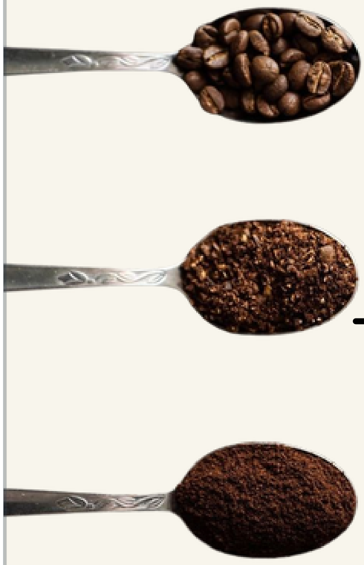
Introduction:

Our presentation will highlight how we've streamlined Lavazza's distribution, cutting costs by 15.36% without compromising quality. We'll cover freight optimization that reduced transportation costs, and how our model meets Lavazza's demand across all segments, boosting customer satisfaction. We'll also discuss decision-making support through sensitivity analysis, and our commitment to sustainability by improving route efficiency, thus reducing costs and the carbon footprint.

Lavazza’s coffee distribution network



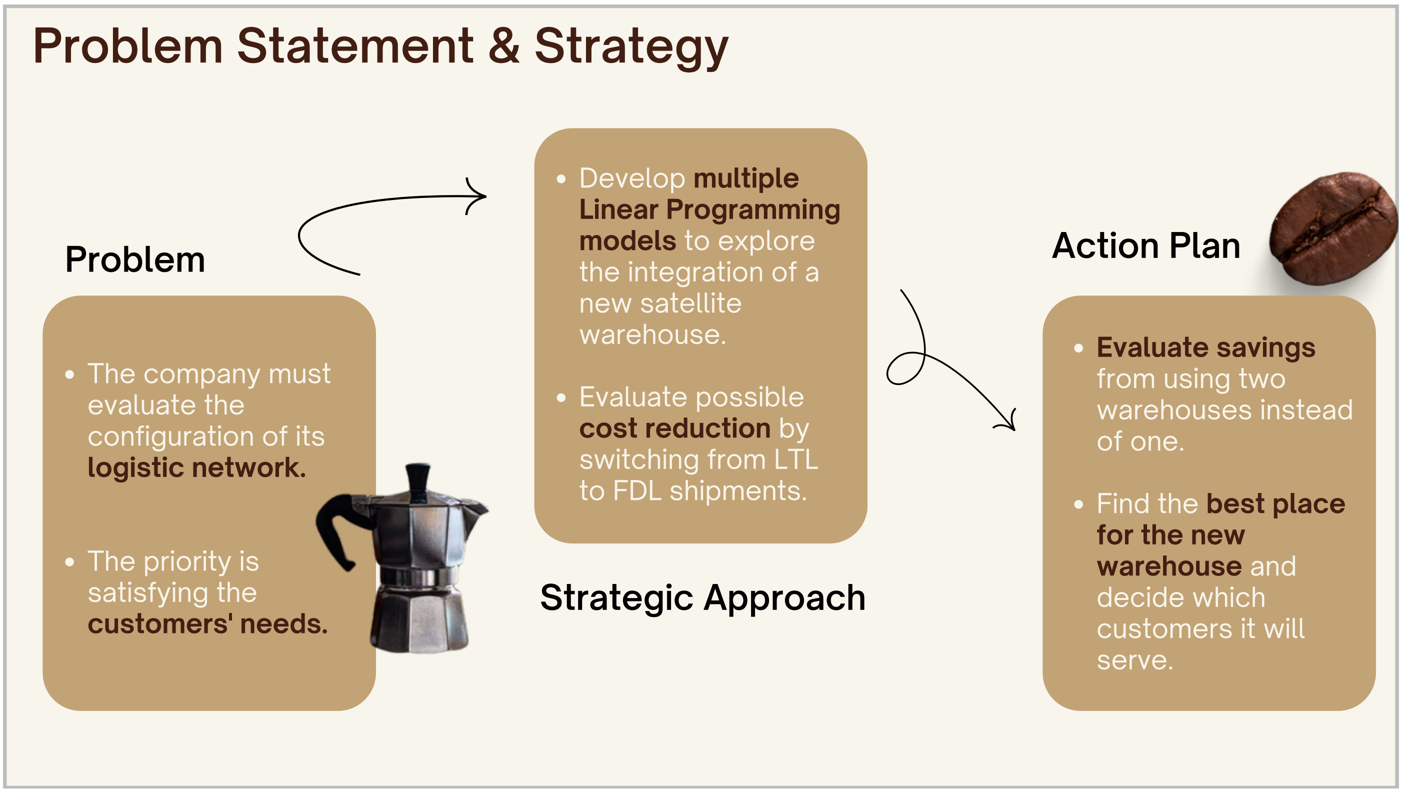
Context

- The demand fluctuations and market changes called for a reassessment of Lavazza’s logistics strategy.
- Current logistics involve a single central warehouse serving six major customers via LTL deliveries.

Objective

- Assess and redesign Lavazza's logistic network to reduce transportation costs and enhance cost efficiency.

As we adapt to the evolving demands of the coffee market, our logistics system is ripe for modernization. Currently, a single warehouse orchestrates deliveries to six principal customers using the LTL method. Our aim is to critically evaluate and refine Lavazza’s logistic network to achieve a more cost-effective and responsive distribution framework. The initiative is driven by the need to enhance operational efficiency and reduce transportation costs, ensuring our logistics infrastructure aligns with the strategic vision of Lavazza for superior customer service and competitive advantage.



Problem Statement:

Our current analysis indicates that Lavazza's logistics network may not be optimized, potentially incurring unnecessary transportation costs. The challenge is to ensure the network is as efficient as possible while still meeting the high standards of service our customers expect.

Strategic Approach:

To address this, we're proposing the development of a linear programming model. This model will help us assess the benefits of integrating a new satellite distribution warehouse into our network. Moreover, we'll explore cost efficiencies, particularly by considering a shift from less-than-truckload (LTL) to full-truckload (FTL) shipments, which could offer a 40% reduction in costs.

Team Action Plan:

Our team will meticulously analyze the potential savings from adopting a dual-warehouse system compared to our current single-warehouse structure. We'll also determine the most strategic location for this new warehouse and devise a plan for the optimal distribution of customers between the two warehouses, ensuring that we not only cut costs but also improve our service delivery.

Model Assumptions

1. Handling Costs

Generally linked to the preparation and transportation of inventory. It has been assumed that the company incurs handling costs upon dispatch from the central warehouse and during processing at the satellite warehouse.

2. Double costs

This also implies that all goods shipped from any new satellite warehouse come initially from the central warehouse and require handling in both warehouses.

3. Equal investment

For simplicity, the cost of opening each warehouse was considered equal.

4. Multiple Scenarios

Seven models were made to simplify and better visualize the company's options for opening the new warehouse. One for each option of a new satellite warehouse and one with no open warehouse.

