```python
# Importing necessary libraries
import numpy as np  # For linear algebra operations
import pandas as pd  # For data processing and CSV file I/O operations
import matplotlib.pyplot as plt  # For creating visualizations
import seaborn as sns  # For enhanced data visualization support
import os  # For operating system dependent functionality

# Listing all files in the input directory in a Kaggle environment
# Useful to understand the structure of the dataset directory
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/)
that gets preserved as output when you create a version using "Save &
Run All"
# You can also write temporary files to /kaggle/temp/, but they won't
be saved outside of the current session
```

```
/kaggle/input/online-retail-transaction-data/online_retail.csv
```

```python
# Import necessary libraries
import missingno as msno

# Load the dataset
df =
pd.read_csv('/kaggle/input/online-retail-transaction-data/online_retai
l.csv')
# Display the first few rows of the dataframe
df.head()
```

```
   index InvoiceNo StockCode                          Description
Quantity  \
0      0    536365    85123A   WHITE HANGING HEART T-LIGHT HOLDER
6
1      1    536365     71053                  WHITE METAL LANTERN
6
2      2    536365    84406B       CREAM CUPID HEARTS COAT HANGER
8
3      3    536365    84029G  KNITTED UNION FLAG HOT WATER BOTTLE
6
4      4    536365    84029E       RED WOOLLY HOTTIE WHITE HEART.
6

      InvoiceDate  UnitPrice  CustomerID         Country
0  12/1/2010 8:26       2.55     17850.0  United Kingdom
1  12/1/2010 8:26       3.39     17850.0  United Kingdom
2  12/1/2010 8:26       2.75     17850.0  United Kingdom
3  12/1/2010 8:26       3.39     17850.0  United Kingdom
4  12/1/2010 8:26       3.39     17850.0  United Kingdom
```

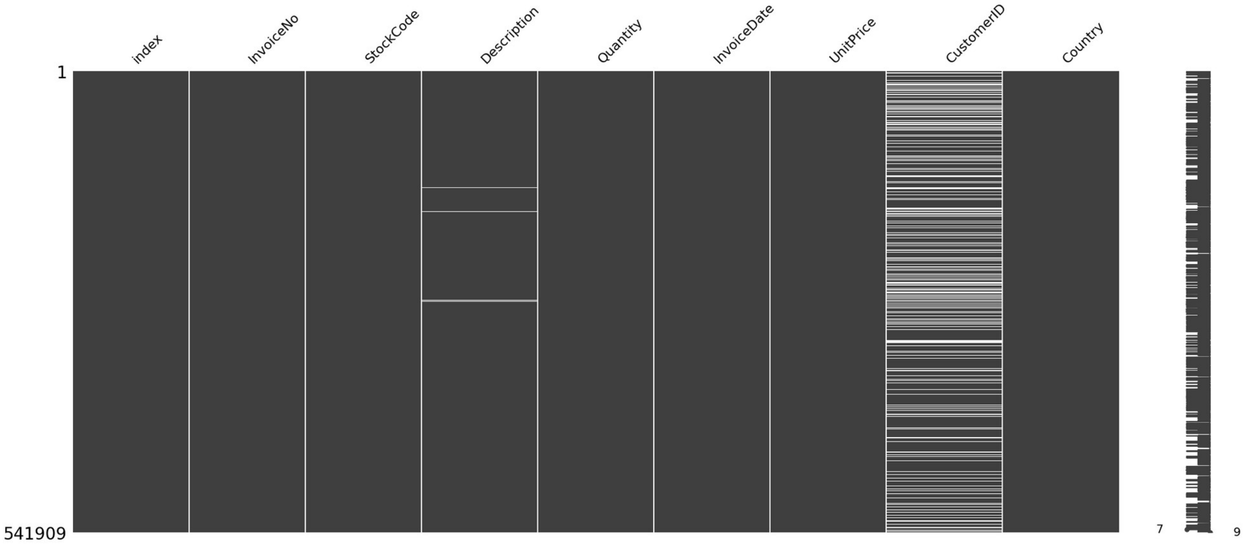
```
#
print("data structure is:",df.shape)
print("data type is:", df.dtypes)
print("data column is:",df.columns)
```

```
data structure is: (541909, 9)
data type is: index            int64
InvoiceNo       object
StockCode       object
Description     object
Quantity         int64
InvoiceDate     object
UnitPrice      float64
CustomerID     float64
Country         object
dtype: object
data column is: Index(['index', 'InvoiceNo', 'StockCode',
'Description', 'Quantity',
       'InvoiceDate', 'UnitPrice', 'CustomerID', 'Country'],
      dtype='object')
```

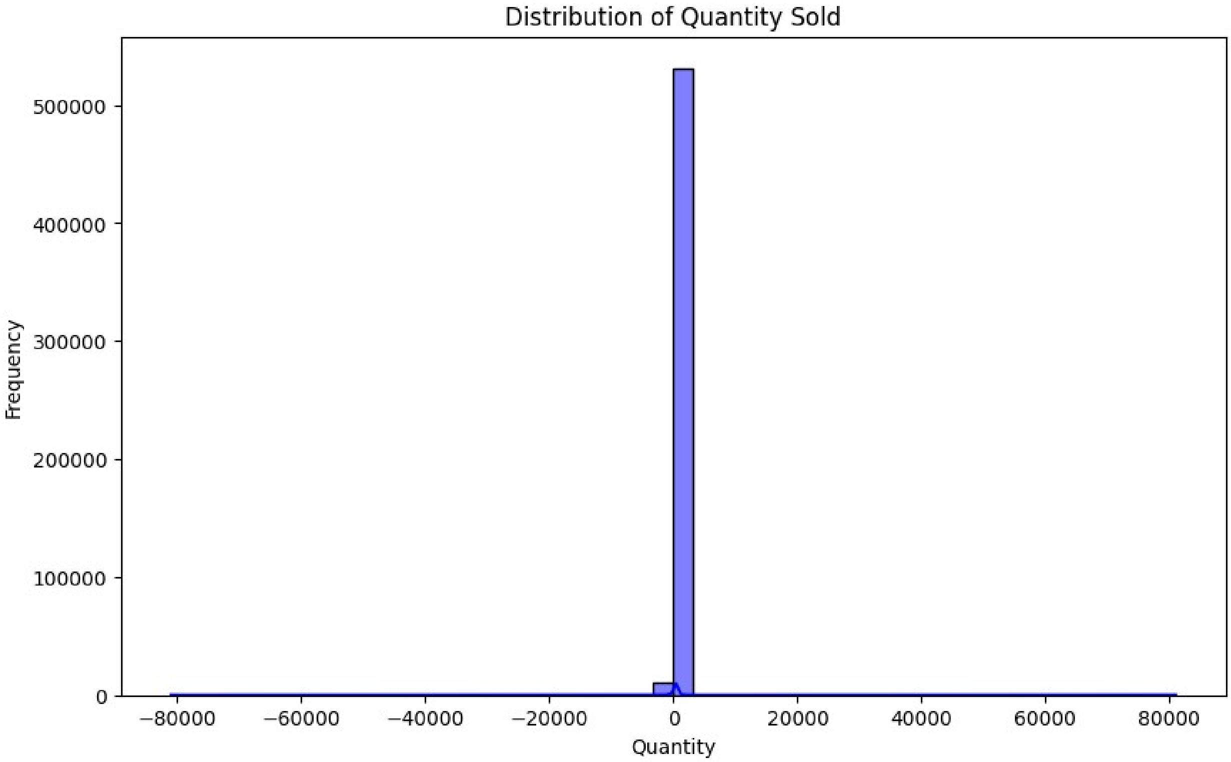
```
df.isna().sum()
```

```
index               0
InvoiceNo           0
StockCode           0
Description      1454
Quantity            0
InvoiceDate         0
UnitPrice           0
CustomerID     135080
Country             0
dtype: int64
```

