Window Manufacturing Optimization Using R-Shiny

This project addresses the critical issue of window breakage during manufacturing, which leads to financial losses and inefficiency. The goal is to develop a Decision Support System (DSS) using R-Shiny to minimize window breakage rates through data analytics. The Shiny app integrates descriptive, predictive, and prescriptive analytics to assist manufacturers in optimizing production and reducing breakage.

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Analytics Problem Framing

The primary challenge is to identify factors influencing window breakage and develop models to predict and optimize outcomes. Key factors include cut speed, window size, glass thickness, ambient temperature, and glass supplier. Descriptive analytics explored relationships between these variables, while predictive analytics used linear regression models to forecast breakage rates. Prescriptive analytics focused on determining the optimal cut speed to minimize breakage while maintaining efficiency.

1. **Descriptive Analytics**

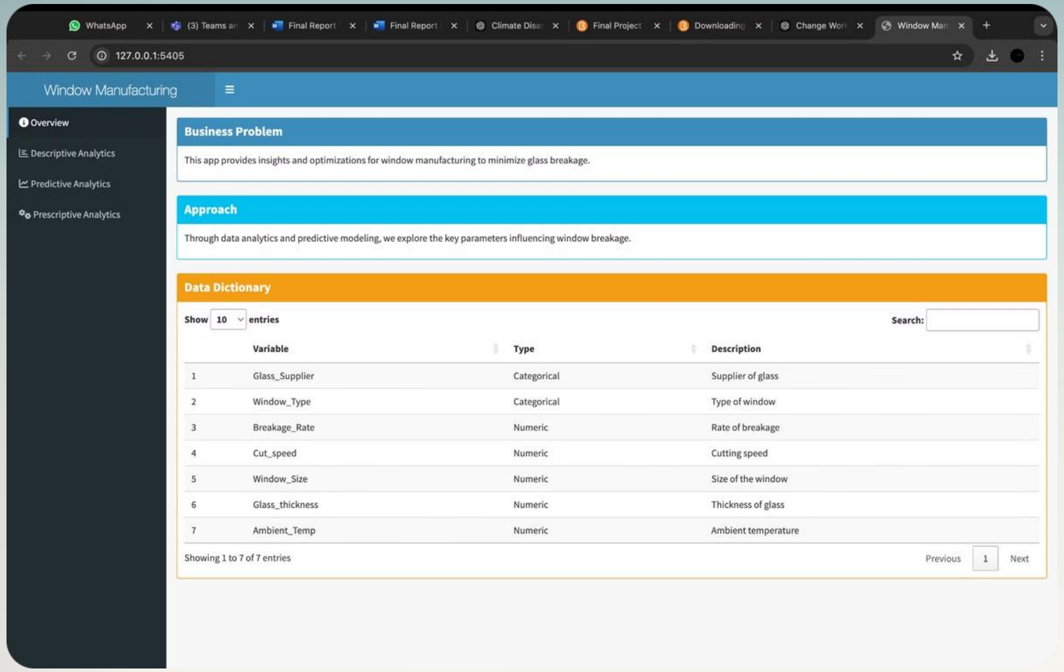
   Explore relationships between variables

2. **Predictive Analytics**

   Forecast breakage rates using linear regression

3. **Prescriptive Analytics**

   Determine optimal cut speed for efficiency



Data Overview

The dataset contains key variables hypothesized to impact breakage rates: Breakage Rate, Window Size, Glass Thickness, Cut Speed, Ambient Temperature, and Glass Supplier. Understanding these variables is critical for predicting breakage rates and optimizing the production process.

Variable	Description
Breakage Rate	Rate of window breakage during manufacturing
Window Size	Size of the window in inches
Glass Thickness	Thickness of the glass in inches
Cut Speed	Speed of cutting glass in meters per minute
Ambient Temperature	Temperature during production in Celsius
Glass Supplier	Company providing the glass material

Shiny App Features

The Shiny app developed for this project includes three primary sections:

