

TiffinTrails: Software Documentation

CSC-510: Software Engineering Project 2

Version 1.0.0

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1 Introduction

TiffinTrails is a data-driven, reward-based platform designed to address food waste challenges in the restaurant and food delivery ecosystem. This project is part of the CSC-510 Software Engineering course and demonstrates modern software development practices including full-stack web development, data analysis, API design, and modular architecture.

Food waste and inefficient delivery remain major challenges for restaurants and food platforms, increasing costs and environmental impact. **TiffinTrails** tackles this through a data-driven, reward-based system that tracks delivery efficiency, waste reduction, and sustainability. Restaurants earn badges and improved scores for minimizing waste and offering rescue meals—discounted portions that prevent food loss—while customers enjoy fresher, eco-friendly choices. By combining analytics, incentives, and transparency, **TiffinTrails** promotes smarter, sustainable dining for all.

The platform consists of a web application where customers can browse partner restaurants, view their efficiency metrics, discover rescue meals at discounted prices, add items to their cart, and place orders. When customers purchase rescue meals, restaurants are rewarded with points and improved efficiency scores, creating a positive feedback loop that incentivizes sustainable practices.

Why TiffinTrails?

Every year, millions of tons of perfectly good food end up in landfills while millions of people struggle with food insecurity. Traditional food delivery platforms prioritize speed and convenience, but ignore the environmental and economic costs of food waste. **TiffinTrails** changes this narrative by creating a win-win solution: customers save money on delicious meals while restaurants reduce waste and earn rewards for sustainable practices.

Our platform transforms food waste from a problem into an opportunity. By connecting environmentally conscious customers with restaurants committed to sustainability, we're building a community that values both great food and a healthier planet. Every rescue meal purchased is a vote for a more sustainable future—a future where technology, data, and human values align to create meaningful change.

Join us in revolutionizing how we think about food delivery. Together, we can turn the tide on food waste, one rescue meal at a time.

Motivation

Traditional food delivery platforms focus primarily on convenience and speed, often overlooking the environmental and economic costs of food waste. **TiffinTrails** addresses this gap by:

- Providing transparency into restaurant efficiency metrics

- Creating incentives for restaurants to minimize waste through rescue meal programs
- Empowering customers to make sustainable choices while saving money
- Building a data-driven foundation for continuous improvement in delivery operations
- Enabling seamless order placement through cart functionality

Objectives

The primary objectives of this project are:

- To design and implement a full-stack web application with modular frontend and backend components
- To generate and process synthetic datasets that simulate real-world restaurant and delivery operations
- To compute quantitative efficiency scores for restaurants based on delivery performance and waste metrics
- To create a user-friendly interface for customers to discover restaurants and rescue meals
- To establish a reward system that incentivizes sustainable practices
- To implement cart functionality and order placement system
- To demonstrate reproducibility, clarity, and maintainability through strong documentation and testing

2 Target Users

2.1 Who Should Use TiffinTrails?

TiffinTrails is designed for three primary user groups, each with distinct needs and goals:

2.1.1 Customers

Ideal Users:

- **Environmentally Conscious Consumers:** Individuals who want to reduce their carbon footprint and support sustainable practices while enjoying quality meals
- **Budget-Conscious Food Lovers:** People seeking delicious restaurant meals at discounted prices (up to 40% off through rescue meals)
- **Local Community Supporters:** Customers who want to support local restaurants and contribute to community food waste reduction efforts

- **Tech-Savvy Millennials and Gen Z:** Users comfortable with web applications who value transparency, data-driven decisions, and mobile-friendly interfaces

Use Cases:

- Finding affordable lunch options near work or home
- Discovering new restaurants with strong sustainability practices
- Making environmentally responsible dining choices
- Tracking personal impact on food waste reduction
- Supporting local businesses while saving money

2.1.2 Restaurants

Ideal Users:

- **Local and Independent Restaurants:** Establishments looking to reduce food waste and operating costs while attracting environmentally conscious customers
- **Restaurants with Surplus Food:** Businesses that frequently have prepared meals approaching expiration and want to minimize waste
- **Sustainability-Focused Establishments:** Restaurants committed to environmental responsibility and seeking recognition for their efforts
- **Data-Driven Operations:** Restaurants interested in analytics and metrics to improve delivery efficiency and reduce waste

Use Cases:

- Reducing food waste and associated costs
- Attracting new customer segments interested in sustainability
- Improving delivery efficiency metrics
- Earning points and badges for sustainable practices
- Gaining visibility in a competitive market through efficiency scores

2.1.3 Researchers and Analysts

Ideal Users:

- **Data Scientists:** Researchers studying food waste patterns, delivery efficiency, and sustainability metrics
- **Environmental Researchers:** Academics investigating the impact of technology on food waste reduction
- **Policy Makers:** Government and NGO representatives exploring data-driven solutions for food waste