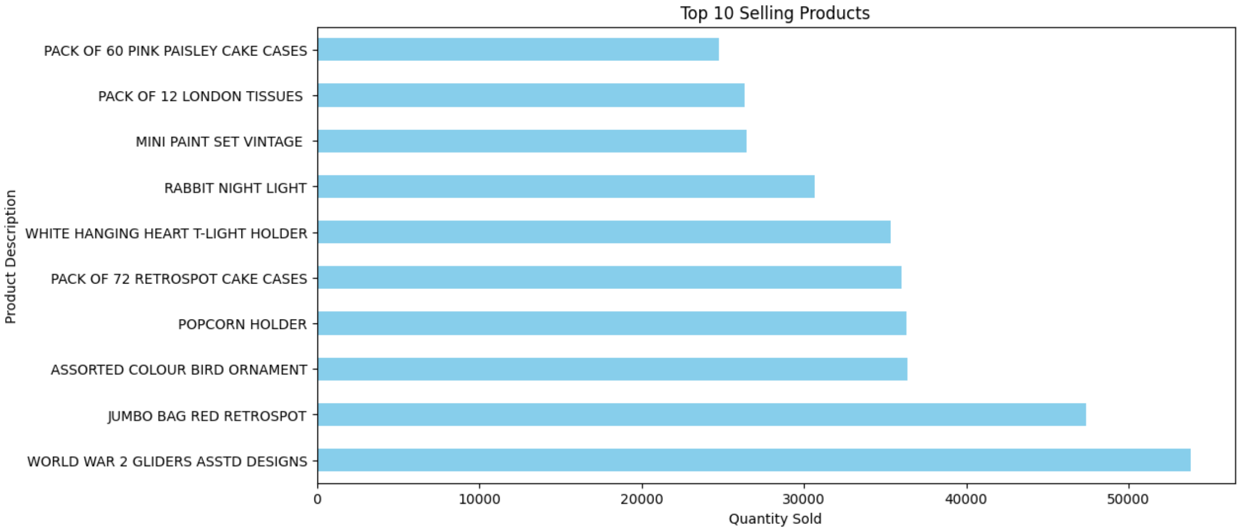
```
msno.matrix(df)
plt.show()
```



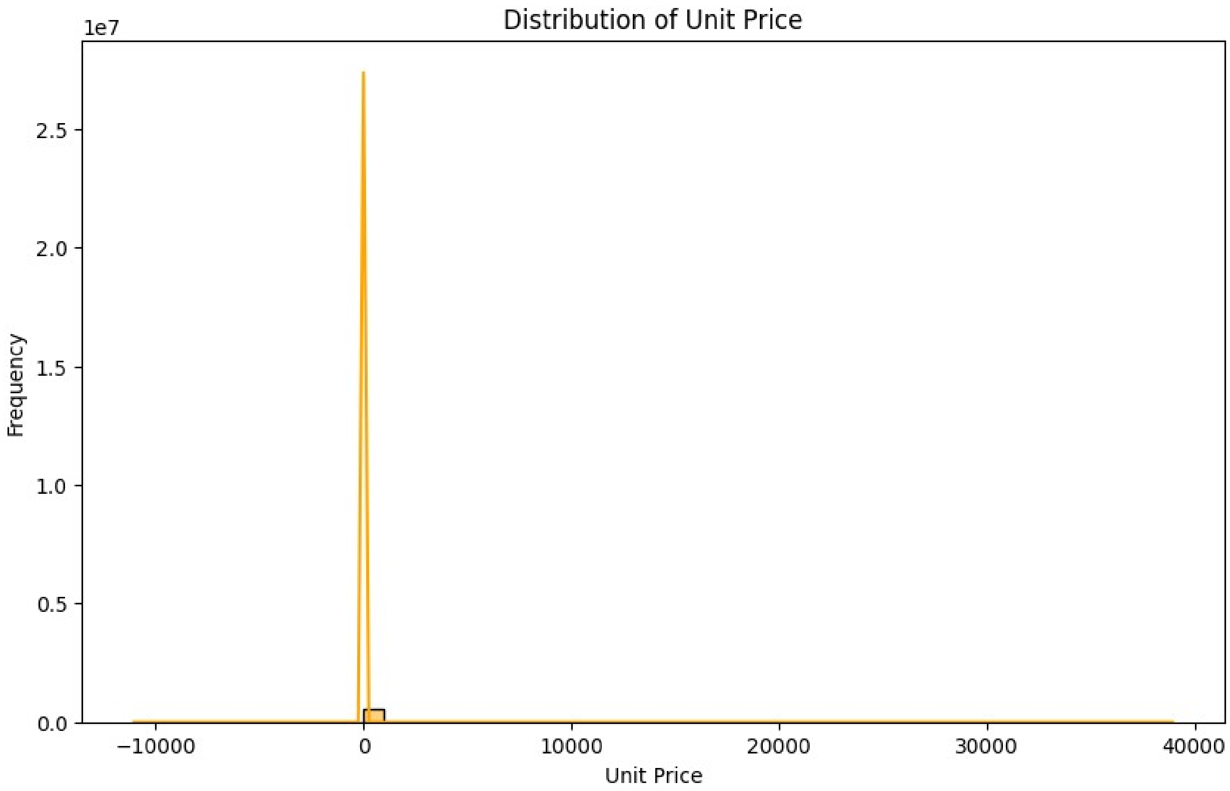
```
# Visualizing the distribution of 'Quantity' sold
# A histogram is used to understand the frequency of different quantity values
plt.figure(figsize=(10, 6))
sns.histplot(df['Quantity'], bins=50, kde=True, color='blue')
plt.title('Distribution of Quantity Sold')
plt.xlabel('Quantity')
plt.ylabel('Frequency')
plt.show()
```



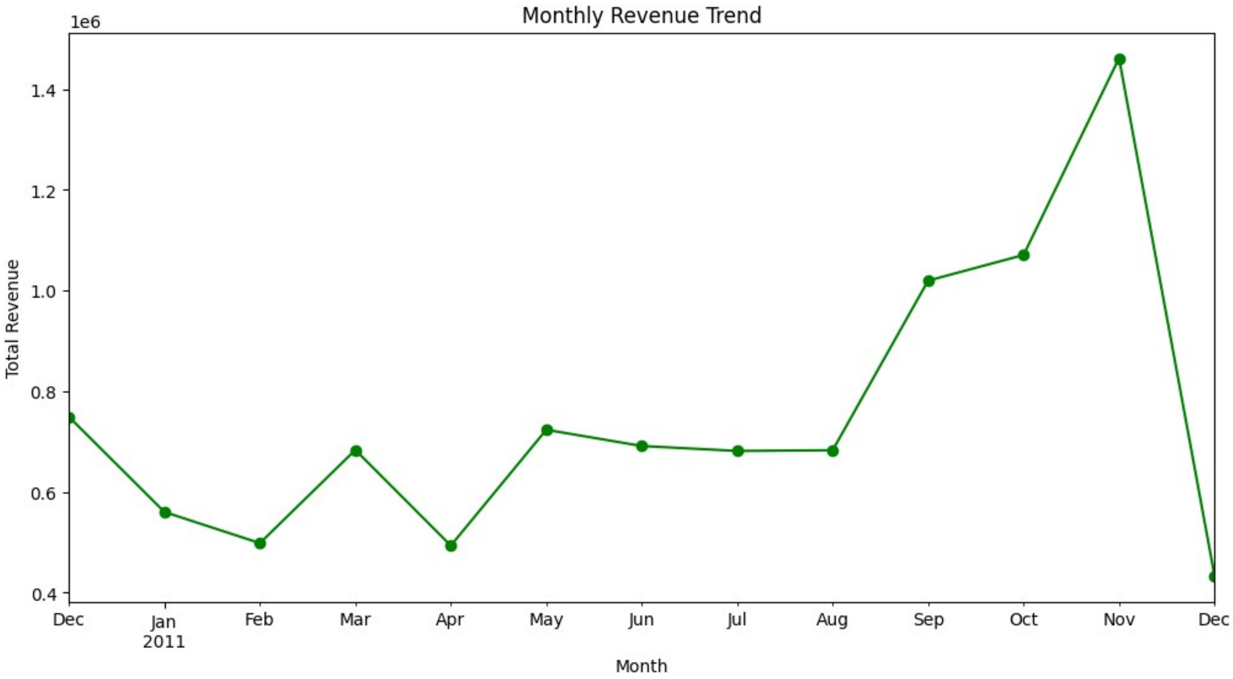
```python
# Identifying the top 10 products by quantity sold
# The 'Description' column is used to identify products, and the sum
of 'Quantity' is used to rank them
top_products = df.groupby('Description')
['Quantity'].sum().sort_values(ascending=False).head(10)

# Visualizing the top 10 selling products using a horizontal bar chart
plt.figure(figsize=(12, 6))
top_products.plot(kind='barh', color='skyblue')
plt.title('Top 10 Selling Products')
plt.xlabel('Quantity Sold')
plt.ylabel('Product Description')
plt.show()
```



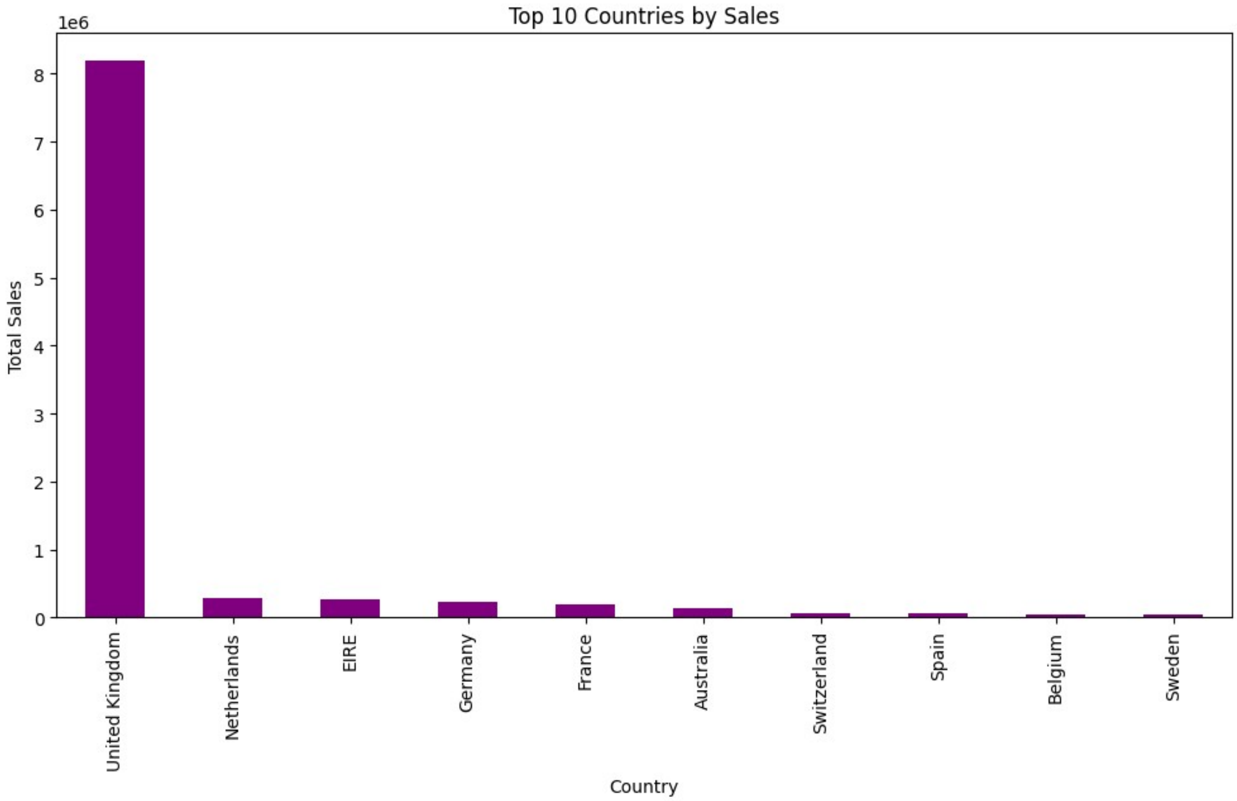
```python
# Visualizing the distribution of 'UnitPrice'
# A histogram is used to understand the frequency of different unit
price values
plt.figure(figsize=(10, 6))
sns.histplot(df['UnitPrice'], bins=50, kde=True, color='orange')
plt.title('Distribution of Unit Price')
plt.xlabel('Unit Price')
plt.ylabel('Frequency')
plt.show()
```



