Optimizing Urban Distribution based on Opportunity Cost considering Fleet Sharing

Ms. Garima[1] & Ms. Akshika Joshi[2]

1 & 2:Department of Transport Planning , School of Planning and Architecture Bhopal, India

Abstract

- Urban freight distribution underlines the physical and managerial activities necessary to support and make the economy and social life of the cities functional .
- It becomes imperative to mention that the optimization of the cost involved in logistics has not yet received the attention it deserves in practice due to an unorganized and fragmented market setup.
- This research is an attempt to quantify and evaluate the various costs incurred in the distribution channel taking the case of textile markets in the study area Indore, India under the context of constrained optimization and test the contextual validity of collaborative logistics practices in terms of fleet sharing.

Introduction

- In a competitive market, obtaining the maximum profit plays an important role in the success of any business.
- Cost optimization is the continuous process of obtaining the best cost with no impact or reduction in service delivery and ensuring customer satisfaction as well. It increases the profits to the stakeholders as well.
- The process of Distribution refers to the chain involved in moving and storing products from the supplier stage to getting it delivered to the customer.
- Since distribution affects both the supply chain cost and the customer experience directly, it acts as a key driver of the overall profitability of the firm.
- Any changes brought in the distribution network design affect the following supply chain costs – Inventories, Transportation, Facilities and Handling, and Information.

Methodology

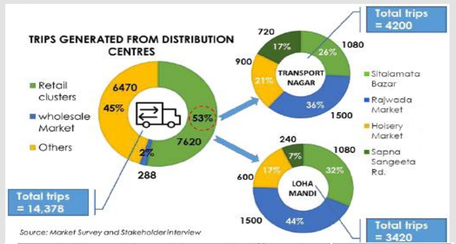
- Stage 1 deals with the thorough data collection from the identified stakeholders through clustered sampling. It involves retailers, transport operator, godown operators, and road network surveys. Total of 2800 samples (68%) were for the analysis purpose.
- Stage 2 involves quantification and analysis of distribution costs in terms of both generalized and opportunity costs.
- Stage 3 deals with the evaluation of benefits arising from fleet sharing as a tool for cost optimization in the urban freight distribution.

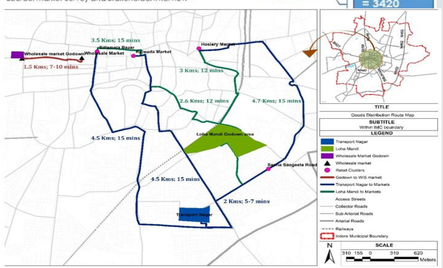
Study Area

- Indore is the largest and the most populous city in the state of Madhya Pradesh. It is considered as a business hub and acts as the financial and commercial capital of Madhya Pradesh due to its business-driven economy.
- As per Census 2011, the population within the Municipal Corporation is 1,994,397 and the GDP of Indore was $14 billion.
- Indore is well connected to other parts of the state and the country through National and State Highways. The national highways are the freight routes followed generally.
- Textile has been identified as one of the most important sectors responsible for shaping the economy of the city and in the development of the state .
- The study focuses on the following markets:
  1. Wholesale textile market
  2. Sitalamata Bazar
  3. Rajwada market
  4. Hoisery Market
  5. Sapna Sangeeta Road Market

Results

Distribution channel and its characteristics





Distribution routes in the study area

Performance Analysis – Retail & Wholesale Market Distribution

Capacity utilization of freight vehicles

Distribution Centre	Market	Capacity utilisation	No. of trips
Loha Mandi	Sitalamata Bazar	20%	1950
	Rajwada Market	28%	4290
	Hoisery Market	24%	910
	Sapna Sangeeta Rd.	36%	390
Transport Nagar	Sitalamata Bazar	32%	1950
	Rajwada Market	28%	4290
	Hoisery Market	20%	1365
	Sapna Sangeeta Rd.	48%	1170
W/S market godown	W/S Market	40%	5200

Factors	By object relationship		By behaviour regarding activity quantity		By relationship with management process	
	Direct Costs	Indirect Costs	Variable Costs	Fixed Costs	Opportunity Costs	Sunk Costs
Vehicle Operating Cost		0.775				
Labor Cost	0.762					
Commodity Holding Cost	0.667					
Cost of Idle time					0.653	
Penalties			0.435			
Toll fee			0.319			
Capital cost of vehicle						0.232
Market entry charges				0.215		

Method: **Exploratory Factor Analysis** with Orthogonal Varimax Rotation with Kaiser Normalization; Kaiser-Meyer-Olkin measure of sampling adequacy: 0.707; Variance explained: 56.7%; Bartlett's Test of Sphericity [χ2; df ; p-value]: [2553.234; 153; 0.000]; *Loadings smaller than 0.200 were suppressed

Analysis of Goods in Transit

Analysis of goods in transit helps to assess the time value of goods in transit as well the time value
of the handling durations considering the idle time. The following parameters are assessed in the
coming sections to arrive at the total distribution cost:

1. Vehicle Operating Cost
2. Commodity Holding Cost of the Freight Vehicle
3. Value of Idle time in the markets

Total distribution cost between distribution centers to markets

Distribution Centre	Market	VKT/ market	Tonnage	VOC/ tonne (Rs/ ton-km)	VO Comm (Rs/ ton-km)	CHC/ tonne (Rs/ ton-km)	VOIT tonne (Rs/ ton-km)	TDC/tonne (Rs/ ton-km)
Loha Mandi	Sitalamata Bazar	4550	390	14	91	1.68	35	141
	Rajwada Market	7436	1201	14	29	0.60	16	60
	Hoisery Market	2048	218	14	162	1.33	38	215
	Sapna Sangeeta Rd.	332	140	14	251	0.34	6	272
Transport Nagar	Sitalamata Bazar	5850	624	14	57	1.05	22	93
	Rajwada Market	11440	1201	14	29	0.76	16	60
	Hoisery Market	4277	273	14	129	1.99	46	191
	Sapna Sangeeta Rd.	1560	562	14	63	0.36	5	82
W/S market godown	W/S Market	6240	2080	14	17	0.58	35	66

[Note: VKT –Vehicle kilometers travelled; VOC – Vehicle Operating Cost; VOComm – Value of Commodity; CHC – Commodity Holding Cost; VOIT – Value of Idle Time; TDC – Total Distribution Cost]

Evaluation of Total Distribution Cost

Generalized cost equations for all distribution channels

Market	Loha Mandi	R^2	Transport Nagar	R^2
Sitalamata Bazar	y = 0.91x1 + 8.73x2 + 0.94x3 + 0.36x4 + 105.300	0.72	y = 1.00x1 + 8.88x2 + 0.72x3 + 0.28x4 + 65.37	0.72
Rajwada Market	y = 1.03x1 - 14.66x2 + 0.77x3 + 2.88x4 + 47.72	0.84	y = 0.99x1 -0.345x2 + 0.95x3 + 1.44x4 + 24.25	0.73
Hosiery Market	y = 1.03x1 – 11.29x2 + 0.93 x3 – 1.07x4 + 102	0.82	y = 0.977x1 -27.66x2 + 0.980x3 + 0.876x4 + 210.56	0.79
Sapna Sangeeta Road	y = 1.21x1 + 16.81x2 + 1.07x3 + 1.21x4 – 1.28	0.91	y = 0.9547x1 - 66.20x2 - 1.21x3 - 14.54x4 + 767.0413	0.72
Wholesale Market	y = 1.31x1 + 10.10x2 + 0.015x3 + 1.83x4 + 166.52			0.67

Here, the equations are justified as the R^2 values for each regression is **greater than 0.5** and the significance value is less than 0.05.

Distribution through fleet optimization

$$y = -0.0009x^3 + 0.5688x^2 - 115.21x + 8018.4$$

Where,
y = Number of trips made by LCVs
x = Tonnage carried per trip (in kg)

Cost reduction through trip optimization

Distribution Centre	Market	Vehicle Operating Cost (Rs)	Total Distribution Cost (Rs/day)	Optimized Vehicle Operating Cost (Rs/day)	Optimized Total Distribution Cost (Rs/day)	Percentage Reduction in Cost
Loha Mandi	Sitalamata Bazar	52580	53397	19841	20658	61%
	Rajwada Market	54249	55066	26613	27429	50%
	Hoisery Market	25038	25574	11338	11874	54%
	Sapna Sangeeta Rd.	5675	6132	3855	4312	30%
Transport Nagar	Sitalamata Bazar	67603	68401	28699	29498	57%
	Rajwada Market	83460	84452	44092	45084	47%
	Hoisery Market	58839	59547	26644	27352	54%
	Sapna Sangeeta Rd.	20030	20368	13795	14132	31%
W/S market godown	W/S Market	62595	63852	29526	30783	52%

From Table it is clear that optimization in number of trips through maximum capacity utilization of freight vehicles results in reduction of number of trips and distribution cost by an average of **49%**.

Conclusion

- The research concludes with the identification of an optimum distribution mechanism by utilizing the maximum loading potential of the available fleet, thereby resulting in profits through reduced operational costs. It highlights that, for the study area, 49% distribution cost can be optimized by working through this scenario, where the vehicle optimization would be 95%. Compared to study conducted by Das & Adnan, 2017 which resulted in 13% reduction in costs through a complete exchange of fleet by higher capacity vehicles, this research has covered a broader perspective by including the associated opportunity cost and thereby getting greater profits by utilizing the existing resources in terms of fleet. Considering the challenges associated with such collaborative functioning of the freight vehicles, it should be brought to the knowledge of the stakeholders, the profit associated with this tool. Also, there is a requirement of coordination and mutual trust among the stakeholders to encourage this budding concept in the field of city logistics.
- The research is applicable to any similar market setup where point to point distribution with underutilized fleet is being neglected, thus resulting in higher costs to the stakeholders. Such an approach deserves prime attention owing to the unregulated setup of such old markets.