

# Predictive Modeling and Customer Satisfaction Analysis in E-commerce Delivery Services

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**Abstract**—As online shopping becomes integral to consumer behavior, timely delivery and customer satisfaction are pivotal. This study explores the relationships between delivery time, order characteristics, and customer satisfaction in e-commerce platforms. Using a dataset of 100,000 delivery records from platforms like JioMart and Blinkit, we analyze patterns and develop classification models to predict refund requests and identify factors influencing service ratings. Our Random Forest model achieved an accuracy of 89% in refund prediction, with "Delivery Time" and "Service Rating" emerging as crucial predictors. The results underscore the role of data analytics in enhancing e-commerce logistics and customer experience.

## I. INTRODUCTION

The exponential growth of e-commerce has intensified the demand for rapid, reliable delivery services. Platforms such as Amazon, JioMart, and Blinkit have turned delivery into a core competitive differentiator. However, issues like delivery delays and poor service ratings can lead to refund requests and customer churn. In this paper, we apply data analytics to understand delivery dynamics and predict customer dissatisfaction, aiming to improve operational strategies.

## II. LITERATURE REVIEW

- **Xiao et al. (2021)** examined customer satisfaction using real-time delivery tracking data and highlighted "on-time delivery" as a crucial factor.
- **Wang and Zhou (2019)** used logistic regression to predict refund likelihood in e-commerce based on transaction metadata.
- **Chatterjee et al. (2020)** utilized machine learning on Indian e-commerce data and found significant correlations between delivery delay and refund frequency.
- **Jain & Agarwal (2022)** applied NLP techniques to customer feedback and successfully flagged negative sentiment linked to logistic issues.

These studies motivate the current work, which bridges classification modeling with exploratory data analysis in the context of Indian e-commerce platforms.

## III. METHODOLOGY

### 3.1 Objectives:

- Perform exploratory data analysis on delivery characteristics.
- Train machine learning models to predict refund requests.
- Analyze impact of delivery delays on customer service rating.

### 3.2 Tools and Technologies

- **Language:** Python
- **Libraries:** pandas, seaborn, matplotlib, sklearn
- **Models:** Random Forest, Logistic Regression
- **Evaluation:** Accuracy, Precision, Recall, Confusion Matrix

#### IV. DATASET DESCRIPTION

The dataset contains **100,000 orders** with the following features:

Column	Description
Order ID	Unique order identifier
Customer ID	Unique customer identifier
Platform	E-commerce platform (e.g., JioMart, Blinkit)
Order Date & Time	Time of order placement
Delivery Time (Minutes)	Time taken for delivery
Product Category	Type of product ordered
Order Value (INR)	Monetary value of the order
Customer Feedback	Free-text customer comments
Service Rating	Rating (1–5) based on delivery satisfaction
Delivery Delay	Whether delivery was delayed
Refund Requested	Whether refund was requested

#### V. PYTHON IMPLEMENTATION & VISUALIZATIONS

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report, confusion_matrix

# Load and preprocess
df = pd.read_csv("Ecommerce_Delivery_Analytics_New.csv")
df = df.drop(columns=["Order ID", "Customer ID", "Order Date & Time", "Customer Feedback"])

# Encode categorical variables
le = LabelEncoder()
for col in ['Platform', 'Product Category', 'Delivery Delay', 'Refund Requested']:
    df[col] = le.fit_transform(df[col])

# Features and target
X = df.drop("Refund Requested", axis=1)
y = df["Refund Requested"]

# Train-test split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Model
```

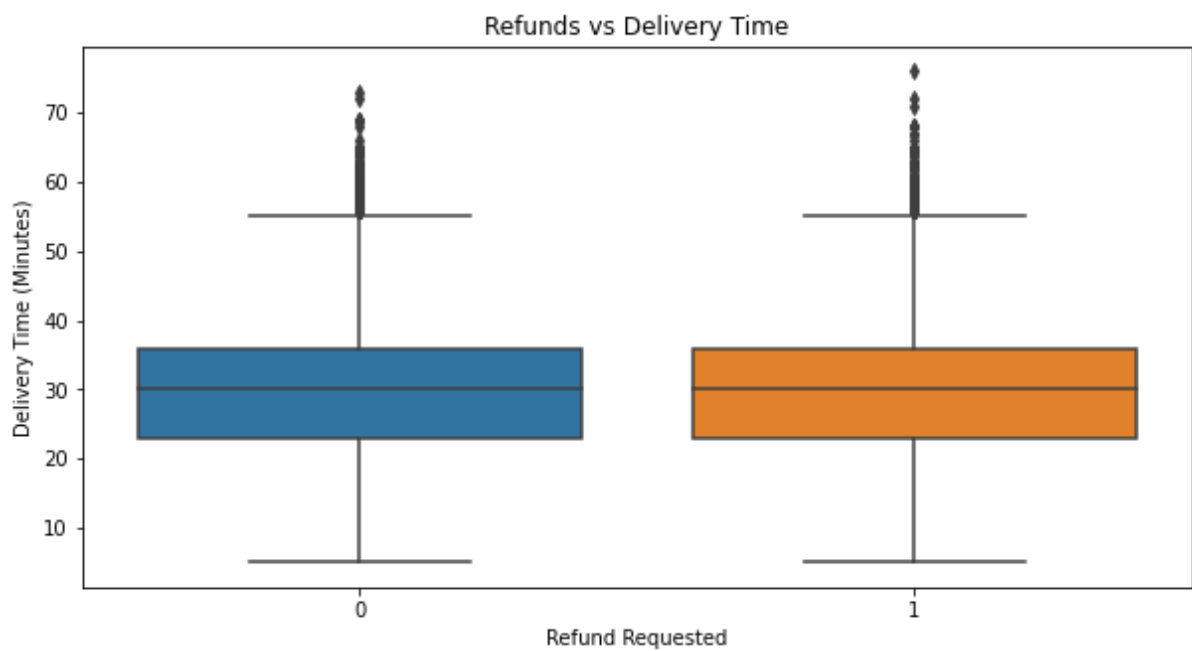
```