Use Cases:

- Analyzing correlation between delivery efficiency and waste metrics
- Studying the effectiveness of reward-based systems in promoting sustainability
- Accessing synthetic datasets for research purposes
- Understanding patterns in restaurant operations and customer behavior

3 Software Overview

3.1 Project Structure

The folder structure below represents the modular organization of the project:

Proj2/

```
data/                                # Dataset files (CSV, JSON)
  cleaned_master_dataset.csv
  Customer_Feedback.csv
  Delivery_Logs.csv
  Menu_Portions.csv
  rescue_meals.csv
  Restaurant_Metadata.csv
  vendor_delivery_metrics.csv
  vendor_efficiency_scores.csv

src/                                  # Source code
  data_generator.py    # Synthetic data generation
  data_loader.py       # Data loading and cleaning
  delivery_metrics.py  # Delivery performance metrics
  efficiency_scoring.py # Restaurant efficiency scoring
  rescue_meals_integration.py # Rescue meal data generation

backend/                          # Node.js backend API
  server.js               # Express server
  routes/                 # API route handlers
    home.js              # Home routes
    cart.js              # Cart and order routes
  data/                   # Data storage
    restaurant_points.json
    orders.json
  secrets/                # User credentials
    users.js
```

```
api/                                # Python Flask API
  app.py                            # Flask REST API server

frontend/                           # React frontend application
  src/
    App.jsx                        # Main application component
    components/                   # React components
      Home.jsx
      LoginChoice.jsx
      CustomerLogin.jsx
      Dashboard.jsx
      Cart.jsx
      RestaurantCard.jsx
      ImpactCard.jsx
      Navbar.jsx
    data/                         # Static data
  package.json

analysis/                           # Data analysis modules
  correlate_efficiency_waste.py

visualization/                      # Visualization modules
  efficiency_waste_viz.py

README.md
SE_Proj2_Documentation.pdf
```

3.2 Purpose of Each Module

3.2.1 Backend Modules

- **data_generator.py:** Generates realistic synthetic datasets for restaurant meta-data, menu portions, and waste data.
- **data_loader.py:** Loads, validates, and integrates all generated data into a single clean master dataset for analysis.
- **delivery_metrics.py:** Computes performance metrics such as average delivery time, on-time rate, average distance, and deliveries per day for each restaurant.
- **efficiency_scoring.py:** Merges metrics and metadata to compute an overall restaurant efficiency score using a weighted formula.

- **rescue_meals_integration.py:** Generates rescue meal data for restaurants, including meal names, original prices, discounted rescue prices, quantities, and expiration times.
- **backend/server.js:** Express.js server providing REST API endpoints for user authentication, order placement, and restaurant points management. Handles CORS and JSON parsing.
- **backend/routes/home.js:** Route handlers for restaurant data and impact statistics endpoints.
- **backend/routes/cart.js:** Route handlers for order placement, restaurant points retrieval, and order history. Manages restaurant points increment when rescue meals are ordered.
- **analysis/correlate_efficiency_waste.py:** Performs statistical analysis to correlate delivery efficiency with waste metrics, providing insights for restaurant improvement.
- **visualization/efficiency_waste_viz.py:** Creates visualizations and charts for efficiency and waste data analysis.

3.2.2 Frontend Components

- **Home.jsx:** Landing page displaying TiffinTrails mission, partner restaurants, and community impact statistics. Features a call-to-action to join the platform.
- **LoginChoice.jsx:** Login selection page allowing users to choose between customer or restaurant login. Restaurant login is marked as "Coming Soon" for future implementation.
- **CustomerLogin.jsx:** Customer authentication interface with email and password fields. Validates credentials against stored user data.
- **Dashboard.jsx:** Main customer dashboard displaying available restaurants with their menus, distance, on-time rate, efficiency scores, and rescue meal availability. Features cart icon navigation, browse and rescue meal views, and cart management integration.
- **Cart.jsx:** Cart page component displaying order items in a table format. Features quantity management, item removal, order summary with savings calculation, and order placement functionality. Shows success message after order placement and tracks rescue meal impact.
- **RestaurantCard.jsx:** Component rendering individual restaurant information cards with key metrics and action buttons.
- **ImpactCard.jsx:** Component displaying user environmental impact metrics.
- **Navbar.jsx:** Navigation component providing consistent navigation across the application.

3.2.3 API Module

- **api/app.py:** Flask REST API server providing endpoints for efficiency-waste correlation analysis, health checks, and data access. Uses Flask-CORS to enable cross-origin requests from the frontend.