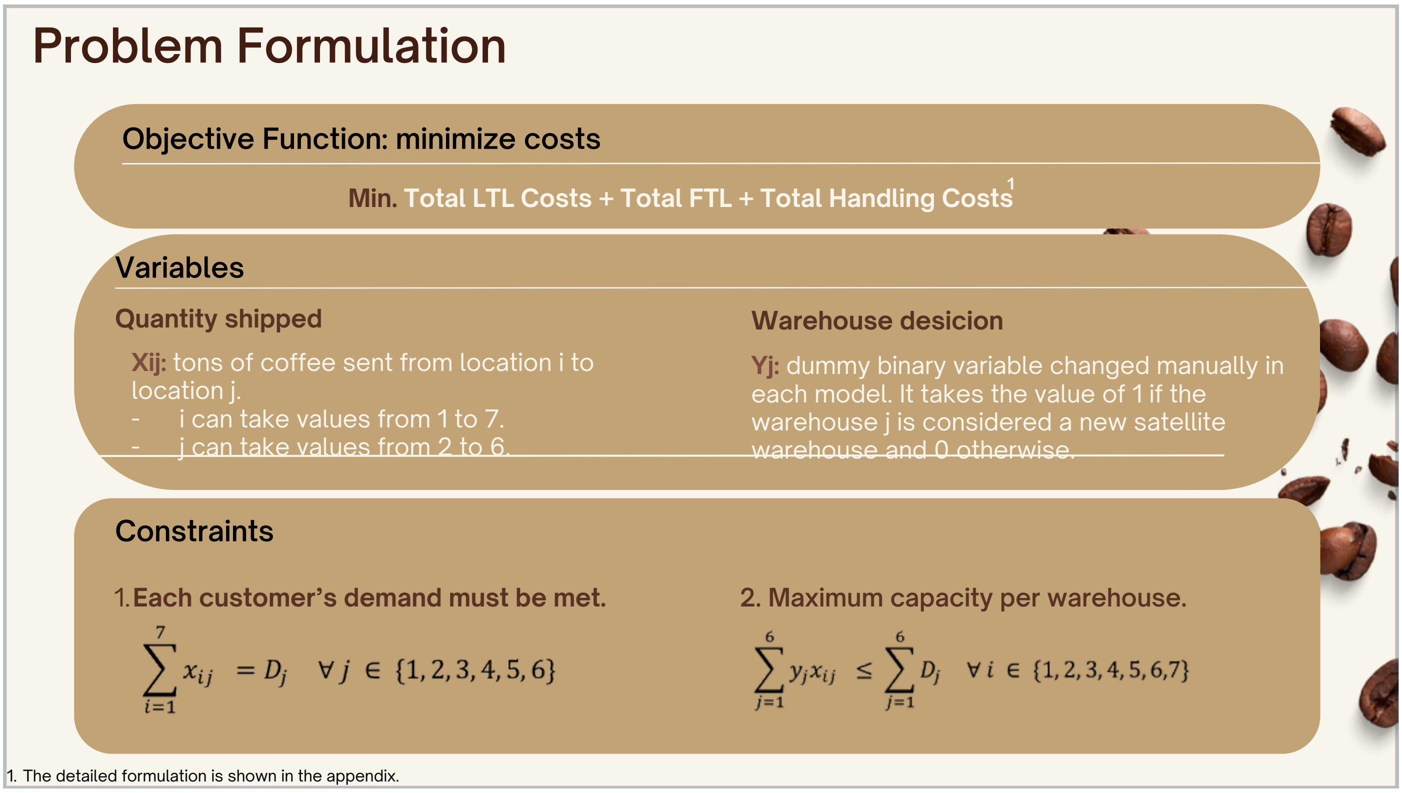
5. Warehouse Capacity

A capacity of the total sum of the demand was assumed for each warehouse.

6. FTL discount

FTL cost will be 60% of the LTL cost, which is only applied to the transport from the central warehouse to the new satellite warehouse. All other routes were done using LTL.

[All necessary information is in the slide]



Here is the mathematical formulation of a linear programming model for the Lavazza logistic case.

* Objective Function:
The goal is to minimize the total costs, which are the sum of Less-than-Truckload (LTL), Full Truckload (FTL), and handling costs for inventory transportation and preparation.

Variables:
* Quantity shipped (Xij): This represents the tons of coffee sent from location i (which can be any location from 1 to 7, including the central warehouse and potential satellite warehouses) to location j (customer locations ranging from 2 to 6).
* Warehouse decision (Yj): A binary variable indicating whether a warehouse j is considered a new satellite warehouse (1) or not (0). This variable is manually adjusted for each scenario in the model.

