



# ROUTE SENSE: REVOLUTIONIZING LAST-MILE DELIVERIES USING TSP AND TRAFFIC ENGINEERING

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## TEAM 36

### INTRODUCTION

#### PROBLEM STATEMENT:

Inefficiencies in last-mile delivery in Saudi Arabia's e-commerce, including large delivery windows and suboptimal routing, leads to increased fuel consumption, delivery times, and customer dissatisfaction.



Hi Nawaf,

Your package will be delivered between 9:00 AM - 9:00 PM by our Amazon Delivery Agent.

Manage Your Order

This email was sent from an email address that can't receive emails. Please don't reply to this email.

### CONSTRAINTS

#### Constraints From the Delivery Driver:

- **Delays:** The driver may face unexpected delays or no-shows for the delivery
- **Safety:** Must relay the correct routes and ensure the necessary safety measures.
- **Legal:** All parties involved must adhere to the local regulations and traffic laws.
- **Technology Dependence:** Disconnections of the servers, interruptions of the internet service and battery life.

#### Constraints From the Retailer/Company:

- **Scalability:** Scaling the application scope to specific companies can prove challenging.
- **Integration:** Companies have different systems.
- **Price:** Companies want to ensure that the cost of the application is justified.
- **Communication:** A lack of a support line or a direct communication link can negatively impact the reputation of Route sense and its main features.

#### Constraints From the End Customers:

- **Location Accuracy:** Users may inadvertently provide incorrect information.
- **Schedule and Time Issues:** Handling each conflicted schedule for each end user will be difficult.

### TARGET SPECIFICATIONS

- 1 **Easy to Use Mobile App:** Provide an easy-to-use application for the driver.
- 2 **Customer Data Access:** Enable drivers to access customer location, enhancing delivery accuracy.
- 3 **Multi-Platform Support:** Available on iOS and Android platforms, covering over 80% of smartphone users.
- 4 **TSP and VRP Implementation:** Improve delivery routes efficiency by 20% to up to 30%.
- 5 **Fast Model Calculations:** The model calculates in less than 5 seconds.
- 6 **Creation of a Concept Car:** a newly designed concept car with efficiency in mind.
- 7 **Fuel Savings:** reduction of fuel consumption depending on route up to 20%.
- 8 **Clear Time Windows:** provide precise delivery time windows.
- 9 **Privacy Assurance:** Guarantee user data privacy.

### PROJECT IMPACT

#### Economic Impact:

Route Sense can have a big economic impact in Saudi Arabia by increasing daily deliveries per driver. This boosts efficiency and lowers shipping costs, potentially encouraging more customer orders. Additionally, it could spur growth in skilled labor sectors like logistics, transportation, software development, and data analysis.

#### Societal Impact:

By optimizing routes for both individual and company drivers, Route Sense promotes sustainability and resource efficiency. This leads to reduced emissions, cost savings, and time management benefits. Businesses can operate more efficiently, fostering growth. Moreover, decreased traffic congestion translates to lower pollution levels, benefiting public health and safety. Additionally, reduced rush delivery pressures may contribute to fewer car accidents.

#### Environmental Impact:

By optimizing routes with Route Sense, CO2 emissions from delivery vehicles in Saudi Arabia can be significantly reduced. For instance, assuming a 20% reduction in distance covered, the emissions drop from 235,000 grams to 188,000 grams per 1000 km for an average driver. This reduction in CO2 emissions has multiple environmental benefits:

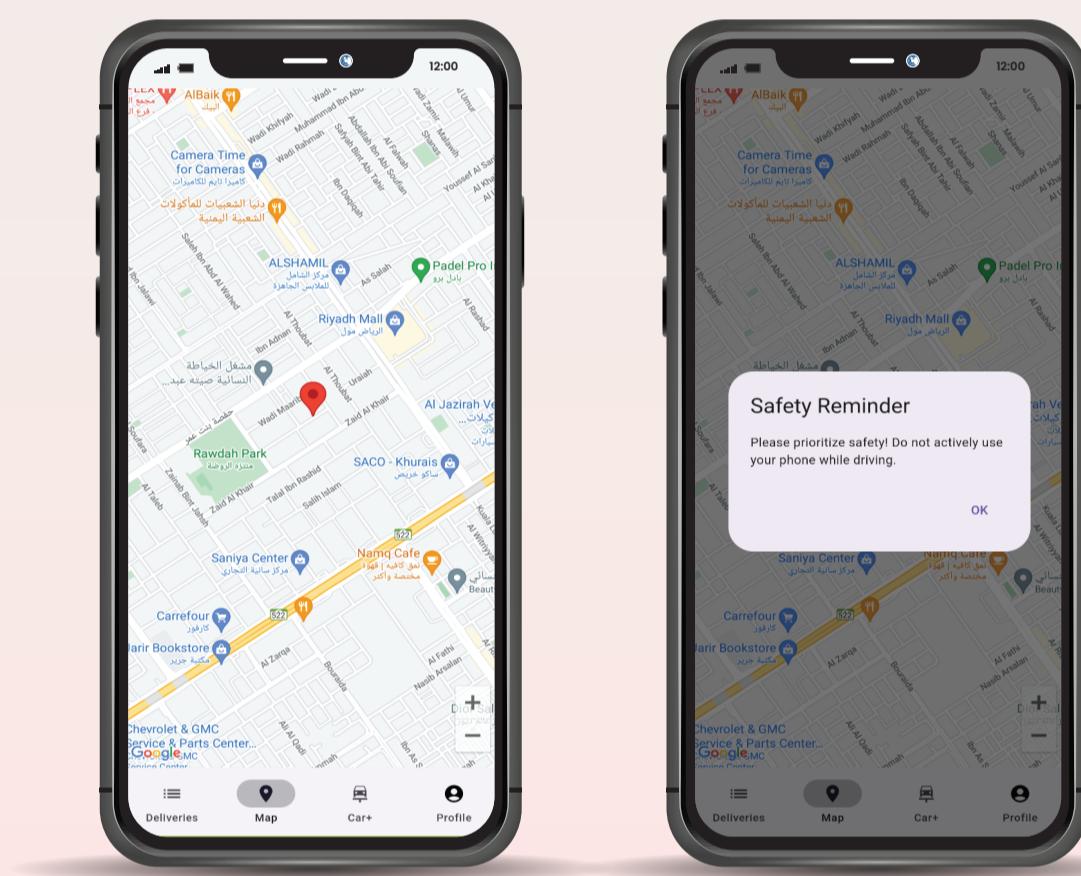
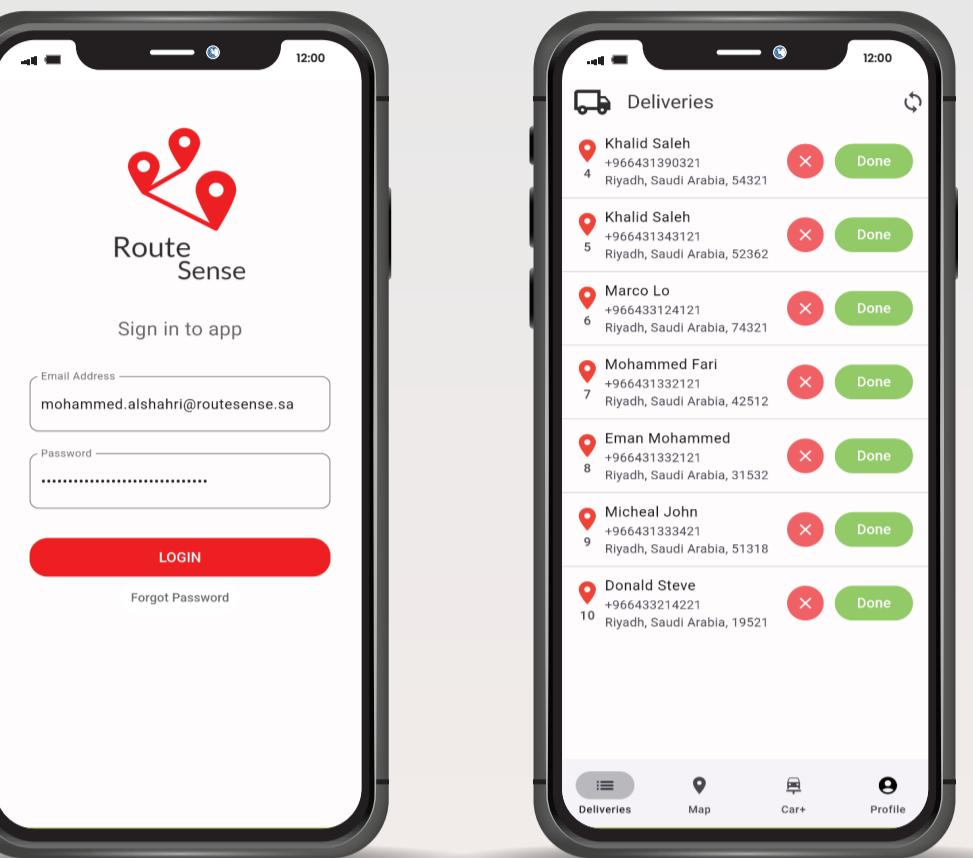
- 1 **Reduced Pollution:** Cleaner air and healthier surroundings for plants, animals, and humans.
- 2 **Combating Climate Change:** Decrease the rate of climate change, preserving ecosystems, preventing extreme weather events, and safeguarding sensitive wildlife.
- 3 **Conservation of Natural Resources:** Reduction in demand for oil and other fossil fuels, contributing to the sustainability of natural resources.
- 4 **Improved Public Health:** Minimizes the release of other dangerous pollutants, such as nitrogen oxides and particulate matter.