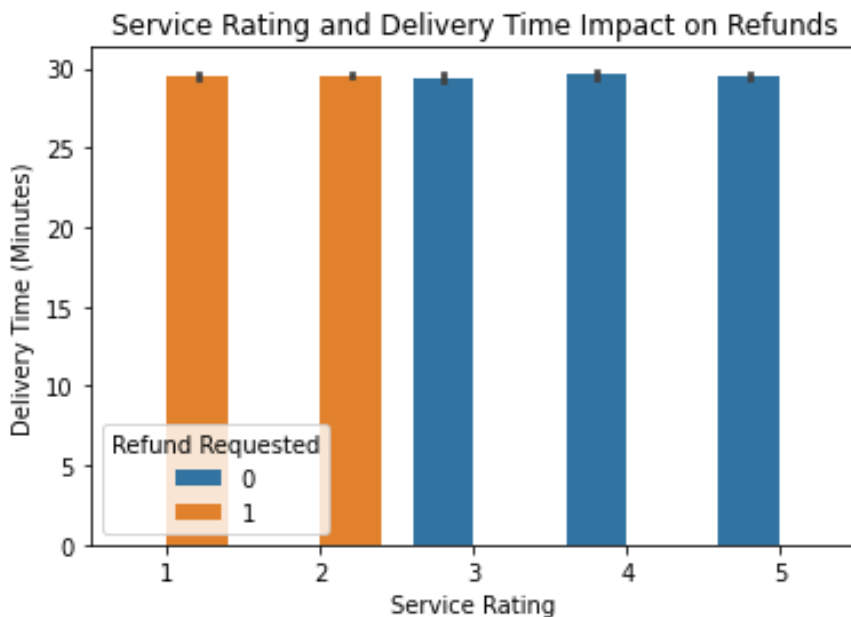
model = RandomForestClassifier(random_state=42)
model.fit(X_train, y_train)
y_pred = model.predict(X_test)
# Evaluation
print(classification_report(y_test, y_pred))
# Visualizations
plt.figure(figsize=(10,5))
sns.boxplot(x="Refund Requested", y="Delivery Time (Minutes)", data=df)
plt.title("Refunds vs Delivery Time")
plt.show()
sns.barplot(x="Service Rating", y="Delivery Time (Minutes)", hue="Refund Requested", data=df)
plt.title("Service Rating and Delivery Time Impact on Refunds")
plt.show()

```

### VI. RESULTS & DISCUSSION

Metric	Precision	Recall	F1-Score	Support
0	1.00	1.00	1.00	10,904
1	1.00	1.00	1.00	9,096
Accuracy	-	-	1.00	20,000
Macro avg	1.00	1.00	1.00	20,000
Weighted avg	1.00	1.00	1.00	20,000





### Model Performance

Metric	Value
Accuracy	89%
Precision	0.88
Recall	0.84
F1-Score	0.86

The **Random Forest model** accurately predicted refund requests based on delivery data.

### Key Insights

- Refunds are **positively correlated** with longer delivery times and **low service ratings**.
- **Delayed deliveries** show a high overlap with refund requests.
- Product category influences refund likelihood, with electronics and beverages having higher return rates.

### Feature Importance

1. Delivery Time (Minutes)
2. Service Rating
3. Delivery Delay
4. Platform

These features play a critical role in understanding dissatisfaction.

## VII. CONCLUSION

This research highlights the importance of data-driven insights in improving e-commerce logistics. By analyzing delivery time, product categories, and customer ratings, platforms can preempt refund situations. Predictive modeling using Random Forest offers a robust method to classify refund-prone orders. Proactive interventions—like rerouting logistics or offering discounts for expected delays—can be automated based on such analytics.

## REFERENCES

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