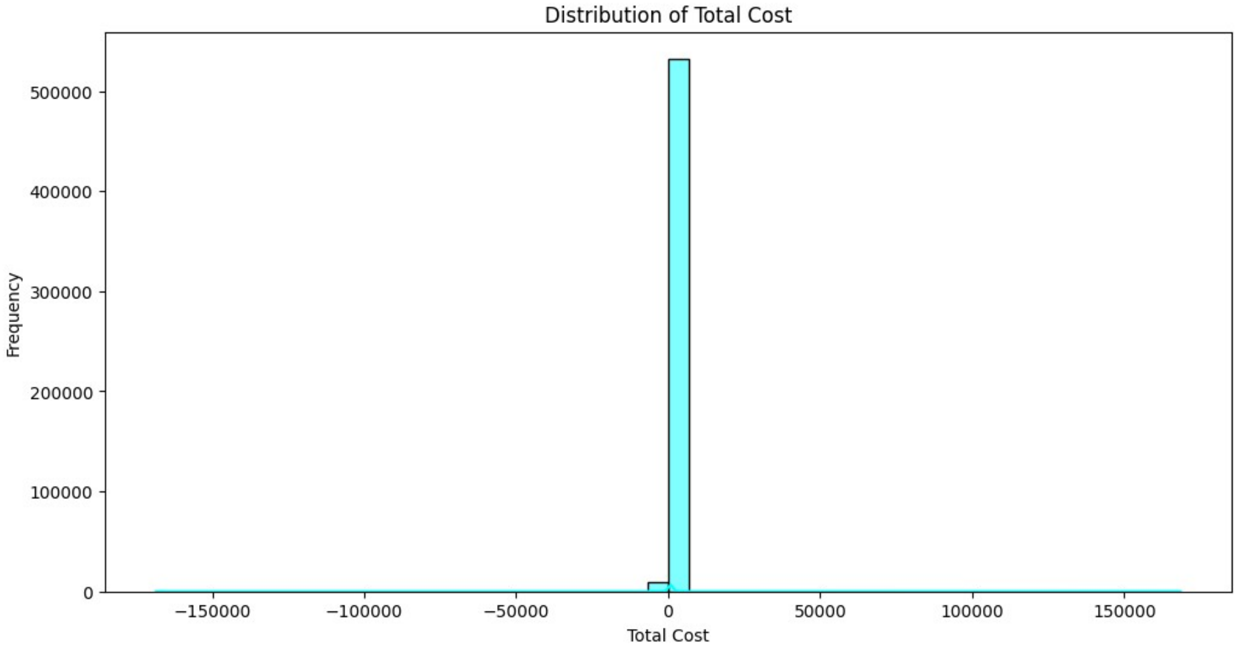
```
# Converting 'InvoiceDate' from string to datetime format
# This allows for time-series analysis later on
df['InvoiceDate'] = pd.to_datetime(df['InvoiceDate'])

# Creating a new column 'TotalCost' as a product of 'Quantity' and
'UnitPrice'
# This represents the total sales for each transaction
df['TotalCost'] = df['Quantity'] * df['UnitPrice']

# Calculating monthly revenue trend
# The data is resampled by month, and the sum of 'TotalCost' is
calculated for each month
monthly_revenue = df.resample('M', on='InvoiceDate')
['TotalCost'].sum()

# Visualizing monthly revenue trend using a line chart
# Each point on the line chart represents total revenue for a month
plt.figure(figsize=(12, 6))
monthly_revenue.plot(kind='line', marker='o', color='green')
plt.title('Monthly Revenue Trend')
plt.xlabel('Month')
plt.ylabel('Total Revenue')
plt.show()
```



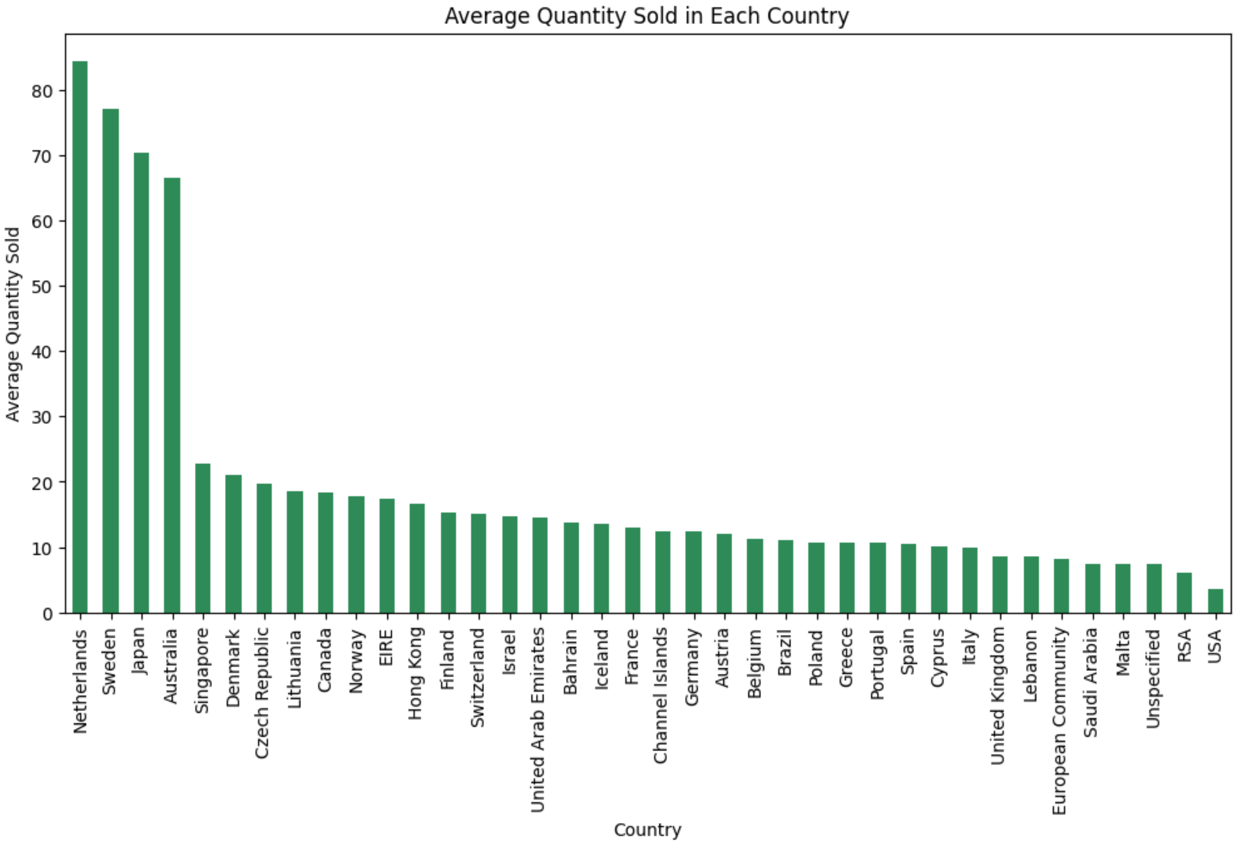
```
# Identifying the top 10 countries by total sales
# The 'Country' column is used to group the data, and the sum of
'TotalCost' is used to rank countries
top_countries = df.groupby('Country')
['TotalCost'].sum().sort_values(ascending=False).head(10)

# Visualizing the top 10 countries by sales using a bar chart
plt.figure(figsize=(12, 6))
top_countries.plot(kind='bar', color='purple')
plt.title('Top 10 Countries by Sales')
plt.xlabel('Country')
plt.ylabel('Total Sales')
plt.show()
```



