Cutting Starbucks' Cold Drink Costs Through Smarter Sourcing and Roasting

Presented By:
Team 2
Aastha Surana,
Jooyeon Lee,
Zicheng Wang

Starbucks' Cost Challenge & Strategic Opportunity

75%

Over **75% of Starbucks beverage sales are now cold drinks,** Make **bean quality differences less noticeable**

$4.4

Arabica prices hit **$4.40/lb** in 2024 → *47-year high* Driven by **climate disruptions** and **supply shortages** in Brazil & Colombia

Introducing **Robusta beans** in beverages allow Starbucks to **reduce costs**, diversify sourcing, improve environmental sustainability.

What's the Optimization Goal?

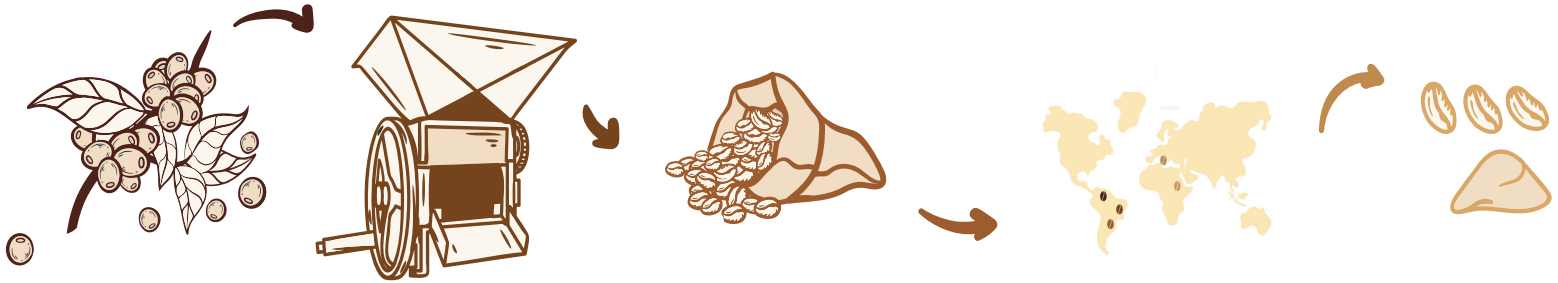
Optimization Objective

Minimize total system cost of producing 100M+ beverages by strategically incorporating **cost-effective Robusta** beans, while maintaining **quality standards** & **operational feasibility**.

Robusta Benefits

- **40–60% cheaper** than Arabica ($2.00–$2.50/lb)
- **Higher caffeine** & **bolder taste**
- **More climate-resilient**, needs less water/altitude
- Well-suited for cold beverages diluted with milk/sugar

DECISION VARIABLES



	BEAN MIX	ROAST	BEAN ORIGIN	TRANSPORTATION	INVENTORY
VARIABLES	**arabica_hot, robusta_hot, arabica_cold, robusta_cold**	**r_blonde, r_medium, r_dark**	**origin_brazil, origin_colombia, origin_ethiopia, origin_vietnam**	**t_air, t_ocean, t_land**	**inventory**
MEANING	Controls the proportion of Arabica and Robusta beans in hot vs. cold beverages	Determines the roast level mix to balance flavor, cost, and customer preferences	Decides how much beans comes from each country	Allocates bean volumes across air, ocean, and land transportation modes	Sets minimum storage level to prevent disruptions and ensure supply chain resilience

CONSTRAINTS

DEMAND

- 100M beverages = 2.2M lbs beans
- 25% hot, 75% cold drinks

BLEND

- Hot: Max 15% Robusta
- Cold: 100% Robusta allowed

ROAST

- Blonde ≤ 30%
- Medium, dark required for balance

ORIGIN

No more than 40% from a single origin

INVENTORY

Minimum 20% buffer

TRANSPORT

At least 10% via ocean, air and land each

OBJECTIVE FUNCTION

MINIMIZE TOTAL COST

$$Z = 4.4 * a_{arabica} + 2.4 * a_{robusta}$$ (bean sourcing cost)

$$+ 4.0 * r_{blonde} + 4.5 * r_{medium} + 5.0 * r_{dark}$$ (roasting cost)

$$+ 0.03 * t_{land} + 0.01 * t_{ocean} + 4.6 * t_{air}$$ (transportation cost)

$$+ 0.5 * w$$ (inventory holding cost)

OPTIMAL SOLUTION

OPTIMAL COST

$16,633,100

BEAN USAGE

HOT BLEND

COLD BLEND

ROAST

Blonde: 660,000 lbs (30%)
Medium: 1,320,000 lbs (60%)
Dark: 220,000 lbs (10%)

TRANSPORT

Ocean: 1,760,000 lbs (80%)
Land: 220,000 lbs (10%)
Air: 220,000 lbs (10%)

