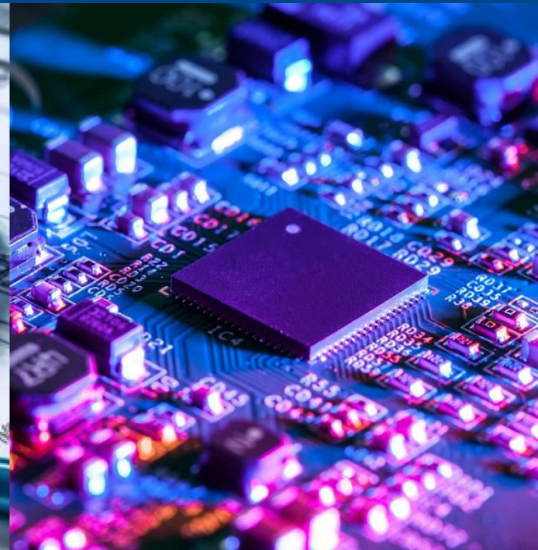
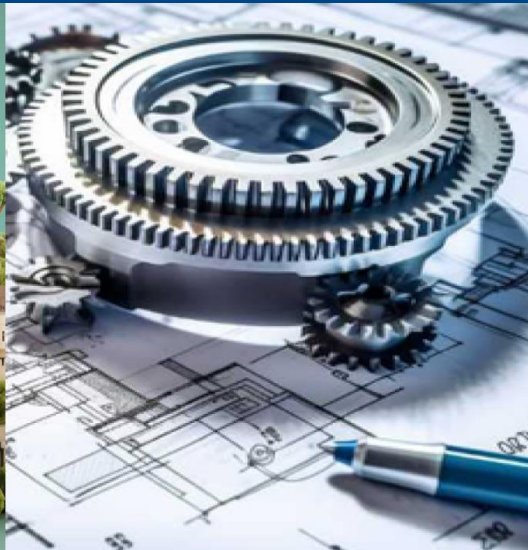
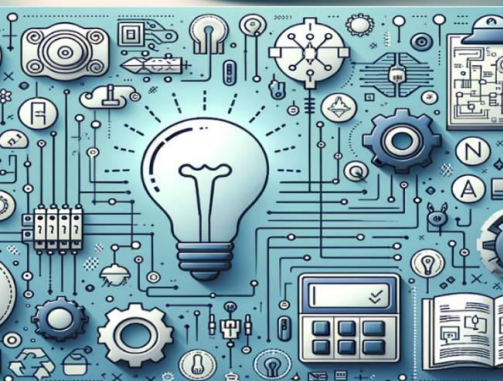




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An Analytical Study of E-Commerce Shipping Performance and Customer Satisfaction using Data Analytics

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ABSTRACT: In order to determine how left-behind and low levels of customer satisfaction lead to repeat business in today's highly competitive E-Commerce landscape, we will utilize the E-Commerce Delivery Dataset, which consists of 10,999 records of transactions related to the purchase of digital goods by 32 suppliers. The purpose of this study is to identify the key variables contributing to delivery speed through supply chain process improvements while documenting and analyzing how these variables affect shipping costs and delivery times. The analysis will also provide further insights into the relationship between delivery types standard versus express, delivery weights and the use of discounts by suppliers, and customer behaviors e.g., the level of interaction with suppliers based on whether a particular product was delivered faster than anticipated. Furthermore, data analysis will also reveal the remaining unknown variables related to the digital product delivery process that involve customer interaction with customer care, or customer support activities; all of which deliver customer service and satisfaction.

KEYWORDS: E – Commerce, customer satisfaction, delivery time, shipping cost, supply chain management, delivery speed, customer behavior, discount strategies, logistics optimization.