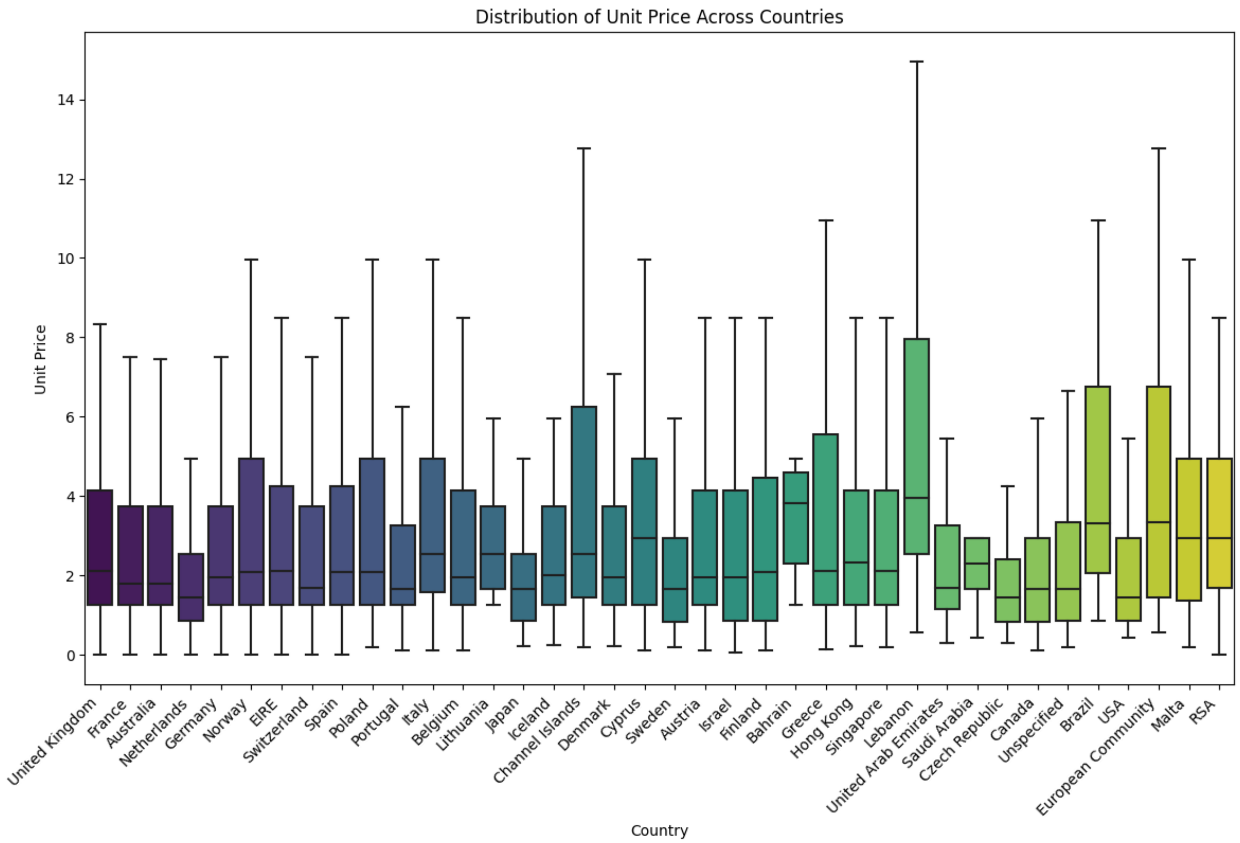
```python
# Visualizing the distribution of 'TotalCost'
# A histogram is used to understand the frequency of different total cost values
plt.figure(figsize=(12, 6))
sns.histplot(df['TotalCost'], bins=50, kde=True, color='cyan')
plt.title('Distribution of Total Cost')
plt.xlabel('Total Cost')
plt.ylabel('Frequency')
plt.show()
```



```
# Calculate the average quantity sold per country
# The 'Quantity' column is grouped by 'Country', and the mean quantity is calculated for each country.
avg_quantity_by_country = df.groupby('Country')['Quantity'].mean().sort_values(ascending=False)

# Visualize the average quantity sold per country using a bar chart
# Each bar represents the average quantity of products sold in a particular country.
plt.figure(figsize=(12, 6))
avg_quantity_by_country.plot(kind='bar', color='seagreen')
plt.title('Average Quantity Sold in Each Country')
plt.xlabel('Country')
plt.ylabel('Average Quantity Sold')
plt.show()
```

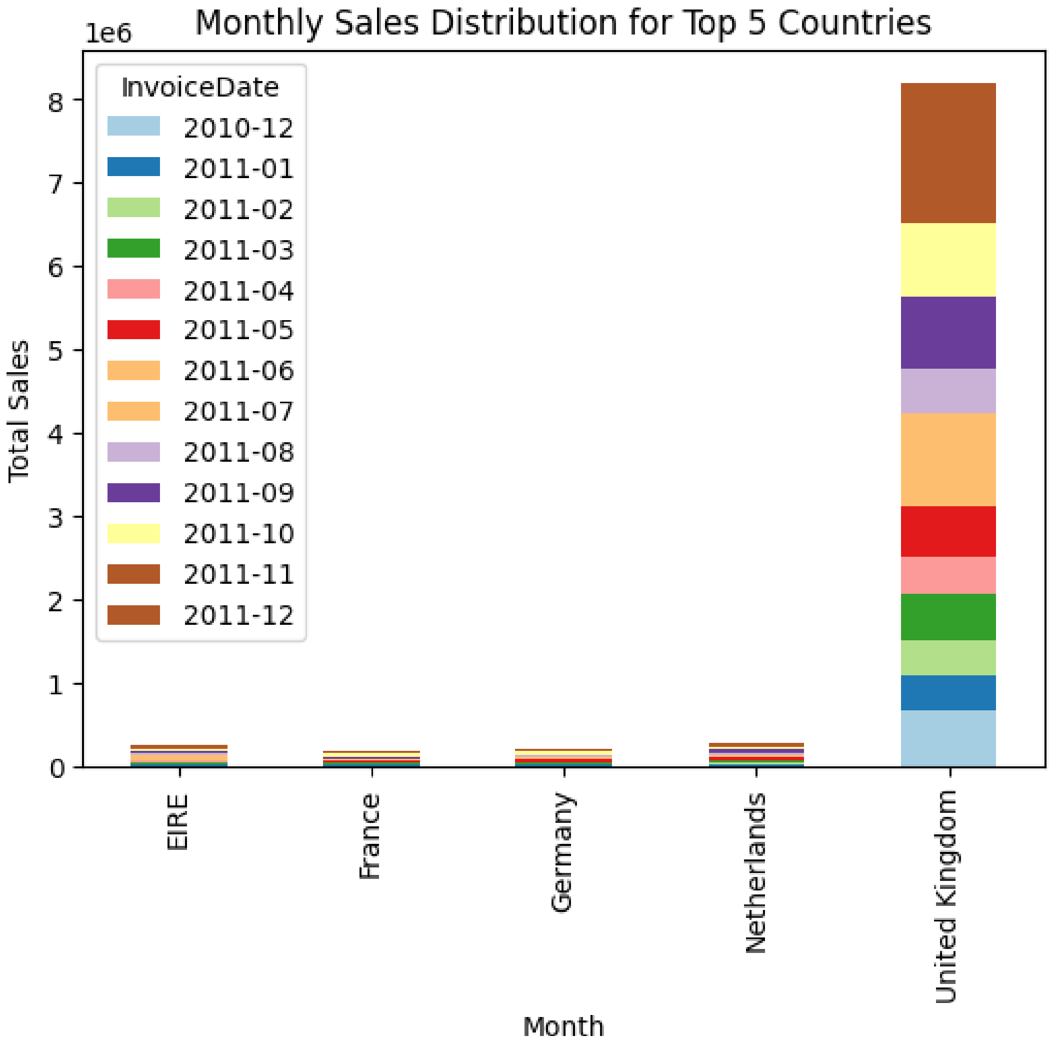


```python
# Visualize the distribution of unit price across countries using a boxplot
# The 'UnitPrice' distribution is shown for each country, excluding outliers for better clarity.
plt.figure(figsize=(14, 8))
sns.boxplot(x='Country', y='UnitPrice', data=df, showfliers=False, palette='viridis')
plt.title('Distribution of Unit Price Across Countries')
plt.xlabel('Country')
plt.ylabel('Unit Price')
plt.xticks(rotation=45, ha='right')  # Rotate x-axis labels for better readability
plt.show()
```



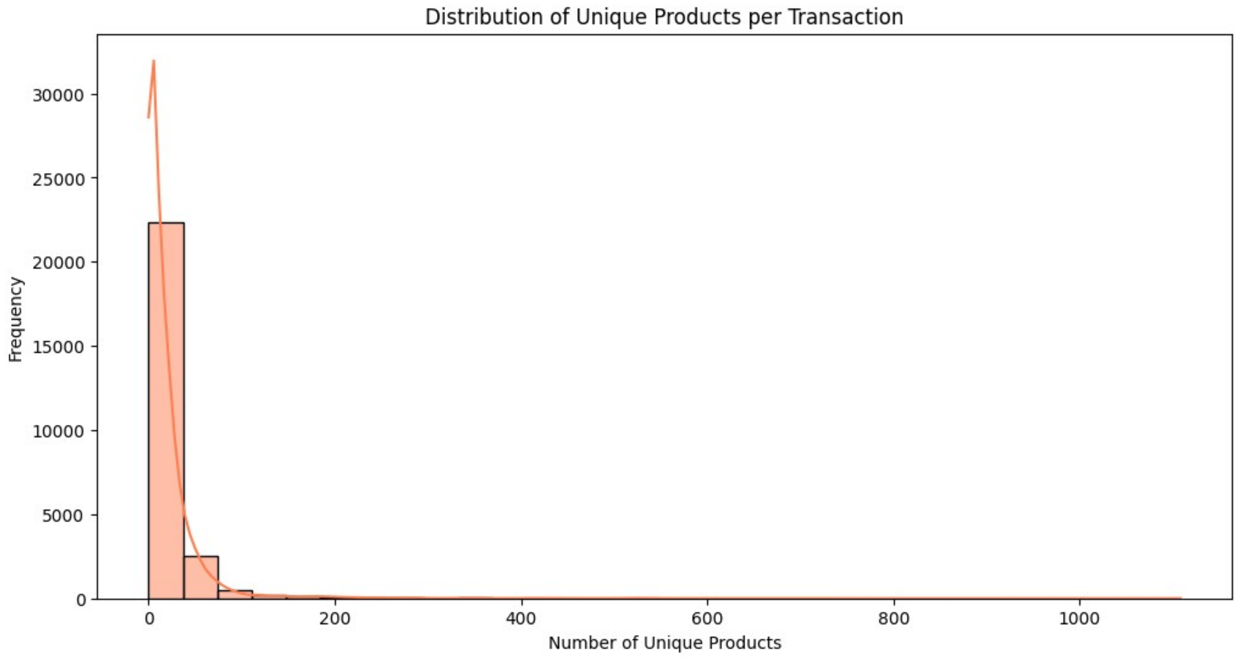
```
# Filtering the top 5 countries with the highest sales
# It groups the data by 'Country', calculates the sum of 'TotalCost'
for each country,
# sorts the countries by this total sales value in descending order,
and then selects the top 5.
top_countries = df.groupby('Country')
['TotalCost'].sum().sort_values(ascending=False).head(5).index
df_top_countries = df[df['Country'].isin(top_countries)]

# Calculating the monthly sales distribution for the top 5 countries
# It groups the filtered top countries' data first by 'Country', then
by month of 'InvoiceDate',
# calculates the sum of 'TotalCost' for each group, and reshapes the
result so that each country's
# sales are displayed as separate columns with months as the row
index.
monthly_distribution_top_countries =
df_top_countries.groupby(['Country',
df_top_countries['InvoiceDate'].dt.to_period("M")])
['TotalCost'].sum().unstack()

# Visualizing the monthly sales distribution for the top 5 countries
# It creates a stacked bar chart showing each country's total sales
per month.
```

```
# This visualization helps in comparing monthly sales trends across
the top countries.
plt.figure(figsize=(14, 8))
monthly_distribution_top_countries.plot(kind='bar', stacked=True,
colormap='Paired')
plt.title('Monthly Sales Distribution for Top 5 Countries')
plt.xlabel('Month')
plt.ylabel('Total Sales')
plt.show()

<Figure size 1400x800 with 0 Axes>
```

