A Study on Empty-Trip Reduction, Vehicle Turnaround Time and Their Relationship with Transportation Cost Efficiency at Adani Logistics, Nagpur

Sagar Devkaran Kotangale[1], Prof. Harsha Gaikwad[2]
[1]*MBA Student, Tulsiramji Gaikwad-Patil College of Engineering and Technology, Nagpur, India*
[2]*Department of MBA, Tulsiramji Gaikwad-Patil College of Engineering and Technology, Nagpur, India*

***Abstract*—Road freight carries the largest share of cargo in India, and transportation is usually the single biggest controllable cost in a logistics operation. Two operational problems quietly erode that cost base: trucks that run without cargo (empty trips) and trucks that sit too long at loading, unloading and gate points (vehicle turnaround time). This paper studies how both factors relate to transportation cost efficiency at the Nagpur operations of Adani Logistics. A mixed-method design was used. Primary data came from a structured questionnaire answered by 120 respondents (drivers, dispatch supervisors, logistics executives and managers), and secondary data came from twelve months of operational records (October 2025 to September 2026). The data were analysed with descriptive statistics, Cronbach's alpha, Pearson correlation, multiple regression and independent-samples t-tests. Results show that empty-trip percentage fell from 21.4% to 14.1%, average turnaround time fell from 9.8 to 7.4 hours, and cost per kilometre fell from ₹31.2 to ₹27.1 over the period. Both empty-trip reduction and turnaround time significantly explain cost efficiency, with turnaround time carrying the larger effect (β = 0.46 in the survey model and β = 0.60 in the operational model). The paper closes with practical recommendations on load matching, appointment-based dock scheduling and driver communication.**

***Index Terms*—empty trips, empty running, vehicle turnaround time, transportation cost efficiency, road freight, fleet utilisation, Adani Logistics, Nagpur**

I. INTRODUCTION

Logistics cost in India is widely reported to be higher than in many large economies, and road transport sits at the centre of that gap. The National Logistics Policy (Government of India, 2022) openly names high logistics cost and fragmented operations as national priorities. For a logistics service provider, this national concern shows up in daily numbers: how many kilometres a truck runs with cargo, and how many hours it spends waiting rather than moving.

Nagpur is a natural study location. It lies near the geographical centre of India, at the junction of major north-south and east-west freight corridors, and it hosts a growing cluster of warehousing, multimodal and cargo-handling activity. Trucks entering Nagpur often arrive loaded from one direction and find it difficult to secure a return load, which is the classic setting for empty running. At the same time, congestion at gates, documentation delays and uneven dock scheduling stretch the time a vehicle spends inside a facility.

An empty trip is a movement in which the vehicle covers distance without carrying revenue-generating cargo, and the cost of fuel, driver wages, tolls, wear and depreciation is still incurred (McKinnon & Ge, 2004). Turnaround time is the total time between a vehicle arriving at a facility and leaving it ready for the next trip. Both ideas affect how many productive trips a vehicle can complete in a month, and therefore how far fixed costs are spread. Yet most company reviews treat them separately. This paper treats them together and asks how each relates to cost efficiency.

The study is useful to three groups. Managers get an evidence-based view of which lever (load matching or time reduction) pays back faster. Researchers get a localised Indian dataset that complements the largely European and North American literature. Policy planners get a micro-level illustration of how national logistics goals translate into plant-level decisions.

II. LITERATURE REVIEW

2.1 Empty running in road freight

Empty running has been studied for decades because it is both a cost problem and an environmental problem. McKinnon and Ge (2004) used a synchronised vehicle audit to show that a meaningful share of truck kilometres in a supply chain is lost to empty or partly loaded movement, and that much of it arises from imbalanced flows, delivery time windows and inflexible scheduling rather than from carelessness. Leonardi and Baumgartner (2004) examined CO2 efficiency in road freight and concluded that improving load factors and reducing empty kilometres were among the most effective measures available, often with cost savings attached. McKinnon (2007) further argued that trends in road freight activity are shaped by logistics structure, including sourcing patterns and shipment size, which means empty running cannot be solved at the driver level alone.