I. INTRODUCTION

E-Commerce continues to grow rapidly, transforming how individuals buy, sell and receive products around the world. Many companies have struggled to compete with established players in the industry and enter new markets and therefore, logistics performance has become one of the top three differentiators between E-Commerce providers. Delayed deliveries, choosing the wrong mode of transport, or issuing incorrect discounts can have an adverse effect on a company's reputation and ability to compete. Shipping information that can be used to evaluate a company's delivery performance include delivery schedule, mode of transport, weight per shipment, location of the warehouse, whether a discount was applied and customer feedback regarding the prior shipment. This article is primarily a data analysis to analyse shipment and customer relationship data for the purpose of understanding trends that drive delivery performance. This analysis will focus mainly on identifying lag times and inefficiencies within the logistics process. The results of this data analysis will provide logistics executives, supply chain analysts, and decision-makers with recommendations for enhancing delivery reliability and service performance. Logistics analysis was performed by utilising tools and software Excel, Python and exploratory statistics to determine the point at which shipping information converges with the business strategy of the company being evaluated.

OBJECTIVES OF THE STUDY:

- To identify elements impacting on time delivery.
- To examine the correlation between customer service interactions and customer satisfaction ratings.
- To analyse the effects of shipping type, product weight and discounts on customer satisfaction.
- To discover areas of inefficiency in operation at locations in the warehouse block.
- To deliver data driven recommendations for improving logistics efficiency



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DATASET DESCRIPTION:

The dataset consists of 10,999 records with a total of 12 variables per record and is collected from a customer who has made an individual purchase.

KEY VARIABLES:

Category	Variables
Customer Interaction	Customer_care_calls / Customer_rating
Order Characteristics	Cost_of_the_Product / Weight_in_Grams/ Importance_of_Product
Logistics	Mode_of_Shipment / Block_Warehouse
Customer Attitude	Prior_Purchases / Gender
Commercial Factors	Discount_Provided
Target Variable	Reached_on_Time_Y / N

The target variable of Reached_on_Time_Y / N summarizes if a product was delivered on or before the date of expected delivery.

II. REVIEW OF LITERATURE

G. A. Nisha, S. P, S. A, K. Manickam, S. K. Jagannathan and S. S D, (2025) found that The Deep Random Forest method introduced in this study is an up-and-coming technique that can help analyse and forecast key logistics indicators including delivery time and satisfaction, which resulted in a minimum of a 10% increase in user satisfaction and a 12% decrease in costs from existing baselines created using Gradient Boosting and XGBoost, which increased satisfaction by only 9% & by 8%, respectively. **Balamurugan, Dr. G. and K, Arunthathi, (2025)** The study also reviewed the obstacles facing companies wanting to implement predictive analytics or AI chatbots e.g., data integration, privacy. Finally, the authors made strategic recommendations on how to successfully use these tools to drive innovation and increase efficiency within e-commerce logistics. **Neha Choudhary, Anand Prasad Sinha and Somnath Mukherjee, (2025)** It also highlights how service quality is an important measure of customers' satisfaction when receiving products from E-Commerce businesses. Final results shows improving the quality of service indicators e.g. timely, creates an overall larger positive impact on furthering customer satisfaction and loyalty. **Junbo Wang, (2025)** The research proposed an overall approach using machine learning models to analyse both past shipment data and current real-time data. The proposed method represents an enhancement of using predictive modelling to enhance the overall efficiency and customer satisfaction of e-commerce logistics. **Nagian Toni, (2025)** examined a statistical significance of 5% was set for determining sample size with a t-value cut off at 1.96. As per findings, the study established that supply chain sustainability would be positively influenced by both e-commerce and digital marketing on SMEs. **Shizhong Shan, Jin Sun and Remson Mark C. Macawile, (2025)** aimed at identifying the Random Forest with XGBoost model reached an accuracy of 82.43%, while the SVC with SGD model achieved an accuracy of 88.84%; thus, both displayed average performance, comparatively. It was concluded that transformer-based frameworks provided new opportunities for implementing advanced contextual analyses by successfully identifying key sentiment patterns, product-specific issues, and customer requirements. **Hui, G., Al Mamun, A., Reza, M. N. H., & Hussain, W. M. H. W. (2025)** aimed to test the validity of the research model, the researchers applied the structural equation modelling for partial least squares. The results indicated that both delivery service quality, return logistics services, and cross-border online shopping experiences have a significant effect on consumer satisfaction. **Wang, J., Darwis, D., Gunawan, R. D., & Ariany, F. (2025)** utilized the Root Assessment Method (RAM) as a mean of performing a comprehensive evaluation on various e-commerce platforms. The authors identify limitations on this study, and recommend that future studies utilize AI techniques and advanced predictive analytics to create better predictive and robust models. **Yang, J. M., Qiu, J. R., Chiang, M. H., & Wang, Y. H. (2026)** aimed to evaluate the



