# Product Demand Forecasting Using Machine Learning Project

At this point, we adopted the prototype that we had previously trained. We will now evaluate the expected quantitative demand and perform analyses to align with the motivating objectives of building the model.

- **Average Order Quantity**
  We observe that the values are almost equal by comparing the order quantity in the data set and predicting the order quantity.

```
average_order_quantity = dataVaild['OrderQuantity_Prediction'].mean()
print(f'Average Order Quantity Prediction: {average_order_quantity:.2f}')
```

```
Average Order Quantity Prediction: 1.51
```

```
average_order_quantity = dataVaild['OrderQuantity'].mean()
print(f'Average Order Quantity: {average_order_quantity:.2f}')
```

```
Average Order Quantity: 1.51
```

- **Order Quantity Distribution Analysis**
  These visualizations provide a clear representation of the distribution characteristics of both predicted and actual order quantities, offering a visual narrative that enhances our understanding of the forecasting model's efficacy. Further investigation into the nuances of these distributions can yield actionable insights for optimizing predictive accuracy.


**Figure 1: Order Quantity Prediction Distribution**


**Figure 2: Actual Order Quantity Distribution**

- ## Gender-Based Analysis of Order Quantities

  Comparing these two visualizations allows us to assess how well the predictive model captures patterns in order quantities across gender categories. Any disparities observed between the actual and predicted distributions can inform adjustments or enhancements to our forecasting model.

  This gender-based analysis contributes valuable insights into the relationship between gender and average order quantities, aiding in strategic decision-making and targeted marketing efforts.

