



# Rougir Cosmetics demand

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# Problem Summary



Rougir Cosmetics needs to plan production for one quarter to meet forecasted demand for 3 products:

- Face Cream: 12,000 units
- Body Cream: 8,000 units
- Hand Cream: 18,000 units

## The company can:

- Produce products in-house
- Or subcontract (outsource) production at a higher cost



# Objective Function

**MIN**

$$\text{FCS1} + \text{FCS2} + \text{FCP} + \text{BCS1} + \\ \text{BCS2} + \text{BCP} + \text{HCS1} + \text{HCS2}$$

# Decision Variables

**FCS1, FCS2, FCP, BCS1, BCS2, BCP, HCS1, HCS2**

*FCS1 = Face cream produced in-house in shift 1*

*FCS2 = Face cream produced in-house in shift 2*

*FCP = Face cream produced by subcontracting*

*BCS1 = Body cream produced in-house in shift 1*

*BCS2 = Body cream produced in-house in shift 2*

*BCP = Body cream produced by subcontracting*

*HCS1 = Hand cream produced in-house in shift 1*

*HCS2 = Hand cream produced in-house in shift 2*

# Demand Constraints

$$FCS1 + FCS2 + FCP = 12000$$

$$BCS1 + BCS2 + BCP = 8000$$

$$HCS1 + HCS2 = 18000$$

# Material Constraints

**Water:**  $8.0*(FCS1 + FCS2) + 6.0*(BCS1 + BCS2) + 7.0*(HCS1 + HCS2) \leq 200,000$

**Oil:**  $1.0*(FCS1 + FCS2) + 3.0*(BCS1 + BCS2) + 2.0*(HCS1 + HCS2) \leq 50,000$

**Fragrance:**  $0.5*(FCS1 + FCS2) + 0.3*(BCS1 + BCS2) + 0.4*(HCS1 + HCS2) \leq 7,500$

**Emulsifiers:**  $0.50*(FCS1 + FCS2) + 0.70*(BCS1 + BCS2) + 0.6*(HCS1 + HCS2) \leq 15,000$

# Capacity Constraints

## Shift 1

$$2.30 * FCS1 + 2.80 * BCS1 + 1.50 * HCS1 + 2.30 * FCS2 + 2.80 * BCS2 + 2.30 * HCS2 \leq 15,000$$

## Shift 2

$$2.30 * FCS1 + 2.80 * BCS1 + 1.50 * HCS1 + 2.30 * FCS2 + 2.80 * BCS2 + 2.30 * HCS2 \leq 10,000$$

# Scenarios & Sensitivity Analysis

## Scenario 1: Base Case Results

Variable Cells						
Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
\$B\$24	Face Cream Shift 1 Prod	0	98.67833333	32.15	1E+30	98.67833333
\$C\$24	Face Cream Shift 2 Prod	0	98.68083333	34.165	1E+30	98.68083333
\$D\$24	Face Cream External Purch	12000	0	40	98.67833333	40
\$B\$25	Body Cream Shift 1 Prod	0	112.0366667	37.35	1E+30	112.0366667
\$C\$25	Body Cream Shift 2 Prod	0	112.0416667	39.805	1E+30	112.0416667
\$D\$25	Body Cream External Purch	8000	0	55	112.0366667	55
\$B\$26	Hand Cream Shift 1 Prod	10000	0	25.525	60.01964286	1E+30
\$C\$26	Hand Cream Shift 2 Prod	6666.666667	0	26.8375	60.02232143	1E+30
\$D\$26	Hand Cream External Purch	1333.333333	0	95	1E+30	60.01964286

- Shift 1 & Shift 2 are fully utilized → capacity is the limiting factor.
- Face and body creams are outsourced due to high internal production costs.
- Hand cream is prioritized for in-house production because it is cost-effective, except for 1,333 units outsourced.

# Scenarios & Sensitivity Analysis

## Scenario 2: Labor Expansion Results

Variable Cells						
Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
\$B\$24	Face Cream Shift 1 Prod	0	6.648214286	32.15	1E+30	6.648214286
\$C\$24	Face Cream Shift 2 Prod	0	6.650714286	34.165	1E+30	6.650714286
\$D\$24	Face Cream External Purch	12000	0	40	6.648214286	40
\$B\$25	Body Cream Shift 1 Prod	357.1428571	0	37.35	0.005	112.0366667
\$C\$25	Body Cream Shift 2 Prod	0	0.005	39.805	1E+30	0.005
\$D\$25	Body Cream External Purch	7642.857143	0	55	112.0366667	8.093478261
\$B\$26	Hand Cream Shift 1 Prod	10666.66667	0	25.525	60.01964286	0.002678571
\$C\$26	Hand Cream Shift 2 Prod	7333.333333	0	26.8375	0.002678571	1E+30
\$D\$26	Hand Cream External Purch	0	60.01964286	95	1E+30	60.01964286

- Shift 1 (17,000 hrs) & Shift 2 (11,000 hrs) fully utilized → capacity remains limiting, but less severe.
- All hand cream is produced in-house (0 units outsourced).
- 357 units of body cream are produced internally due to extra labor capacity, with the remainder (7,643 units) still outsourced.
- Face cream continues to be fully outsourced because its internal production cost is still too high.
- Labor's shadow price drops from \$46/hr to \$6/hr, showing diminishing returns on further capacity expansion.