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authors concluded that e-commerce businesses must develop and implement proactive business strategies as well as create policies that develop and promote logistical functions. **Saidov, D., Saidov, O., Kulmanov, T., Mamadiyarov, Z., Kurpayanidi, K., Ismoilov, B., & Makhmudov, S. (2026)** identified seven essential elements of an online marketing mix that contribute to customer experience and brand image: usability of the platform, information quality, delivery experience, service quality, security, customer review trust, and perceived value for money. The results support that service quality and experience design are fundamental marketing elements of all e-commerce markets that contribute to creating positive customer experiences and increasing a digital brand's value. **Amaral, J., de Oliveira, L. K., & Beckers, J. (2026)** founded a comprehensive set of research regarding the rapid growth of e-commerce and its corresponded increase of parcel deliveries and the impacts on urban logistics. The findings demonstrate the complex and heterogeneous nature of last-mile delivery operations and indicate a valuable resource for logistics modelling, urban freight planning and policy development. **Katal, A. (2026)** highlighted that they can tailor customer experiences, manage inventory, prevent fraud, and provide real-time customer sentiment analysis within E-Commerce. The study concluded that companies will need to adopt these technologies in order to differentiate themselves from competitors and remain viable.

III. RESEARCH METHODOLOGY

Tools Used:

- Excel: Data analysis and initial processing
- Python (Pandas, Numpy & Matplotlib): Use for data analysis/graphing
- Descriptive Statistics: mean, frequency, distribution

Data Preparation:

- Verified that no null values were included
- Categorical columns were converted for analysis
- Numerical columns were standardized for comparative analysis

Exploratory Data Analysis (EDA):

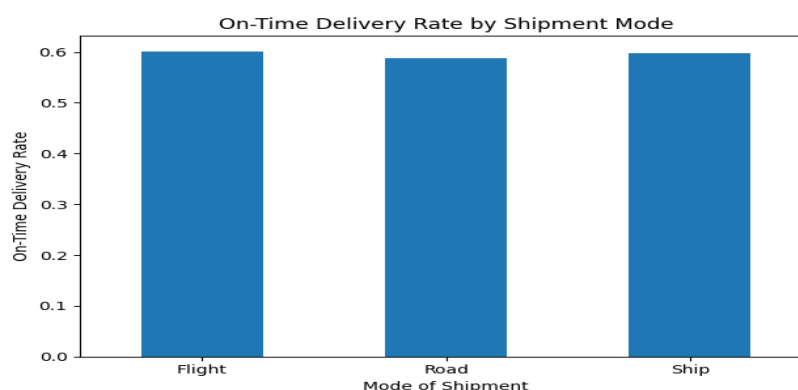
EDA is the process of examining and summarizing a dataset before applying any formal modelling or analysis. It helps analysts understand the structure, patterns, and anomalies hidden within the data using statistical summaries and visualizations such as histograms, box plots, and heatmaps. The main goal of EDA is to uncover key insights, detect outliers, identify missing values, and understand relationships between variables. Ultimately, EDA serves as a critical first step that guides better decision-making and builds a strong foundation for accurate predictive modelling.

