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An Empirical Study on Packaging Customization, Delivery Timeliness and Product Damage Rates in Logistics Industry

Nisitha Niroza K, Dr. P. Shanmugha Priya

Kumaraguru School of Business, Coimbatore, Tamil Nadu, India

nisithaniroza.24mba@ksbedu.in, shanmughapriya.p@ksbedu.in

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ABSTRACT

In the rapidly evolving logistics industry, packaging customization and delivery timeliness play a crucial role in ensuring product safety and customer satisfaction. This study examines the relationship between customized packaging, delivery timeliness, and product damage rates, with the objective of identifying factors that influence damage during transit and suggesting effective measures to improve delivery performance. The research focuses on the logistics sector in India and uses a quantitative, cross-sectional research design. Data were collected from 117 respondents through structured questionnaires and supported by logistics records. Customized packaging and delivery timeliness were treated as independent variables, while product damage rate was considered the dependent variable.

Statistical analysis, including correlation, regression, and One-Way ANOVA, revealed that packaging material has a significant influence on product damage. The findings indicate that poor packaging quality and delivery delays increase the likelihood of product damage, while effective customization and timely delivery significantly reduce losses and improve operational efficiency. The study also highlights the importance of proper handling practices, coordination among logistics teams, and the use of suitable delivery modes in minimizing damage. Based on the results, the study suggests adopting high-quality and customized packaging materials, improving delivery scheduling and coordination, implementing real-time tracking technologies, and providing proper training for logistics personnel.

KEY WORDS:

Packaging Customization , Delivery Timeliness, Product Damage Rate, Packaging Material , Product Handling , Delivery Performance.

I. INTRODUCTION:

In today's competitive logistics industry, packaging plays an important role in safeguarding products during transit, while delivery timeliness ensures customer loyalty. Product damage rates, often stemming from inadequate customization or handling, lead to significant financial losses and dissatisfaction. The recent studies indicate that up to 11% of goods are damaged due to poor packaging. This empirical study explores the interplay between customized packaging solutions, on-time delivery performance, and damage minimization to propose actionable strategies for supply chain efficiency

II. RESEARCH OBJECTIVES

1. The primary objective of the project is to study the relationship between customized packaging, delivery timeliness and product damage rates.
2. To examine the intercorrelation of factors affecting Delivery Timeliness.
3. To study the impact of mode of delivery on damaged products
4. To analyse the influence of packaging material on the product damage.
5. To suggest suitable measures to improve product delivery without damage.

III. SCOPE OF THE STUDY

The study focuses on logistics industry in India, examining secondary/tertiary packaging for consumer goods, with data from warehouses, logistics firms, and delivery services over a 12-month period. It excludes primary packaging or hazardous materials.

IV. NEED FOR THE STUDY

Rising e-commerce volumes amplify damage risks and 82% of logistics professionals report packaging-related issues that are necessitating research to cut returns, boost efficiency, and align with sustainability goals amid growing consumer expectations for fast, undamaged deliveries.

V. LIMITATIONS

Data is geographically limited to Indian urban logistics hubs like Coimbatore, potentially overlooking rural or international variations. Short study duration (one year) misses long-term trends in packaging material degradation or evolving tech like AI-optimized designs.

VI. REVIEW OF LITERATURE

S. Banerjee & Dr. K. Joseph (2024), ***"Impact of Delivery Timeliness on Rework and Waste Generation in Precision Manufacturing"*** assesses how deviations from planned delivery schedules influence manufacturing rework, scrap, and defect rates. Based on data from precision instrument manufacturers, the study found a strong negative correlation ($r = -0.72$) between on-time delivery and rework frequency. The authors suggest that synchronized logistics scheduling and proactive communication between production and transportation units are crucial to sustaining process efficiency and minimizing damage-related waste.

Anand Babu & Dr. V. Soundarya (2023), ***"Customized Packaging Strategies to Minimize Product Returns in Industrial Manufacturing"*** evaluates packaging innovations—like modular trays, foam inserts, and anti-rust coatings—in relation to product returns. Data from a mechanical parts manufacturer indicated a 31% reduction in customer returns and 18% lower in-transit damage after implementing customized packaging. The study concludes that collaboration between design engineers and packaging teams enhances end-to-end supply reliability.

Raghavendra Rao K. & Dr. P. Devi Priya (2023), ***"Influence of Customized Packaging on Material Handling Efficiency in Manufacturing Units"*** examines how industrial packaging customization, including use of molded inserts, anti-static linings, and vibration-absorbing materials, enhances material flow and reduces handling damage during factory-to-warehouse transfers. The study, based on data from automotive and machinery plants, revealed that customized packaging reduced microdents and surface abrasions by 37%. The authors emphasized that packaging standardization aligned with ergonomic handling designs contributes to operational efficiency and product integrity throughout the manufacturing chain.

