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An Analytical Study on Minimising Road Freight Delays Through Optimized Routing in the Logistics Industry

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ABSTRACT

Road freight transportation is really important for moving goods from one place to another. When there are delays in transportation it costs more money and people do not get their goods on time. This study is about finding out what cause delays in road freight transportation and how we can make the routes better to reduce these delays. We got information, from freight drivers. Used special methods to look at the data. What we found out is that how far the truck has to travel affects how long it takes to get to the place and how much it costs. The type of vehicle does not make a difference. The study says that if we plan the routes better and make them more efficient it can help reduce delays and make the process of moving goods better. Road freight transportation can be improved with routes and this will help people get their goods on time.

Key words: Optimized Routing, Freight Transportation, Transit Delays, Supply Chain Efficiency, Transportation Cost

I. INTRODUCTION

Transportation is really important for getting things from the people who make them to the people who buy them. A lot of companies use trucks to move goods because it is a flexible way to get things delivered right to the customers door. Sometimes the trucks get stuck in traffic or have to drive on bad roads or, in bad weather and that can cause delays. These delays can be expensive. Mean that things do not get to the customer on time. So, logistics companies are trying to figure out the way to plan their routes. They want to find the routes that're the shortest and the fastest and that have the least traffic. By planning their routes companies can get things to the customer more quickly and make the whole process of getting things from the producer to the customer work better. Transportation and route planning are parts of this process and companies are working to make transportation and route planning more efficient.

II. RESEARCH OBJECTIVES

1. To identify and analyse the key factors contributing to freight transit delays with a focus on route and schedule optimization.
2. To analyze the relationship between key factors contributing to freight transit delays
3. To examine the impact of type of vehicle on route choice lead-in to the transit delays

III. SCOPE OF THE STUDY

This study focuses on the main factors that affect freight operations in road transportation. It considers aspects such as driver profiles, route selection, vehicle types, and external factors like weather conditions and road quality. The study also examines how these factors influence transportation cost, transit time, and overall logistics efficiency. By understanding these factors, the research aims to identify ways to improve freight operations and reduce delays.

IV. NEED FOR THE STUDY

This study is important to understand the operational challenges faced in freight transportation. It helps identify ways to improve route planning and scheduling for better efficiency. The research also focuses on reducing transportation costs and improving safety in logistics operations. By analyzing these factors, the study supports better decision-making and helps logistics companies minimize delays and improve overall performance.

V. LIMITATIONS

This study has certain limitations. The data was collected at a single point in time, which does not capture seasonal variations that may affect freight transportation and delays. Additionally, the study focuses only on road freight transportation and does not consider other modes of transport such as rail, air, or sea. As a result, the findings are limited to road logistics operations and may not fully represent the broader multimodal transportation system.

VI. REVIEW OF LITERATURE

A. Shahedi, F. Gallo, M. Saeednia, and N. Sacco (2023), Lead-Time-Based Freight Routing in Multi-Modal Networks studied multi-objective model to reduce time, cost, and delays, improving efficiency.

Y. Wang, X. Liu, and H. Chen (2022), Optimized Routing Using Real-Time Traffic Data developed real-time data to optimize routing and reduce delays. It improved delivery reliability and minimized waiting time.

S. Kumar and R. Singh (2021), Vehicle Routing Problem Optimization for Delay Reduction focused on VRP and genetic algorithms to reduce delays, resulting in less idle time and fewer late deliveries.