# Scenarios & Sensitivity Analysis

## ***Scenario 3: Hand Cream Outsourcing Cost \$60/carton***

Variable Cells						
Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
\$B\$24	Face Cream Shift 1 Prod	0	45.01166667	32.15	1E+30	45.01166667
\$C\$24	Face Cream Shift 2 Prod	0	45.01416667	34.165	1E+30	45.01416667
\$D\$24	Face Cream External Purch	12000	0	40	45.01166667	40
\$B\$25	Body Cream Shift 1 Prod	0	46.70333333	37.35	1E+30	46.70333333
\$C\$25	Body Cream Shift 2 Prod	0	46.70833333	39.805	1E+30	46.70833333
\$D\$25	Body Cream External Purch	8000	0	55	46.70333333	55
\$B\$26	Hand Cream Shift 1 Prod	10000	0	25.525	25.01964286	1E+30
\$C\$26	Hand Cream Shift 2 Prod	6666.666667	0	26.8375	25.02232143	1E+30
\$D\$26	Hand Cream External Purch	1333.333333	0	60	1E+30	25.01964286

- Hand cream outsourcing price lowered to \$60/carton, Solver continues to prioritize in-house production for hand cream:
- 10,000 units in Shift 1; 6,667 units in Shift 2; Only 1,333 units outsourced (overflow).
- Reason: In-house production cost ( $\approx \$25\text{--}\$27$ ) is still cheaper than the reduced outsourcing price (\$60).
- Face and body creams remain fully outsourced due to high internal production costs.
- Insight: Even significant outsourcing price reductions must fall below internal production cost to shift production strategy.

# Insights & Recommendations



## Scenario 1:

- Outsource 100% of face and body cream due to high internal production costs.
- Produce hand cream in-house except for 1,333 units (capacity overflow).
- Labor hours are the binding constraint; raw materials are non-binding.

## Scenario 2

- Extra labor capacity (+2,000 hrs Shift 1, +1,000 hrs Shift 2) eliminates hand cream outsourcing and allows 357 body cream units to be produced in-house.
- Labor remains the key bottleneck but shadow price drops from \$46/hr to \$6/hr, showing diminishing returns on further expansion.

## Scenario 3

- Lowering hand cream outsourcing price to \$60/carton does not shift production significantly because internal hand cream production (~\$25–\$27) remains cheaper.
- Face and body creams remain fully outsourced, showing vendor pricing must drop below internal cost to change the optimal mix.

**Continue outsourcing all face & body cream and allocate internal labor to hand cream. Expand labor capacity strategically (e.g., temporary overtime) when demand surges. Vendor negotiations are valuable but must meet or beat internal costs to impact production strategy.**

# Optimization results

Our linear programming model for Rougir Cosmetics optimally allocates production volumes across shifts and external suppliers to meet product demand at the lowest possible cost, while respecting resource and labor constraints.

- **Optimal Production Plan:** All Face Cream (12,000 units) and Body Cream (8,000 units) demand is fulfilled entirely through external purchasing. Hand Cream is made using in-house production.

The model minimizes total cost by strategically assigning external purchasing to the products with the highest in-house production cost (Hand Cream), and outsourcing others entirely when more cost-effective.



# Key Takeaways



- *Approximately 60% of beauty brands are outsourcing face and body cream production to manage costs and speed, (Business Research Insights, 2024).*
- *Expanding labor lowers outsourcing, but the benefits of doing so gives diminishing returns (shadow price ↓ \$46/hr → \$6/hr). Instead of expanding permanently, they can use automation or temporary hires.*
- *They can negotiate contracts with sustainability-focused outsourcing partners for long-term alignment,(Datainsightsmarket, 2025).*
- *Focusing in-house labor on flagship hand cream will maintain quality control and brand equity, (Washington Post, 2025).*

# References

1. Business Research Insights (2024) – Global Cosmetic Outsourcing Market Forecast 2024–2033  
<https://www.businessresearchinsights.com/market-reports/cosmetic-outsourcing-market-115339>
2. Datainsightsmarket (2025) – Cosmetic Contract Outsourcing Trends  
<https://www.datainsightsmarket.com/reports/cosmetic-contract-outsourcing-1970852>
3. Washington Post (2025, May 5) – Cosmetics Are a U.S. Manufacturing Success Story. Tariffs Pose a Threat.  
<https://www.washingtonpost.com/technology/2025/05/05/cosmetics-tariffs-supply-chains>