4 System Architecture and User Flow

4.1 Application Flow

TiffinTrails follows a clear user journey:

1. **Home Page:** Users land on the homepage which showcases:
 - TiffinTrails mission and values
 - Partner restaurants and their cuisine types
 - Community impact statistics (meals rescued, waste prevented, active users)
 - Call-to-action button to join the platform
2. **Login Selection:** Users choose between customer or restaurant login. Currently, only customer login is implemented; restaurant login is designated for future milestones.
3. **Customer Authentication:** Customers enter their email and password credentials. The system validates against stored user data and authenticates valid users.
4. **Customer Dashboard:** After successful login, customers see:
 - Navigation bar with Browse, Rescue Meals, My Impact, and Community tabs
 - Cart icon in the top right corner showing number of items
 - List of available partner restaurants with:
 - Restaurant name and cuisine type
 - Distance from customer location
 - On-time delivery rate percentage
 - Efficiency score and sustainability metrics
 - Available rescue meals (if any)
 - Rescue meal sections showing discounted meals with expiration times
 - "Rescue" or "Rescue This Meal" buttons to add items to cart
5. **Cart Page:** When customers click the cart icon, they navigate to the cart page which displays:
 - Table of all cart items with columns for item name, restaurant, price, quantity, total, and actions
 - Quantity controls (+/- buttons) to modify item quantities
 - Remove item functionality

- Order summary sidebar showing subtotal, savings, and final total
- Impact points message indicating rescue meals in the order
- "Place Order" button to complete the purchase

6. **Order Placement:** When customers click "Place Order":

- Order is sent to backend API (POST /api/orders)
- Restaurant points are calculated and updated (10 points per rescue meal)
- Order record is saved with timestamp, items, totals, and points earned
- Success message is displayed: "Order Placed Successfully!"
- Impact message shows number of rescue meals saved
- Cart is automatically cleared
- Option to continue shopping and return to dashboard

7. **Restaurant Rewards:** When customers place orders with rescue meals:

- Restaurants receive points (10 points per rescue meal ordered)
- Points are stored in `restaurant_points.json`
- Order history is maintained in `orders.json`
- Restaurant efficiency scores can be updated based on points earned
- Positive feedback loop encourages waste reduction

4.2 Future Milestones

The upcoming development goals for TiffinTrails focus on expanding functionality, intelligence, and sustainability-driven features:

- **Restaurant Portal and Analytics Dashboard:**

Build a dedicated restaurant dashboard to manage rescue meals, analyze delivery performance, and monitor waste reduction metrics. The dashboard will also feature visual analytics and performance trends.

- **Smart Insights and Recommendation Engine:**

Develop a data-driven engine that provides actionable recommendations for optimizing delivery routes, minimizing waste, and improving overall operational efficiency.

- **Gamified Reward System:**

Introduce an engaging reward mechanism for both customers and restaurants to promote sustainable practices, offering badges, points, and incentives for consistent eco-friendly participation.

- **Sustainability Analytics and API Integration:**

Enhance sustainability tracking by integrating external APIs and environmental databases to calculate real-time carbon savings and food waste reduction metrics.

- **Integrated Payment System:**

Implement a secure payment processing module for customer orders, supporting multiple payment methods and providing transaction history within the app.

5 Quick Start Guide

This section provides a concise walkthrough for new users to get TiffinTrails running locally.

5.1 Prerequisites

- Python 3.8 or higher
- Node.js 16.x or higher and npm
- Required Python libraries:

```
pandas
numpy
flask
flask-cors
```

- Required JavaScript libraries (managed via npm):

```
react
react-dom
react-router-dom
express
cors
tailwindcss
```

- Ensure that Git and pip are properly configured on your system.

5.2 Installation

Follow these steps to set up and deploy the software:

```
# Clone the repository

git clone https://github.com/YashDhavale/CSC-510-SE-Project.git

# Navigate to project directory

cd CSC-510-SE-Project/Proj2
```

```
# Install Python dependencies

pip install pandas numpy flask flask-cors

# Install backend dependencies

cd src/backend

npm install

# Install frontend dependencies

cd ../frontend

npm install

# Return to Proj2 directory

cd ../../
```

After installation, verify the environment by executing:

```
python --version

node --version

npm --version

pip list
```

5.3 Step-by-Step Deployment Instructions

This section provides clear, detailed instructions for deploying and using TiffinTrails. Follow each step in order to ensure successful deployment.

5.3.1 Step 1: Generate Synthetic Datasets

Purpose: Create the necessary data files for the application to function.

Instructions:

1. Open a terminal or command prompt
2. Navigate to the Proj2 directory:

```
cd CSC-510-SE-Project/Proj2
```

3. Run the data generator script:

```
python src/data_generator.py
```

4. Run the rescue meals integration script:

```
python src/rescue_meals_integration.py
```

5. **Verification:** Check that CSV files have been created in the `data/` directory:

- Restaurant_Metadata.csv
- Delivery_Logs.csv
- Customer_Feedback.csv
- Menu_Portions.csv
- rescue_meals.csv
- Raleigh_Food_Waste__1-week_sample_.csv

5.3.2 Step 2: Load and Clean Data

Purpose: Integrate all datasets into a unified, clean format.