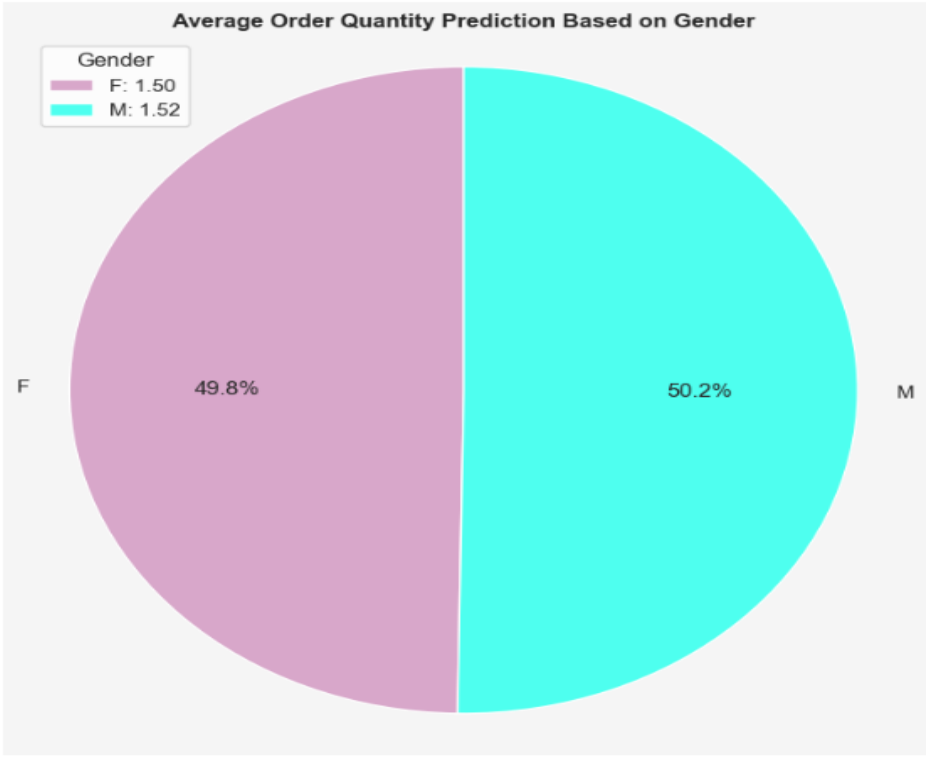


**Figure 3: Average Order Quantity Prediction Based on Gender**

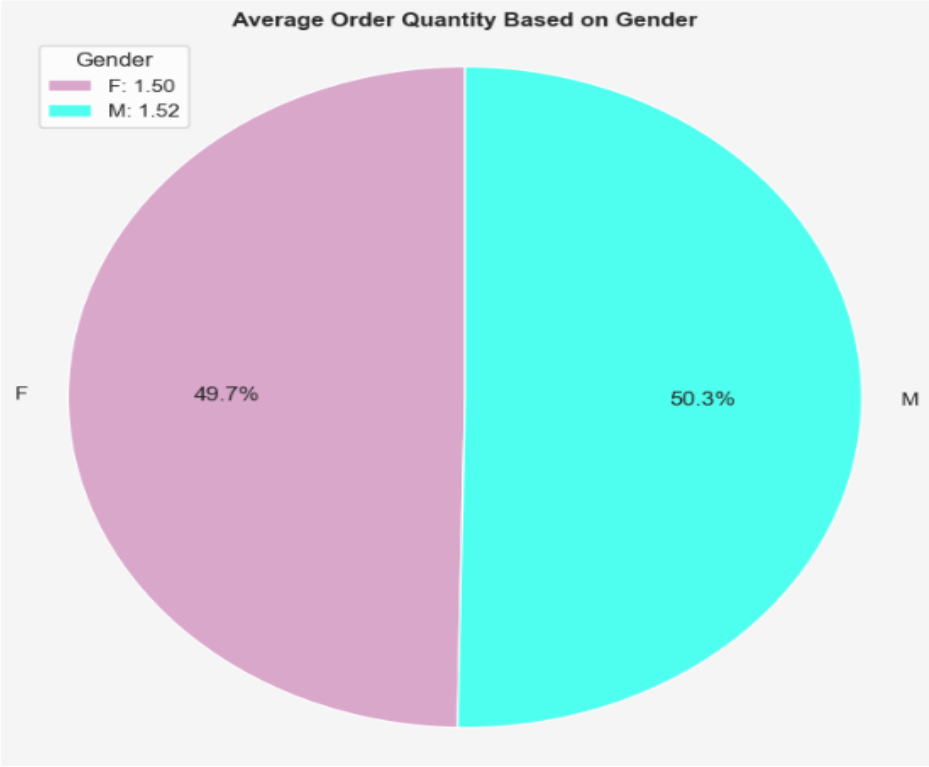


**Figure 4: Average Order Quantity Based on Gender**

- ## Age Distribution of Customers

The histogram reveals insights into the composition of our customer base, highlighting peaks and trends in age groups. Such insights are invaluable for tailoring marketing strategies, product offerings, and customer experiences to better suit the preferences and needs of specific age demographics.

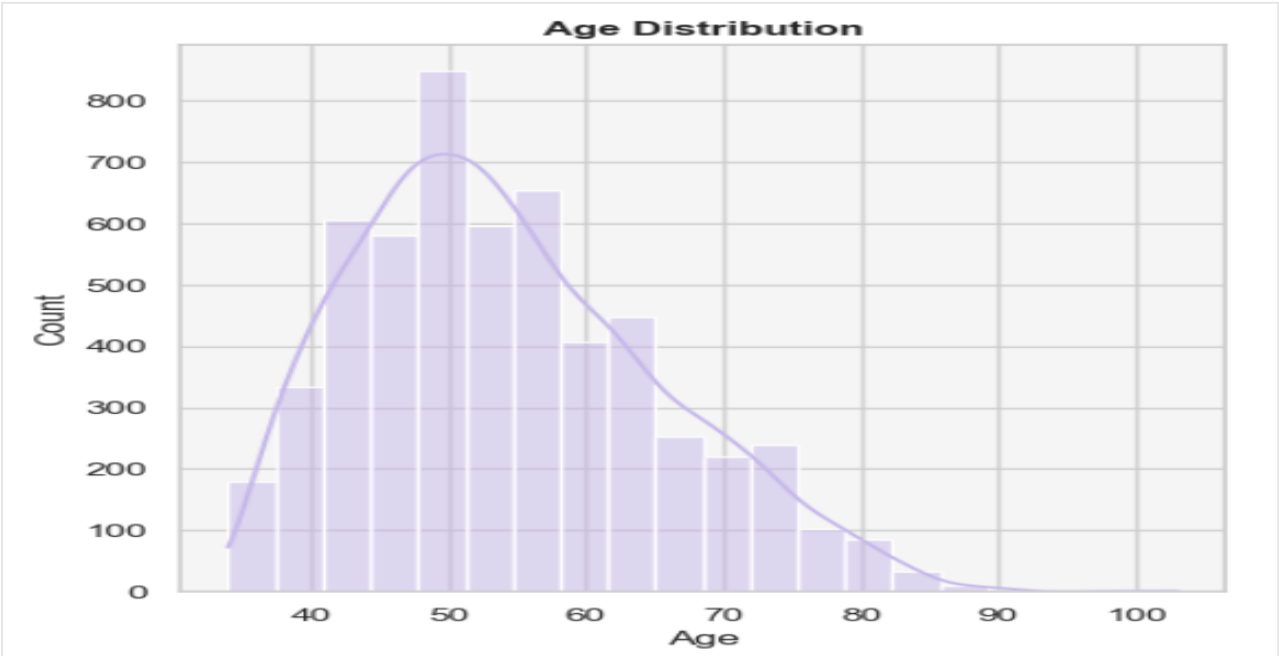


**Figure 5: Age Distribution of Customers**

- **Average Order Quantity Prediction by Category**

The vertical bars represent the mean order quantities, providing a comparative view of product categories and their associated predicted average order quantities. This visualization is crucial for identifying categories with higher or lower predicted demand, offering strategic insights for inventory management, marketing, and product development.