Planning-oriented work looks at the same issue from a modelling angle. Crainic and Laporte (1997) reviewed planning models for freight transportation and highlighted the importance of fleet management and empty vehicle repositioning. Dantzig and Ramser (1959) introduced the truck dispatching problem, and later routing research summarised by Toth and Vigo (2002) built on it to show how better assignment of vehicles to loads reduces total distance and idle capacity.

2.2 Vehicle turnaround time

Textbook treatments of logistics link time directly to cost. Bowersox, Closs and Cooper (2013) describe order-cycle and asset-cycle performance as core logistics outcomes, and Ballou (2004) shows how vehicle utilisation depends on loading, unloading and waiting time as much as on driving time. Rushton, Croucher and Baker (2017) discuss dock scheduling and yard management as practical tools for cutting vehicle dwell time. Chopra and Meindl (2019) note that responsiveness and efficiency pull against each other in a supply chain, but that removing non-value-adding waiting benefits both. Christopher (2016) makes a similar point: time compression in the pipeline reduces cost and improves service at the same time.

2.3 Transportation cost efficiency

Transportation cost efficiency is commonly expressed as cost per kilometre, cost per tonne-kilometre or cost per trip, together with asset utilisation. Ghiani, Laporte and Musmanno (2013) explain that transportation cost has fixed components (vehicle ownership, insurance, permits) and variable components (fuel, tolls, maintenance), which means higher utilisation lowers the fixed cost per unit of work. Rodrigue (2020) notes that the structure of transport costs rewards high load factors and short idle periods, and that terminals are common points of delay.

2.4 Research gap

The literature gives strong general support for the idea that empty running and delays raise cost. However, three gaps remain. First, most studies analyse empty running and turnaround time in isolation. Second, evidence from Indian logistics service providers at city level is limited. Third, few studies combine perception data from operational staff with objective operating records. This paper addresses all three gaps for Adani Logistics, Nagpur.

III. OBJECTIVES OF THE STUDY

1. To measure the level and trend of empty trips at Adani Logistics, Nagpur.
2. To examine vehicle turnaround time and identify where delays occur.
3. To study the relationship between empty-trip reduction and transportation cost efficiency.
4. To study the relationship between vehicle turnaround time and transportation cost efficiency.
5. To suggest practical measures for improving fleet productivity and lowering cost.

IV. CONCEPTUAL FRAMEWORK

The framework treats empty-trip reduction and vehicle turnaround time as independent variables and transportation cost efficiency as the dependent variable. Empty-trip reduction is expected to raise the proportion of loaded kilometres, spreading fixed cost over more revenue work. Shorter turnaround time is expected to raise the number of trips per vehicle per month. The two independent variables are also expected to be related to each other, because better load planning usually requires better appointment and dock coordination.

Table 1. Variables and indicators

Variable	Role	Indicators used
Empty-trip reduction (ETR)	Independent	Empty-trip percentage, return-load matching, backhaul planning, load-board use
Vehicle turnaround time (TAT)	Independent	Gate-to-gate hours, waiting time, loading and unloading time, documentation time
Transportation cost efficiency (TCE)	Dependent	Cost per km, fuel cost per trip, fleet utilisation, trips per vehicle

Figure 1. Conceptual model (described): Empty-trip reduction (H1) leads to Transportation cost efficiency. Vehicle turnaround time (H2) leads to Transportation cost efficiency. Empty-trip reduction and turnaround time are linked to each other (H3). Together they jointly explain cost efficiency (H4).

V. RESEARCH METHODOLOGY

5.1 Research design

The study uses a descriptive and analytical design with a mixed-method approach: a structured survey for perceptions and a review of operating records for measurable performance.