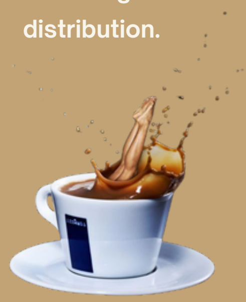
Constraints:
* Customer Demand: The sum of products shipped from all locations i to a specific customer j must meet that customer's demand (Dj). This ensures that every customer's order is fulfilled.
* Warehouse Capacity: The total quantity shipped to each customer from any warehouse cannot exceed the sum of all customers' demands (a capacity constraint), ensuring that the warehousing facilities are not overextended.

Model Results

Model	Total Costs
Opening Warehouse 1	$ 9,889,800
Opening Warehouse 2	$ 8,599,040
Opening Warehouse 3	$ 9,122,400
Opening Warehouse 4	$ 8,548,200
Opening Warehouse 5	$ 9,272,200
Opening Warehouse 6	$ 9,397,300
No Warehouse Opening	$ 10,099,200
Cost reduction	$ 1,551,000
Percentage of cost reduction	15.36%

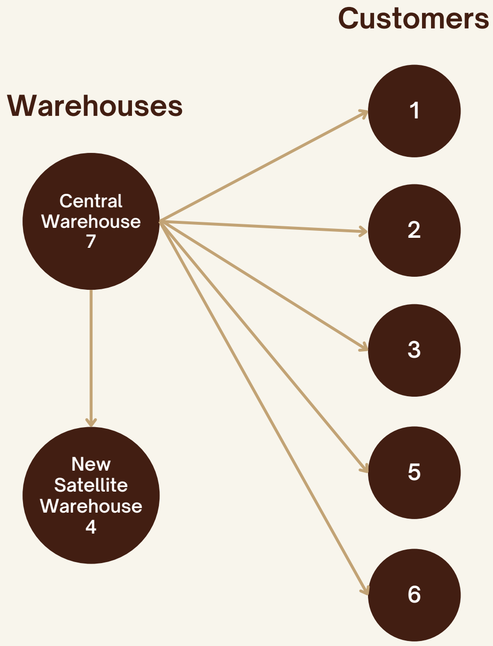
Warehouse 4 should open

It represents the minimum cost out of all the options, with a cost reduction of 15.36% compared to the current logistic distribution.



The model column lists different scenarios, including opening Warehouse 1 through Warehouse 6 and an option for "No Warehouse Opening." Each scenario is associated with a total cost.
Opening Warehouse 4 is the least expensive option at $8,548,200, followed closely by Warehouse 2. The most expensive scenario is not opening any warehouse, costing $10,099,200.
There is a possible cost reduction of $1,551,000, or 15.36% when comparing the cost of opening Warehouse 4 to the "No Warehouse Opening" scenario.

Recommended distribution



Decision Variables	Xij
X71	1500
X72	2300
X73	3000
X74	5500
X75	3000
X76	2300
X41	0
X42	0
X43	0
X45	0
X46	0

This is a visual representation of how the proposed distribution would look like.
The table on the right represents the quantity of goods transported from each warehouse, 7 and 4, to all the routes.
Even though is the cheapest option, we can observe that satellite warehouse 4 only supplies its own demand.

Analysis and Recommendations

Decision Variables	Reduced Cost
X71	0
X72	0
X73	0
X74	0
X75	0
X76	0
X41	745
X42	269
X43	0
X45	328
X46	716

Analysis

X71 - X76, X43

- Shipping quantities are **meeting demand.**

X41, 42, 45, 46

- Not utilizing these routes for **cost-minimizing**

Recommendation

- Investigate the reasons for their **underutilization.**
- Take an **incremental approach** to increase shipments
- Utilize the optimization models to simulate the **potential impacts.**

As we review the sensitivity report, there are several key takeaways that present opportunities for cost optimization.

