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REDUCTION OF LOGISTICS COST BY OPTIMIZING THE DESIGN OF SUPPLY CHAIN NETWORK FOR WHOLESALE DISTRIBUTION COMPANY

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Abstract - *Supply chain network optimization makes use of technology and resources to improve efficiency and performance in a supply chain network. The work was carried out in a wholesale distribution company, the company provides custom solutions to meet the regional and International needs of its wholesale and retail customers.*

A branch of wholesale distribution company in comparison with other branches incurring more than estimated logistics and distribution costs, due to which the monthly revenue was not up to the target. According to the data, it was estimated that in wholesale company 3.6% (7.17 Crores) was the logistics cost particularly the Transportation cost. In the data it is evident that optimizing the supply chain network and applying Machine learning and GurobiPy Optimization Software will reduce cost within direct control from Transportation and logistics team.

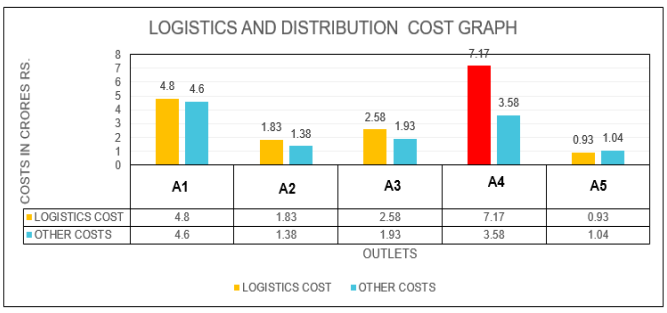
Further, the project can be used as a standard to reduce the logistics costs of other branches. This percentage of reduction in logistics cost will increase the company's profit by efficiently optimizing the network.

Key Words: **Supply chain and Logistics Cost, Machine Learning, Supply Network Optimization, Wholesale Distribution Company, GurobiPy optimization Software, Logistics cost.**

1. PROBLEM STATEMENT

Considering the Logistics costs of 5 distribution centers namely A1 Outlet, A2 Outlet, A3 Outlet, A4 Outlet and A5 Outlet. The bar graph is plotted using Logistics and Distribution Cost (in Crores) against Revenue in Rupees.

Chart 1: Logistics cost Distribution graph



The logistics cost of A4 DC has increased drastically over a period of 6 months compared to other outlets. A4 unit needs the reduction of Logistics cost by 3.6%.

The costs associated with Logistics cost (Rs.7.17 Crores breakdown) includes

Table 1: Logistics cost breakdown table

Logistics costs	Cost per month in Rs.	Cost per day in Rs.
Packaging(10%)	28,80,000	96,000
Transportation(52%)	58,80,000	1,96,000
Storage(38%)	31,89,990	1,06,333

Existing Supply chain network design is causing increased logistics cost the reasons include:

a) Improper Demand Forecasting

b) Supplier Reliability

2. OBJECTIVES

1. To Reduce logistics cost by optimizing the supply chain network design The logistics cost of A4 Distribution Centre incurring 7.17 Crores which is more than the main distribution Centre located in A1, hence there is a need to reduce logistics cost.

1. To forecast the demand using Machine Learning algorithm: Considering the previous sales data of daily commodities distributed by A4 Distribution Centre, the demand is forecasted using machine learning algorithm.

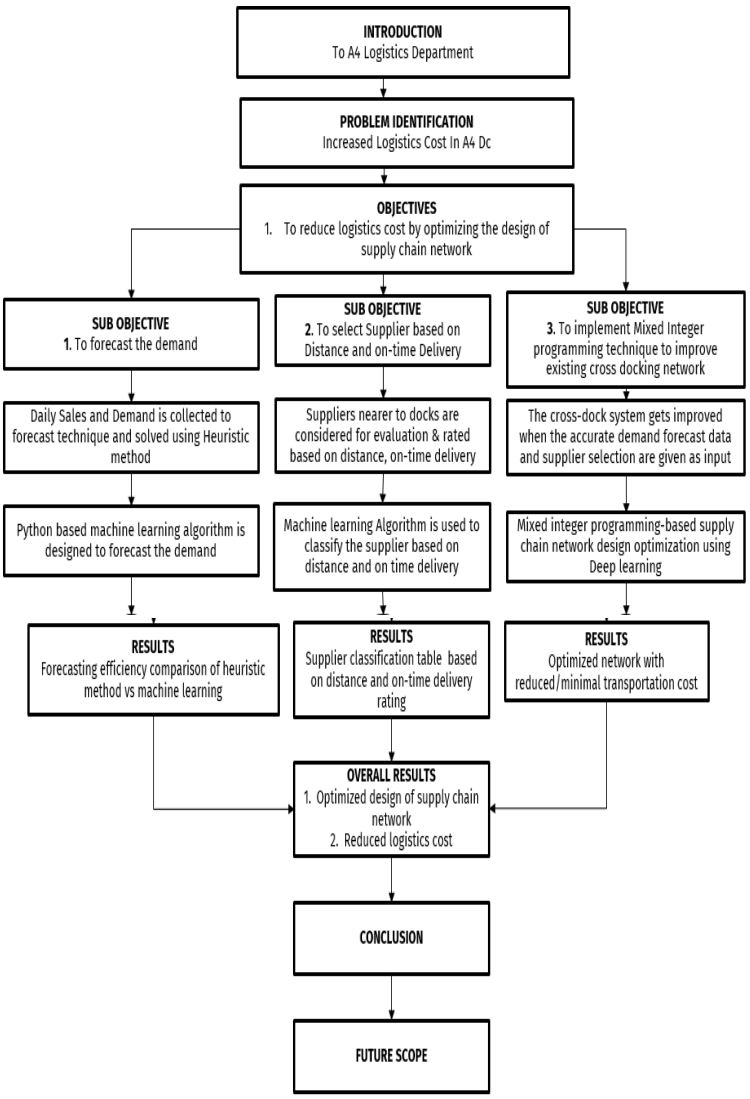
2. To select the suppliers based on distance using Machine Learning algorithm: Given that the quality and quantity of the daily commodities procured is known, appropriate supplier will be chosen based on distance and on-time delivery using machine learning algorithm.