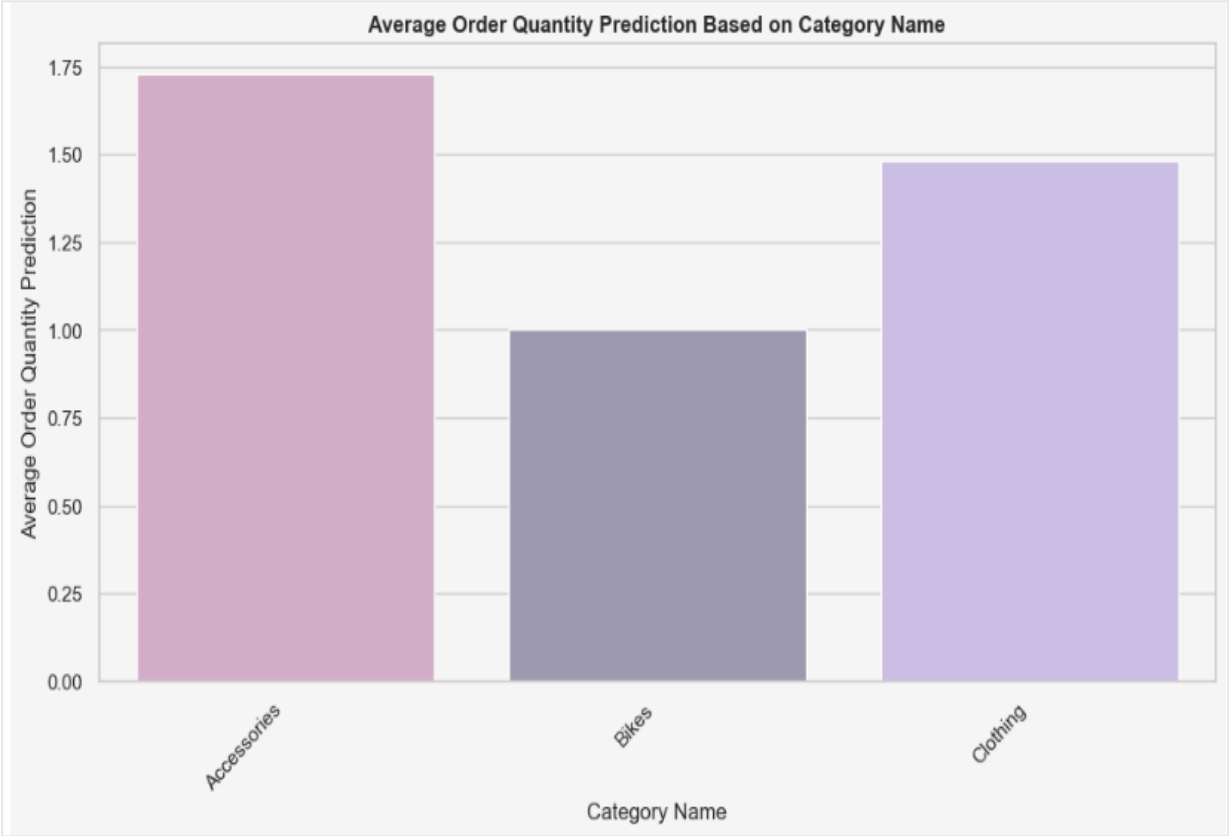


**Figure 6: Average Order Quantity Prediction by Category**

To validate the accuracy of our forecasting model, we also explored the actual average order quantities observed for each product category.