EXPLORATORY DATA ANALYSIS (EDA):

ANALYSIS OF ON-TIME DELIVERY RATE BY SHIPMENT MODE

The data set contains three shipping methods:

- Flight
- Road
- Ship





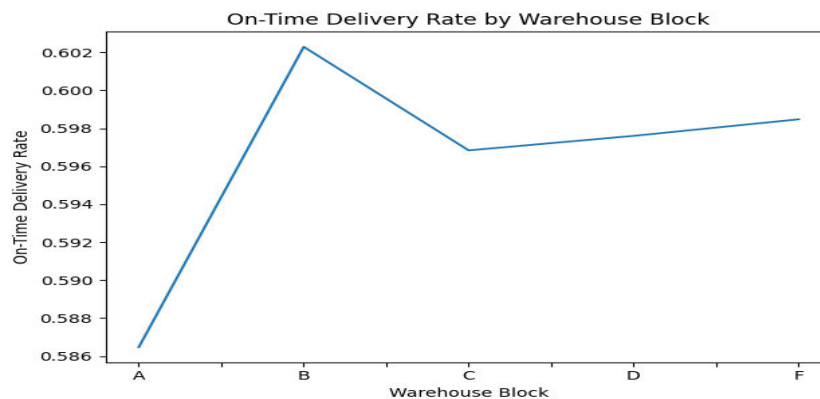
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INTERPRETATION

From the above bar chart, I identified which mode of transportation is more reliable for the shipment of flights. In the case of flight transportation, the mode of transportation that offers faster delivery is also accompanied by larger discounts.

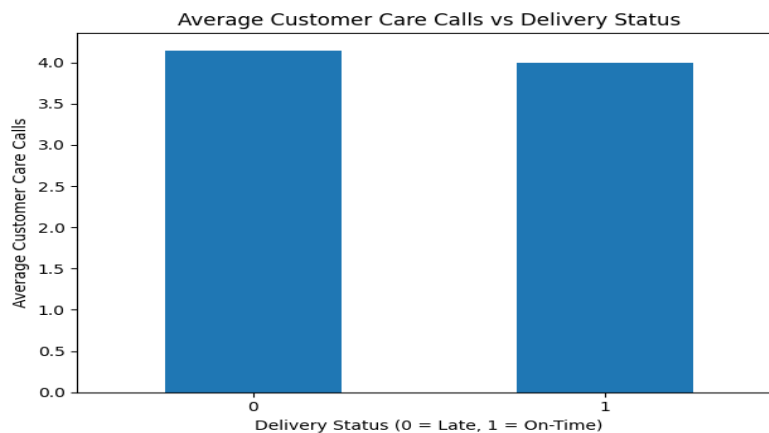
ANALYSIS OF ON-TIME DELIVERY RATE BY WAREHOUSE BLOCK



INTERPRETATION

Based on the above line chart, I assumed that some of the warehouse blocks keep displaying lower percentages for on-time delivery, whereby operational inefficiency or geographical constraints might be existing.

ANALYSIS OF AVERAGE CUSTOMER CALLS BY DELIVERY PERFORMANCE



INTERPRETATION

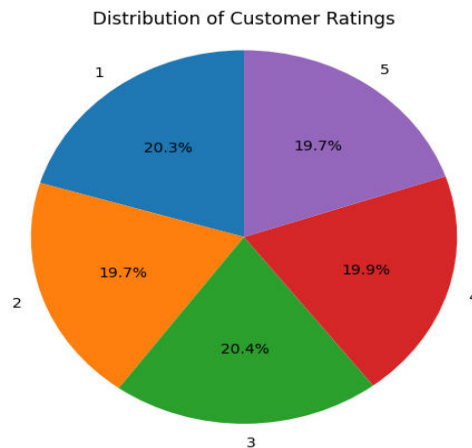
The above bar chart indicates the relationship between customer care calls and the delivery of orders. It also indicates that the higher the customer care calls, the related orders may be late in delivery. The graph also shows the relationship between the delivery of orders and customer satisfaction.