Instructions:

1. From the Proj2 directory, run:

```
python src/data_loader.py
```

2. **Verification:** Confirm that `cleaned_master_dataset.csv` has been created in the `data/` directory.

5.3.3 Step 3: Compute Delivery Metrics

Purpose: Calculate performance metrics for each restaurant.

Instructions:

1. Run the delivery metrics script:

```
python src/delivery_metrics.py
```

2. **Verification:** Check that `vendor_delivery_metrics.csv` has been created in the `data/` directory.

5.3.4 Step 4: Calculate Efficiency Scores

Purpose: Compute overall restaurant efficiency scores.

Instructions:

1. Run the efficiency scoring script:

```
python src/efficiency_scoring.py
```

2. **Verification:** Confirm that `vendor_efficiency_scores.csv` has been created in the `data/` directory.

5.3.5 Step 5: Start Backend API Server

Purpose: Launch the Express.js server to handle API requests.

Instructions:

1. Navigate to the backend directory:

```
cd src/backend
```

2. Start the server:

```
node server.js
```

3. **Verification:** You should see the message: "Server running on `http://localhost:5000`"
4. **Note:** Keep this terminal window open. The server must remain running for the application to work.
5. **Troubleshooting:** If port 5000 is already in use:
 - Windows: `netstat -ano | findstr :5000` then `taskkill /PID <PID> /F`
 - Mac/Linux: `lsof -ti:5000 | xargs kill -9`

5.3.6 Step 6: Start Frontend Development Server

Purpose: Launch the React application in your browser.

Instructions:

1. Open a **new** terminal window (keep the backend server running)
2. Navigate to the frontend directory:

```
cd CSC-510-SE-Project/Proj2/src/frontend
```

3. Start the React development server:

```
npm start
```

4. **Verification:** Your default web browser should automatically open to `http://localhost:3000`
5. If the browser doesn't open automatically, manually navigate to `http://localhost:3000`
6. **Note:** Keep this terminal window open as well. Both servers must run simultaneously.

5.4 Testing the Application

1. Navigate to `http://localhost:3000` in your browser
2. You should see the TiffinTrails homepage
3. Click "Join Us Today" or navigate to the login page
4. Select "Customer" login
5. Use test credentials (see `src/backend/secrets/users.js`) to log in
6. Explore the dashboard with restaurant listings and metrics
7. Click on rescue meals or browse restaurants to add items to cart
8. Click the cart icon in the top right corner
9. Review your order in the cart page table
10. Click "Place Order" to complete the purchase
11. Verify the success message and order confirmation

6 Mini-Tutorials: Common Use Cases

This section provides step-by-step worked examples for common use cases, demonstrating how to accomplish specific tasks with TiffinTrails.

6.1 Tutorial 1: Finding and Ordering a Rescue Meal

Scenario: You're a customer looking for an affordable lunch option while supporting sustainable practices.

Step-by-Step Instructions:

1. **Access the Application:** Open your web browser and navigate to `http://localhost:3000`
2. **Login:** Click "Get Started" or "Join Us Today" on the homepage

3. **Select Customer Login:** Choose "Customer" from the login options
4. **Enter Credentials:** Use your email and password to log in (or register a new account if needed)
5. **Navigate to Rescue Meals:** Once logged in, click the "Rescue Meals" tab in the navigation bar
6. **Browse Available Meals:** You'll see a grid of available rescue meals with:
 - Meal name and restaurant
 - Original price (crossed out) and rescue price
 - Expiration time (e.g., "2 hours")
 - Available quantity
7. **Select a Meal:** Click "Rescue This Meal" button on your desired item
8. **Verify Cart:** Check the cart icon in the top right - it should show "1" indicating one item added
9. **View Cart:** Click the cart icon to review your order
10. **Review Order Details:** In the cart page, verify:
 - Item name and restaurant
 - Price (showing savings)
 - Quantity (default is 1)
11. **Place Order:** Click the "Place Order" button
12. **Confirm Success:** You should see "Order Placed Successfully!" message with impact information
13. **Continue Shopping:** Click "Continue Shopping" to return to the dashboard

Expected Outcome: You've successfully ordered a rescue meal at a discounted price, saved money, and contributed to food waste reduction. The restaurant has earned 10 points for the rescue meal.

6.2 Tutorial 2: Managing Cart Items and Quantities

Scenario: You want to order multiple items and adjust quantities before placing your order.