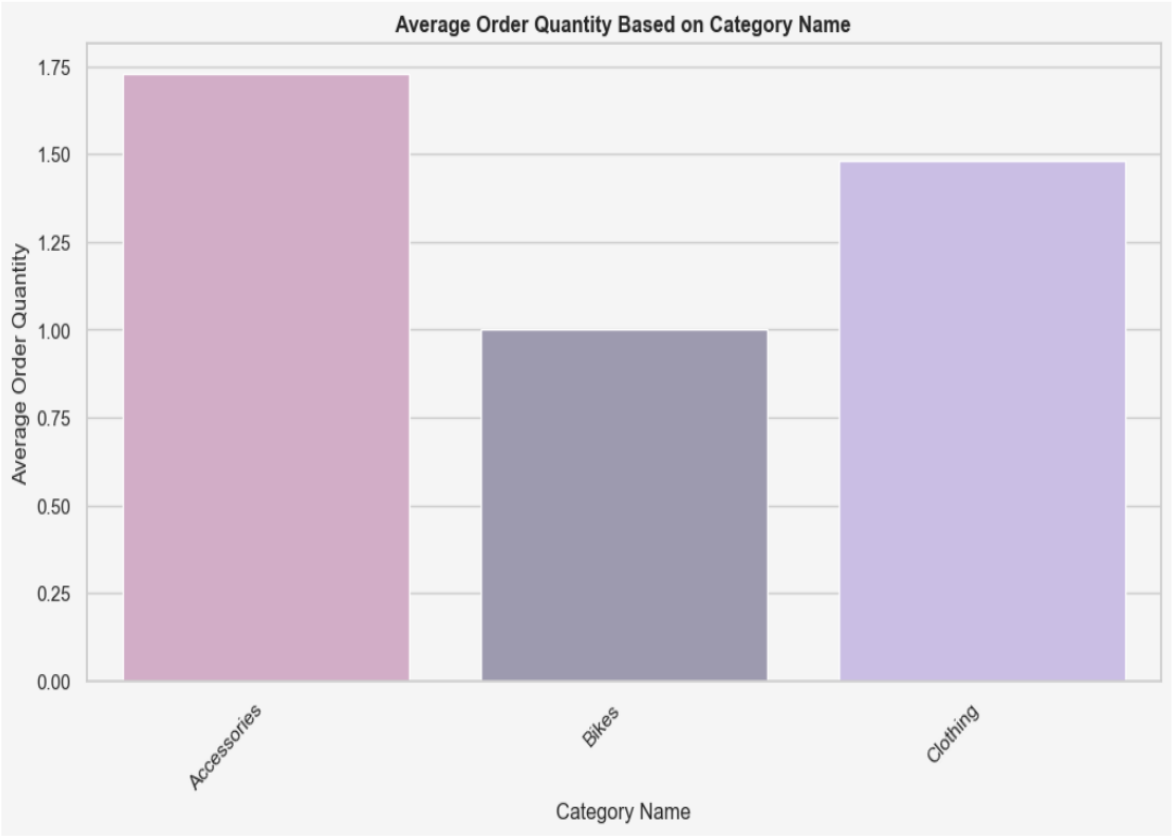


**Figure 7: Actual Average Order Quantity by Category**

By comparing the two visualizations, we can assess the model's effectiveness in predicting order quantities accurately. Any disparities observed between the predicted and actual distributions guide us in refining our forecasting model, ultimately enhancing its precision and reliability.

- ## Country and Continent Distribution

his visualization enables us to comprehend broader geographic trends in customer distribution. It empowers us to pinpoint regions characterized by elevated customer engagement and identify potential growth opportunities within those areas.

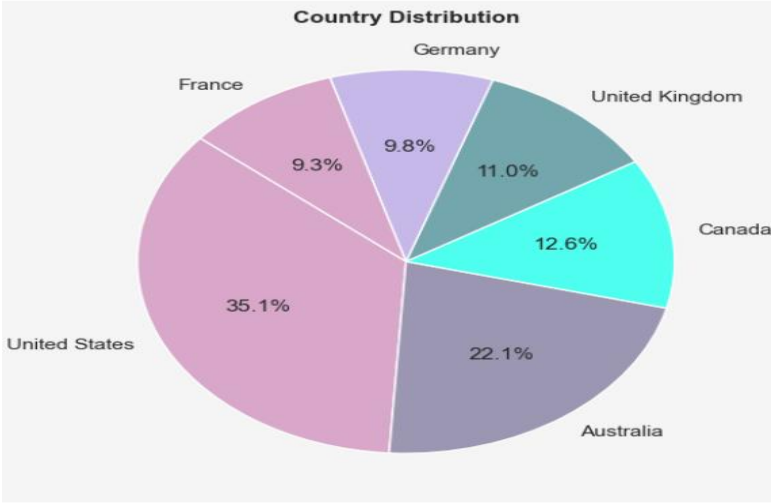


**Figure 8: Country Distribution**

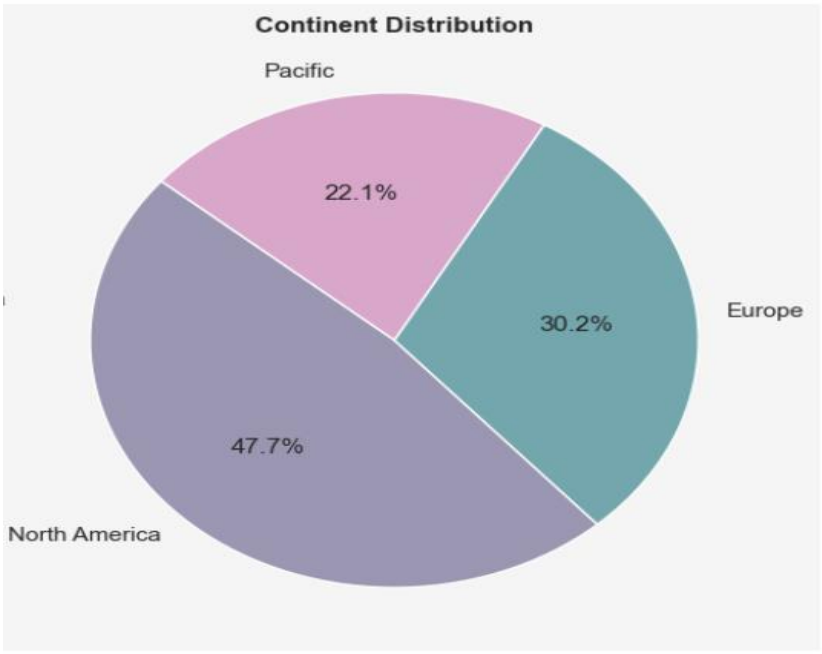


**Figure 9: Continent Distribution**

- **Distribution of Order Quantities Analysis**

  To gain insights into the distribution of order quantities, we transformed our data to visualize the predicted and actual order quantities using a pie chart.