1. **Descriptive Analytics**

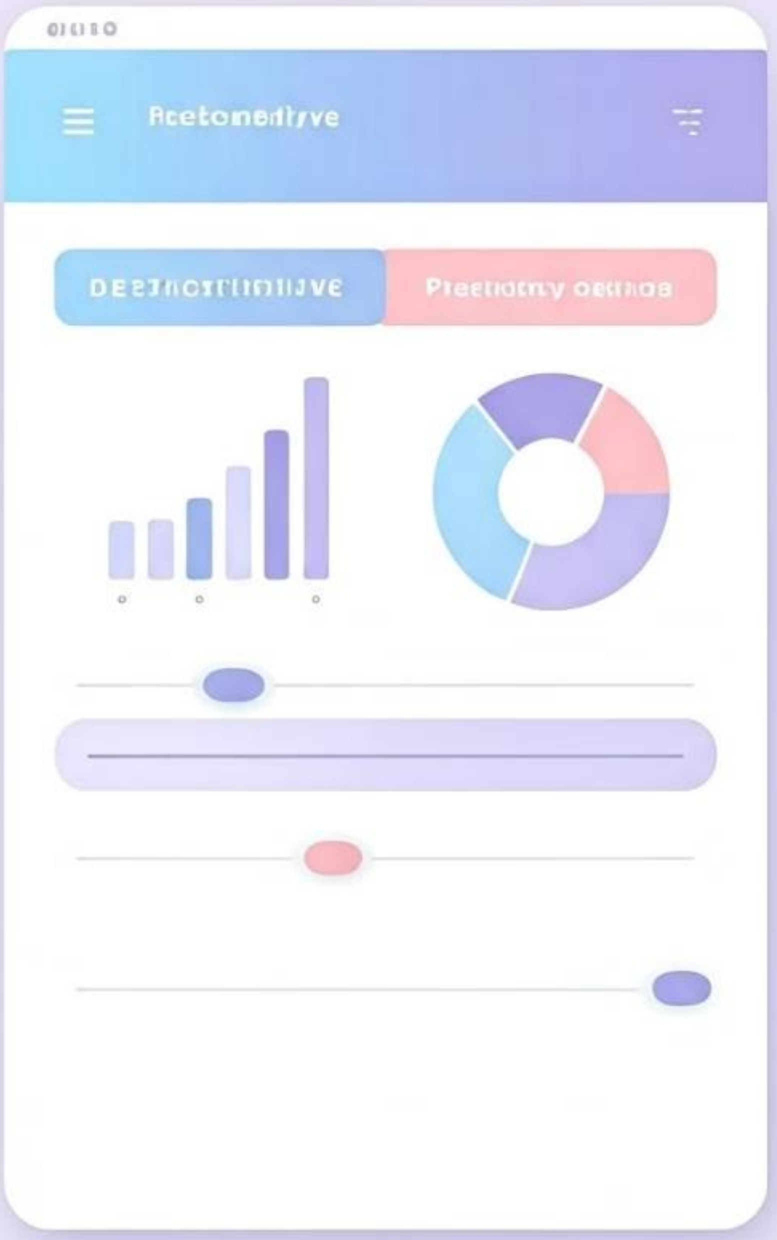
   Visualize relationships between key variables using histograms and scatter plots

2. **Predictive Analytics**

   Linear regression model predicts breakage rates based on user-selected parameters

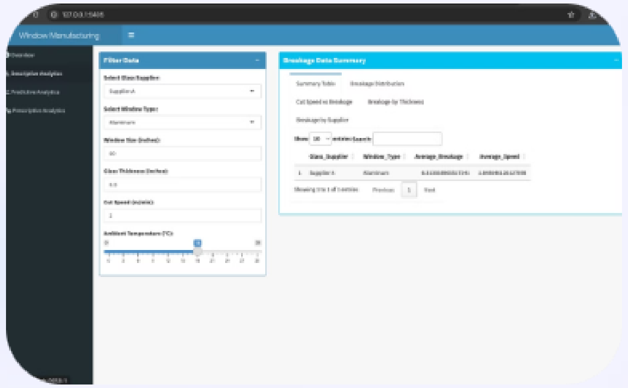
3. **Prescriptive Analytics**

   Calculates optimal cut speed to minimize breakage while maintaining production efficiency



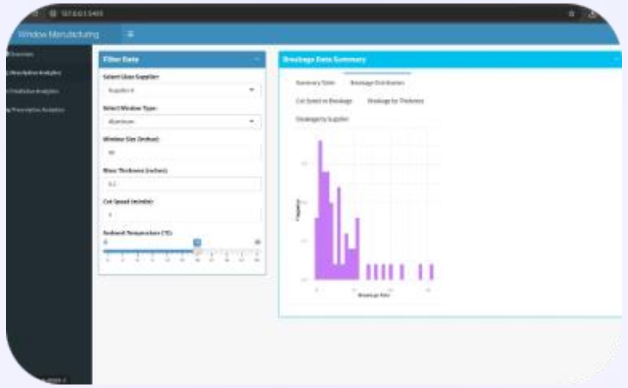
Descriptive Analytics

The Descriptive Analytics section aims to gain insights into factors affecting window breakage rates during manufacturing. Through visualizations, relationships between variables such as glass supplier, window type, glass thickness, cut speed, and ambient temperature are explored. These insights provide valuable information for optimizing the manufacturing process.