Step-by-Step Instructions:

1. **Add Multiple Items:** From the dashboard or rescue meals page, add 2-3 different items to your cart
2. **Open Cart:** Click the cart icon (should show the number of items)
3. **Review Cart Table:** You'll see all items listed with:

- Item name with rescue meal badge (if applicable)
- Restaurant name
- Price information
- Current quantity
- Total price per item
- Action buttons

4. **Increase Quantity:** Click the "+" button next to an item to increase quantity
5. **Decrease Quantity:** Click the "-" button to decrease (minimum is 1)
6. **Remove an Item:** Click the trash icon to remove an item completely
7. **Check Order Summary:** Look at the sidebar on the right:
 - Subtotal updates automatically
 - Total savings shown (for rescue meals)
 - Final total displayed
 - Impact points message (if rescue meals included)
8. **Adjust as Needed:** Continue modifying quantities until satisfied
9. **Place Order:** When ready, click "Place Order"
10. **Verify Totals:** Confirm the order summary matches your expectations

Expected Outcome: You've successfully managed your cart, adjusted quantities, and placed an order with multiple items. The order summary accurately reflects your selections and savings.

6.3 Tutorial 3: Exploring Restaurant Efficiency Metrics

Scenario: You want to find restaurants with the best sustainability scores and delivery efficiency.

Step-by-Step Instructions:

1. **Login to Dashboard:** Access the customer dashboard after logging in
2. **View Browse Tab:** Ensure you're on the "Browse" tab (default view)
3. **Review Restaurant Cards:** Each restaurant card displays:
 - Restaurant name and cuisine type
 - Star rating and review count
 - Sustainability score (green badge)
 - Average delivery time
 - On-time delivery rate percentage

- Average distance
 - Waste reduction percentage
4. **Use Search Function:** Type a restaurant name or cuisine type in the search bar
 5. **Filter by Cuisine:** Use the dropdown menu to filter by cuisine type (e.g., "Indian", "BBQ", "Deli")
 6. **Click Restaurant:** Click on a restaurant card to view detailed information
 7. **Review Detailed Metrics:** In the restaurant detail view, see:
 - Four metric cards: Sustainability, Delivery, Efficiency, Waste Cut
 - Specific numerical values for each metric
 - Available rescue meals (if any)
 8. **Compare Restaurants:** Navigate back and compare different restaurants
 9. **Check Rescue Meals:** Look for restaurants with rescue meals available (indicated by orange badges)
 10. **Make Informed Choice:** Use the efficiency scores and metrics to choose a restaurant

Expected Outcome: You've successfully explored restaurant metrics, compared efficiency scores, and made an informed decision based on sustainability and delivery performance data.

6.4 Tutorial 4: Tracking Personal Impact

Scenario: You want to see your personal contribution to food waste reduction and environmental impact.

Step-by-Step Instructions:

1. **Login to Dashboard:** Access your customer account
2. **Navigate to My Impact:** Click the "My Impact" tab in the navigation bar
3. **View Impact Metrics:** You'll see four key metrics:
 - **Meals Rescued:** Total number of rescue meals you've ordered
 - **Waste Prevented:** Total pounds of food waste prevented
 - **Carbon Reduced:** Total kilograms of carbon emissions reduced
 - **Money Saved:** Total dollars saved through rescue meal discounts
4. **Check Impact Level:** View your current impact level badge (e.g., "Sustainability Champion")
5. **Review Restaurant Support:** See how many local restaurants you've supported

6. **Place More Orders:** Continue ordering rescue meals to increase your impact
7. **Monitor Progress:** Return to "My Impact" periodically to see your metrics grow
8. **Share Achievement:** Use your impact level as motivation to continue sustainable dining

Expected Outcome: You've successfully viewed your personal environmental impact metrics and understand your contribution to food waste reduction. The dashboard motivates continued participation in the rescue meal program.

7 Detailed Documentation

This section provides comprehensive explanations of each source file, their major functions, parameters, and intended outputs.

7.1 Backend Data Processing

7.1.1 data_generator.py

Purpose: Generates synthetic datasets that simulate real-world restaurant operations.

Key Functions:

- `generate_waste_data(n)` – Creates weekly food waste dataset with timestamps and quantities
- `generate_restaurant_metadata()` – Builds restaurant profiles with names, cuisines, locations, and contact information
- `generate_customer_feedback()` – Simulates customer review data with ratings and comments
- `generate_menu_portions()` – Generates menu item data with portion sizes and prices
- `generate_delivery_logs()` – Produces delivery activity logs with timestamps, distances, and status

Usage:

```
from src.data_generator import main

main()  # generates all datasets under /data
```

Each generated dataset is saved as a CSV file under the `data/` directory and can be reused across modules.

7.1.2 data_loader.py

Purpose: Loads, validates, and integrates datasets into a unified structure.

Key Functions:

- `load_csv(name)` – Loads CSV files into pandas DataFrames with error handling
- `basic_clean(df)` – Cleans string values, removes duplicates, and handles missing data
- `integrate_all()` – Merges all datasets into one unified table using appropriate join keys

Usage:

```
from src.data_loader import integrate_all

merged_df = integrate_all()
```

This module ensures dataset integrity before analytical processing.

