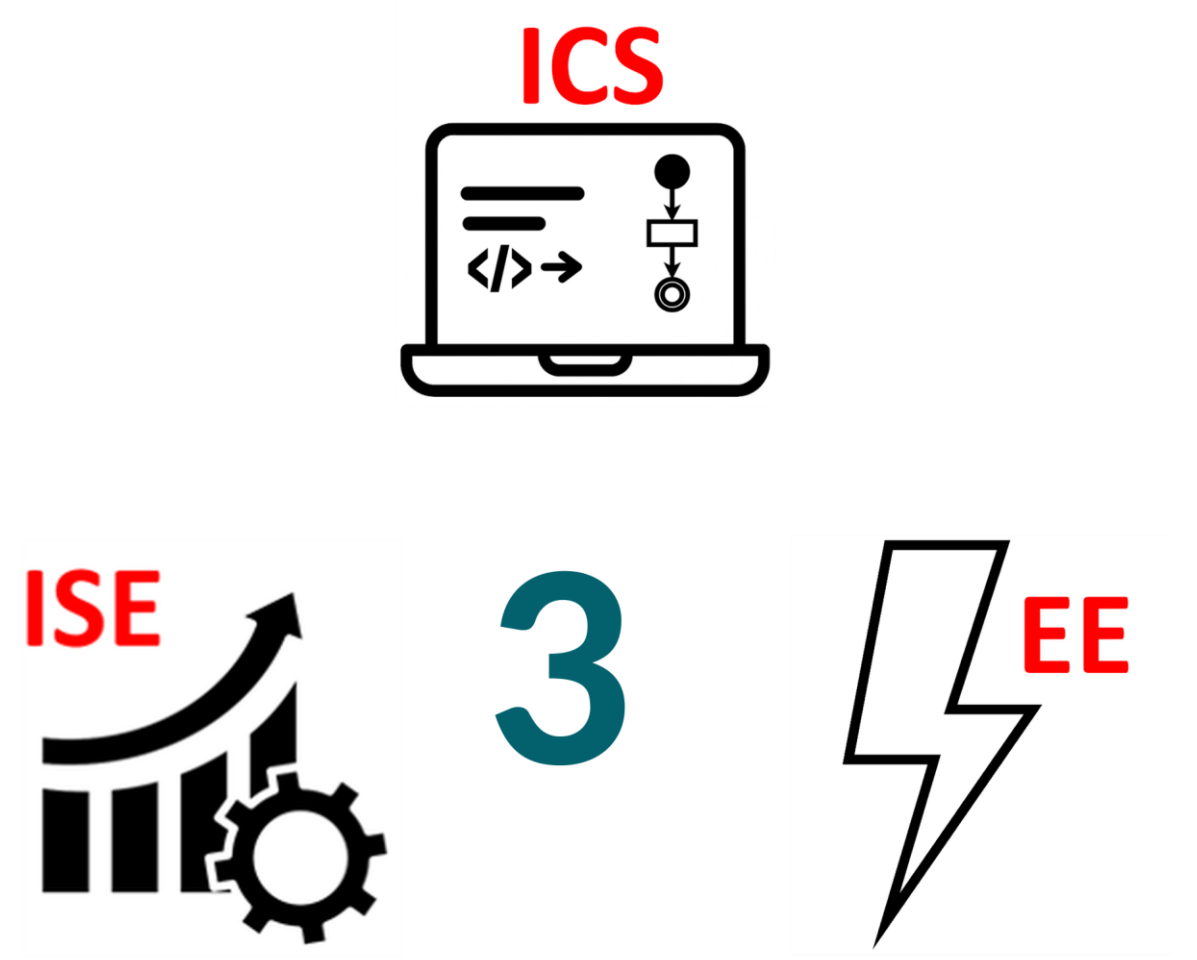


# Localized Multi-Objective Fleet & Route Optimization Platform

## for Saudi Arabia

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### Background

Saudi last-mile logistics face mixed fleets, fluctuating demand, congested urban routes, and long intercity links. Most commercial tools are generic and do not localize routing, language support, or sustainability trade-offs for Saudi operations

### Problem Statement

Design a localized hybrid platform that combines AI forecasting, real-time IoT tracking, and multi-objective optimization. The system must reduce delivery cost and CO2 emissions, improve fleet utilization, balance driver workload, and remain usable for dispatchers and drivers through Arabic/English/Urdu interfaces.