3. To optimize the existing cross docking technique: The supply chain network design is optimized based on the data acquired from demand forecast and

supplier selected by machine learning algorithm. The optimized network design is obtained by mixer integer programming method.

3. METHODOLOGY

Fig 1: Methodology flow Diagram



The methodology as shown in the figure above describes the flow of project. Methodology includes introduction to Company profile, problem identification, objectives and sub-objectives and the process flow to achieve the sub-objectives thereby achieving the objective.

4. FORECASTING THE DEMAND USING MACHINE LEARNING ALGORITHM

The Data Considered To Forecast the Demand Using Exponential Smoothing Method:

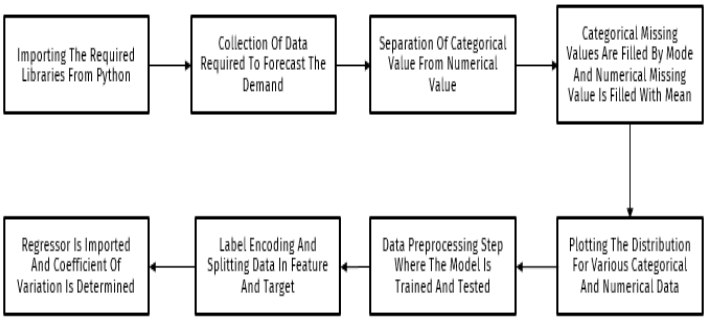
1. Previous months Demand data
2. Demand of Daily commodities: 8000 products
3. Item Price
4. Item Availability and Visibilities

The demand forecasting by Exponential Smoothing method, the data obtained as follows:

Table 2: Exponential Smoothing method result table

Exponential smoothing Method	
Mean Absolute Error	29.89939407
R squared Value	0.4836954
Accuracy of Forecasting	Low Accurate

Fig 2: Steps to implement Machine learning for demand forecasting



The demand Forecasted using machine Learning Algorithm is shown in the figure below:

Table 3: forecasted demand after machine learning implementation

FORECASTED DEMAND ACCURACY FROM MACHINE LEARNING ALGORITHM	
R Squared Value	0.68854
Accuracy Of Forecasting	Moderate Accuracy

The results of demand forecasting using exponential smoothing method are compared with the demand forecasting using Machine Learning

Table 4: Comparison between heuristic and Machine learning method

PARAMETER	HEURISTIC METHOD	MACHINE LEARNING METHOD
Coefficient of	0.48	0.6895

Variation		
Accuracy of Demand Forecasted	LOW ACCURATE	MODERATE ACCURATE

5. SELECTION OF SUPPLIER BASED ON DISTANCE AND ON-TIME DELIVERY RATING

Selection of Supplier Is Important For Improving Cross Docking Efficiency.

To implement the supplier rating the parameters considered are: for (200 Suppliers)

a) Supplier rated based on quality.

b) Supplier rated based on quantity.

c) Supplier rated based on nearest location to docks.

d) Supplier rated based on On-time delivery.

Fig 3: Steps to implement Machine learning for Supplier rating

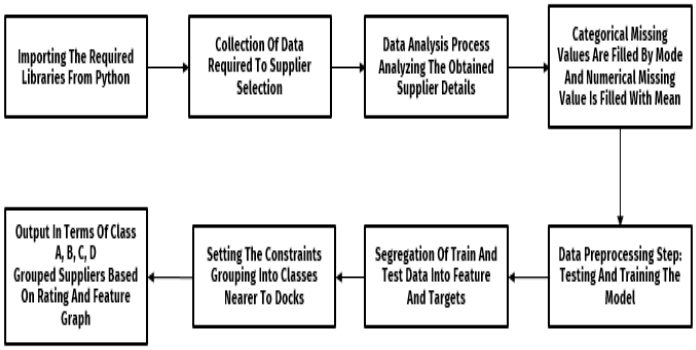


Table 5: The Categories of suppliers are grouped into classes

SL NO	CLASS OF SUPPLIERS	A4 DC DOCKS
1	CLASS A	NEAR TO DOCK A
2	CLASS B	NEAR TO DOCK B
3	CLASS C	NEAR TO DOCK C
4	CLASS D	NEAR TO DOCK D

Suppliers from class B which is nearer to dock B is selected using Machine learning algorithm.