### TRAFFIC IMPACT ASSESSMENT (TIA)

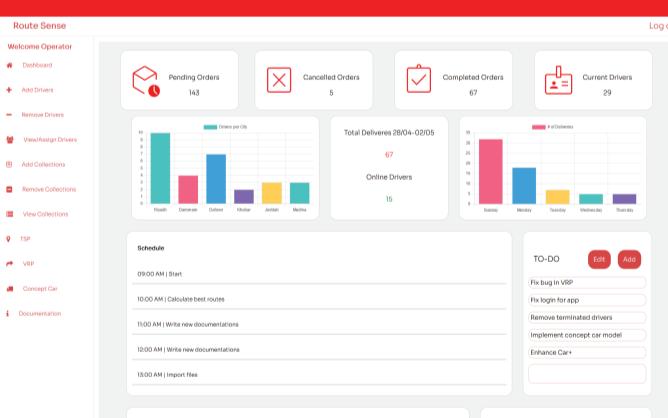
A traffic impact assessment (TIA) is a tool that helps to evaluate the probable impacts of projects on the existing and future traffic conditions. Our program's database provides understandings into road utilization, so to perform an infrastructure assessment that meets the needs of last-mile delivery optimization, allowing for evaluation of the condition of the current transportation infrastructure and suggesting the upgrades needed, data from the software can be utilized.

### PROTOTYPE

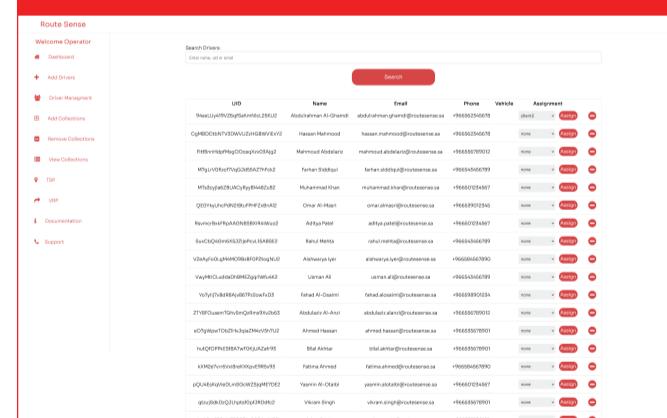
We offer a multitude of project components such as a mobile application, an admin dashboard, and a concept car.