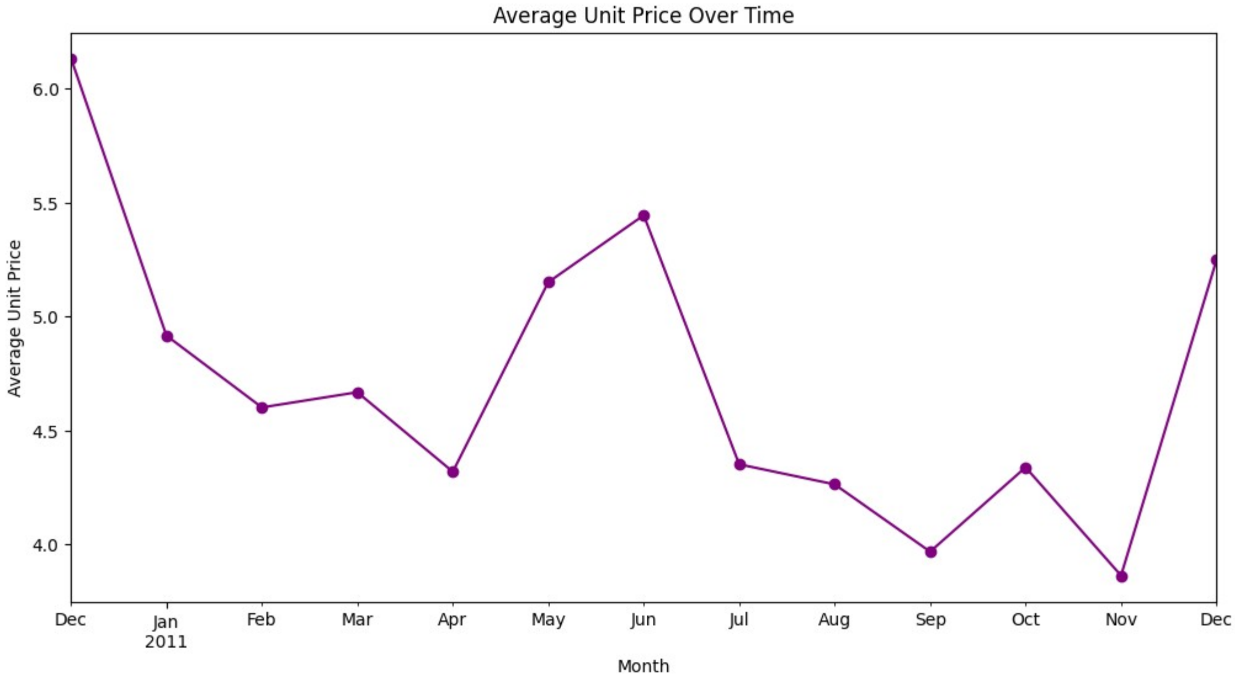


```
# Calculating the number of unique products per transaction
# It groups the data by 'InvoiceNo', then counts the unique
'Description' values for each group
unique_products_per_transaction = df.groupby('InvoiceNo')
['Description'].nunique()
```

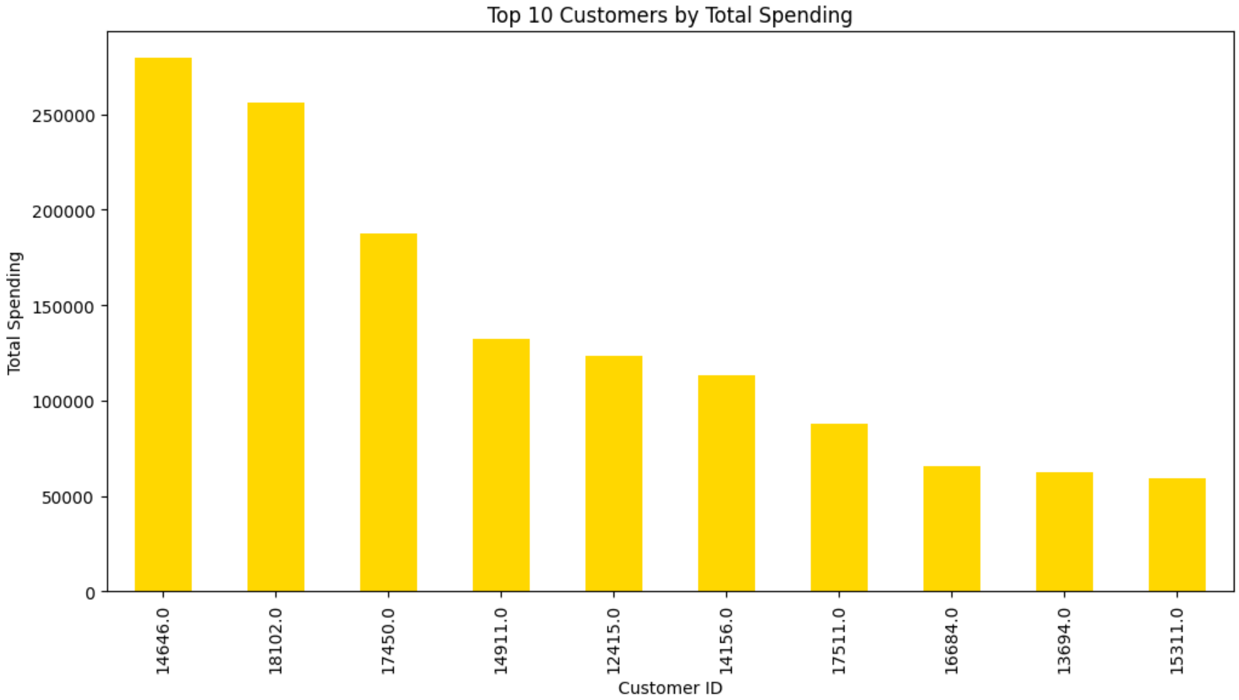
```
# Visualizing the distribution of unique products per transaction
# A histogram is used to understand the frequency of different counts
of unique products in transactions
plt.figure(figsize=(12, 6))
sns.histplot(unique_products_per_transaction, bins=30, kde=True,
color='coral')
plt.title('Distribution of Unique Products per Transaction')
plt.xlabel('Number of Unique Products')
plt.ylabel('Frequency')
plt.show()
```



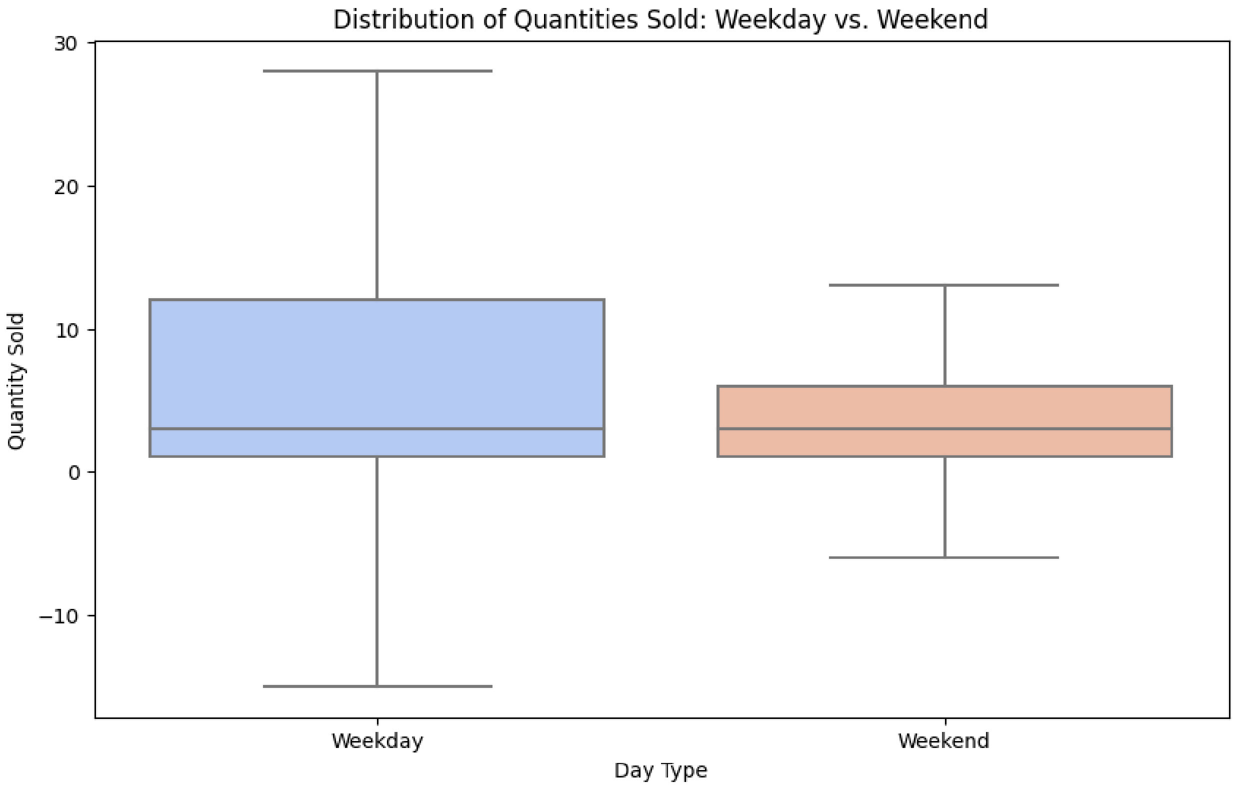
```
# Calculating the average unit price over time
# It groups the data by month of 'InvoiceDate', then calculates the
mean 'UnitPrice' for each month
avg_unit_price_over_time =
df.groupby(df['InvoiceDate'].dt.to_period("M"))['UnitPrice'].mean()

# Visualizing the average unit price over time
# A line chart is used to track changes in the average unit price
across different months
plt.figure(figsize=(12, 6))
avg_unit_price_over_time.plot(kind='line', marker='o', color='purple')
plt.title('Average Unit Price Over Time')
plt.xlabel('Month')
plt.ylabel('Average Unit Price')
plt.show()
```