**Goal: deliver a pilot-ready FleetIoT platform for Saudi Arabia with measurable gains in cost, emissions, responsiveness, and fairness.**

### Constraints

- Saudi compliance + Arabic UI
- IoT update  $\leq 5s$ ,  $\geq 90\%$  uptime
- Secure data ( $\geq 256$ -bit encryption)
- $\geq 10$  users,  $\leq 2s$  latency
- Operate up to  $55^\circ C$
- Power  $\leq 3W$ /device
- $\geq 3$  languages (AR/EN/UR)
- HW latency  $\leq 30\%$  total

### Specifications

- Cost  $\downarrow \geq 15\%$
- Utilization  $\uparrow \geq 20\%$
- CO<sub>2</sub>  $\downarrow \geq 10\%$
- Forecast accuracy  $\geq 85\%$
- Re-routing  $\leq 10s$
- Platform latency  $\leq 2s$
- $\geq 3$  languages supported
- IoT refresh  $\leq 5s$ , 99% uptime
- GPS error  $\leq 5m$
- $\geq 90\%$  Pareto solutions,  $\geq 15\%$  improvement

### Testing / Validation

Type	Name	# Requests	# Fails	Average (ms)	Min (ms)	Max (ms)	Average size (Bytes)	RPS	Failures/s
GET	Analytics Page /analytics	200	0	6.32	2	16	605	0.8	0
GET	Dashboard Home /	388	0	5.74	2	39	605	1.55	0
GET	Fleet Map Page /fleet	318	0	6.39	2	14	605	1.27	0
GET	Optimization Page /optimization	217	0	6.5	2	10	605	0.87	0
GET	Settings Page /settings	110	0	6.46	3	16	605	0.44	0
Aggregated		1233	0	6.2	2	39	605	4.93	0

LOCALIZED MULTI-OBJECTIVE FLEET & ROUTE OPTIMIZATION Senior Design Project - KFUPM TEAM097

(1) Generating data: 15 customers, 5 vehicles ...  
 Depot: Depot (Riyadh Warehouse)  
 Vehicle 0: Truck-ICE-1 [ICE] cap=500kg range=400km  
 Vehicle 1: Truck-ICE-2 [ICE] cap=500kg range=400km  
 Vehicle 2: Van-ICE-1 [ICE] cap=500kg range=350km  
 Vehicle 3: Van-EV-1 [EV] cap=200kg range=150km  
 Vehicle 4: Van-EV-2 [EV] cap=200kg range=150km  
 Total demand: 973 kg / Total capacity: 1900 kg (51%)

(2) Baseline (nearest-neighbor) ...  
 Cost: 233.65 SAR  
 CO2: 35.85 kg  
 Distance: 129.81 km  
 Vehicles: 2/5  
 Balance: 0.761

(3) MILP optimization (Limit 120s) ...  
 STATUS: Optimal  
 Cost: 178.72 SAR  
 CO2: 24.62 kg  
 Distance: 131.17 km  
 Vehicles: 4/5  
 Balance: 0.929  
 Time: 120.32 s

(4) Comparison ...  
 Cost reduction: 23.51% (PASS  $\geq 15\%$ )  
 CO2 reduction: 29.76% (PASS  $\geq 10\%$ )  
 Vehicles: 2  $\rightarrow$  4 (PASS)  
 Workload: 0.761  $\rightarrow$  0.929

Model Comparison

Model	MAE_val	MAE_test	RMSE_val	RMSE_test	RMSLE_val	RMSLE_test	Poisson Deviance_val	Poisson Deviance_test
XGBoost (Poisson)	0.123643	0.137504	0.541401	0.620930	0.190175	0.202354	0.280524	0.314702
XGBoost (squaredLogerror)	0.115194	0.128133	0.577833	0.656311	0.186021	0.197760	0.325001	0.369022

### Conclusions

The proposed platform demonstrates a localized, pilot-ready solution for Saudi logistics by integrating AI forecasting, IoT tracking, and multi-objective optimization. The prototype shows clear improvements in cost efficiency, fleet utilization, and environmental impact while maintaining real-time performance and usability.

### Prototype Design