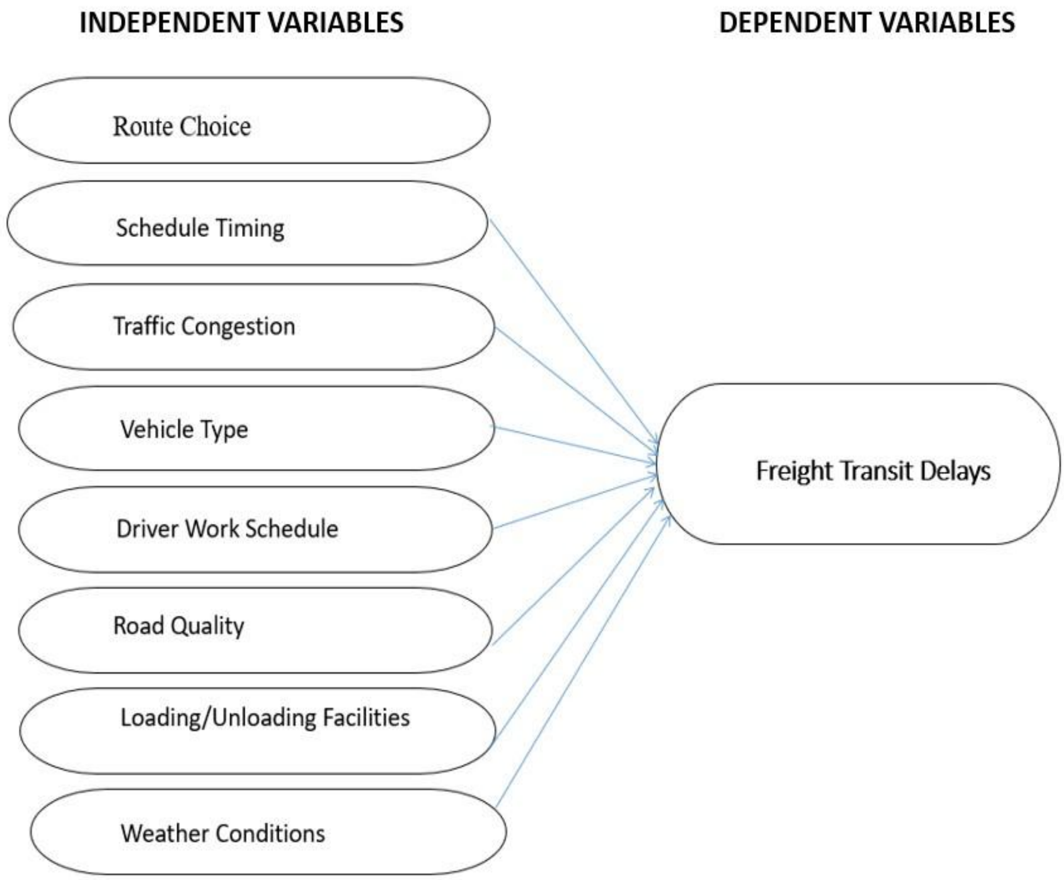
M. Crainic, G. Perboli, and W. Rei (2020), Advanced Routing and Scheduling Models in Freight Transport examined advanced and real-time routing to improve on-time delivery. It also reduced congestion-related delays through better planning.

P. Toth and D. Vigo (2019), Routing Optimization Techniques in Large-Scale Logistics Networks reviewed flexible routing and predictive planning can reduce delays, improve service levels, and shorten lead time.

VII. THEORETICAL BACKGROUND

Freight transit delays are affected by various independent factors such as route choice, scheduling, traffic congestion, vehicle type, infrastructure, and weather conditions. These variables collectively influence the efficiency and reliability of freight transportation.

Figure No: 1 Represents the Conceptual Model



VIII. RESEARCH DESIGN

This study uses data from 112 drivers to analyze freight delays, focusing on factors like traffic, routes, vehicle condition, and scheduling. CPM is used to identify bottlenecks, aiming to improve logistics efficiency.

IX. DATA ANALYSIS

The descriptive analysis of all categorical variables, as presented in the table below, highlights the major findings of the study.

Table No.: 1 Representing a variable which is measured in interval scale and nominal scale

Variables	Category	Frequency	Percentage
Age	26 to 35	57	50.9
	36 to 45	50	44.6
	46 to 55	5	4.5
	TOTAL	112	100
Education	Primary school	48	42.9
	High school diploma	45	40.2
	Vocational/Technical training	19	17.0
	TOTAL	112	100

Year of Experience	1 to 3	38	33.9
	4 to 6	63	56.3
	7 to 10	11	9.8
	TOTAL	112	100
Average Working Shift	Less than 6 hours	3	2.7
	6 to 8	50	44.6
	9 to 12	55	49.1
	More than 12 hours	4	3.6
	TOTAL	112	100
Type of Vehicle	Light commercial vehicle (e.g., van)	4	3.6
	Medium truck	38	33.9
	Heavy truck / trailer	55	49.1
	Container truck	15	13.4
	TOTAL	112	100
Type of Routes	Urban (Within cities)	20	17.9
	Intercity (between cities)	30	26.8
	Rural / remote areas	45	40.2
	Mixed	17	15.2
	TOTAL	112	100
Employment Status	Direct employee of the logistics company	51	45.5
	Independent contractor / Owner-operator	29	25.9
	Hired temporarily by a logistics agency	32	28.6
	TOTAL	112	100
Company	TCI freight	33	29.5
	Karthika	22	19.6
	Triwall	13	11.6
	RK Industry	17	15.2
	BRC	2	1.8
	Dynamic	5	4.5
	Keynes	5	4.5
	ARC	3	2.7
	Sasskthi	12	10.7
	TOTAL	112	100
Helper	Alone	32	28.6
	With a helper/assistant	45	40.2
	Varies depending on load	35	31.3
	TOTAL	112	100

INTERPRETATION

Respondents are mostly aged 26–45 with 4–6 years of experience, working 9–12-hour shifts. They mainly drive heavy trucks on rural or mixed routes, are largely TCI Freight employees, and often work with a helper, indicating demanding conditions.

