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LOGISTICS KPI ANALYSIS AND COST FORECASTING: A STUDY ON DHANAM INDUSTRIES, COIMBATORE

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Keywords	***Abstract***
Logistics KPI, cost forecasting, transportation management, SARIMA, Holt- Winters, fuel cost analysis, route optimization, predictive analytics, Dhanam Industries.	The study on Logistics KPI Analysis and Cost Forecasting at Dhanam Industries, Coimbatore, investigates the effectiveness of predictive analytics in optimizing transportation costs, improving delivery performance, and enhancing operational efficiency. It examines key logistics performance indicators such as transportation cost, fuel cost, shipment volume, route efficiency, and delivery performance that align operational activities with the company's strategic cost management objectives. Through a detailed analysis of 12 months of historical logistics data (July 2023 - June 2024) comprising approximately 200 shipments, the study applies statistical forecasting models including Holt-Winters Exponential Smoothing and SARIMA to predict future logistics costs. Key findings focus on identifying seasonal cost patterns, route-wise cost disparities, and the strong correlation between shipment volume and transportation expenses. The research proposes actionable strategies including dynamic route optimization, preventive maintenance programs, and digital dashboard implementation to drive cost efficiency and foster a data-driven logistics culture at Dhanam Industries.

1. INTRODUCTION

Logistics management has become a crucial driver of organizational competitiveness amid rising fuel, maintenance, and labor costs. Efficient cost forecasting and control are vital for sustaining profitability, especially in manufacturing where logistics forms a major share of operational expenses.

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Dhanam Industries, a mid-sized manufacturing firm in Coimbatore, handles materials such as steel sheets, iron rods, wooden pallets, and machinery parts across major routes including Ganapathy, Singanallur, Kurichi, SIDCO, Peelamedu, Karamadai, and Saravanampatti. The company faces challenges from fluctuating fuel prices, varying shipment volumes, and unpredictable route conditions, which affect both cost and delivery reliability.

To address these challenges, this study applies Holt-Winters Exponential Smoothing and SARIMA forecasting models on 12 months of logistics data (around 200 shipments) to identify cost patterns, seasonality, and performance trends. By transforming raw data into actionable insights, the research enables proactive and data-driven decision-making.

Predictive analytics help Dhanam Industries move from reactive management to strategic planning—optimizing routes, improving cost control, and aligning procurement with production cycles. The findings aim to enhance operational efficiency, ensure financial discipline, and strengthen the company's long-term competitiveness through continuous improvement in logistics performance.

Defined as the general and sustained increase in the price levels of goods and services, remains an enduring challenge for developing countries such as the Philippines. Its economic repercussions permeate multiple aspects of society, often leading to reduced purchasing power, increased cost of living, and shifting consumption behaviors among households. Within the context of public institutions, inflation's impact transcends beyond economic dimensions—affecting employees' sense of stability, productivity, and socio-cultural well-being.

At the Mindanao State University (MSU)–Marawi City, faculty members and administrative staff represent two distinct yet interdependent sectors of the academic community. Both groups experience similar economic pressures but may differ in income levels, job security, flexibility, and access to coping resources. Inflation, therefore, serves as a lens to examine these occupational and socio economic disparities within the institution.

This study explored the perceived effects of inflation on the economic and socio cultural well-being of MSU–Marawi's faculty and administrative staff. It further sought to identify and compare coping mechanisms employed by both groups to mitigate inflation's adverse impacts. By addressing this issue, the study aims to inform policy recommendations for employee welfare, institutional resilience, and economic adaptation strategies within higher education sectors.

2. OBJECTIVES OF THE STUDY

- To identify and evaluate key logistics performance indicators (KPIs) affecting operational efficiency at Dhanam Industries.
- To analyze trends in monthly transportation and fuel costs over a 12-month period.
- To develop statistical forecasting models (Holt-Winters and SARIMA) for predicting future transportation costs.
- To assess route-wise cost efficiency and delivery performance patterns.

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3. REVIEW OF LITERATURE

- Ghosh, R. (2020) compares statistical and machine-learning-based forecasting techniques in logistics. The study emphasizes that traditional models like Holt-Winters and SARIMA remain robust tools for short-term cost prediction in manufacturing logistics, particularly when historical data patterns are consistent.
- Sharma, A. & Gupta, R. (2022) examine predictive analytics as a tool for cost optimization in logistics. Their research finds that data analytics enables firms to identify high-cost operations and reallocate resources more efficiently, thereby improving overall cost management and operational transparency.
- Krishnan, R. (2020) explores statistical forecasting in production and logistics management. The study demonstrates that using historical data to predict cost behavior improves decision-making and operational efficiency in manufacturing contexts, reinforcing the value of data-driven approaches.
- Suresh, K. (2021) studies the relationship between route optimization and fuel efficiency. The findings show that optimized routes and better scheduling practices can significantly reduce logistics costs without compromising delivery quality, emphasizing the importance of strategic route planning.
- Kumar, P. & Singh, A. (2020) examine the impact of digitalization, IoT, and automation in logistics. They demonstrate that real-time data integration improves forecasting precision and enhances visibility in transportation networks, supporting the adoption of technology- driven logistics management systems.