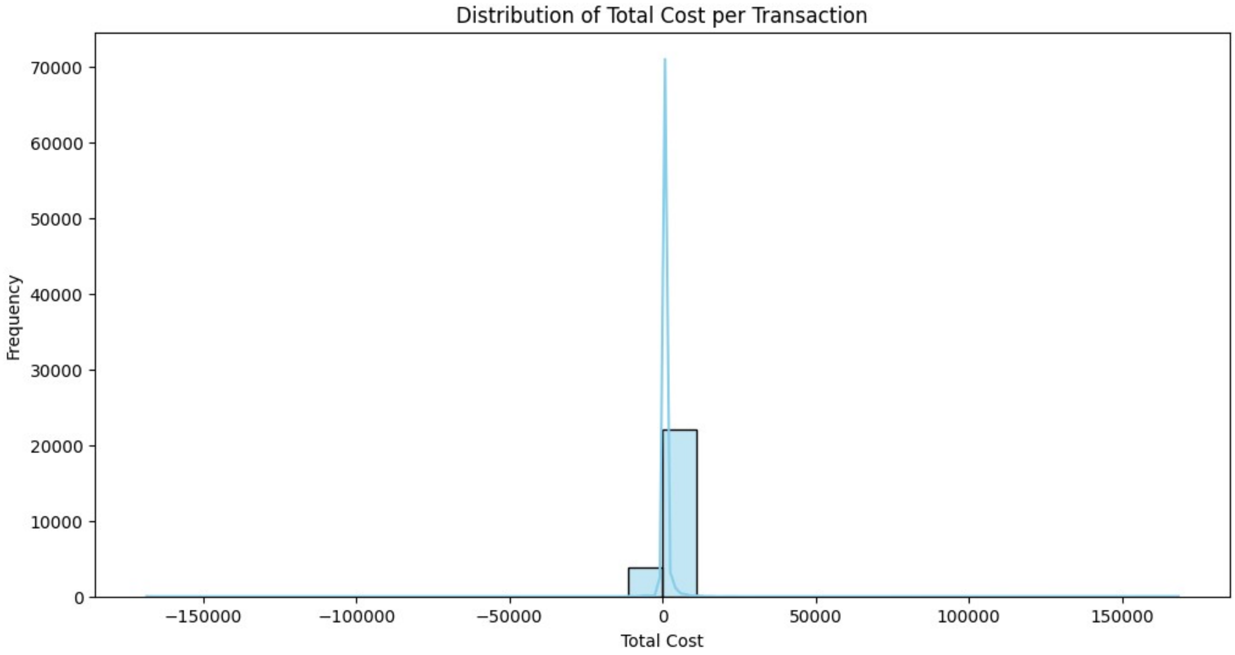
```python
# Calculating the total spending of the top 10 customers
# It groups the data by 'CustomerID', then sums 'TotalCost' for each customer and sorts the totals
# to find the top 10 customers with the highest spending
top_customers = df.groupby('CustomerID')['TotalCost'].sum().sort_values(ascending=False).head(10)

# Visualizing the total spending of the top 10 customers
# A bar chart is used to display the total spending of each of the top 10 customers
plt.figure(figsize=(12, 6))
top_customers.plot(kind='bar', color='gold')
plt.title('Top 10 Customers by Total Spending')
plt.xlabel('Customer ID')
plt.ylabel('Total Spending')
plt.show()
```



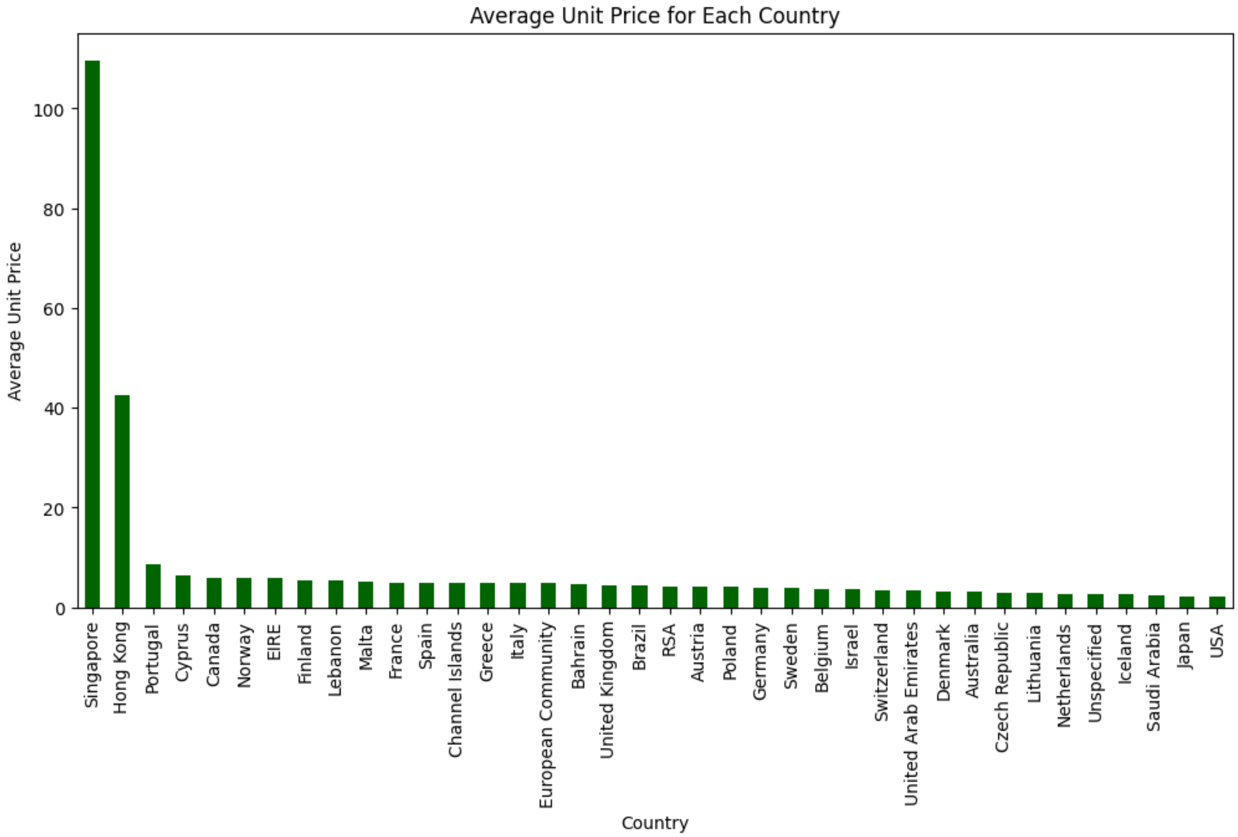
```python
# Extracting day type (Weekday/Weekend) and creating a new column 'DayType'
# 'InvoiceDate' is used to determine the day of the week (0 to 6). Days 5 and 6 correspond to the weekend.
df['DayType'] = df['InvoiceDate'].dt.dayofweek.apply(lambda x: 'Weekend' if x >= 5 else 'Weekday')

# Visualizing the distribution of quantities sold on weekdays vs weekends
# A boxplot shows the spread and central tendency of quantities sold for each day type category
plt.figure(figsize=(10, 6))
sns.boxplot(x='DayType', y='Quantity', data=df, showfliers=False, palette='coolwarm')
plt.title('Distribution of Quantities Sold: Weekday vs. Weekend')
plt.xlabel('Day Type')
plt.ylabel('Quantity Sold')
plt.show()
```



