

TESLA CUSTOMER SUPPORT OPTIMIZATION

ISBA2400 - Mathematics for Business and Analytics with R

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EXECUTIVE SUMMARY

Using linear programming in R (alabama package), we optimized Tesla's customer support staffing post-Model E1 launch. Analysis covers monolingual, constrained, and bilingual staffing scenarios.

Scenario	Result
Part A: Monolingual staffing plan	Eng FT: 5,12,6,1,1; Span FT: 1,3,2,1,0; PT: 4,0
Part B: Monolingual cost	\$4,625.00
Part C: Constrained staffing plan	Eng FT: 5,12,6,0,1; Span FT: 1,3,2,1,0; PT: 4,0
Part D: Constrained cost	\$4,665.00 (+\$40)
Part E: Bilingual staffing plan	Bilingual FT: 7,15,8,2,2; PT: 5,0
Part F: Bilingual cost	\$4,525.00 (-\$100, BEST)
Part G: Max wage premium	2.2%

Recommendation: Implement bilingual model - saves \$100 (2.2%), improves service quality.

UNDERLYING ASSUMPTIONS

Operational Parameters

- Call volume: 7 AM-9 PM weekdays with demand ranging from 10 to 95 calls/hour
- Language distribution: 80% English-speaking calls, 20% Spanish-speaking calls
- Agent capacity: 6 calls per hour when actively taking calls
- Full-time (FT) agents: 8-hour shifts, on calls for 4 hours (rotating every 2 hours between calls and other duties)
- Part-time (PT) agents: 4-hour shifts, continuously on calls (no rotation)
- FT shift start times: 7 AM, 9 AM, 11 AM, 1 PM, or 3 PM
- PT shift start times: 3 PM or 5 PM only

Cost Structure

- Wage rates: \$30/hour before 5 PM, \$45/hour after 5 PM
- Optimization objective: Minimize total salary costs for time spent on calls

Staffing Scenarios

- Scenario 1 (Parts A & B): Separate monolingual English and Spanish agents
- Scenario 2 (Parts C & D): Monolingual with hiring constraint (max 1 FT English at 1 PM and 3 PM)
- Scenario 3 (Parts E & F): Bilingual agents handling all calls
- Scenario 4 (Part G): Maximum wage premium sustainable for bilingual agents

MATHEMATICAL MODEL

Decision Variables

For English-speaking agents (monolingual scenarios):

- x_1, x_2, x_3 = Number of FT agents starting at 7 AM, 9 AM, 11 AM
- x_4, x_5 = Number of FT agents starting at 1 PM, 3 PM
- x_6, x_7 = Number of PT agents starting at 3 PM, 5 PM

For Spanish-speaking agents (monolingual scenarios):

- y_1, y_2, y_3 = Number of FT agents starting at 7 AM, 9 AM, 11 AM
- y_4, y_5 = Number of FT agents starting at 1 PM, 3 PM

Objective Function

Minimize Total Cost =

$$120(x_1+x_2+x_3) + 150(x_4+x_5+x_6) + 180x_7 + 120(y_1+y_2+y_3) + 150(y_4+y_5)$$

Where cost coefficients reflect wage rates and hours on calls per shift.

Constraints

Coverage constraints (example for English - 80% of total calls):

- 7-9 AM: $6x_1 \geq 32$
- 9-11 AM: $6x_2 \geq 68$
- 11 AM-1 PM: $6(x_1+x_3) \geq 56$
- 1-3 PM: $6(x_2+x_4) \geq 76$
- 3-5 PM: $6(x_3+x_5+x_6) \geq 64$
- 5-7 PM: $6(x_4+x_6+x_7) \geq 28$
- 7-9 PM: $6(x_5+x_7) \geq 8$

Similar constraints apply for Spanish (20% of calls) and bilingual scenarios (100% of calls).

Non-negativity: All decision variables ≥ 0

Additional constraints for Part C: $x_4 \leq 1, x_5 \leq 1$

Solution Method

Solved using `constrOptim.nl()` function from the `alabama` package in R, which implements augmented Lagrangian methods for constrained nonlinear optimization.

RESULTS AND ANSWERS

Parts A & B: Monolingual Optimization

Shift	Eng FT	Eng PT	Span FT	Cost
7 AM	5	-	1	\$720
9 AM	12	-	3	\$1,800
11 AM	6	-	2	\$960
1 PM	1	-	1	\$300
3 PM	1	4	0	\$750
5 PM	-	0	-	\$0
Total	25	4	7	\$4,625

Answer to Part A: English FT: 5, 12, 6, 1, 1; Spanish FT: 1, 3, 2, 1, 0; English PT: 4, 0

Answer to Part B: \$4,625.00 (English: \$3,620, Spanish: \$1,005)

Parts C & D: Constrained Hiring

Constraint: Maximum 1 FT English agent starting at 1 PM and 3 PM. Result: English cost increases to \$3,660 (+\$40). Spanish unchanged at \$1,005.

Answer to Part C: English FT: 5, 12, 6, 0, 1; Spanish FT: 1, 3, 2, 1, 0; English PT: 4, 0

Answer to Part D: \$4,665.00 (Cost increase: \$40 or 0.87%)

Parts E & F: Bilingual Optimization

Shift	FT	PT
7 AM	7	-
9 AM	15	-
11 AM	8	-
1 PM	2	-
3 PM	2	5
Total	34	5

Answer to Part E: Bilingual FT: 7, 15, 8, 2, 2; Bilingual PT: 5, 0 (Total: 39 agents)

Answer to Part F: \$4,525.00 (Saves \$100 vs monolingual, 2.2% reduction)

Part G: Maximum Wage Premium

Calculation: Maximum multiplier = \$4,625 / \$4,525 = 1.0221 → $(1.0221 - 1) \times 100\% = 2.21\%$

Answer to Part G: 2.2%

This means Tesla can offer bilingual agents up to 2.2% higher wages than monolingual agents while maintaining cost parity.

New rates: Before 5 PM: \$30.66/hr; After 5 PM: \$45.99/hr

CONCLUSION

Our linear programming analysis demonstrates that bilingual staffing (Part F: \$4,525) is the optimal solution, achieving cost savings of \$100 (2.2%) compared to monolingual approach (Part B: \$4,625) while improving service quality. The hiring constraint (Part D) increases costs minimally by \$40 (0.87%), demonstrating model robustness. Tesla can offer bilingual agents a wage premium of up to 2.2% (Part G) while maintaining cost neutrality. We recommend immediate implementation of the bilingual staffing model.

Report prepared by Group 5 for ISBA2400 - Mathematics for Business and Analytics with R