6. SUPPLY CHAIN NETWORK DESIGN BY MIXED INTEGER LINEAR PROGRAMMING MODEL

Model Formulation

Sets and Indices

S ∈ SUPPLIERS = {SUPPLIER 1, SUPPLIER 2}
D ∈ DOCKS = {DOCK A, DOCK B, DOCK C, DOCK D}
C ∈ Customers = {H1, R2, C3, H4, R5, C6}

Cities = SUPPLIERS ∪ DOCKS ∪ Customers

Parameters

$cost_{s,t} \in R+$: Cost of shipping one ton from source s to destination t.
Supply ∈ R+: Maximum possible supply from supplier S (in units per day).
Through ∈ R+: Maximum possible flow through docks d (in units per day).
Demand ∈ R+: Demand for goods at customer c (in units per day).

Decision Variables

$Flows_{,t} \in N+$: Quantity of goods (in units) that is shipped from source s to destination t.

Objective Function

Cost: Minimize total transportation cost costs

$$\text{Minimize} \quad Z = \sum_{(s,t)\in \text{Cities}\times\text{Cities}} cost_{s,t} * flow_{s,t}$$

Constraints

- **Supplier output**: Flow of goods from a supplier must respect maximum capacity.

$$\sum_{s\in Cities} flows, t \le supply(s) \; \forall f \in SUPPLIER$$

- **Customer demand:** Flow of goods must meet customer demand.

$$\sum_{s\in Cities} flows, c = demand_c \; \forall c \in Customers$$

- **Dock flow**: Flow into a docks equals flow out of the docks.

$$\sum_{s\in Cities} flows, d = \sum t \in Cities\; flow_{d,t} \; \forall d \in Docks$$

- **Dock capacity:** Flow into a dock must respect dock capacity.

$$\sum_{s\in Cities} flows, d \le throughd \; \forall d \in Docks$$

Fig 4: Steps to implement Machine learning for Supply chain network Optimization

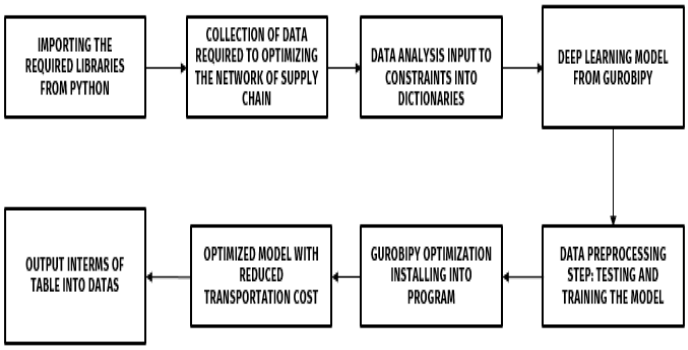


Fig 5: Optimized Network Obtained from GurobiPy Software

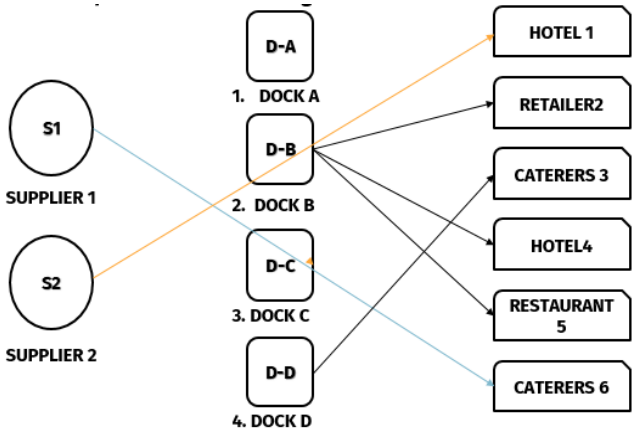


Table 6: The optimized network design for a day

FROM	TO	FLOW IN UNITS PER DAY
S1	C6	20000
S2	H1	50000
DOCKB	R2	10000
DOCKB	H4	35000
DOCKB	R5	60000
DOCKD	C3	40000

The Transportation Cost From Above Optimized Model Is Rs. 1, 08, 000

7. RESULTS

The Demand Forecasting accuracy was Low before implementing machine Learning and After implementation of Machine Learning Algorithm Accuracy is Moderate with Coefficient of variation from 0.52 to 0.68 and the percentage improvement of 23.5%.

The transportation cost before optimization was Rs. 1,96,000 per day and after Mixed Integer programming based Supply chain Network optimization using GurobiPy is Rs. 1,08,000 with the Savings of 44.89%.

8. CONCLUSIONS

The demand forecasting method by Machine learning algorithm provides accurate R squared value of 0.6895.

Suppliers nearer to docks are selected using machine learning algorithm. By the application of Mixed Integer Linear programming, the existing cross docking is optimized. The proposed model reduces the logistics cost by 44.89%.

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