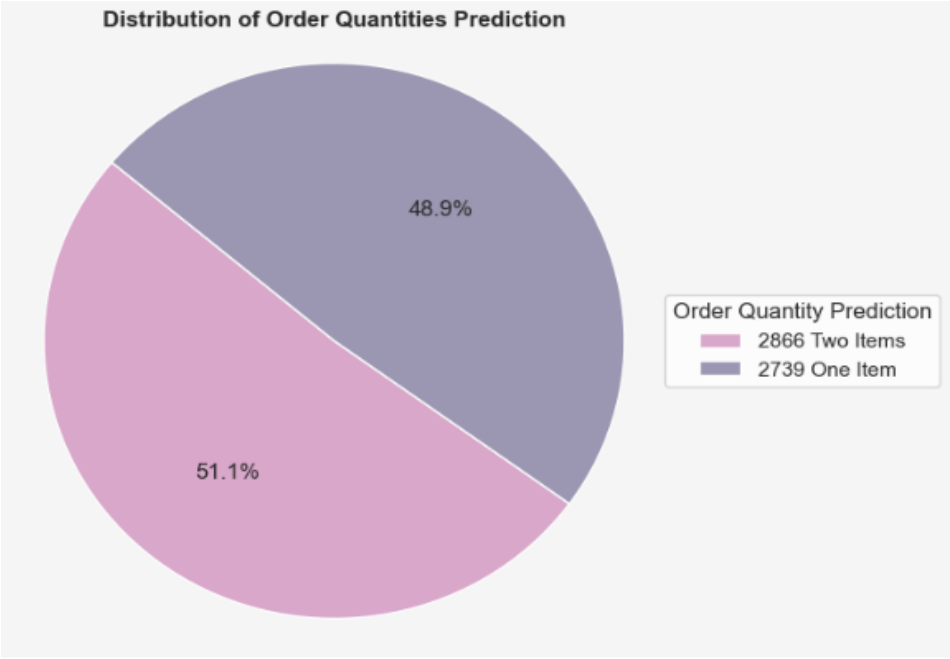


**Figure 10: Order Quantities Prediction Distribution**

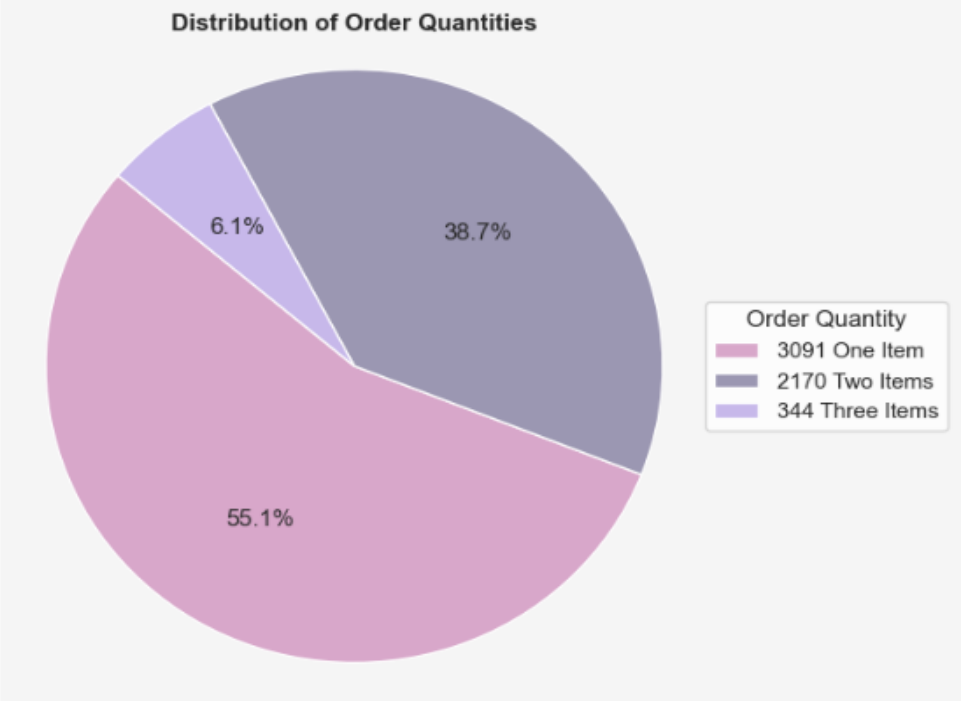


**Figure 11: Order Quantities Distribution**

### Predicted Order Quantities Distribution

In the first chart, we categorized the predicted order quantities into meaningful labels such as 'One Item,' 'Two Items,' and 'Three Items.' The pie chart vividly illustrates the distribution of predicted order quantities, with each slice representing a category. The legend on the right provides a breakdown of the counts for each quantity category.

### Actual Order Quantities Distribution

Similarly, in the second chart, we categorized the actual order quantities using the same labeling approach. The resulting pie chart offers a visual representation of the distribution of actual order quantities across different categories, facilitating a direct comparison with the predicted values.

These visualizations not only enhance our understanding of the spread of order quantities but also provide a user-friendly representation of the data. This analysis is instrumental in identifying trends and patterns in order quantities, and guiding strategic decisions for inventory management and customer engagement.

- ## Top 10 Products by Sales Analysis

  To identify the top-performing products based on sales, we conducted an analysis that revealed the products with the highest total order quantities. Two separate visualizations were created, showcasing the top 10 products for both actual and predicted order quantities.