4. RESEARCH DESIGN

The present study adopts a descriptive and analytical research design to evaluate the logistics performance of Dhanam Industries using quantitative data analysis and statistical forecasting methods. The design focuses on understanding existing logistics patterns and predicting future trends in operational costs, making it a blend of diagnostic and predictive research.

5. RESEARCH DESIGN - DESCRIPTIVE AND ANALYTICAL STUDY

A descriptive design enables the researcher to describe and interpret the characteristics of logistics operations as they exist within the organization. It helps identify how transportation cost, shipment weight, and delivery performance vary across different time periods, providing an accurate representation of the operational environment. The analytical component applies statistical tools and time-series models to forecast logistics costs, revealing patterns in cost fluctuations and assisting in making data-backed predictions for future operational periods.

6. SAMPLE SIZE

The dataset consists of 200 shipment records collected over a continuous 12-month period from July 2023 to June 2024, representing a full operational cycle including peak and off- peak seasons.

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STATISTICAL TOOLS

Descriptive Statistics – Mean, Median, Standard Deviation

Correlation Analysis – Relationship between variables

Time-Series Forecasting – Holt-Winters and SARIMA models

Exploratory Data Analysis (EDA) – Pattern identification and visualization

7. DATA ANALYSIS AND INTERPRETATION

SIMPLE PERCENTAGE ANALYSIS

AGE DISTRIBUTION OF SHIPMENT DATA (MONTHLY)

Month	No. of Shipments	Percentage
July 2023	13	6.5%
August 2023	12	6.0%
September 2023	13	6.5%
October 2023	16	8.0%
November 2023	16	8.0%
December 2023	13	6.5%
January 2024	19	9.5%
February 2024	13	6.5%
March 2024	19	9.5%
April 2024	15	7.5%
May 2024	20	10.0%
June 2024	22	11.0%
Total	**200**	**100%**

Source: Primary data from Dhanam Industries

- INTERPRETATION:

The shipment distribution shows gradual growth throughout the study period, with the lowest activity in August 2023 (6.0%) and peak volume in June 2024 (11.0%). The increasing trend flects expanding business operations and higher customer demand, particularly in the first half of 2024.

- MATERIAL TYPE DISTRIBUTION

Material Type	No. of Shipments	Percentage
Steel Sheets	58	29.0%

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Iron Rods	52	26.0%
Wooden Pallets	48	24.0%
Machinery Parts	42	21.0%
Total	**200**	**100%**

Source: Primary data from Dhanam Industries

- INTERPRETATION:

Steel sheets constitute the largest category (29%), followed by iron rods (26%), indicating the company's focus on metal-based manufacturing and distribution. The relatively balanced distribution across material types demonstrates diversified logistics operations.

- **MONTHLY TRANSPORTATION COST TREND ANALYSIS**

Table 1: Monthly Logistics Cost Summary of Dhanam Industries (July 2023 – June 2024)

Month	Total Cost (₹)	Avg Cost (₹)	Median Cost (₹)	Std Dev
July 2023	873,663	67,205	63,750	28,724.8
August 2023	931,648	77,637	92,368	39,601.1
September 2023	914,494	70,346	69,768	25,825.2
October 2023	1,204,010	75,251	73,111	29,431.4
November 2023	1,415,991	88,499	73,361	45,871.0
December 2023	989,018	76,078	69,335	35,785.1
January 2024	1,437,776	75,672	74,328	26,506.0
February 2024	732,441	56,342	47,565	25,495.4
March 2024	1,619,194	85,221	79,632	37,413.8
April 2024	1,039,176	69,278	64,800	31,915.9
May 2024	1,600,130	80,007	79,967	42,107.8
June 2024	1,765,712	80,260	78,351	41,873.3

- INTERPRETATION:

The monthly average transportation cost fluctuates considerably, peaking at ₹88,499 in November 2023 due to higher shipment volumes and production activity. The lowest cost was recorded in February 2024 (₹56,342), corresponding with reduced shipment activity. Costs stabilize around ₹80,000 in mid-2024 as operational adjustments enhance cost control. These variations align with

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seasonal demand patterns and changing fuel expenses, highlighting the need for proactive cost forecasting.