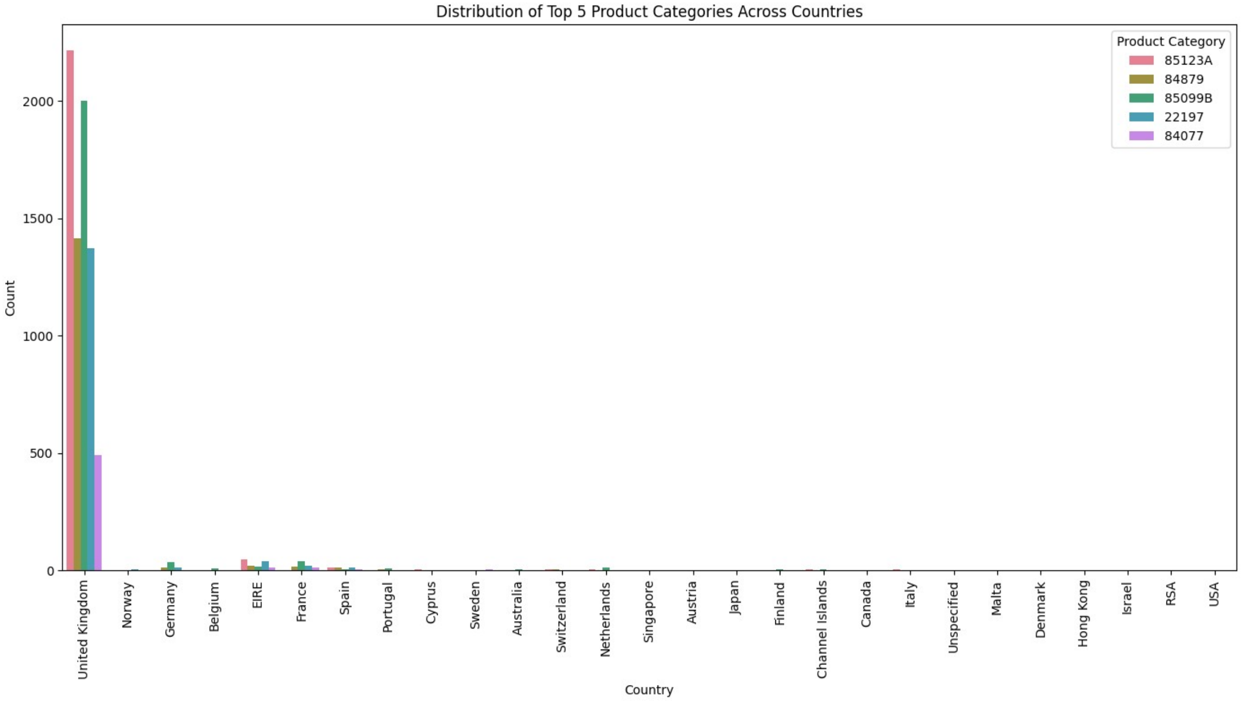
```python
# Visualizing the distribution of total cost per transaction
# A histogram shows the frequency of different total cost values for
all transactions
plt.figure(figsize=(12, 6))
sns.histplot(df.groupby('InvoiceNo')['TotalCost'].sum(), bins=30,
kde=True, color='skyblue')
plt.title('Distribution of Total Cost per Transaction')
plt.xlabel('Total Cost')
plt.ylabel('Frequency')
plt.show()
```



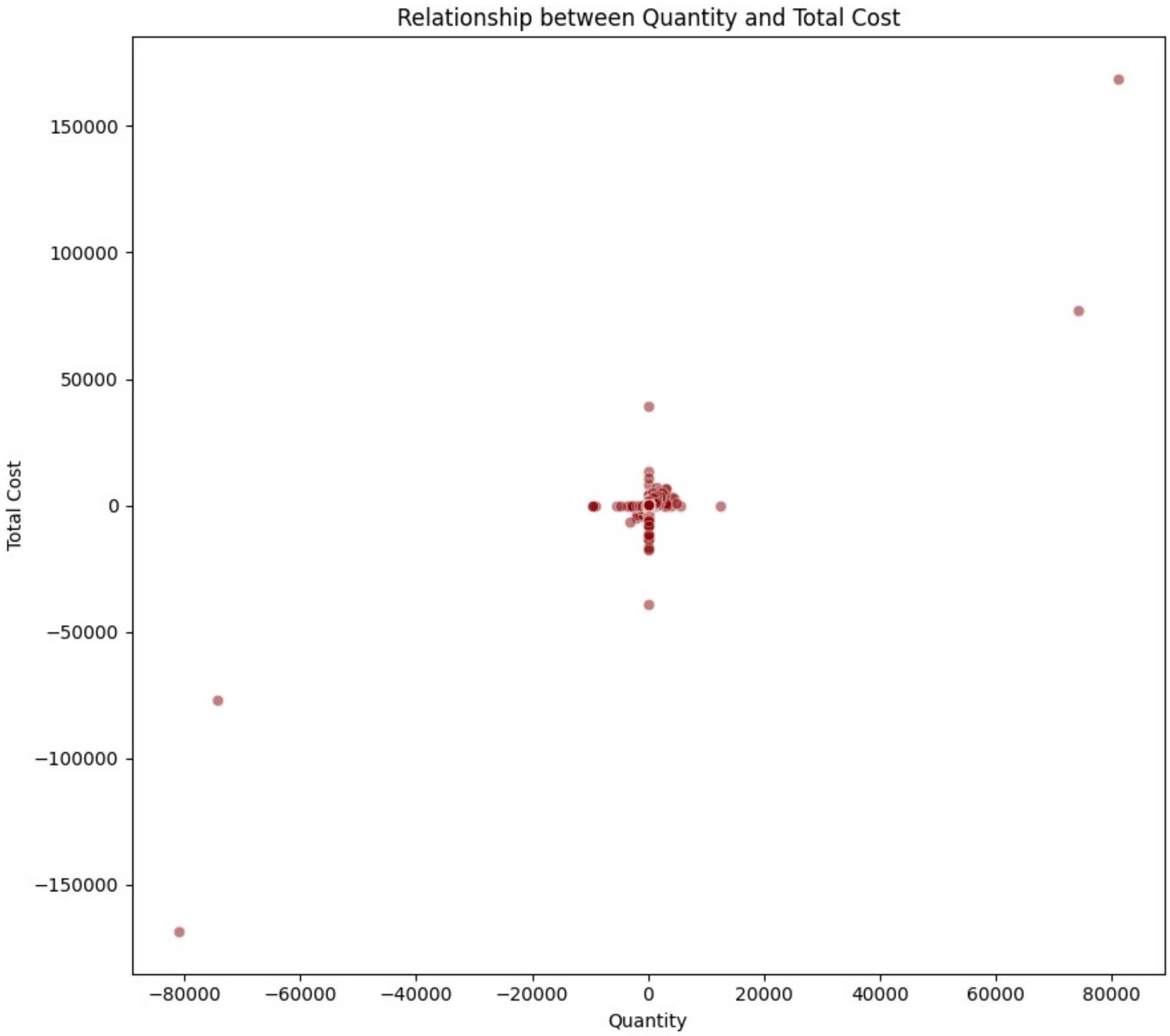
```
# Calculating the average unit price per country
# The mean 'UnitPrice' is calculated for each country and sorted in
descending order to identify the countries with the highest and lowest
average prices
avg_unit_price_by_country = df.groupby('Country')
['UnitPrice'].mean().sort_values(ascending=False)

# Visualizing the average unit price per country using a bar chart
# Each bar represents the average unit price of products sold in a
particular country
plt.figure(figsize=(12, 6))
avg_unit_price_by_country.plot(kind='bar', color='darkgreen')
plt.title('Average Unit Price for Each Country')
plt.xlabel('Country')
plt.ylabel('Average Unit Price')
plt.show()
```



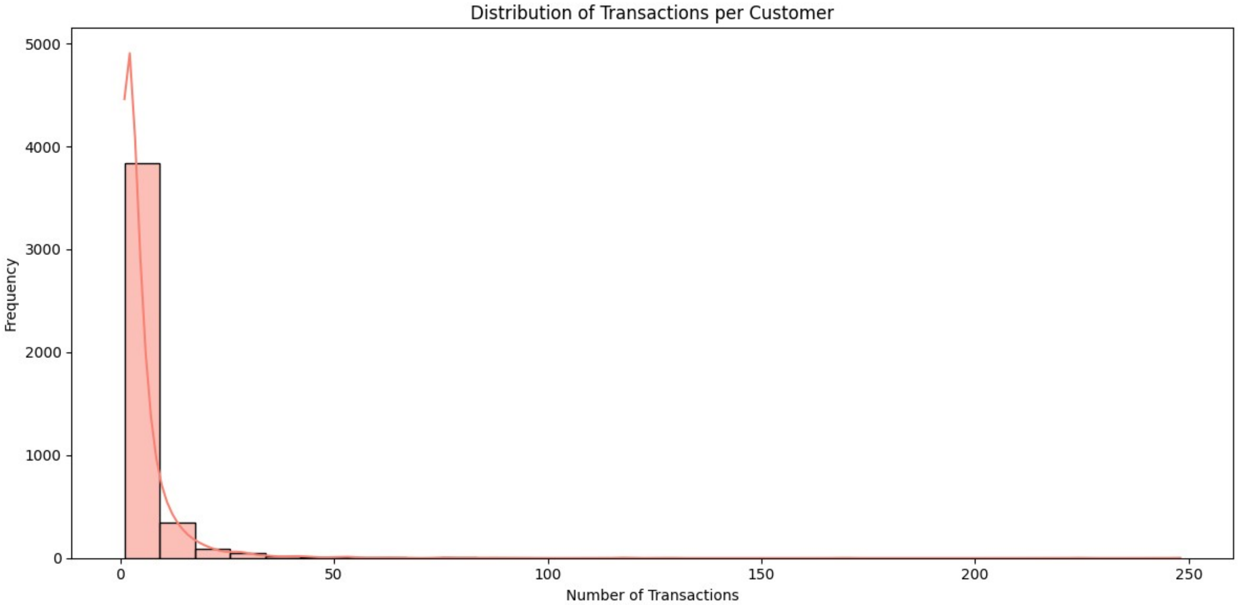
```
# Identifying the top 5 product categories with the highest sales volumes
# This is achieved by grouping the data by 'StockCode', summing the 'Quantity', and sorting in descending order
top_categories = df.groupby('StockCode')['Quantity'].sum().sort_values(ascending=False).head(5).index
df_top_categories = df[df['StockCode'].isin(top_categories)]

# Visualizing the distribution of these top 5 product categories across different countries
# This provides insight into which countries have higher sales for these categories
plt.figure(figsize=(14, 8))
sns.countplot(x='Country', hue='StockCode', data=df_top_categories, palette='husl')
plt.title('Distribution of Top 5 Product Categories Across Countries')
plt.xlabel('Country')
plt.ylabel('Count')
plt.xticks(rotation=90)  # Rotate x-axis labels for better readability
plt.legend(title='Product Category')
plt.tight_layout()  # Adjusting the layout for better fit
plt.show()
```