**Top 10 Products by Actual Sales**

In the first bar chart, the top 10 products are highlighted based on the sum of their actual order quantities. The chart provides a clear representation of each product's contribution to overall sales, with product names listed along the x-axis and corresponding total order quantities on the y-axis.

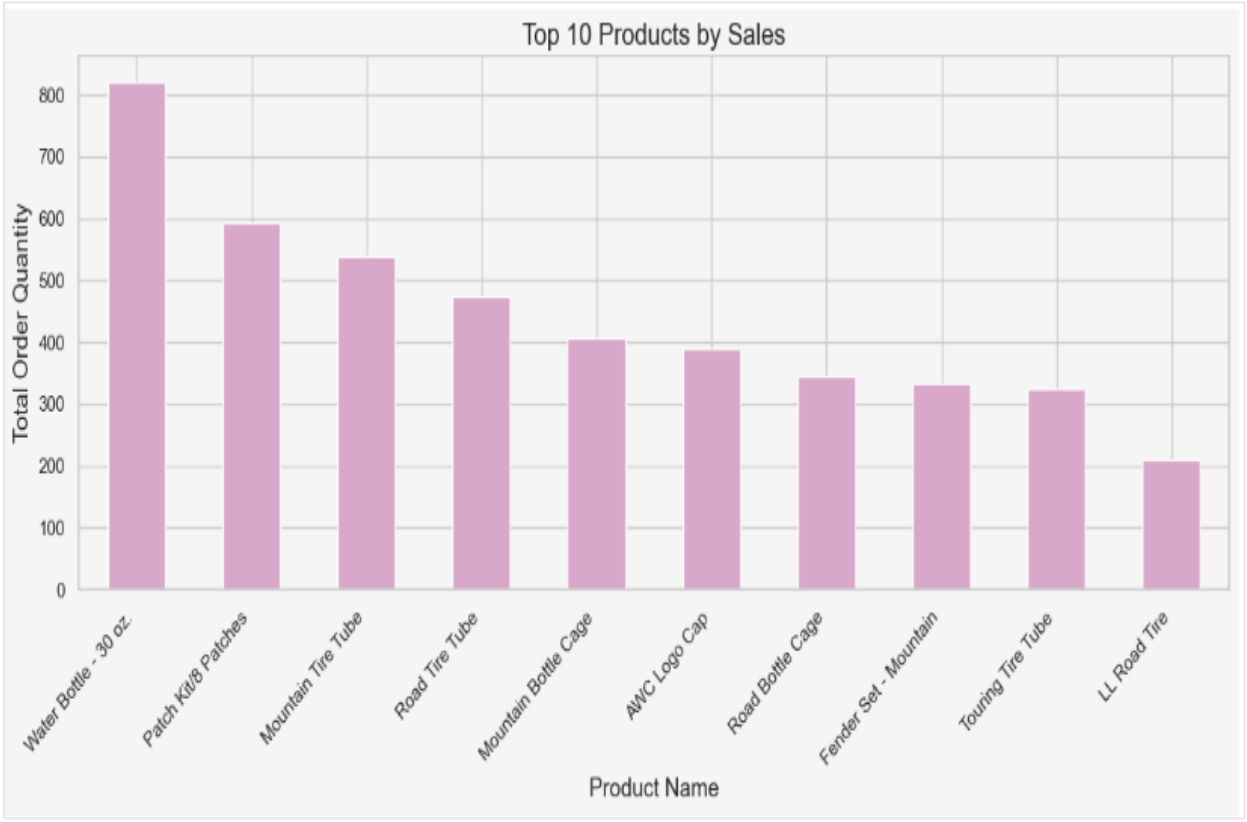


**Figure 12: Top 10 Products by Actual Sales**

**Top 10 Products by Predicted Sales**

Similarly, the second bar chart depicts the top 10 products based on the sum of their predicted order quantities. This visualization allows for a direct comparison between the actual and predicted sales performance of each product, aiding in the assessment of the forecasting model's accuracy.