Please look at the "reduced costs". The X71 through, X76, and X43 show 0. That means our current shipping quantities for them are precisely meeting demand. However, the positive reduced costs associated with X41 and X45 shipments suggest that we are not utilizing these routes to their cost-minimizing potential.

We need to thoroughly investigate the reasons for their underutilization by reviewing our operational processes and customer demand patterns. An incremental approach to increase shipments should be employed, utilizing our optimization models to simulate the potential impacts. At the same time, we carefully ensure that any increase in shipments does not exceed customer needs or our logistical capabilities.

Analysis and Recommendations

Constraints	Shadow Price	Allowable Decrease
X71	379	0
X72	493	0
X73	844	0
X74	453	0
X75	490	0
X76	245	0
X45	-12	3000
X46	0	17600

Analysis

X73
- Increasing the capacity could yield the most significant return on investment

X45
- Current capacity exceeds the demand

X46
- Have a large cushion before a potential shortage affects our operations

Recommendation

- **Negotiate** better terms with suppliers (X73).
- Explore why this **excess capacity** exists (X45). And consider to be **reallocated** to better serve demands like X73 (X45).
- Conducting a **market analysis** (X46). Revisit our **marketing** and **sales strategies**(X46).

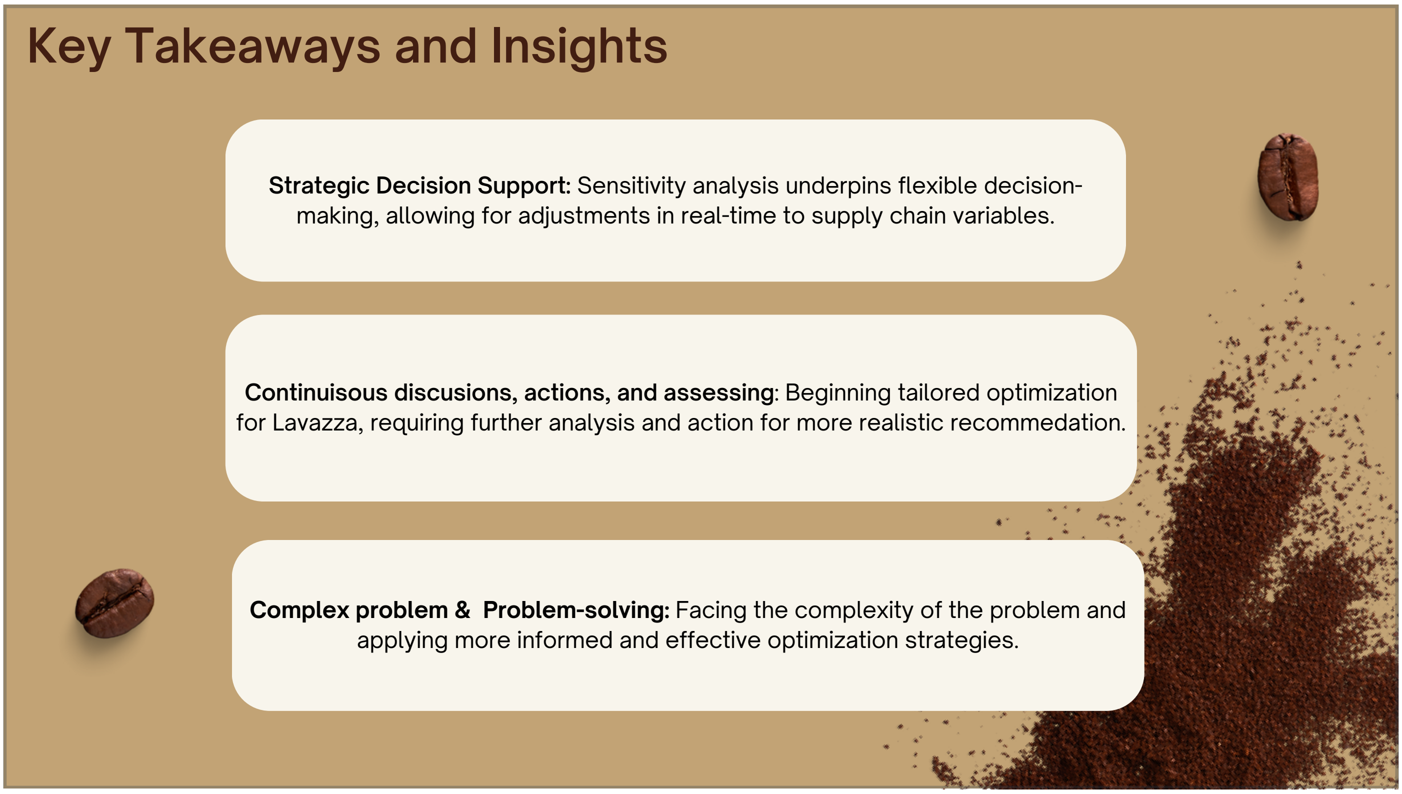
The 'Shadow Price' metric is an indicator of the potential improvement in our objective function, telling us, "Where would adding resources be most valuable in our operations?"