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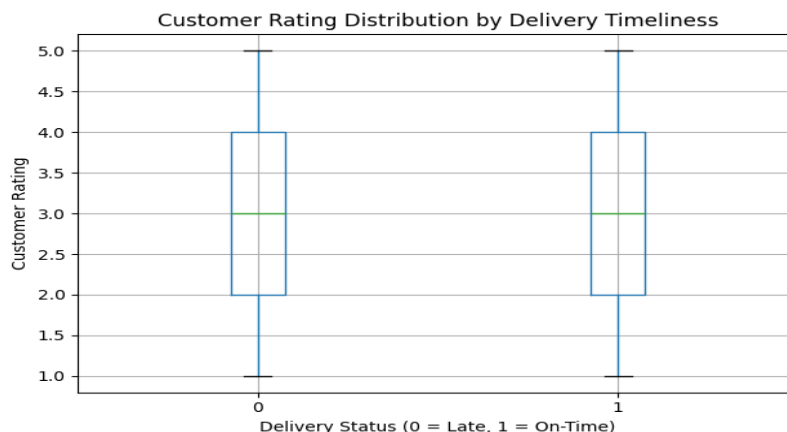
ANALYSIS OF CUSTOMER RATINGS DISTRIBUTION



INTERPRETATION

In the pie chart, the distribution of customer feedback is shown in terms of percentages corresponding to the rates given, which vary between 1 and 5. A significant number of high feedbacks 4 and 5 significantly influences the total responses given, signifying that customer experiences are somewhat positive. A significant number of low feedbacks also relate to delays in delivery.

ANALYSIS OF CUSTOMER RATING BY DELIVERY STATUS



INTERPRETATION

A box plot illustrates that customer ratings for on-time orders are always higher than those for delayed orders. The distribution analysis indicates additional insight into delayed orders' generally low customer rating and higher variability.

ANALYSIS OF PRODUCT FEATURES AND DELIVERY

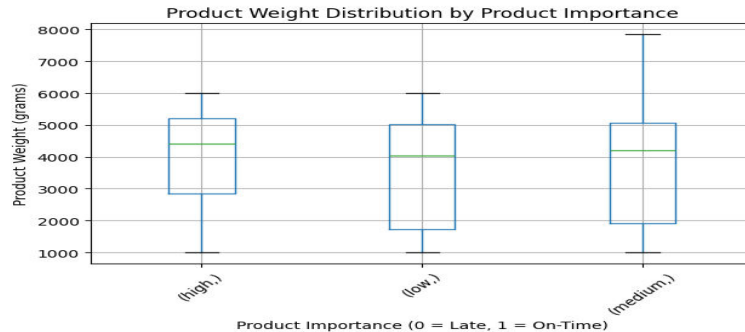
Products classified as:

- Low
- Medium
- High



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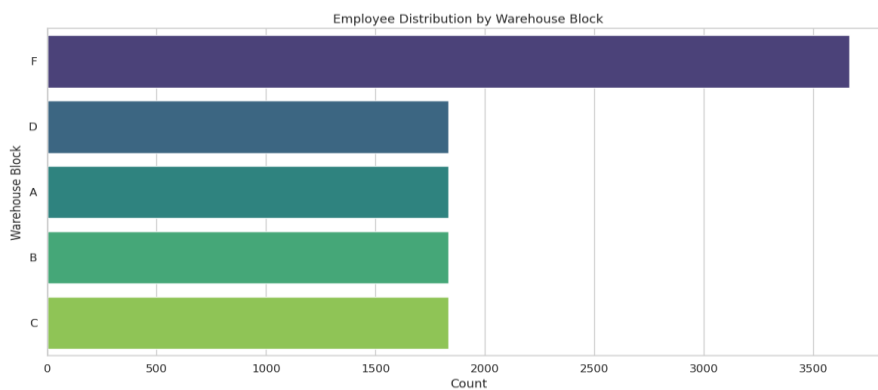
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INTERPRETATION

The box plot also shows that high-importance products have operational priority; however, when the weight of the product goes beyond the optimal weight for handling, delivery is still delayed.