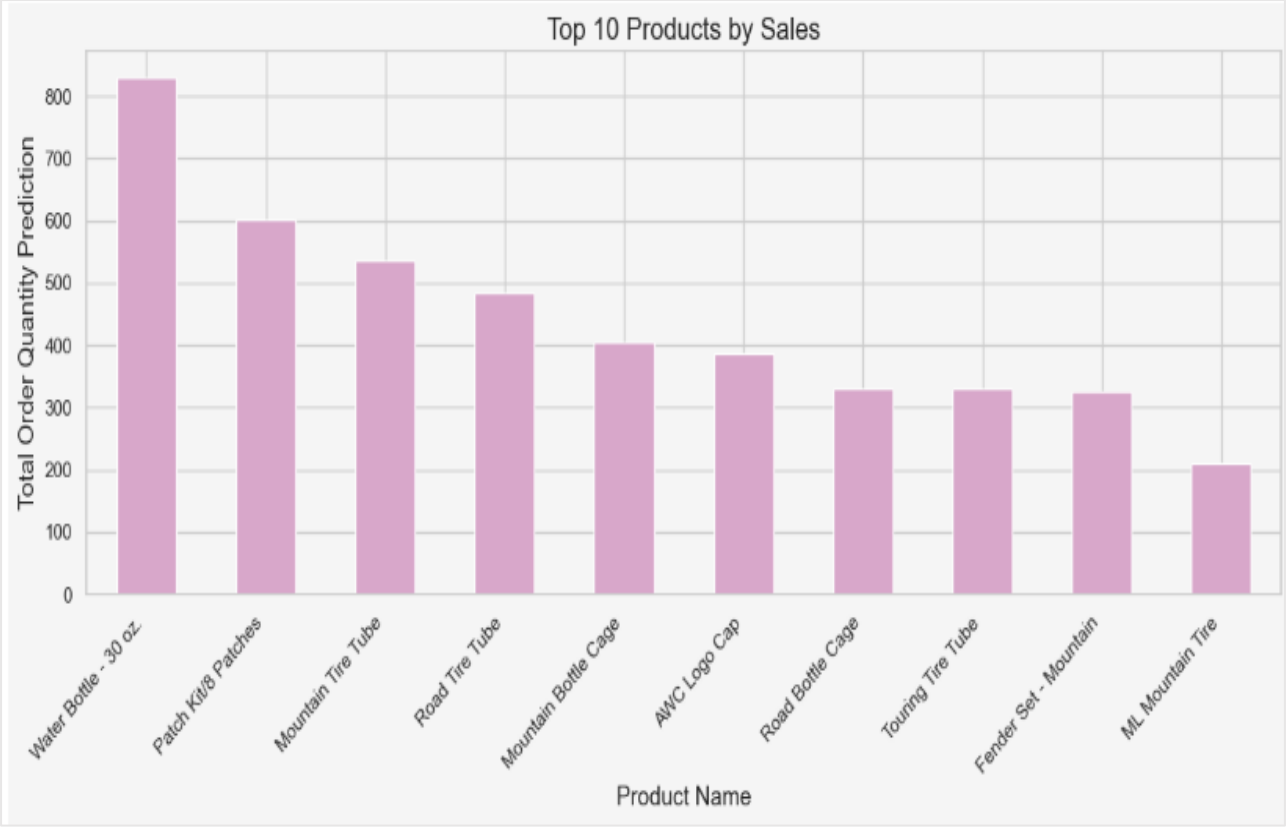


**Figure 13: Top 10 Products by Predicted Sales**

These visualizations are instrumental in recognizing the most impactful products in our catalog, informing inventory management, marketing strategies, and product development decisions. The alignment of the bar charts ensures a cohesive presentation of both actual and predicted sales data, facilitating a comprehensive understanding of product performance**.**

- ## Least 10 Selling Products by Sales Analysis

In this analysis, we focused on identifying the products with the lowest total order quantities, showcasing the least-performing products in terms of both actual and predicted sales.

**Least 10 Selling Products by Predicted Sales**

The first bar chart highlights the ten products with the lowest total predicted order quantities. Each bar represents a product, with the x-axis displaying the product names and the y-axis indicating the corresponding total predicted order quantities. The visualization provides valuable insights into products that may require attention or strategic adjustments to enhance their sales performance.


**Figure 14: Least 10 Selling Products by Predicted Sales**

### Least 10 Selling Products by Actual Sales

Similarly, the second bar chart illustrates the least-performing products based on actual sales data. The visualization facilitates a direct comparison between the predicted and actual sales performance of each product, aiding in the evaluation of forecasting model accuracy.