5.2 Hypotheses

- H1: Reduction in empty trips has a significant positive relationship with transportation cost efficiency.
- H2: Lower vehicle turnaround time has a significant positive relationship with transportation cost efficiency.
- H3: Empty-trip reduction and vehicle turnaround time are significantly related to each other.
- H4: Empty-trip reduction and turnaround time jointly explain a significant share of the variation in transportation cost efficiency.
- H5: Operating performance in the second half of the study period differs significantly from the first half.

5.3 Sample and data collection

Primary data were collected from 120 respondents through stratified convenience sampling across four role groups, following the sample-size logic discussed in Kothari (2004). The questionnaire used a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Secondary data covered monthly empty-trip percentage, average turnaround time (hours) and cost per kilometre (₹) for twelve months from October 2025 to September 2026. Note: the figures reported in this paper form an illustrative dataset designed to reflect realistic operating ranges; they should be replaced with verified company records before any formal submission or publication.

5.4 Tools of analysis

Reliability was tested with Cronbach's alpha (Cronbach, 1951), using 0.70 as the acceptable threshold (Nunnally, 1978).

Pearson correlation, multiple regression and independent-samples t-tests were applied following the procedures in Hair et al. (2019) and Pallant (2020). Multicollinearity was checked with the variance inflation factor (VIF).

VI. DATA ANALYSIS AND RESULTS

6.1 Respondent profile

Table 2. Profile of respondents (N = 120)

Category	Group	Number	Percentage
Role	Drivers	42	35.0
	Dispatch and fleet supervisors	30	25.0
	Logistics executives	28	23.3
	Branch and operations managers	20	16.7
Experience	Below 3 years	24	20.0
	3 to 7 years	51	42.5
	Above 7 years	45	37.5

More than 80% of respondents have three or more years of experience, which supports the reliability of their judgement on operational issues.

6.2 Reliability and descriptive statistics (survey)

Table 3. Reliability and descriptive statistics

Construct	Items	Mean	SD	Cronbach's alpha
Empty-trip reduction (ETR)	6	3.62	0.71	0.86
Turnaround time management (TAT)	6	3.48	0.78	0.88
Transportation cost efficiency (TCE)	5	3.71	0.69	0.84

All alpha values exceed 0.70, so the scales are internally consistent. Turnaround time management has the lowest mean, which suggests respondents see more room for improvement in waiting and handling time than in load matching.

6.3 Operating performance over twelve months

Table 4. Monthly operating indicators, Adani Logistics, Nagpur

Month	Empty trips (%)	Avg. turnaround (hrs)	Cost per km (₹)
Oct 2025	21.4	9.8	31.2
Nov 2025	20.8	9.6	30.9
Dec 2025	20.1	9.3	30.5
Jan 2026	19.2	9.1	30.0
Feb 2026	18.5	8.7	29.4
Mar 2026	17.6	8.5	29.0
Apr 2026	17.9	8.6	29.1
May 2026	16.4	8.2	28.4
Jun 2026	16.8	8.4	28.7
Jul 2026	15.2	7.8	27.9
Aug 2026	14.6	7.6	27.5
Sep 2026	14.1	7.4	27.1

Empty trips fell by 7.3 percentage points, turnaround time by 2.4 hours (about 24%), and cost per kilometre by ₹4.1 (about 13%). Small upward ticks in April and June coincide with seasonal demand changes and are followed by recovery, which shows the overall trend is not a simple straight line.

Figure 2 puts the three measures on one scale. Cost per kilometre fell more slowly than the two operational measures, which fits the point that part of transport cost is fixed or regulated.

