: Immersive visuals for better parking decisions.

Operator Dashboard: Real-time analytics, occupancy, and dynamic control.

Explainable AI (SHAP): Transparent model insights for trust & debugging.

Smartphone Sensors: Real-time traffic & occupancy detection using mobile data.

Crowdsourced Data: Continuous accuracy improvement via user input.

Smart City Integration: Unified ecosystem with EV, pollution & mobility data.

Github & Demo video URL

GitHub Link - https://github.com/parthpetkar/i.mobilothon

Demo Video URL (You tube) - https://www.youtube.com/watch?v=oyV-yxdzriU

Demo Video URL (Google Drive) - https://drive.google.com/drive/folders/1-wgqprJRAGO1s9kClrestwgYWK1P0Eh4?usp=sharing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