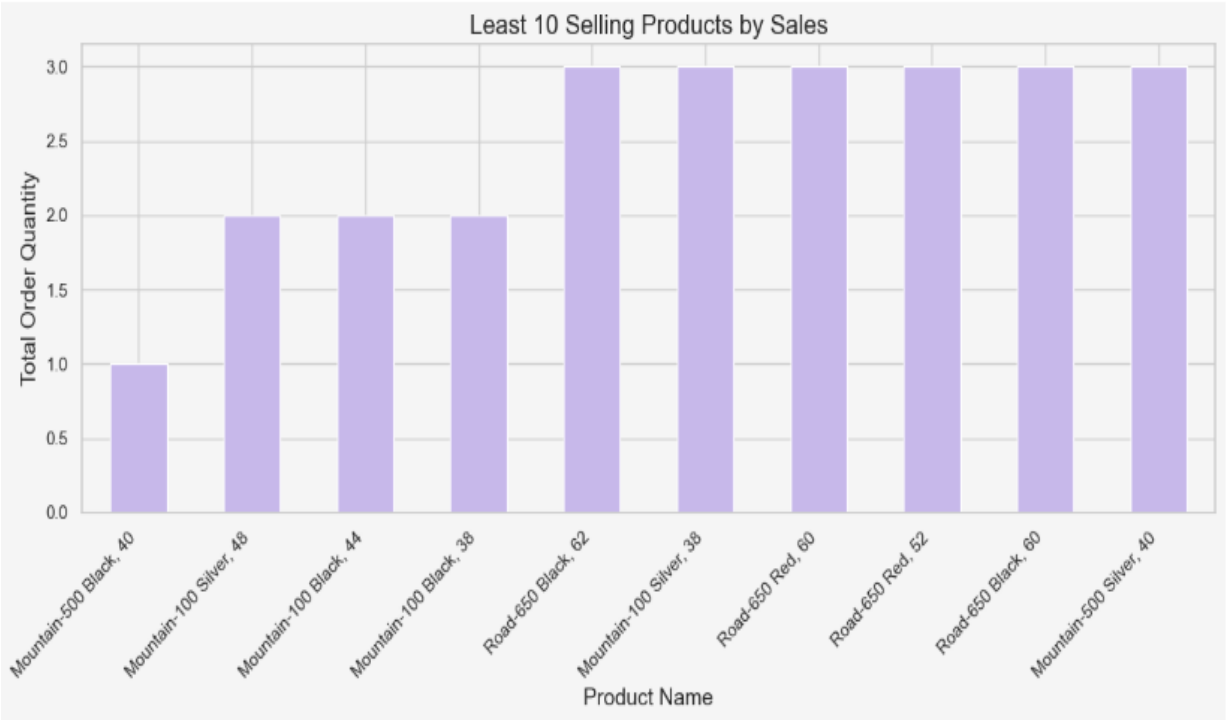


**Figure 15: Least 10 Selling Products by Actual Sales**

These visualizations serve as a valuable tool for identifying products that may require additional marketing efforts, adjustments in pricing, or other strategic interventions. Understanding the least-performing products complements our overall sales analysis and assists in making informed decisions for product management and marketing strategies.

- **Order Quantity Analysis by Category and Subcategory**

  In this analysis, we delved into understanding the distribution of order quantities across different product categories and their respective subcategories. Two separate data frames were created to represent the actual order quantities and predicted order quantities.

  **Order Quantity by Category and Subcategory**
  The first data frame, 'order quantity by category,' summarizes the total order quantities for each combination of 'Category Name' and 'Subcategory Name.' This insightful data allows us to discern patterns and trends within various product categories and subcategories.

| CategoryName | SubcategoryName | OrderQuantity |
|---|---|---|
| Accessories | Bike Racks | 27 |
| | Bike Stands | 22 |
| | Bottles and Cages | 1573 |
| | Cleaners | 174 |
| | Fenders | 333 |
| | Helmets | 591 |
| | Hydration Packs | 66 |
| | Tires and Tubes | 3058 |
| Bikes | Mountain Bikes | 486 |
| | Road Bikes | 720 |
| | Touring Bikes | 200 |
| Clothing | Caps | 389 |
| | Gloves | 256 |
| | Jerseys | 291 |
| | Shorts | 102 |
| | Socks | 138 |
| | Vests | 37 |

**Order Quantity Prediction by Category and Subcategory**
The second data frame, 'order quantity by category prediction,' provides a parallel analysis but focuses on the predicted order quantities. This is particularly valuable for assessing the accuracy of forecasting models and understanding how well predictions align with actual order quantities.

| CategoryName | SubcategoryName | OrderQuantity_Prediction |
|---|---|---|
| Accessories | Bike Racks | 27 |
| | Bike Stands | 22 |
| | Bottles and Cages | 1564 |
| | Cleaners | 178 |
| | Fenders | 326 |
| | Helmets | 591 |
| | Hydration Packs | 66 |
| | Tires and Tubes | 3081 |
| Bikes | Mountain Bikes | 486 |
| | Road Bikes | 720 |
| | Touring Bikes | 200 |
| Clothing | Caps | 386 |
| | Gloves | 258 |
| | Jerseys | 291 |
| | Shorts | 102 |
| | Socks | 136 |
| | Vests | 37 |

## Conclusion and Key Findings

1. **Gender Representation:**

The gender distribution among our customers indicates a nearly equal percentage of men and women. Given this balanced representation, it is crucial to consider the perspectives

and preferences of both genders when developing and proposing new products. Ensuring inclusivity in product design and marketing strategies can lead to broader market appeal.

2. **Average Customer Age:**

Analysis of customer demographics reveals that the average age of our customer base is approximately 50 years. This age insight serves as a crucial factor for tailoring our product offerings, marketing campaigns, and user experiences to align with the preferences and expectations of this demographic.

3. **Product Preference - Accessories vs. Clothes:**

A notable trend emerges from our analyses, indicating that customers demonstrate a stronger inclination towards purchasing accessories compared to clothing items. This preference insight offers valuable guidance for inventory management decisions and presents an opportunity to focus marketing efforts on accessory-related product offerings.

4. **Regional Sales Disparities:**

Our analyses highlight significant disparities in product sales among different countries. The United States emerges as the top-performing country, showcasing robust sales. On the contrary, France is identified as the least fortunate country, indicating room for improvement in marketing plans to enhance brand presence and sales in this region.

5. **Product Performance Ranking:**

Through comprehensive analyses, we have identified the top ten best-selling products and the ten least-selling products in our inventory. This knowledge serves as a foundation for refining product strategies, emphasizing popular items, and addressing challenges associated with less-performing products. Strategic adjustments based on this ranking can contribute to improved overall product performance.