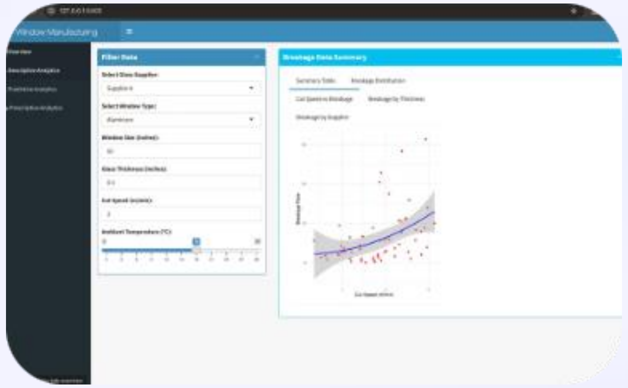
Breakage Data Summary

Summary table showing average breakage rate and speed for each glass supplier and window type



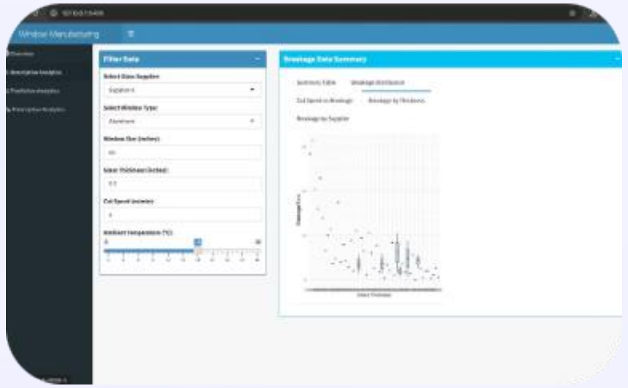
Breakage Distribution

Histogram displaying the frequency of different breakage rates across the dataset



Cut Speed vs Breakage

Scatter plot with regression line showing the relationship between cut speed and breakage rate



Breakage by Thickness

The boxplot illustrates the relationship between glass thickness and breakage rate. It shows the distribution of breakage rates across different thickness levels.

Predictive Analytics

The predictive analytics section uses a linear regression model to forecast window breakage rates based on input variables: window size, glass thickness, cut speed, and ambient temperature. Users input desired values, and the app calculates and displays the predicted breakage rate. The screenshot shows a table summarizing the regression model's coefficients, including the intercept and influence of each variable on the breakage rate.

Input Variables

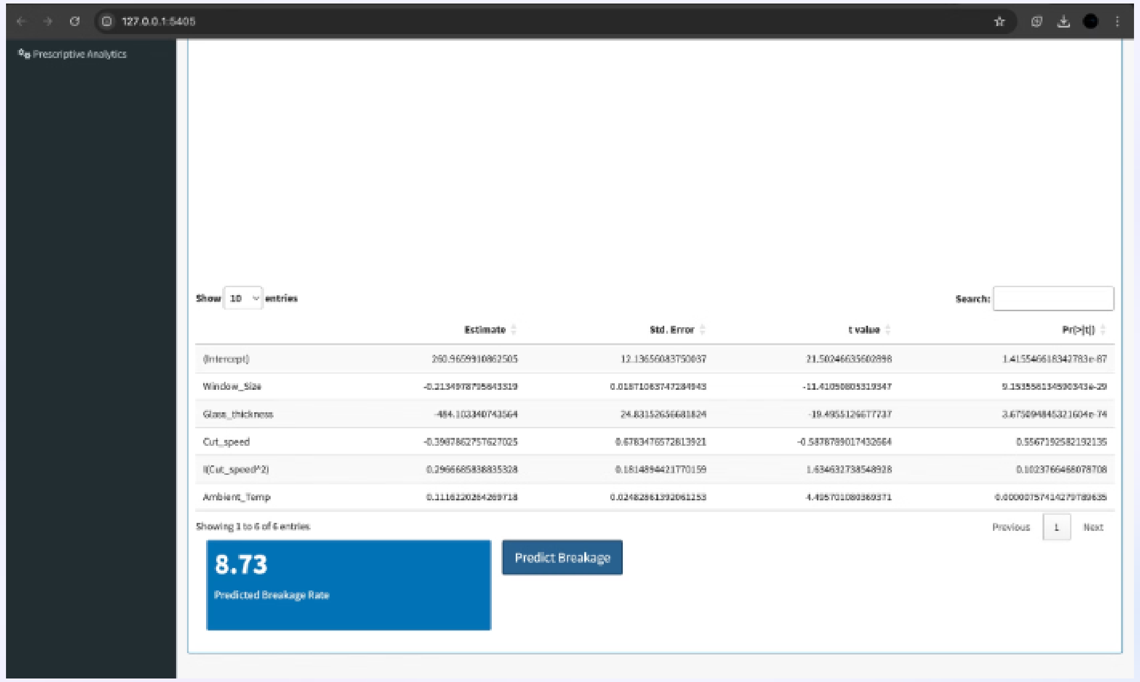
Window size, glass thickness, cut speed, ambient temperature