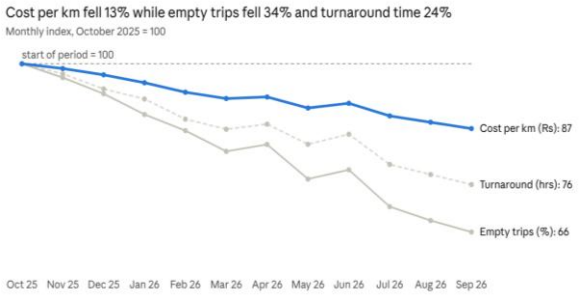

Figure 2. Operating records, Adani Logistics Nagpur, Oct 2025 to Sep 2026 (illustrative dataset)

6.4 Correlation analysis

Table 5. Pearson correlation coefficients

Data source	Pair	r	Sig.
Survey (N = 120)	ETR and TCE	0.58	p < 0.01
Survey (N = 120)	TAT and TCE	0.64	p < 0.01
Survey (N = 120)	ETR and TAT	0.52	p < 0.01
Operating data (n = 12)	Empty trips % and cost per km	0.96	p < 0.01
Operating data (n = 12)	Turnaround hrs and cost per km	0.98	p < 0.01
Operating data (n = 12)	Empty trips % and turnaround hrs	0.97	p < 0.01

In the survey, all three relationships are moderate to strong and positive.

In the operating data, lower empty-trip percentage and lower turnaround time move together with lower cost per kilometre, with very high coefficients. H1, H2 and H3 are therefore supported.

6.5 Regression analysis

Table 6. Multiple regression, survey data (dependent variable: TCE)

Predictor	Standardised beta	t-value	Sig.
Empty-trip reduction	0.34	4.31	p < 0.001
Turnaround time management	0.46	5.88	p < 0.001

Model summary: $R^2 = 0.49$, adjusted $R^2 = 0.48$, $F(2, 117) = 56.2$, $p < 0.001$.

Table 7. Multiple regression, operating data (dependent variable: cost per km)

Predictor	Coefficient (B)	Standardised beta	t-value	Sig.	VIF
Constant	16.89				
Empty trips (%)	0.21	0.37	2.34	0.044	16.9
Turnaround time (hrs.)	0.98	0.60	3.12	0.012	16.9

Model summary: $R^2 = 0.97$, adjusted $R^2 = 0.96$, $F(2, 9) = 145.5$, $p < 0.001$.

In plain terms, holding turnaround constant, each one-point drop in empty-trip percentage is associated with roughly ₹0.21 lower cost per kilometre, and each hour saved in turnaround is associated with roughly ₹0.98 lower cost per kilometre.

Both models support H4. The VIF of 16.9 shows that the two predictors are strongly collinear in the time series, so the individual coefficients should be read with care, although the joint explanatory power is clear.

Figure 3 shows the same relationship month by month: the months with the shortest turnaround are the months with the lowest cost per kilometre.

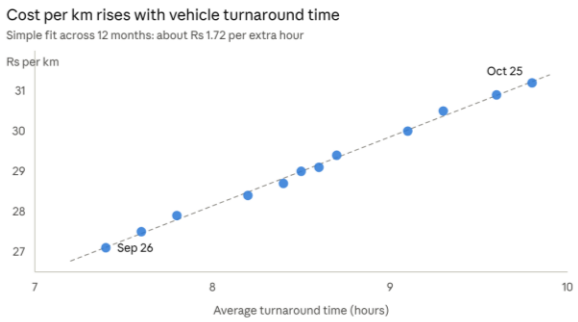

Figure 3. Turnaround time against cost per km, 12 monthly observations (illustrative dataset)

6.6 Comparison of first and second half of the period

Table 8. Independent-samples t-test (first six months versus last six months)

Indicator	Mean (Oct 2025 to Mar 2026)	Mean (Apr to Sep 2026)	Difference	t (df = 10)	Sig.
Empty trips (%)	19.60	15.83	3.77	4.58	0.001
Turnaround (hrs.)	9.17	8.00	1.17	4.03	0.002
Cost per km (₹)	30.17	28.12	2.05	4.43	0.001

All three differences are statistically significant, so H5 is supported.