Let's focus on X73. The X73, highlighted with brown, has the highest shadow price among our products. This implies that any increase in the capacity to meet the X73 demand could yield the most significant return on investment. So, focusing on strategies that enable us to meet more of the X73 demand could be beneficial. Specifically, we can invest in faster production lines, negotiate better terms with suppliers to ensure a steady flow of necessary inputs or optimize logistics to reduce delivery times.

Move on to the next two constraints.
X45, highlighted with brown, shows a shadow price of -12. This indicates that the current capacity exceeds the demand by a significant margin. For the X45, it may be worth exploring why this excess capacity exists and whether it can be reallocated to serve demands like X73 better.

The last one is X46 at the bottom. The zero shadow price informs us that increasing shipments from the warehouse won't contribute to our bottom line. However, the significant allowable decrease implies that we have a large cushion before a potential shortage affects our operations. This could be a chance to reduce our warehouse capacity or reallocate resources to other products with higher margins or demand.
Moving forward, we recommend conducting a market analysis for X46 to ascertain the reasons behind the lack of warehouse shipments. Should this be a demand issue, we may need to revisit our marketing and sales strategies for X46. On the other hand, if the product is being supplied

adequately through other means, we could consider optimizing our warehouse space usage, potentially repurposing it for higher-demand products.



Strategic Decision Support:
The incorporation of sensitivity analysis into the model equips Lavazza with a powerful decision-making tool. This enables the company to adapt proactively to market changes, cost variations, and supply chain challenges, maintaining operational excellence.

Continuisous discusions, actions, and assessing:
On the other hand, our business reccommendations are relatively broad. That is because it requires us to deeply understand the Lvazza's situation such as goal and strategy of Lavazza for more detailed recommendations. This presentation is just the beggining of the journey for solving thier problem by using the optimization model. Futher discusions, actions, and assessing are needed for more realistic recommendations with this model.

Complex problem & Problem-solving:
As we wrap up our project, we need to recognize the tricky parts we faced while figuring out Lavazza's delivery system. We ended up making seven different models because of the binary variables in our calculations made things more complex than expected. We first wanted to make just one model to make our work simpler and help us find the best way to manage Lavazza's deliveries. But mixing these binary variables with our main goals of cutting costs and improving how things run made us rethink and go for a more detailed strategy. This not only improved our understanding of Lavazza's distribution network but also enriched our problem-solving toolkit, ultimately leading to more informed and effective optimization strategies.

Appendix

Model Formulation:

- The six models performed to analyze each of the possible warehouses share the following formulation:
- **Objective Function: Minimize. Total LTL Costs + Total FTL Costs + Total Handling Costs:**

-- **Total LTL Costs**: sum-product of all the routes costs and xij, except the one from the central warehouse to the new satellite warehouse, for each model considered.