Deepa Narang & Dr. M. Balaji (2022*), "Effect of Packaging Design on Product Integrity During Domestic Transit in Heavy Engineering Goods"* explores the role of packaging design parameters—such as cushioning type, load distribution, and crate geometry—on damage prevention. The study employed a sample of 2,500 consignments from heavy engineering plants, showing a 28% reduction in structural deformation when customized crate reinforcements and

moisture-proof linings were used. Recommendations include investing in design simulation tools and packaging audits to ensure optimal product safety during transportation.

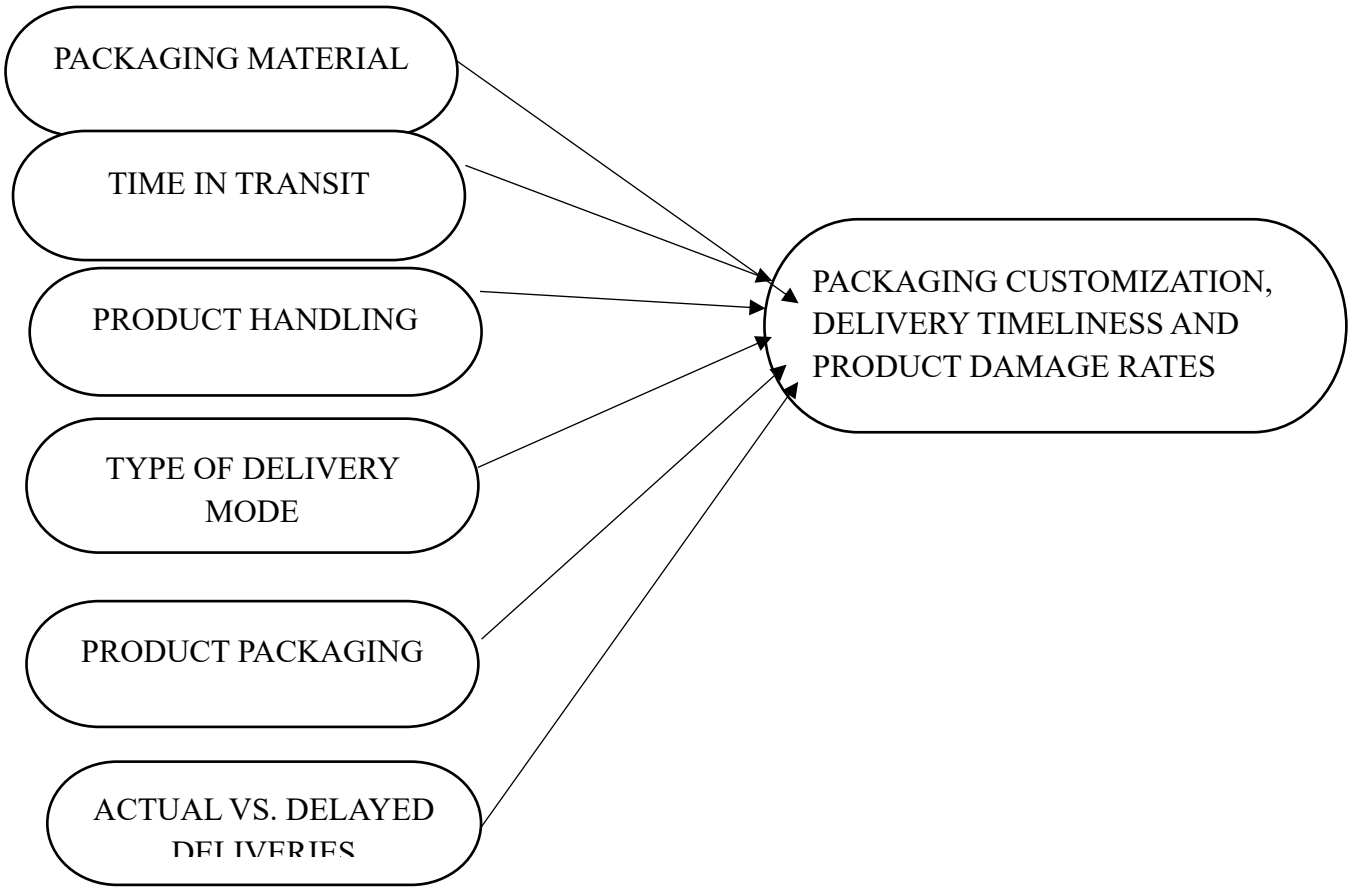
Dr. P. S. Menon & Ritu Sharma (2022), *"Relationship Between Logistics Timeliness and Packaging Integrity in Electronics Manufacturing"* investigates how delays in logistics schedules affect the physical and environmental integrity of packaged electronic goods. Using statistical correlation and field inspection data, the study found that delayed shipments face higher humidity exposure, leading to corrosion and insulation breakdown. The authors suggest humidity-controlled packaging and strict adherence to dispatch windows to minimize damage.

VII. THEORETICAL BACKGROUND:

In the logistics industry, packaging customization, delivery timeliness, and product damage rates influence service quality and customer satisfaction. Factors such as packaging material, product packaging, and product handling help protect goods during transportation, while time in transit and type of delivery mode affect delivery efficiency and risk of damage. Actual vs. delayed deliveries reflects the reliability of logistics services and overall operational performance.