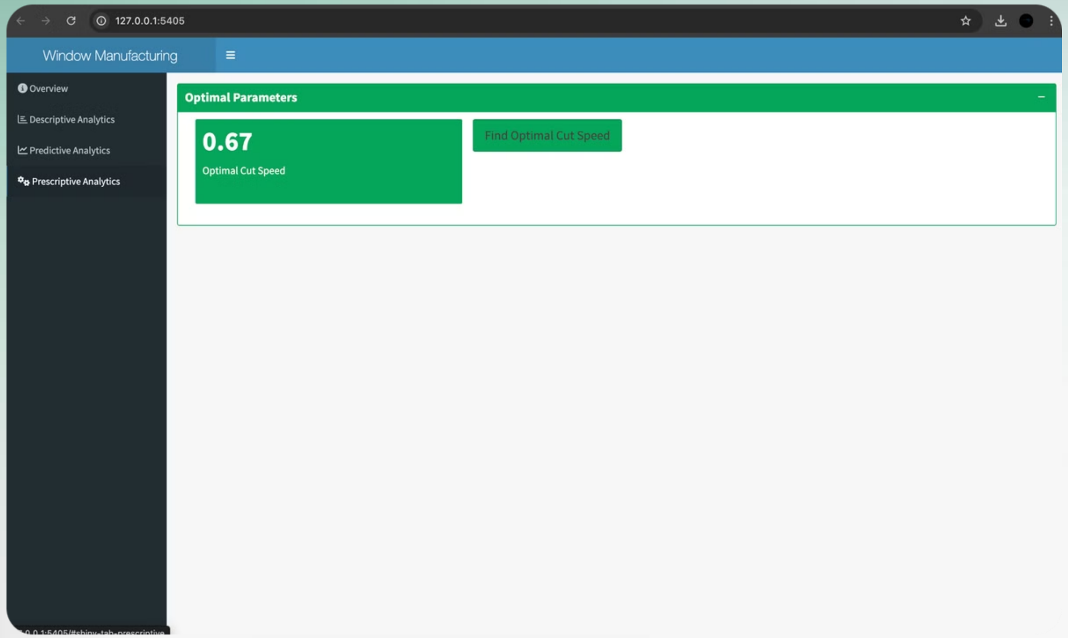
Model Output

Regression coefficients, predicted breakage rate

User Interface

Input fields, results display





Prescriptive Analytics

The prescriptive analytics section focuses on optimizing production parameters to minimize window breakage. It calculates the optimal cut speed based on input parameters such as window size, glass thickness, and ambient temperature. By adjusting these variables, the app computes the cut speed that minimizes the breakage rate while maintaining production efficiency. In the screenshot, the app has determined that the optimal cut speed is 0.67 m/min, helping manufacturers balance the trade-off between production speed and breakage rate.