LTLij was replaced with 0 for all routes from the central warehouse to the new satellite warehouse.

Model 1

$$x_{72} * LTL_{72} + x_{73} * LTL_{73} + x_{74} * LTL_{74} + x_{75} * LTL_{75} + x_{76} * LTL_{76} + x_{12} * LTL_{12} + x_{13} * LTL_{13} + x_{14} * LTL_{14} + x_{15} * LTL_{15} + x_{16} * LTL_{16}$$

Model 2

$$x_{71} * LTL_{71} + x_{73} * LTL_{73} + x_{74} * LTL_{74} + x_{75} * LTL_{75} + x_{76} * LTL_{76} + x_{21} * LTL_{21} + x_{23} * LTL_{23} + x_{24} * LTL_{24} + x_{25} * LTL_{25} + x_{26} * LTL_{26}$$

Model 3

$$x_{71} * LTL_{71} + x_{72} * LTL_{72} + x_{74} * LTL_{74} + x_{75} * LTL_{75} + x_{76} * LTL_{76} + x_{31} * LTL_{31} + x_{32} * LTL_{32} + x_{34} * LTL_{34} + x_{35} * LTL_{35} + x_{36} * LTL_{36}$$

Model 4

$$x_{71} * LTL_{71} + x_{72} * LTL_{72} + x_{73} + * LTL_{73} + x_{75} * LTL_{75} + x_{76} * LTL_{76} + x_{41} * LTL_{41} + x_{42} * LTL_{42} + x_{43} * LTL_{43} + x_{45} * LTL_{45} + x_{46} * LTL_{46}$$

Model 5

$$x_{71} * LTL_{71} + x_{72} * LTL_{72} + x_{73} + * LTL_{73} + x_{74} * LTL_{74} + x_{76} * LTL_{76} + x_{51} * LTL_{51} + x_{52} * LTL_{52} + x_{53} * LTL_{53} + x_{54} * LTL_{54} + x_{56} * LTL_{56}$$

Model 6

$$x_{71} * LTL_{71} + x_{72} * LTL_{72} + x_{73} + * LTL_{73} + x_{74} * LTL_{74} + x_{75} * LTL_{75} + x_{61} * LTL_{61} + x_{62} * LTL_{62} + x_{63} * LTL_{63} + x_{64} * LTL_{64} + x_{65} * LTL_{65}$$

Model 7

$$x_{71} * LTL_{71} + x_{72} * LTL_{72} + x_{73} + * LTL_{73} + x_{74} * LTL_{74} + x_{75} * LTL_{75} + x_{75} * LTL_{76}$$

-- **Total FTL Costs:** route cost from the central warehouse to the new satellite warehouse times xij determined by the model. For model 7 the value is 0.

$$LTL_{7j} * 0.6 * \left(\sum_{j=1}^{6} x_{7j} \right) \quad \forall\, j, \textit{each } j \textit{ represents the the FTL cost for each model considering opening a location.}$$

-- **Total Handling Costs:** sum of all handling costs according to previous assumptions.

Appendix

- **Variables:**

-- Xij: tons of coffee sent from location i to location j.

- i can take values from 1 to 7
- j can take values from 2 to 6, since the central warehouse doesn't need to be supplied

-- Yj: dummy binary variable changed manually in each model. It takes the value of 1 if the warehouse j is considered a new satellite warehouse and 0 otherwise.

- **Constraints**

-The demand for each of the six customers must be met: $\sum_{i=1}^{7} x_{ij} = D_j \quad \forall j \in \{1, 2, 3, 4, 5, 6\}$

-Each warehouse's maximum capacity is the sum of the demand: $\sum_{j=1}^{6} y_j x_{ij} \leq \sum_{j=1}^{6} D_j \quad \forall i \in \{1, 2, 3, 4, 5, 6, 7\}$

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Presentation
Thanks