CONCEPTUAL MODEL:

Fig No.1 Conceptual Model of Dependent and Independent Variables



RESEARCH DESIGN

This study employs a quantitative, cross-sectional correlational research design to examine the relationships among customized packaging, delivery timeliness, and product damage rates. Data were collected from 117 customers of Logistics Industry using a structured questionnaire with Likert-scale and frequency-based items, complemented by relevant logistics records. Customized packaging and delivery timeliness were treated as independent variables, while product damage rates served as the dependent variable.

To reduce potential bias, control factors such as product type, shipment distance, and handling requirements were considered. Data were analyzed using correlation and regression techniques to assess the strength and direction of relationships among variables. This design enables objective measurement, systematic analysis, and the generation of reliable, evidence-based insights into how packaging and delivery practices influence product damage outcomes.

VIII. DATA ANALYSIS

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

Table No: 1 Descriptive Analysis of Independent Variables

Statement	Mean score
Packaging Material	4.09
Time in Transit	4.13
Product Handling	4.18
Type of Delivery Mode	3.08
Product Packaging	3.56
Actual Vs. Delayed Deliveries	4.10

The mean scores indicate that product handling (4.18) and time in transit (4.13) received the highest ratings, suggesting that respondents are generally satisfied with how products are handled and the duration of delivery. Packaging material (4.09) and actual vs. delayed deliveries (4.10) also show positive perceptions, indicating reliable packaging quality and timely deliveries in most cases. However, product packaging (3.56) and particularly the type of delivery mode (3.08) received comparatively lower scores, highlighting the need for improvements in packaging design and the selection of appropriate delivery modes.

Table No: 2 One-Way ANOVA Test for the Influence of Packing Material on Product Damage

ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	72.631	3	24.210	28.346	.000
Within Groups	96.514	113	.854		
Total	169.145	116			

The One-Way ANOVA test was conducted to examine the influence of packing material on product damage. From the table, the calculated F-value is 28.346 with a significance (Sig.) value of 0.000, which is less than 0.05. This indicates that the result is statistically significant.

Therefore, we reject the null hypothesis (H_0) and accept the alternative hypothesis (H_1). This implies that there is a significant difference in the mean level of product damage among different types of packing materials. In other words, the type of packing material used has a significant influence on the extent of product damage.

IX. MANAGERIAL IMPLICATIONS

1. Strategic Importance of Customized Packaging

Managers should recognize packaging as a strategic function rather than a routine operational activity. The study shows that packaging material has a significant impact on product damage. Therefore, firms must invest in customized packaging solutions tailored to product size, fragility, weight, and transit conditions. Using shock-absorbing, moisture-resistant, and durable materials can minimize breakage and improve product safety during transportation. Packaging design should be tested and continuously improved using performance data.

2. Integration of Packaging with Supply Chain Decisions

Packaging should not be treated independently but integrated with transportation, warehousing, and distribution planning. Managers must ensure that packaging design matches the mode of transport, loading/unloading practices, and duration of transit. For example, long-distance shipments may require reinforced packaging, while fragile items may need special cushioning. Cross-functional coordination between packaging engineers, warehouse managers, and logistics teams is essential for reducing damage and improving efficiency.

3. Emphasis on Delivery Timeliness

The study indicates that delivery delays increase the risk of product damage and reduce customer satisfaction. Managers should focus on improving delivery performance through route optimization, better scheduling, and coordination among production, dispatch, and transport teams. Real-time shipment tracking and automated alerts can help reduce uncertainty and improve reliability. Timely delivery also strengthens customer trust and improves service quality.

4. Workforce Training and Handling Practices

Improper handling is a major cause of product damage. Managers must invest in regular training programs for warehouse staff, drivers, and logistics personnel on safe handling, proper stacking, and packaging guidelines. Standard operating procedures (SOPs) should be implemented and monitored. Employee awareness and accountability can significantly reduce transit-related damage.

5. Adoption of Technology and Digital Solutions

Managers should leverage modern technologies such as IoT sensors, AI-based logistics planning, and real-time monitoring systems. These technologies can track temperature, humidity, vibration, and movement during transit, helping identify potential risks early. Data analytics can also be used to predict delays, optimize delivery routes, and evaluate packaging performance, leading to more informed managerial decisions.

X. CONCLUSION

The study concludes that overall customer satisfaction with Logistics Industry performance is positive, though several operational areas require improvement. However, issues such as frequent product damage, occasional delivery delays, and moderate satisfaction with packaging quality highlight the need for process enhancement. The relationship between delivery performance, packaging, and handling practices suggests that these factors significantly influence customer perception and loyalty. By strengthening coordination among logistics teams, improving packaging materials, and adopting modern technologies like real-time tracking and AI-based route optimization, Logistics Industry can achieve higher efficiency and reliability. Overall, the research emphasizes that consistent quality improvement, timely delivery, and customer-oriented strategies are essential for sustaining satisfaction and business growth.

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