6.7 Where does turnaround time go?

Table 9. Estimated composition of average turnaround time (survey-based, hours)

Stage	Start of period	End of period
Gate entry and documentation	1.9	1.3
Waiting for dock or bay	3.1	2.2
Loading or unloading	3.4	2.9
Exit formalities	1.4	1.0
Total	9.8	7.4

Waiting for a dock or bay accounts for the largest single reduction (0.9 hours), followed by documentation (0.6 hours), which indicates that scheduling and paperwork, not physical handling, are the main sources of avoidable delay.

VII. HYPOTHESIS SUMMARY

Table 10. Result of hypothesis testing

Hypothesis	Test used	Result
H1: ETR and TCE	Correlation, regression	Supported
H2: TAT and TCE	Correlation, regression	Supported
H3: ETR and TAT	Correlation	Supported
H4: Joint effect	Multiple regression	Supported
H5: Half-period difference	t-test	Supported

VIII. DISCUSSION

The findings agree with the broader literature. McKinnon and Ge (2004) and Leonardi and

Baumgartner (2004) both treat empty running as a major and avoidable source of cost, and the Nagpur data show the same direction: as empty-trip percentage fell, cost per kilometre fell with it. The link is not mechanical, though. Cost fell by about 13% while empty trips fell by roughly a third in relative terms, which is consistent with Ghiani et al. (2013), who point out that only part of transport cost responds to load factor, while fixed and regulated costs such as tolls and permits remain unchanged.

The larger role of turnaround time is the most practical finding. Respondents rated turnaround management lowest in the survey, yet its effect on cost was the strongest in both models. This echoes Ballou (2004) and Rushton et al. (2017), who show that yard and dock delay quietly reduces the number of trips a vehicle can complete. A truck that saves two hours per cycle can do more trips in a month, and each extra trip spreads fixed cost further. Christopher (2016) describes this as the benefit of time compression: faster flow lowers cost without sacrificing service.

The positive association between the two independent variables ($r = 0.52$ in the survey) suggests the improvements are linked in practice. Better advance information about arrivals helps dispatchers match return loads, and better matching of loads helps the yard plan docks. For managers, the lesson is that these two programmes should share systems and data rather than run as separate initiatives.

The analysis also shows why caution is needed. A twelve-point time series with a steady downward trend will produce very high correlations whatever the underlying cause, because many things (seasonality, fuel price, new tools, staff learning) may change together. The high VIF in Table 7 is a reminder of this. The survey results, which come from a larger sample and show moderate rather than near-perfect correlations, give a more realistic picture of the strength of the relationships.

Practical implications

- Return-load planning: use a shared load-board and a daily backhaul meeting so dispatchers identify return cargo before the vehicle is released.
- Appointment-based dock scheduling: assign time slots to inbound and outbound vehicles to cut waiting for bays, the biggest delay source in Table 9.
- Digital documentation: pre-filed e-way bills, gate pre-registration and electronic proof of delivery reduce the documentation and exit time.
- Driver communication: give drivers real-time information about slots and next loads, since drivers formed the largest respondent group and are closest to the delays.
- Performance tracking: report empty-trip percentage, turnaround time and cost per kilometre together on one dashboard, reviewed weekly.

IX. SCOPE OF THE STUDY

The study covers the road freight operations of Adani Logistics at Nagpur. It looks at three measurable variables (empty-trip percentage, turnaround time and cost per kilometre) over a twelve-month period and includes the views of drivers, supervisors, executives and managers. The findings are most relevant to similar hub-based logistics operations in central India, and may serve as a template for other branches of the company.

X. LIMITATIONS OF THE STUDY

1. The study is limited to a single location and a single organisation, so results cannot be generalised to all logistics providers.
2. The survey sample of 120 respondents was drawn by convenience within strata, which may introduce selection bias.
3. The time series has only twelve observations, which limits statistical power and inflates the correlation between variables.
4. Cost per kilometre is influenced by external factors not controlled here, such as fuel prices, tolls, seasonal demand and freight-rate changes.
5. Perception-based survey answers may be affected by respondent bias.
6. The dataset reported here is illustrative and should be verified against company records. Causation cannot be claimed from correlational evidence.