1

Input Parameters

Window size, glass thickness, ambient temperature

2

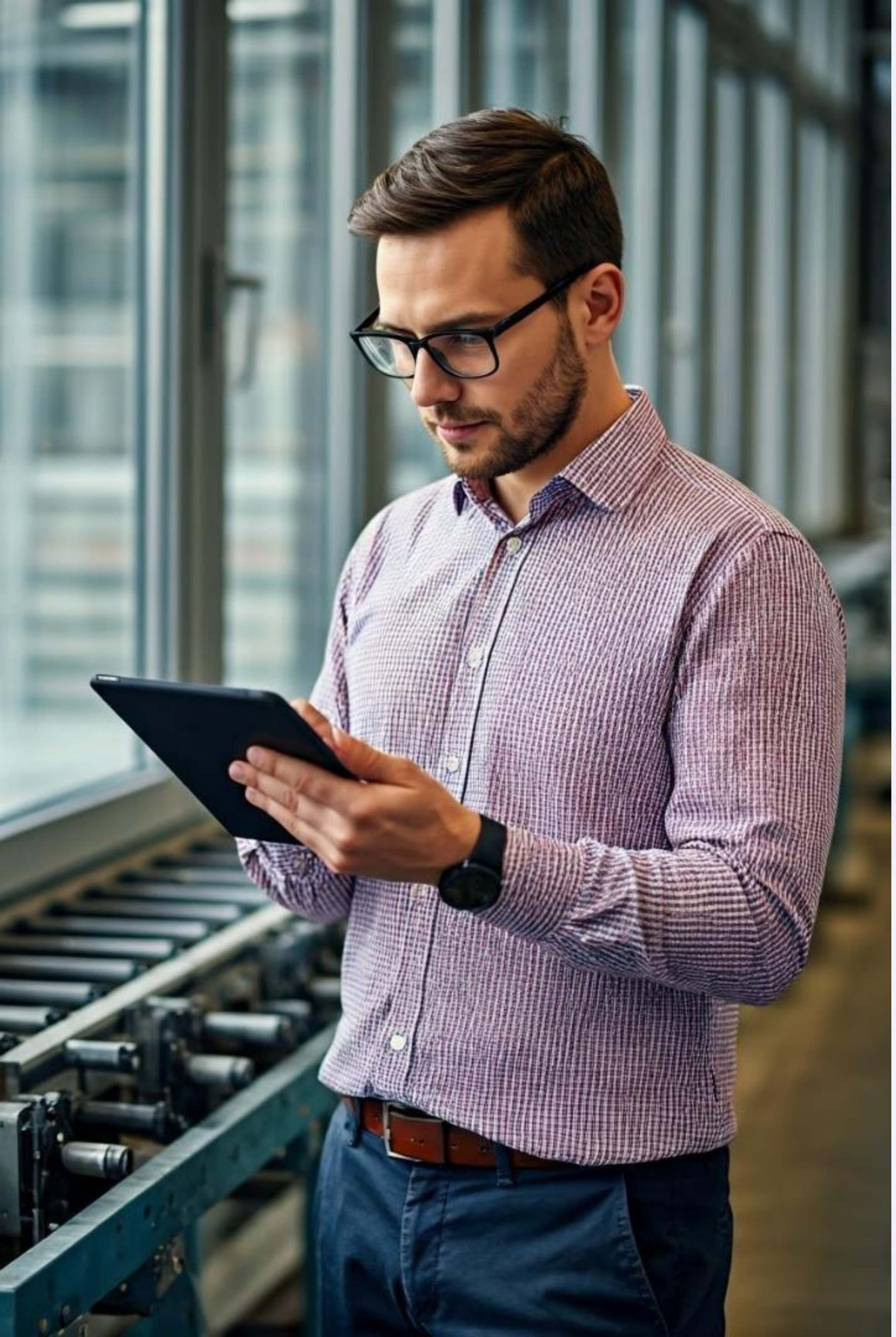
Optimization Process

Calculate optimal cut speed

3

Output

Recommended cut speed for minimal breakage



Key Insights & Recommendations

Based on the analysis of manufacturing data, several important insights were derived:

Glass Thickness

Strong negative correlation with breakage rates (-0.68)

Cut Speed

Positive correlation with breakage rates (0.38)

Window Size

Larger sizes associated with lower breakage rates (-0.50)

Recommendations include optimizing cut speed to around 0.67 m/min and carefully monitoring glass supplier choice.

Conclusion

The Decision Support System developed in this project demonstrates how data analytics can address critical manufacturing issues such as window breakage. The app provides actionable insights and recommendations for optimizing production parameters, resulting in reduced breakage and improved efficiency. By leveraging descriptive, predictive, and prescriptive analytics, manufacturers can make informed decisions that minimize losses and enhance production quality.

Reduced Breakage

Optimized parameters lead to fewer broken windows

Improved Efficiency

Balanced production speed and quality

Informed Decisions

Data-driven insights guide manufacturing processes