ONE-WAY ANOVA ANALYSIS

HYPOTHESIS

- **Null Hypothesis (H_0):** There is no significant difference in route choice (Route Choice) based on the type of vehicle.

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• **Alternative Hypothesis (H_1):** There is a significant difference in route choice (Route Choice) based on the type of vehicle.

Table No.:2 One-Way ANOVA Analysis of Route Choice Based on Type of Vehicle

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.462	3	.154	.797	.498
Within Groups	20.847	108	.193		
Total	21.309	111			

INTERPRETATION

The One-Way ANOVA results indicate that there is no significant difference in route choice based on the type of vehicle (F = 0.797, p = 0.498). Since the p-value is greater than the significance level (0.01), the null hypothesis is accepted. This shows that the type of vehicle does not significantly influence route choice or transit delays.

DESCRIPTIVE STATISTICS

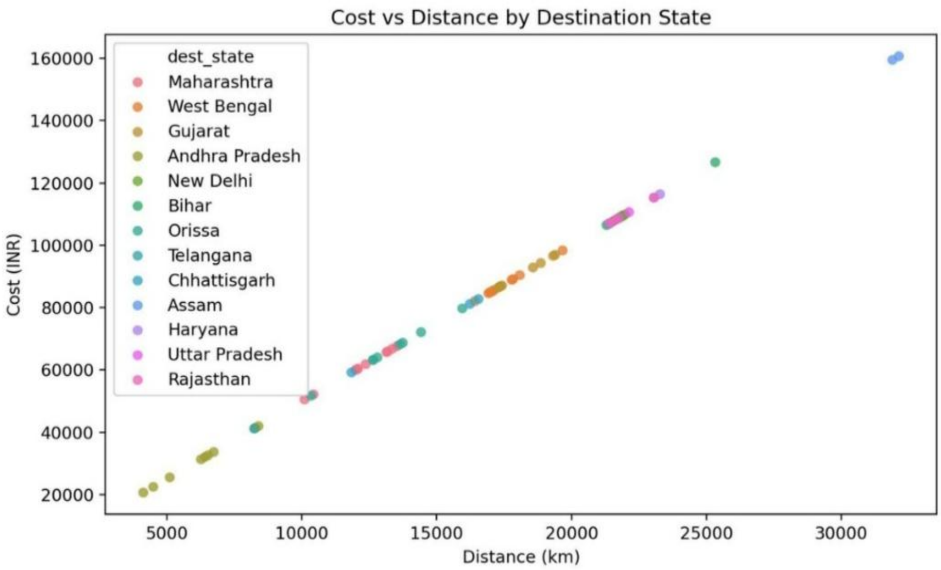
Table No.:3 representing Descriptive Statistics of Freight Trip Distance, Duration, and Transportation Cost Showing the distribution and variation of key trip performance metrics

Metric	Distance (km)	Days	Cost (₹)
Count	80	80	80
Mean	1,681.99	10.10	84,099.38
Std. Deviation	594.94	3.53	29,747.06
Minimum	412	3	20,600
25th Percentile (Q1)	1,264	8	63,200
Median (Q2)	1,734.5	10	86,725
75th Percentile (Q3)	2,166.5	13	108,325
Maximum	3,214	19	160,700

INTERPRETATION

1. The average route length is approximately 1,682 km, typically taking 10 days with an average cost of ₹84,099.
2. Transit days range between 3 and 19 days, while costs vary between ₹20,600 and ₹1,60,700, showing significant variation.
3. The data shows the presence of outliers at the higher end (routes above 3,000 km and costs above ₹1,50,000).

Chart No.:1



RESULTS

• Distance, days, and cost are all highly interdependent (almost linear).

• This means that route length (km) is the main driver for both cost and transit duration.

X. MANAGERIAL IMPLICATIONS

- Use GPS-based routing to reduce disruptions
- Train drivers on safety, risks, and fatigue management
- Monitor weather and plan alternative routes
- Reduce costs with shorter routes and multimodal transport
- Improve coordination for better roads and operations

XI. CONCLUSION

Road freight delays are mainly caused by long distances and operational challenges, not vehicle type. As distance increases, time and cost also rise. ANOVA confirms vehicle type has no significant impact, so better routing, driver skills, and management can reduce delays and improve efficiency.

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