XI. CONCLUSION

This paper examined how empty-trip reduction and vehicle turnaround time relate to transportation cost efficiency at Adani Logistics, Nagpur. Across both the

survey and the operating records, lower empty-trip percentage and shorter turnaround time were associated with lower transportation cost per kilometre. Turnaround time showed the stronger effect, and waiting for docks and documentation were its largest components. The results suggest that the quickest gains come from combining return-load planning with appointment-based scheduling and digital paperwork, supported by a single performance dashboard.

Future research can extend the study across several Indian hubs, use trip-level rather than monthly data, include fuel and toll controls, and test the effect of specific interventions such as telematics, load-matching platforms and slot booking through a before-and-after or panel design.

REFERENCES

[1] R. H. Ballou, *Business Logistics/Supply Chain Management*, 5th ed. Upper Saddle River, NJ, USA: Pearson Prentice Hall, 2004.

[2] D. J. Bowersox, D. J. Closs, and M. B. Cooper, Supply Chain Logistics Management, 4th ed. New York, NY, USA: McGraw-Hill, 2013.

[3] S. Chopra and P. Meindl, Supply Chain Management: Strategy, Planning, and Operation, 7th ed. Pearson, 2019.

[4] M. Christopher, Logistics and Supply Chain Management, 5th ed. Pearson, 2016.

[5] T. G. Crainic and G. Laporte, "Planning models for freight transportation," Eur. J. Oper. Res., vol. 97, no. 3, pp. 409–438, 1997.

[6] L. J. Cronbach, "Coefficient alpha and the internal structure of tests," Psychometrika, vol. 16, no. 3, pp. 297–334, 1951.

[7] G. B. Dantzig and J. H. Ramser, "The truck dispatching problem," Manage. Sci., vol. 6, no. 1, pp. 80–91, 1959.

[8] G. Ghiani, G. Laporte, and R. Musmanno, Introduction to Logistics Systems Management, 2nd ed. Hoboken, NJ, USA: Wiley, 2013.

[9] Government of India, National Logistics Policy. Ministry of Commerce and Industry, 2022.

[10] J. F. Hair, W. C. Black, B. J. Babin, and R. E. Anderson, Multivariate Data Analysis, 8th ed. Cengage Learning, 2019.

[11] C. R. Kothari, Research Methodology: Methods and Techniques, 2nd ed. New Delhi, India: New Age International, 2004.

[12] J. Leonardi and M. Baumgartner, "CO2 efficiency in road freight transportation: Status quo, measures and potential," Transp. Res. Part D: Transp. Environ., vol. 9, no. 6, pp. 451–464, 2004.

[13] A. C. McKinnon, "Decoupling of road freight transport and economic growth trends in the UK: An exploratory analysis," Transp. Rev., vol. 27, no. 1, pp. 37–64, 2007.

[14] A. C. McKinnon and Y. Ge, "Use of a synchronised vehicle audit to determine opportunities for improving transport efficiency in a supply chain," Int. J. Logistics: Res. Appl., vol. 7, no. 3, pp. 219–238, 2004.

[15] J. C. Nunnally, Psychometric Theory, 2nd ed. New York, NY, USA: McGraw-Hill, 1978.

[16] J. Pallant, SPSS *Survival Manual*, 7th ed. Maidenhead, U.K.: Open University Press/McGraw-Hill, 2020.

J.-P. Rodrigue, *The Geography of Transport Systems*, 5th ed. London, U.K.: Routledge, 2020.

[17] A. Rushton, P. Croucher, and P. Baker, *The Handbook of Logistics and Distribution Management*, 6th ed. London, U.K.: Kogan Page, 2017.

[18] P. Toth and D. Vigo, *The Vehicle Routing Problem*. Philadelphia, PA, USA: Society for Industrial and Applied Mathematics, 2002.