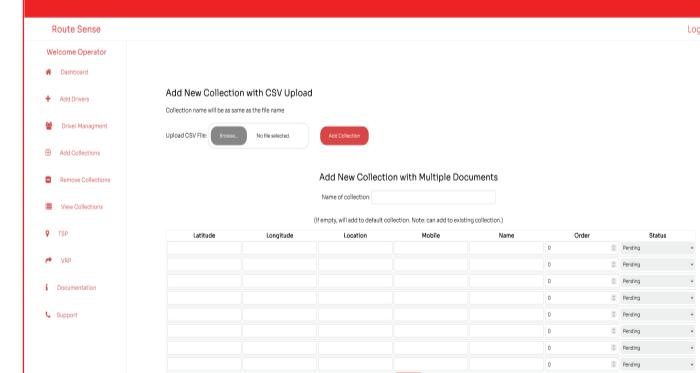
### DASHBOARD



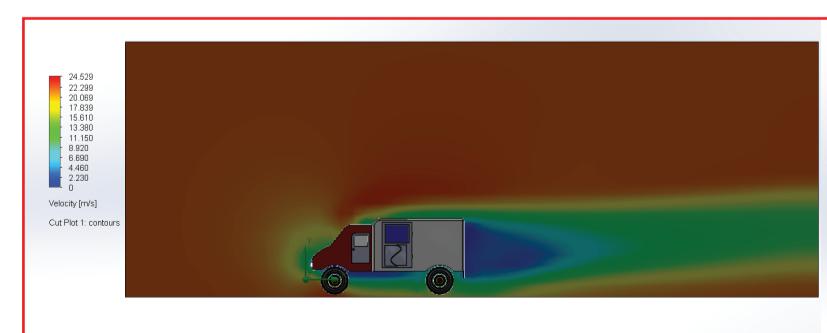
### DRIVER MANAGEMENT



### ADD ROUTES



### CONCEPT CAR



### TESTING & VALIDATION

- **Easy to Use Mobile App:** The application is simple and free of clutter, it can be easily customized, and widgets can be introduced easily.

- **Customer Data Access:** Drivers can access accurate customer locations using the displayed deliveries list in the Route Sense application, they can also contact the customer via mobile number.

- **Multi-Platform Support:** Route Sense's mobile application uses Flutter which is an open-source UI software development kit created by Google. It can be used to develop cross platform applications from a single codebase. The minimum Android version tested is 7 which is API level 24 which can run on over 73.7% of devices in addition to the newest IOS versions.

- **TSP and VRP Implementation:** The mathematical model of VRPTW and TSP calculates the exact optimal route: TSP model provided the exact answer within 10,497 iterations and 256 enumerated nodes

**Problem Size:** The number of nodes (cities/customers) significantly impacts computation time. Larger instances require more computational resources.

**Algorithm Choice:** Different algorithms exist for solving TSP and VRPTW, ranging from exact algorithms to heuristics and metaheuristics. The choice depends on the problem size and the distribution of nodes.

#### Fast Model Calculations:

TSP model calculated the exact solution for 20 points (19 delivery location and 1 depot) in 2.54 seconds. This may differ depending on the number of nodes and the routes.

#### Fuel Savings:

By assuming the distance covered from the deliveries by using the optimal route will be reduced by 20%. Taking the average delivery vehicle fuel consumption 7.5 L/100km. Gasoline 91 price in Mar 2024 is 2.180 SAR/L

For example, for every 1000 km covered by the average driver, 800 km will be covered by The Route Sense driver.

Average driver fuel cost (SAR) = (Fuel consumption L/100km) × (distance covered km) × (Gasoline price SAR/L) = (7.5 L/100km) × (1000 km) × (2.180 SAR/L) = 163.5 SAR

The Route Sense driver fuel cost = (Fuel consumption L/100km) × (distance covered km) × (Gasoline price SAR/L) = (7.5 L/100km) × (800 km) × (2.180 SAR/L) = 130.8 SAR

This shows that our application can reduce the cost by 32.7 SAR for 1000 km in this instance.

- **Clear Time Windows:** Clear time windows will be given for each delivery node with an approximation of time allotted.

- **Privacy Assurance:** The admin dashboard is local host only and uses Firebase database service, The application also uses Firebase. Firebase is a Google product that complies with various industry standards and regulations, including GDPR, HIPAA, and SOC certifications and has regular security audits. It also provides authentication services, and its servers are encrypted using HTTPS.

### CONCLUSION

In summary, Route Sense in Saudi Arabia offers significant economic, societal, and environmental benefits. It speeds up deliveries, potentially lowering costs and boosting consumer spending. Additionally, it targets emissions reduction, traffic congestion, and air pollution, enhancing public health and safety. Ultimately, Route Sense has the power to revolutionize delivery services, driving economic growth, promoting sustainability, and enhancing overall quality of life.