7.1.3 delivery_metrics.py

Purpose: Processes delivery data to calculate vendor KPIs.

Computed Metrics:

- Average delivery time per restaurant
- On-time delivery rate (percentage of deliveries within estimated time)
- Average delivery distance
- Deliveries per day (average)

Usage:

```
from src.delivery_metrics import compute_delivery_metrics

compute_delivery_metrics("data/Delivery_Logs.csv",
                        "data/vendor_delivery_metrics.csv")
```

7.1.4 efficiency_scoring.py

Purpose: Combines delivery metrics with restaurant metadata to compute a normalized efficiency score.

Formula:

$$\text{Efficiency Score} = 0.4(\text{on_time_rate}) + 0.3(1 - \text{norm_delivery_time}) + 0.2(1 - \text{norm_distance}) + 0.1(\text{norm_deliveries_per_day})$$

Where normalization is performed relative to the dataset min/max values.

Usage:

```
from src.efficiency_scoring import compute_efficiency_scores
compute_efficiency_scores("data/vendor_delivery_metrics.csv",
                           "data/Restaurant_Metadata.csv",
                           "data/vendor_efficiency_scores.csv")
```

This computation allows the evaluation of delivery efficiency in a quantitative, comparable form.

7.1.5 rescue_meals_integration.py

Purpose: Generates rescue meal data for restaurants with surplus food.

Key Data Fields:

- Restaurant name
- Meal name
- Original price
- Rescue price (discounted)
- Available quantity
- Expiration time (hours until expiration)

Usage:

```
python src/rescue_meals_integration.py
```

Generates both CSV and JSON formats for easy integration with API and frontend.

7.2 Backend API (Node.js/Express)

7.2.1 backend/server.js

Purpose: Express.js server providing REST API endpoints and middleware configuration.

Key Features:

- CORS configuration for cross-origin requests
- JSON body parsing middleware
- User authentication endpoints (POST /login, POST /register)

- Route integration for home and cart modules
- Port configuration (default: 5000)

Usage:

```
cd src/backend  
  
node server.js
```

The server initializes restaurant points and orders data files if they don't exist.

7.2.2 backend/routes/home.js

Purpose: Route handlers for restaurant data and impact statistics.

Endpoints:

- GET `/restaurants` – Returns restaurant metadata from CSV files
- GET `/impact` – Returns community impact statistics including total meals rescued, waste prevented, and active users

7.2.3 backend/routes/cart.js

Purpose: Route handlers for order placement, restaurant points management, and order history.

Key Functions:

- Initializes restaurant points file with default values (0 points for all restaurants)
- Initializes orders file as empty array
- Processes order placement and calculates restaurant points

Endpoints:

- POST `/api/orders` – Places a new order
 - Request body: `{items: Array, totals: Object}`
 - Validates order data
 - Calculates points earned (10 points per rescue meal)
 - Updates restaurant points in JSON file
 - Creates order record with ID, timestamp, items, totals, and points earned
 - Saves order to `orders.json`
 - Returns success response with order details
- GET `/api/restaurant-points` – Retrieves current restaurant points
 - Returns JSON object with restaurant names as keys and points as values

- GET `/api/orders` – Retrieves all order history
 - Returns array of all orders with full details

Restaurant Points System:

- Each rescue meal ordered earns the restaurant 10 points
- Points are cumulative and persist across sessions
- Points are stored in `data/restaurant_points.json`
- Points can be used to calculate restaurant rankings and rewards

7.3 Frontend Components

7.3.1 App.jsx

Purpose: Main application component managing routing and state.

Key Features:

- State management for current page and user authentication
- Navigation between Home, Login Choice, Customer Login, and Dashboard
- User login handling and session management
- User data passing to Dashboard component

7.3.2 Home.jsx

Purpose: Landing page component showcasing platform mission and features.

Key Sections:

- Hero section with mission statement
- Feature highlights (Save Planet, Save Money, Support Local)
- Partner restaurants grid
- Community impact statistics
- Call-to-action button

7.3.3 LoginChoice.jsx

Purpose: Allows users to select their account type.

Features:

- Customer login option (active)
- Restaurant login option (marked as "Coming Soon")
- Feature lists for each account type
- Navigation back to home page

7.3.4 CustomerLogin.jsx

Purpose: Customer authentication interface.

Features:

- Email and password input fields
- Form validation
- Credential verification against user database via API
- Error handling for invalid credentials
- Navigation to dashboard upon successful login

7.3.5 Dashboard.jsx

Purpose: Main customer interface displaying restaurant information and cart management.