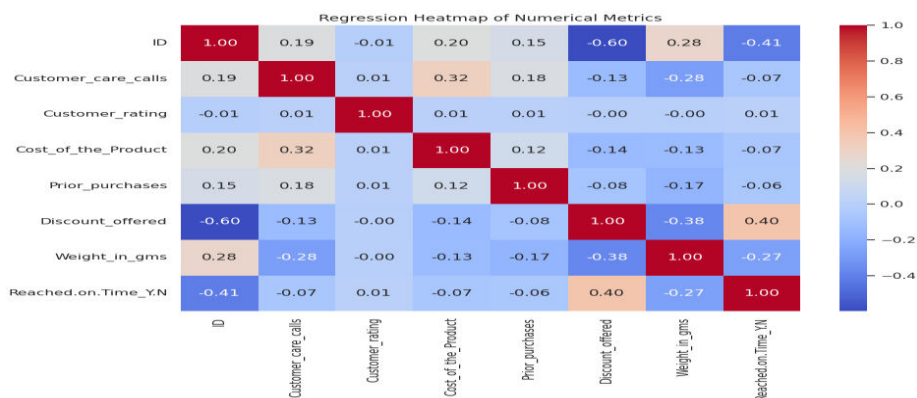
ANALYSIS OF EMPLOYEE DISTRIBUTION BY WAREHOUSE BLOCK



INTERPRETATION

The chart displays how employees are spread across five warehouse blocks in A, B, C, D, and F. Block F stands out significantly with the highest number of employees, at approximately 3,700 workers. This suggests it is the largest or busiest warehouse block. Blocks A, B, C, and D all have a nearly equal number of employees, each with around 1,850 workers. This shows a very balanced and even distribution across these four blocks.

ANALYSIS OF REGRESSION HEATMAP OF NUMERICAL METRIX





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A heatmap shows how strongly two variables are related to each other. The values range from -1 to +1:

- ● Red (closer to +1) = Strong positive relationship (both increase together)
- ● Blue (closer to -1) = Strong negative relationship (one increases, other decreases)
- □ Near 0 = Little to no relationship

INTERPRETATION

Discount & On-Time Delivery (+0.40) Discounted products tend to be delivered on time more often. Weight & On-Time Delivery (-0.27) Heavier products are less likely to arrive on time due to logistical challenges. Customer Care Calls & Product Cost (+0.32) Higher-priced products receive more customer care calls, reflecting greater buyer expectations. Discount & Weight (-0.38) Heavier products receive fewer discounts, likely due to high shipping costs.

PREDICTORS OF ON-TIME DELIVERY :

According to correlative and trend analyses, the most influential factors are:

- Mode of shipment
- Product weight
- Discount offered
- Customer care calls
- Warehouse block

BUSINESS INSIGHTS :

1. Operational Insights:

- There are logistic inefficiencies that are concealed by the reliance on discounts.
- Some warehouses should be audited for performance.
- The method of shipping does not consider the weight of the shipment.

2. Customer Experience Insights:

- Late deliveries negatively impact the customer ratings.
- A large number of customer care calls indicates the presence of operational problems.

IV. BUSINESS RECOMMENDATIONS

Logistics Optimization :

Businesses should utilize weight as the basis for routing of shipments to ensure that heavier products are routed to shipment modes and carriers that can handle them in a manner that optimizes the reliability of shipment delivery. This will reduce delays in transit due to operational limitations. The redesign of warehouse performance metrics (Volume & Delivery Time) and handling efficiency will allow better performance improvements across clusters of warehouses.

Customer service approach :

Companies need to shift their crisis approach to customer service from "reactive," focusing on resolving issues caused by prior call delays or failures, to "predictive" by offering predictive data services using shipment tracking and/or normal company delays as guide. Using these data patterns allows a company to set up clients in advance with delay alerts, thus providing anticipated solutions before delivery issues occur. By doing this, companies promote transparency; reduce the number of unproductive entries into client care; and minimize client dissatisfaction due to insufficient resolution of their future requests.

