Advanced Network Solutions for Supply Chain Excellence

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Business Problem Framing

In a rapidly shifting global economy, optimizing supply chain networks is critical. **Supply Chain network optimization** results in considerable cost savings and improved operational visibility, illustrated by example of a global manufacturer saving **$60 million** (*Supply Chain Brain 2022).

Our client confronts the challenge of **scaling its supply chain** to match its evolutions. Thus, they came up with :

1. Identify five key LC locations for a brand-new distribution network optimized for cost and service.
2. Enhancing an existing network by optimizing LC locations and evaluating the cost-effectiveness.

Constraints

Business Level

1)Population Threshold >**200k** for setting up LC
2)Approximation of demand

Logistics

Restriction on the availability of **3PL for Last Mile delivery**

Stakeholders

Logistic Partner

Warehouse owner

Distributors

Potential Benefit

- ✓ Reduced logistic cost
- ✓ Lower delivery time
- ✓ Scalability
- ✓ Resilience

- Complete fulfilment of demand across regions
- **Weighted Distance** and **distance** is used as a proxy of Cost and service respectively
- A **circuity factor is 1.17** to convert the Haversine distance into actual distance
- Truck travel time **10 hours day**

ASSUMPTION

Analytical Problem Framing

Develop a robust clustering model utilizing **Weighted K-Means** algorithm to conduct a **Green Field Analysis** for identifying optimal locations for Logistic Centre.

Technical Aspects:

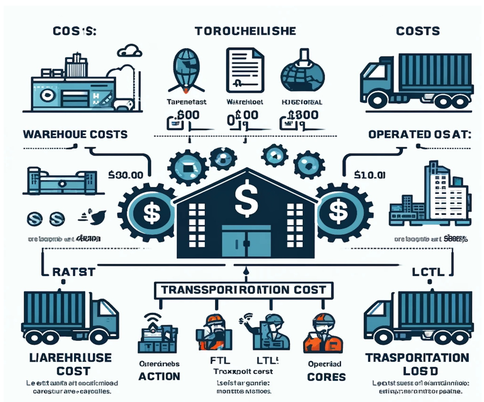
- ❑ Data pre-processing
- ❑ Iterative model refinement

Design and implement a multi-scenario **optimization model** to evaluate the trade-offs between cost-efficiency and service quality.

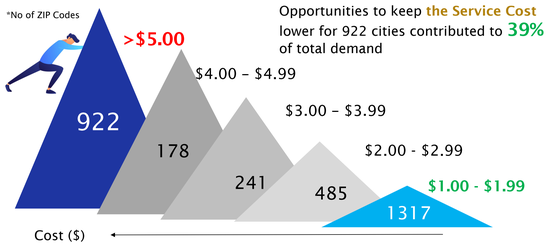
Technical Aspects:

- ❑ Application LP /MILP
- ❑ Parameter Analysis
- ❑ Scenario Analysis

Decoding Supply Chain Expenditure



Service Cost Optimisation



Opportunities to keep **the Service Cost** lower for 922 cities contributed to **39%** of total demand

Success Metrics

- ✓ **Service Cost** of fewer cities would lie in the range at >$5
- ✓ **Miles travelled** for the cities contributed higher demand would be lesser
- ✓ For top contributing DC, Service Cost to be proportionate to the demand catered

Data Sources

Internal

1. **Demand Forecasting** at different Geography
2. Inbound and Outbound **Logistic expense**
3. **Warehouse Operational** Economics

External

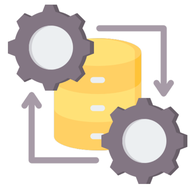
1. **Commercial Property** Valuation and Market Analysis Source :usa.gov
2. **Geospatial Positioning** and Distance Metrics by Geocoder API
1. **Demographical Data** for feasible LC and DC location

Data Pre-Processing

❑ **Null Value Imputation**
For Categorical Variables employed mode imputation
For Continuous Variables utilized median imputation

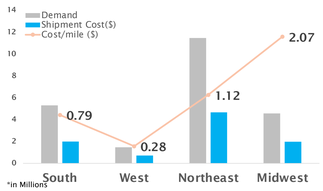
❑ **Data Integration via Pandas**
Used data manipulation, merging disparate datasets into a **single cohesive data frame.**

❑ **Data Normalization**
Standardized naming conventions across the dataset, resolving discrepancies in entity representation to **avoid redundancy and confusion.**



EDA and Insights

Regional Demand and Shipping Cost Analysis



Cost Discrepancy Alert

15% of total demand is travelling **more than 2000 miles**, which is impacting the overall logistic cost.