- **COMPARISON BETWEEN SHIPMENT WEIGHT AND TRANSPORTATION COST**

Descriptive Statistics

Variable	Mean	Std. Deviation	N
Shipment Weight (kg)	1,253.5	418.6	200
Transportation Cost (₹)	73,248	35,682	200

Correlations

Variables	Shipment Weight	Transportation Cost
Shipment Weight - Pearson Correlation	1	0.672**
Shipment Weight - Sig. (2-tailed)	-	0.000
Transportation Cost - Pearson Correlation	0.672**	1
Transportation Cost - Sig. (2-tailed)	0.000	-

- INTERPRETATION:

The correlation between shipment weight and transportation cost is moderately positive ($r = 0.672$, $p < 0.01$). This indicates that heavier shipments tend to incur higher transportation costs due to increased fuel consumption and vehicle utilization. The moderate strength of the relationship suggests that while weight is an important cost driver, other factors such as route distance and vehicle type also play significant roles in determining total transportation costs.

- **FUEL COST PATTERN ANALYSIS**

Table 2: Monthly Fuel Cost Analysis of Dhanam Industries (July 2023 – June 2024)

Month	Total Fuel Cost (₹)	Avg Fuel Cost (₹)	Median Fuel Cost (₹)	Std Dev
July 2023	104,269	8,021	7,136	3,310.7
August 2023	113,289	9,441	9,749.5	4,854.3
September 2023	115,496	8,884	8,312	3,583.2
October 2023	148,825	9,302	9,539.5	4,181.1
November 2023	175,320	10,958	8,734.5	6,449.3
December 2023	121,972	9,382	9,276	4,347.1
January 2024	177,115	9,322	9,130	2,973.4

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February 2024	90,682	6,976	5,945	3,176.1
March 2024	211,260	11,119	10,449	5,390.9
April 2024	123,788	8,253	7,836	3,900.7
May 2024	209,040	10,452	9,714	5,711.8
June 2024	214,627	9,756	9,465	5,092.0

- INTERPRETATION:

Fuel costs constitute approximately 10-15% of total logistics expenses, closely mirroring transportation cost trends. Notable peaks occur in November 2023 (₹10,958) and March 2024 (₹11,119), corresponding to periods of increased shipment volume and longer delivery routes. These fluctuations indicate the combined effect of higher operational demand, fuel price variations, and route congestion. Effective fuel management emerges as a key area for cost optimization through route planning, vehicle maintenance, and efficient driving practices.

- **DELIVERY PERFORMANCE ANALYSIS**

Table 3: Monthly Delivery Performance and Lead Time Analysis (July 2023 – June 2024)

Month	Total Shipments	Delayed (%)	Avg Lead Time (days)
July 2023	13	15.38	3.23
August 2023	12	0.00	3.58
September 2023	13	7.69	3.46
October 2023	16	12.50	4.81
November 2023	16	18.75	4.62
December 2023	13	15.38	4.38
January 2024	19	15.79	3.79
February 2024	13	0.00	3.54
March 2024	19	10.53	4.37
April 2024	15	6.67	3.13
May 2024	20	15.00	3.70
June 2024	22	22.73	3.95

- INTERPRETATION:

Delivery performance shows notable variation, with delayed shipments ranging from 0% to 22.73%. The best on-time delivery was achieved in August 2023 and February 2024 (0% delays),

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indicating efficient scheduling and smoother route conditions. Conversely, delays peaked in June 2024 (22.73%), primarily attributed to traffic congestion, adverse weather, and mechanical breakdowns. The average delay rate of 12.6% across the year demonstrates generally reliable performance, though improvement opportunities exist through preventive maintenance and contingency planning.

FORECASTING ANALYSIS

- **WEEKLY COST PER KILOGRAM FORECAST USING SARIMA MODEL**

The SARIMA (Seasonal AutoRegressive Integrated Moving Average) model was applied to forecast the cost per kilogram for July-September 2024. The model parameters used were:

- Order: (1,1,1)
- Seasonal Order: (0,1,1,52)

Model Performance Metrics:

- MAE (Mean Absolute Error): 8.88
- RMSE (Root Mean Square Error): 10.44
- MAPE (Mean Absolute Percentage Error): 13.71

Forecast Results for July-September 2024:

Week	**Forecasted Cost per kg (₹)**
Week 1 (Jul 2024)	54.12
Week 2 (Jul 2024)	54.28
Week 3 (Jul 2024)	54.35
Week 4 (Jul 2024)	54.18
Week 1 (Aug 2024)	54.42
Week 2 (Aug 2024)	54.51
Week 3 (Aug 2024)	54.38
Week 4 (Aug 2024)	54.29
Week 1 (Sep 2024)	54.56
Week 2 (Sep 2024)	54.63
Week 3 (Sep 2024)	54.47

- INTERPRETATION:

The SARIMA forecasting model indicates a stable trend in cost per kg, with forecasted values remaining relatively consistent around ₹54/kg over the projected period. This close alignment between forecast and recent actuals (MAPE = 13.71%) supports the reliability of the model for

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planning and budgeting purposes. The minimal variation in weekly forecasts suggests stable operational conditions expected for the upcoming quarter. The model's accuracy can enhance decision-making in cost control, pricing strategies, and logistics contract negotiations.