Key Features:

- Navigation bar with multiple views:
 - Browse – List of all restaurants
 - Rescue Meals – Filtered view of available rescue meals
 - My Impact – User’s environmental impact statistics
 - Community – Community-wide statistics
- Cart icon in header with item count badge
- Restaurant listings with menu information, distance metrics, on-time rate percentage, efficiency score, and rescue meal availability
- Add to cart functionality for rescue meals
- Cart state management
- Navigation to cart page
- Favorite restaurants functionality
- Search and filter by cuisine type

7.3.6 Cart.jsx

Purpose: Cart page component for order review and placement.

Key Features:

- **Order Items Table:** Displays all cart items with columns for item name (with rescue meal badge indicator), restaurant name, price (showing original and rescue prices for rescue meals), quantity controls (increase/decrease buttons), total price per item, and remove item button

- **Order Summary Sidebar:** Shows subtotal calculation, total savings display (for rescue meals), final total, and impact points message showing rescue meal count
- **Quantity Management:** Increase/decrease quantity buttons with minimum quantity of 1 enforced and real-time total recalculation
- **Order Placement:** "Place Order" button with API call to `POST /api/orders`, loading state during order processing, success message display, automatic cart clearing after successful order, and continue shopping option
- **Empty Cart State:** Message when cart is empty with button to return to browse page
- **Success State:** Confirmation message "Order Placed Successfully!", impact message showing rescue meals saved, and option to continue shopping

7.4 API Endpoints

7.4.1 Node.js Backend (Express)

- `POST /login` – Customer authentication
 - Request body: `{email: string, password: string}`
 - Returns: `{success: boolean, user: Object}`
- `POST /register` – Customer registration
 - Request body: `{name: string, email: string, password: string}`
 - Returns: `{success: boolean, message: string}`
- `POST /api/orders` – Place order
 - Request body: `{items: Array, totals: Object}`
 - Returns: `{success: boolean, order: Object, message: string}`
 - Updates restaurant points automatically
- `GET /api/restaurant-points` – Get restaurant points
 - Returns: `{success: boolean, points: Object}`
- `GET /api/orders` – Get order history
 - Returns: `{success: boolean, orders: Array}`
- `GET /restaurants` – Get restaurant data
 - Returns: Array of restaurant objects from CSV
- `GET /impact` – Get impact statistics

- Returns: `{mealsRescued: number, wastePreventedTons: number, communityImpact: number}`
- GET / – Root endpoint
 - Returns: "Backend is running successfully!"

7.4.2 Python Flask API (Legacy)

- GET /api/efficiency-waste-correlation – Returns correlation and regression analysis results between delivery efficiency and waste metrics
- GET /api/health – Health check endpoint for API status
- GET / – Root endpoint with API information and available endpoints

Response Format:

The efficiency-waste correlation endpoint returns JSON with:

- Correlation coefficients (Pearson and Spearman)
- Regression model coefficients and R^2 scores
- Summary of strong correlations
- Number of restaurants analyzed

8 Efficiency Scoring System

8.1 Scoring Methodology

The efficiency score is a composite metric that evaluates restaurant performance across multiple dimensions:

- **On-Time Rate (40%):** Weighted highest as it directly impacts customer satisfaction
- **Delivery Time (30%):** Normalized inverse of average delivery time (faster = higher score)
- **Distance Efficiency (20%):** Normalized inverse of average delivery distance (shorter = higher score)
- **Delivery Volume (10%):** Normalized deliveries per day (higher = better, indicating operational capacity)

8.2 Reward System

When customers place orders, especially for rescue meals:

1. Restaurants receive **points** (10 points per rescue meal ordered)
2. Points are stored in `restaurant_points.json` and persist across sessions
3. Restaurant efficiency scores can be **incremented** based on:
 - Number of rescue meals sold
 - Points accumulated
 - Customer feedback ratings
 - Waste reduction metrics
4. Higher efficiency scores improve restaurant visibility and ranking in the platform
5. Orders are tracked in `orders.json` with full details including order ID, timestamp, items ordered, totals and savings, and points earned per restaurant

This creates a positive feedback loop: restaurants that actively reduce waste receive better scores, improved visibility, and more customer orders.

9 Data Analysis and Visualization

9.1 Statistical Analysis

The `analysis/correlate_efficiency_waste.py` module performs:

- Pearson correlation analysis between efficiency metrics and waste data
- Spearman rank correlation for non-parametric relationships
- Linear regression modeling to predict waste based on efficiency metrics
- Summary statistics identifying strong correlations for actionable insights

9.2 Visualization

The `visualization/efficiency_waste_viz.py` module generates:

- Scatter plots showing efficiency vs. waste relationships
- Time series charts for waste trends
- Bar charts comparing restaurant efficiency scores
- Heatmaps for correlation matrices

10 Testing

10.1 Frontend Testing

The frontend includes unit tests using Jest and React Testing Library:

- `CustomerLogin.test.jsx` – Tests login form validation and submission
- `HomePage.test.jsx` – Tests homepage rendering and navigation
- `LoginChoice.test.jsx` – Tests login choice selection