Pricing and Discount Strategy:

In order to implement a pricing and discount strategy based on a delay risk, instead of offering universal discounts, it is suggested that companies use a system of risk-based incentives. Risk-based incentives are selective discounts applied only to high-risk freight shipments. The benefits of giving risk-based incentives are two-fold: they help maintain the company's profit margin and build customer trust by being seen as a fair incentive program.

LIMITATIONS OF THE STUDY:

The study has several limitations that should be acknowledged:



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Lack of geographic distance:

- There isn't enough of an actual distance for delivery due to the short distance of shipping directly from one area to another.
- Because of a customer's location, the distance for delivery from that customer's location will not allow for optimal or ideal distance to analyze the degree to which long-distance shipping and regional logistics challenges directly affect delivery delays.
- The absence of geographic distance will limit the ability of the researcher to analyze other aspects of the delivery process.
- Other factors not assessed in this study include regional infrastructure constraints, as well as urban vs rural distinct deliveries.

No Breakdown of shipment modes cost:

- All data about the actual costs of different shipment modes (i.e., Flight, Road, and Ship) are missing from the dataset.
- Therefore, the researcher cannot determine how cost-efficiently or profitably each of the shipment modes will be compared to the options that are available for faster or slower delivery.
- Without detailed shipment cost analysis, the researcher cannot provide recommendations regarding which shipment mode is best from both cost and performance perspectives.

No information available on customer sentiment:

- Customer satisfaction is recorded as a numeric value only.
- The absence of textual feedback, reviews, or sentiment data means that there is no way to gather enough information to assess customers' emotional and qualitative perspective about your business.
- The researcher could not assess negative feelings associated with a delay in delivery due to service quality or customer service interaction

V. FUTURE SCOPE

Future studies can improve and extend the findings of the current investigation by the following enhancements:

Machine Learning Delivery Prediction Models:

- Prediction models can be developed that identify the parcels at greatest risk for delays prior to the time of dispatch.
- Delivery planning may be optimized through the use of Machine Learning techniques such as logistic regression, decision trees, or Random Forests.
- Proactive actions such as rerouting or giving priority to handling will be possible with these improvements.

Cost-To-Serve Analysis:

- Combining shipment costs with operational costs can allow you to analyze the effective cost to serve various market segments.
- This analysis will assist in achieving an appropriate balance between customer satisfaction, profitability and other objectives.
- This information can also be used for data-driven pricing, discounting and shipping decisions.

Integration with Real-Time Logistics Data:

- The incorporation of real-time tracking information from carriers, warehouses or both will enable better tracking of deliveries for their customers.
- Dynamic decision-making techniques can be used to manage delivery delays.
- The integration of real-time logistics data will also provide customers with the necessary notifications regarding their parcel delivery.

VI. CONCLUSION

This study shows how important data analysis is to improve our understanding and maximize performance of e-commerce delivery and customer satisfaction. Data analysis has identified critical variables or factors that directly affect the ability of a company or store to meet customer expectations regarding delivery e.g., the method used to



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deliver products; the performance variance of warehouses; limitations on total weight; and the reactive nature of using discount policies. All of these factors can lead to delivery problems for a customer.

Late delivery is a major factor affecting customer satisfaction. Therefore, reliability in logistics i.e. delivering products on time is an essential factor to be successful in e-commerce. Late deliveries affect the way a customer rates a company's service and also increase the cost of customer support and reimbursements to the customer.

With insight from data analysis, retailers can begin operating in a proactive manner when planning logistics strategies. Companies can enhance their ability to provide enhanced delivery service through intelligent route planning, warehouse performance policies, and effective communication with customers. Ultimately, delivery should be seen as a key component to the companies' overall strategy, as the way products are delivered can greatly affect customer loyalty in the highly competitive e-market.

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