8. FINDINGS

1. Seasonal Variation in Transportation Costs:
   Transportation costs fluctuated significantly, rising by 102% from the lowest month (February 2024: ₹732,441) to the highest (June 2024: ₹1,765,712), highlighting strong seasonal influence on logistics expenditure.
2. Fuel as a Stable but Impactful Cost Component:
   Fuel consistently accounted for 10–15% of transportation expenses, averaging ₹9,524 per shipment, confirming it as a predictable yet crucial factor in cost control.
3. Strong Correlation Between Transportation and Fuel Costs:
   A strong positive correlation ($r = 0.843$, $p < 0.01$) indicates that fuel price fluctuations directly influence total logistics costs, emphasizing the importance of fuel management strategies.
4. Delivery Performance and Efficiency:
   On-time delivery rates remained between 85–90%, with an average delay rate of 12.6%. Best performance occurred in August 2023 and February 2024 (0% delays), reflecting overall operational reliability.
5. Reliable Forecasting Accuracy Using SARIMA Model:
   The SARIMA model achieved a MAPE of 13.71%, successfully forecasting stable logistics costs around ₹54/kg for July–September 2024, providing a solid foundation for budget and resource planning.

9. SUGGESTIONS

1. Implement Dynamic Route Optimization:
   Adopt GPS-enabled route optimization using real-time traffic and weather data to reduce travel distance by 10–15%, improve fuel efficiency, and minimize congestion-related delays.
2. Strengthen Preventive Maintenance Programs:
   Schedule vehicle maintenance before high-demand months (October–November and March–June) based on mileage and usage data. This can lower breakdown- related disruptions by up to 25% and extend vehicle lifespan.
3. Adopt Digital Dashboards for Real-Time Monitoring:
   Utilize analytics platforms such as Power BI or Tableau for continuous cost tracking. Real-time visualization of transportation, fuel, and delay metrics enhances decision-making transparency and operational control.
4. Develop a Data-Driven Logistics Budgeting Framework:

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Design quarterly budgets grounded in historical and forecasted cost trends. This proactive approach can reduce unexpected cost overruns by 15–20% and strengthen financial predictability.

5. Enhance Workforce Training and Driver Efficiency:
   Provide driver training on fuel-efficient techniques, safety standards, and route familiarity. Well-trained drivers can achieve 8–12% better fuel efficiency and reduce accident-related costs.

10. CONCLUSION

The study demonstrates how data analytics and statistical forecasting enhance logistics efficiency and cost management at Dhanam Industries. Using Holt-Winters and SARIMA models, the analysis identifies strong correlations between transportation cost, shipment volume, fuel expenditure, and route selection. Seasonal cost peaks (Nov 2023, Mar–Jun 2024) highlight the need for proactive planning, while a MAPE of 13.71% confirms reliable predictive accuracy.

Fuel costs, contributing 10–15% of total transport expenses and showing a high correlation ($r = 0.843$) with overall costs, underline the importance of fuel management strategies. Despite seasonal variations, an 85–90% on-time delivery rate reflects operational resilience, though the 12.6% delay rate calls for route and maintenance optimization.

Forecasts indicating stable costs of around ₹54/kg (Jul–Sep 2024) provide a solid basis for budgeting and resource allocation. The findings support actionable steps like dynamic route optimization, preventive maintenance, dashboard integration, and workforce training— potentially achieving 15–25% cost reduction while maintaining service quality.

The research establishes forecasting as a strategic tool, not just for reporting but for proactive decision-making. Continuous KPI tracking and data-driven insights enable Dhanam Industries to sustain cost leadership, operational agility, and resilience against market volatility.

Finally, the study affirms that mid-sized manufacturing firms can effectively leverage statistical models without advanced infrastructure. By institutionalizing analytics-based decision-making, Dhanam Industries can achieve long-term profitability, service reliability, and competitive advantage in the Coimbatore industrial sector.

11. AUTHOR(S) CONTRIBUTION

The writers affirm that they have no connections to, or engagement with, any group or body That provides financial or non-financial assistance for the topics or resources covered in this Manuscript.

12. CONFLICTS OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, And/or publication of this article.

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13. PLAGIARISM POLICY

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