Run tests with:

```
cd src/frontend  
  
npm test
```

10.2 Backend Testing

Backend modules can be tested by:

1. Verifying data generation produces expected CSV files
2. Checking data loading produces clean, integrated datasets
3. Validating metric calculations against known values
4. Testing API endpoints with sample requests:
 - Test order placement with sample cart data
 - Verify restaurant points are incremented correctly
 - Check order history is saved properly
 - Validate authentication endpoints

10.3 Integration Testing

Test the complete order flow:

1. Log in as a customer
2. Add rescue meals to cart
3. Navigate to cart page
4. Verify cart items display correctly
5. Place an order
6. Verify success message appears
7. Check restaurant points are updated
8. Verify order appears in order history

11 Troubleshooting

- **ModuleNotFoundError:**

Ensure all dependencies are installed via

`pip install pandas numpy flask flask-cors` and `npm install` in backend and frontend directories.

- **FileNotFoundError:**

Run `data_generator.py` and `rescue_meals_integration.py` before executing downstream modules.

- **Empty Dataset:**

Check that the data directory is correctly generated and accessible. Verify file paths in configuration.

- **Frontend Build Errors:**

Ensure Node.js and npm are properly installed. Delete `node_modules` and run `npm install` again.

- **API Connection Errors:**

Verify the Express API server is running on port 5000. Check CORS configuration if frontend cannot connect.

- **Port Already in Use:**

If port 3000 (React) or 5000 (Express) is occupied, change ports in configuration or stop the conflicting process.

- **Cart Not Updating:**

Verify cart state is properly managed in Dashboard component. Check browser console for errors.

- **Order Placement Fails:**

Ensure backend server is running and `data/` directory exists with write permissions. Check that `restaurant_points.json` and `orders.json` are initialized.

If persistent issues occur, verify your Python and Node.js environments, check file paths, and consult GitHub issues for support.

12 Release History

12.1 Version 1.0.0 (Initial Release - Current)

Release Date: November 7, 2025

Key Features:

- Complete modular pipeline for generating, cleaning, and analyzing synthetic data for restaurant efficiency scoring

- Full-stack web application with React frontend and Express backend
- Customer authentication and registration system
- Restaurant browsing with efficiency metrics and sustainability scores
- Rescue meal discovery and integration
- Cart functionality with quantity management and item removal
- Order placement system with automatic restaurant points calculation
- Restaurant points tracking and persistence
- Order history management
- Impact tracking for customers (meals rescued, waste prevented, carbon reduced)
- Statistical analysis modules for efficiency-waste correlation
- Visualization modules for data analysis
- Comprehensive API endpoints for data access and order management

12.2 Planned Future Releases

Version 1.1.0 (Planned)

- Restaurant login and dashboard for managing rescue meals
- Real-time order tracking and status updates
- Enhanced restaurant analytics dashboard
- Customer order history page

Version 1.2.0 (Planned)

- Payment processing integration
- Mobile application support
- Real-time notifications for rescue meal availability
- Advanced analytics dashboard for restaurants
- Integration with delivery tracking systems

Version 2.0.0 (Planned)

- Smart Insights and Recommendation Engine
- Gamified Reward System with badges and achievements
- Enhanced sustainability analytics with external API integration
- Multi-city expansion
- Restaurant partnership program

13 Revision Control

Documentation and source code are managed under GitHub version control.

All revisions, commits, and updates are publicly visible in:

<https://github.com/YashDhavale/CSC-510-SE-Project>

Each commit is associated with a descriptive message that records bug fixes, enhancements, or documentation improvements. Version control ensures traceability and collaborative reliability.

14 Conclusion

TiffinTrails integrates data engineering, analytics, and web development to create a comprehensive platform for reducing food waste and promoting sustainable dining practices.

The modular architecture spans backend data processing, REST API services (both Node.js/Express and Python/Flask), and modern frontend interfaces, following professional software engineering standards. The reward-based system creates incentives for restaurants to minimize waste while providing customers with eco-friendly, affordable meal options through an intuitive cart and order placement system.

The cart functionality enables seamless order management with quantity controls, item removal, and real-time price calculations. The order placement system automatically tracks restaurant points, creating a transparent and rewarding experience for both customers and restaurants. This implementation demonstrates the team's ability to design structured, traceable, and extensible software, combining automation, analytics, and user experience design for better data-driven decisions and environmental impact.

15 References

- Python Software Foundation. Python Language Reference, version 3.10.
- <https://pandas.pydata.org/>
- <https://numpy.org/>
- <https://reactjs.org/>
- <https://expressjs.com/>
- <https://flask.palletsprojects.com/>
- <https://tailwindcss.com/>
- <https://jestjs.io/>
- <https://github.com/YashDhavale/CSC-510-SE-Project>