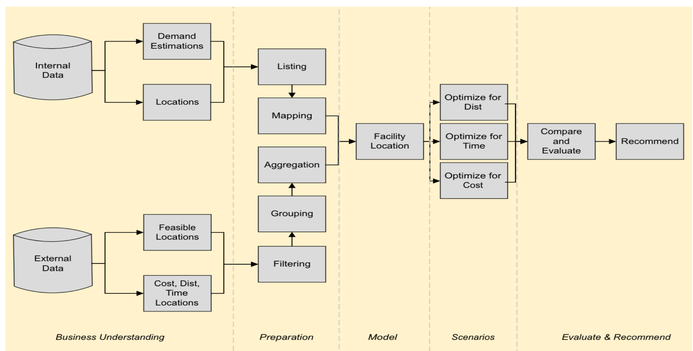
Midwest Cost Peak

Midwest region exhibits lower cost efficiency, with a cost/mile of **$2.07** surpassing the **$1.06 average**.

Costly Service Centre

The unit service cost for the two highest demand-serving warehouses exceeds the overall average.

Methodology



GUROBI OPTIMIZATION | Power BI | MySQL

Model

Below **Formulation** is used for analysis :

Objective Function

$$Minimize\ Z = \sum_{(i,j)\in Pairings} \text{weight}_i \cdot \text{dist}_{i,j} \cdot \text{assign}_{i,j}$$

Decision Variables

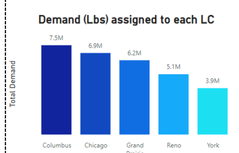
select$_j$ Î {0,1} : 1 if facility location *j* is selected, 0 otherwise
assign$_{i,j}$ Î {0,1} : 1 if customer *i* is assigned to facility location *j*, 0 otherwise

Constraints

1.**Facilities Limit** : Number of facilities opened cannot exceed the limit
2.**Open to assign**: Customer *i* can only be assigned to facility *j* only if that facility is built
3. **Assign to nearest facility**: Customer *i* must be assigned to exactly one facility

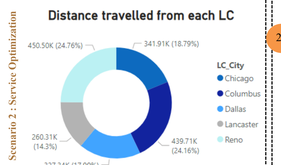
Streamlining Distribution by **Direct Fulfilment** from **5 Logistic Centres**

1



When Service Level is taken into consideration, **Dallas** and **Lancaster** came out as LC location instead **Grand Prairie** and **York**, Respectively.

While **optimizing for service**, **65 %** of total demand travels less than **100 miles** compare to **57%** in case of **cost optimization.**



Integration of **3 Logistic Centres** with **Current DC Network**

2

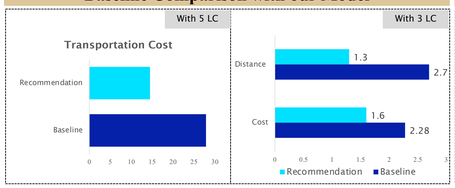
- LC location for Cost optimized scenario
- LC location for Service optimized scenario
- LC location for both the scenario

*keeping all the existing DC but optimizing the assignment to customer

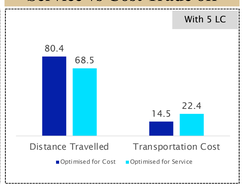
2b

When replacing **Buena Park** , **Fresno** and **North Las Vegas** produced the optimal location for Cost Minimization and Service Level while keeping **Burford** and **Grand Prairie.**

Baseline Comparison with our Model

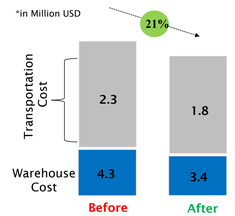


Service vs Cost Trade off



- Distance calculated in Million miles
- Weight calculated in Million lbs

Deployment and LCM



However, as we have mostly two scenarios to address, our solution would differ in two case :

Reduction of **15%** in total Distance travelled

Increase savings by **35%** in Transportation cost

Once done, result will be conveyed to stakeholder through an interactive **Power BI** dashboard.

Future Scope

- ❑ Assess the **demand seasonality** and include the same in supply chain network design
- ❑ **Inventory optimisation** for each LC & DC to be undertaken to execute the solution effectively.