ORIGIN

Brazil: 187,000 lbs (8.5%)
Colombia: 187,000 lbs (8.5%)
Ethiopia: 93,500 lbs (4.2%)
Vietnam: 0 lbs (0%)

INVENTORY

20%
(440,000 lbs)

BUSINESS IMPLICATIONS

COST REDUCTION OPPORTUNITY

Compared to a $21M all-Arabica baseline, the optimized model saves $5M~5.5M annually

CONSUMER-CENTRIC BLENDING

Aligns sourcing with consumer preferences while preserving brand equity in quality-sensitive products

SUPPLY CHAIN RESILIENCE

Enhances sourcing flexibility and mitigates regional supply risk while maintaining flavor standards

ROAST MIX OPTIMIZATON

Balances roast variety with cost—60% Medium, 30% Blonde, 10% Dark—to meet demand without overspending on niche roasts

OPERATIONAL STABILITY

20% inventory buffer (440,000 lbs) reduces stockout risk and ensures consistent roasting and delivery during supply disruptions

EFFICIENT TRANSPORTATION MIX

80% ocean shipping minimizes cost; 10% land and 10% air ensure freshness and flexibility across markets

Key Findings from Sensitivity Analysis

Constraint / Variable	Value	Shadow Price / Reduced Cost	Interpretation
Hot_Demand	550,000 lbs	**$8.84/lb**	High-cost due to Arabica-heavy blend
Cold_Demand	1,650,000 lbs	**$7.14/lb**	Fully met with 100% Robusta
Hot_Arabica_Quality	≥ 85% Arabica	**$2.00/lb**	Binding; raising threshold increases cost
Min_Transport_Air	220,000 lbs	**$2.30/lb**	Required, but expensive
Blonde_Max (≤30%)	660,000 lbs	**– $0.50/lb**	Relaxing cap would reduce cost
Arabica_cold	0 lbs	**$2.00/lb** (Reduced Cost)	Too expensive for cold drinks
Min_Inventory (20%)	440,000 lbs	**$0.50/lb**	Adds cost, but ensures supply buffer

Key Findings from Sensitivity Analysis

Summary Insights

- Starbucks is operating at the **cost-optimal edge** of quality, inventory, and logistics trade-offs.
- Many constraints are **binding**, confirming no slack in key areas like demand, roast balance, and quality.

Cost levers:

- Relaxing **Arabica % in hot drinks** would reduce cost, but compromise quality.
- Relaxing **air transport minimum** saves $2.30/lb.
- Increasing **blonde roast cap** saves $0.50/lb.

Key Findings from Scenario Analysis

Arabica Price	Hot Arabica Min %	Total Cost ($)	Arabica Hot %	Arabica Cold %
4.4	85%	16,633,100	85%	0%
4.4	70%	16,468,100	70%	0%
4.4	60%	16,358,100	60%	0%
5.0	85%	16,913,600	85%	0%
5.0	70%	16,699,100	70%	0%
5.0	60%	16,556,100	60%	0%
6.0	85%	17,381,100	85%	0%
6.0	70%	17,089,600	70%	0%
6.0	60%	16,886,100	60%	0%

Key Findings from Scenario Analysis

Insights & Implications

- **Cost rises with Arabica price and higher quality thresholds**.
  ➤ E.g., raising Arabica price from $4.4 to $6.0 at 85% quality → **+$748K**

- **Arabica in cold drinks is avoided entirely** due to its cost.
  ➤ The model sticks to **100% Robusta in cold beverages** across all cases.

- **Relaxing the hot Arabica requirement** (from 85% → 60%)
  ➤ Saves up to **$495K**, depending on Arabica price.

- **Recommendation:**
  Starbucks should **re-evaluate quality thresholds** (especially for cold drinks) to explore a better **cost–quality balance**.

Challenges

Single-period scope

It does not account for seasonality, inventory rollover, or dynamic planning.

Deterministic inputs

Demand and supply conditions are assumed fixed, without capturing uncertainty.

No disruption modeling

The model excludes risks like climate events, strikes, or geopolitical shocks.

Limited product and perishability scope

Only brewed coffee is considered, with no time-decay or shelf-life effects.

No labor or sustainability metrics

Workforce capacity and carbon emissions are not yet included.

Threshold-driven Structure

The model's most binding limitation is the fixed thresholds we set—requiring 85% Arabica in hot drinks and allowing more Robusta in cold drinks. These constraints strongly shape the output and may prioritize cost over realism or brand alignment.

Next Steps

Validate Assumptions with Internal Data

Incorporate Regional Demand Forecasts

Expand Model Scope to Sustainability Metrics

Leverage Advanced Analytics

Extend to Multi-Period and Stochastic Planning

Revisit Quality Thresholds

Thank you
Q&A