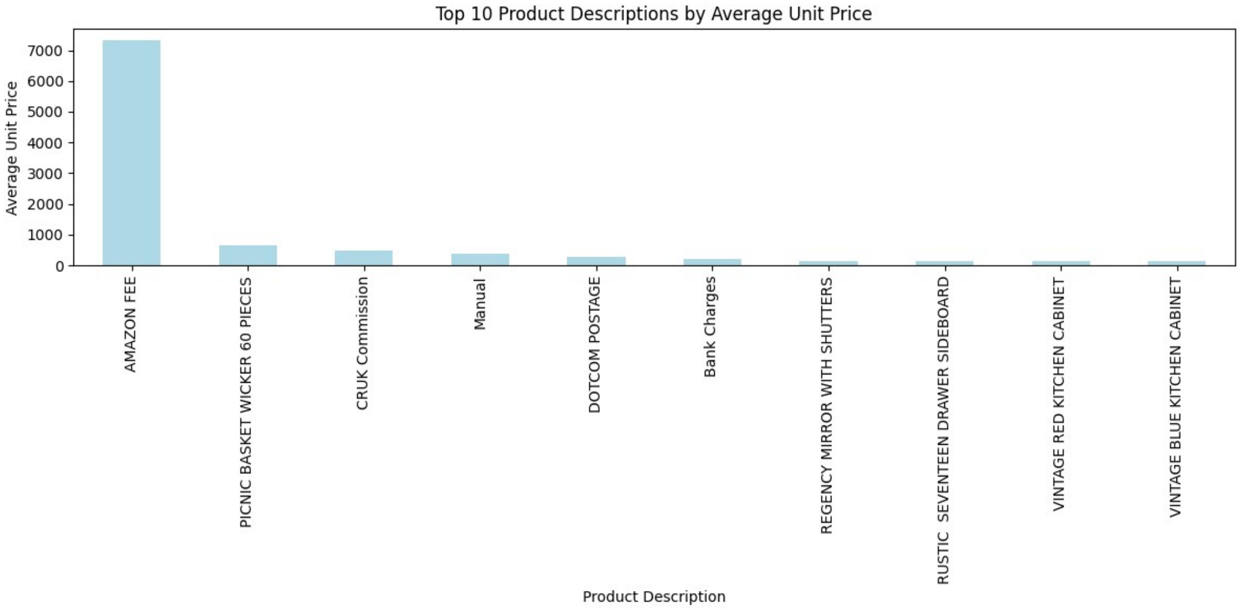
```
# Exploring the relationship between quantity and total cost for
transactions
# This scatter plot helps understand how total cost varies with
quantity - useful for spotting trends or outliers
plt.figure(figsize=(9, 8))
sns.scatterplot(x='Quantity', y='TotalCost', data=df, color='darkred',
alpha=0.5)
plt.title('Relationship between Quantity and Total Cost')
plt.xlabel('Quantity')
plt.ylabel('Total Cost')
plt.tight_layout()  # Adjusting the layout
plt.show()
```



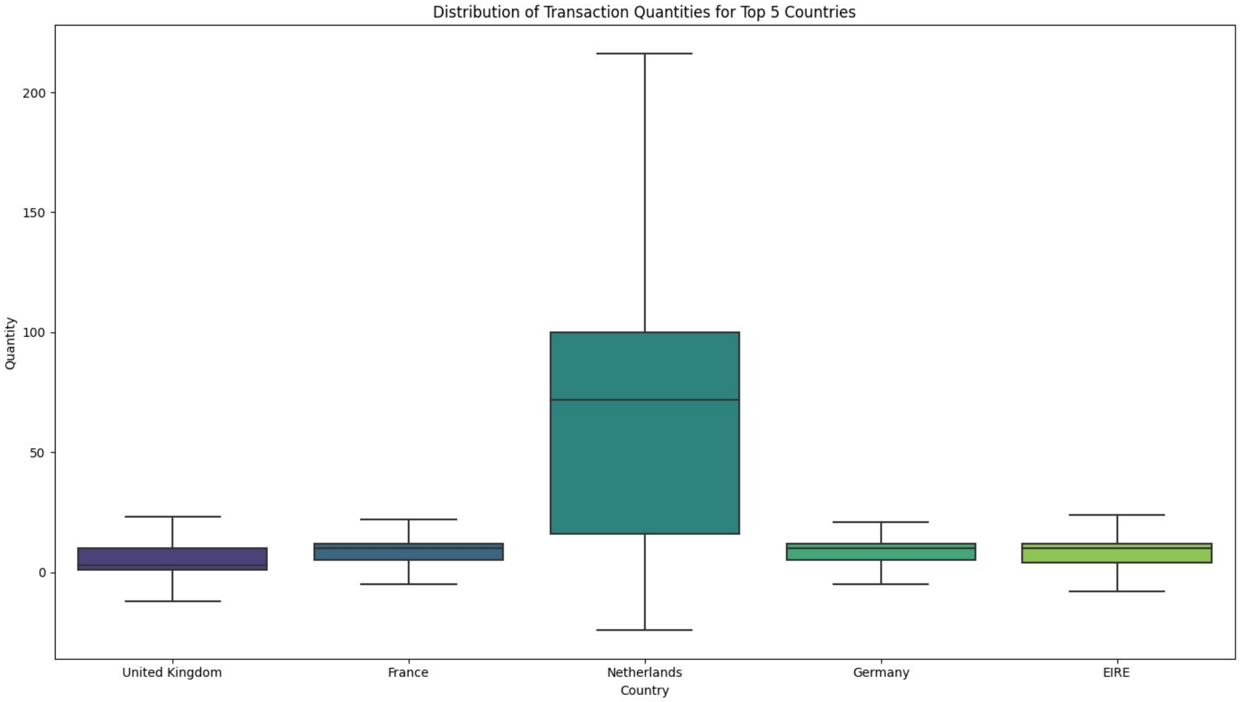
```
# Analyzing the distribution of transactions per customer to
understand customer behavior
# This histogram shows how many transactions are typical per customer
transactions_per_customer = df.groupby('CustomerID')
['InvoiceNo'].nunique()
plt.figure(figsize=(12, 6))
sns.histplot(transactions_per_customer, bins=30, kde=True,
color='salmon')
plt.title('Distribution of Transactions per Customer')
plt.xlabel('Number of Transactions')
plt.ylabel('Frequency')
plt.tight_layout()  # Adjusting the layout
plt.show()
```



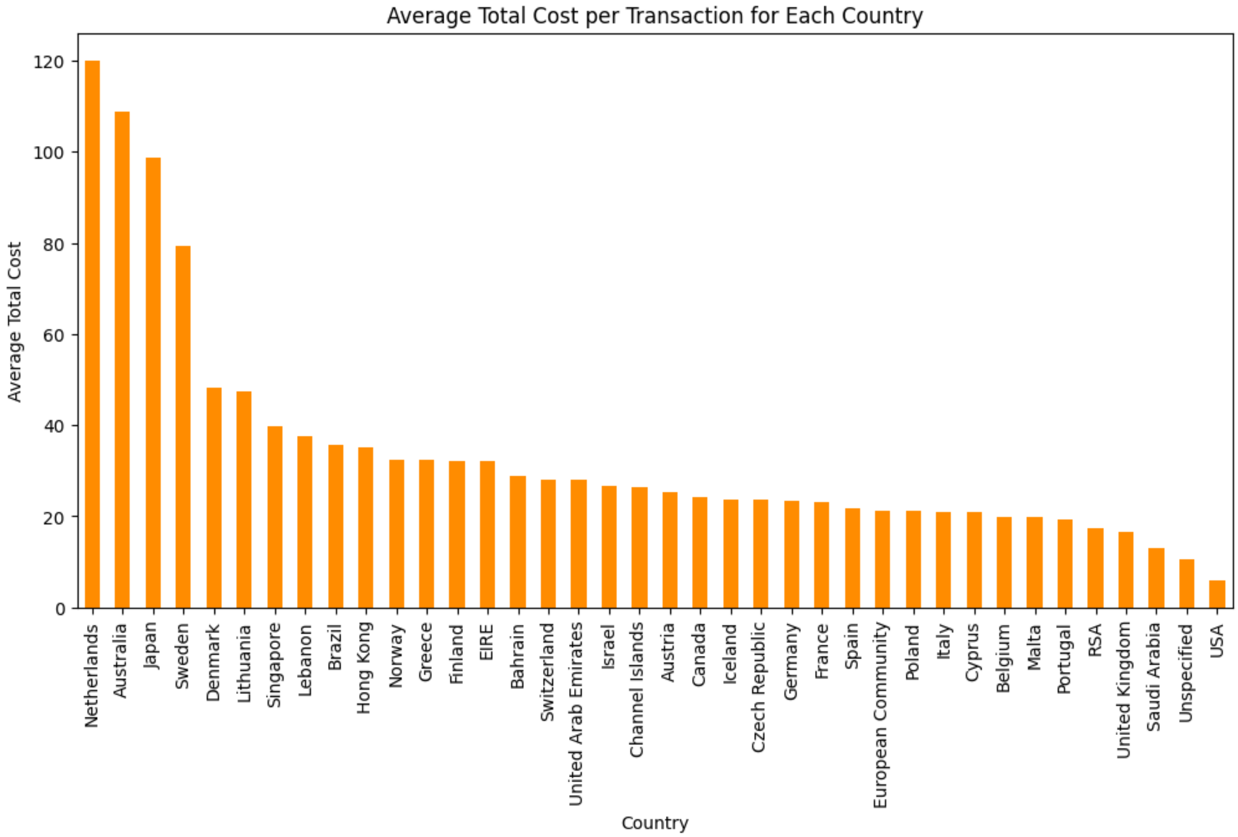
```python
# Determining the top 10 product descriptions by average unit price to identify premium products or categories
# This bar chart visualizes which products tend to have higher prices on average
avg_unit_price_by_description = df.groupby('Description')['UnitPrice'].mean().sort_values(ascending=False).head(10)
plt.figure(figsize=(12, 6))
avg_unit_price_by_description.plot(kind='bar', color='lightblue')
plt.title('Top 10 Product Descriptions by Average Unit Price')
plt.xlabel('Product Description')
plt.ylabel('Average Unit Price')
plt.tight_layout()  # Adjusting the layout
plt.show()
```



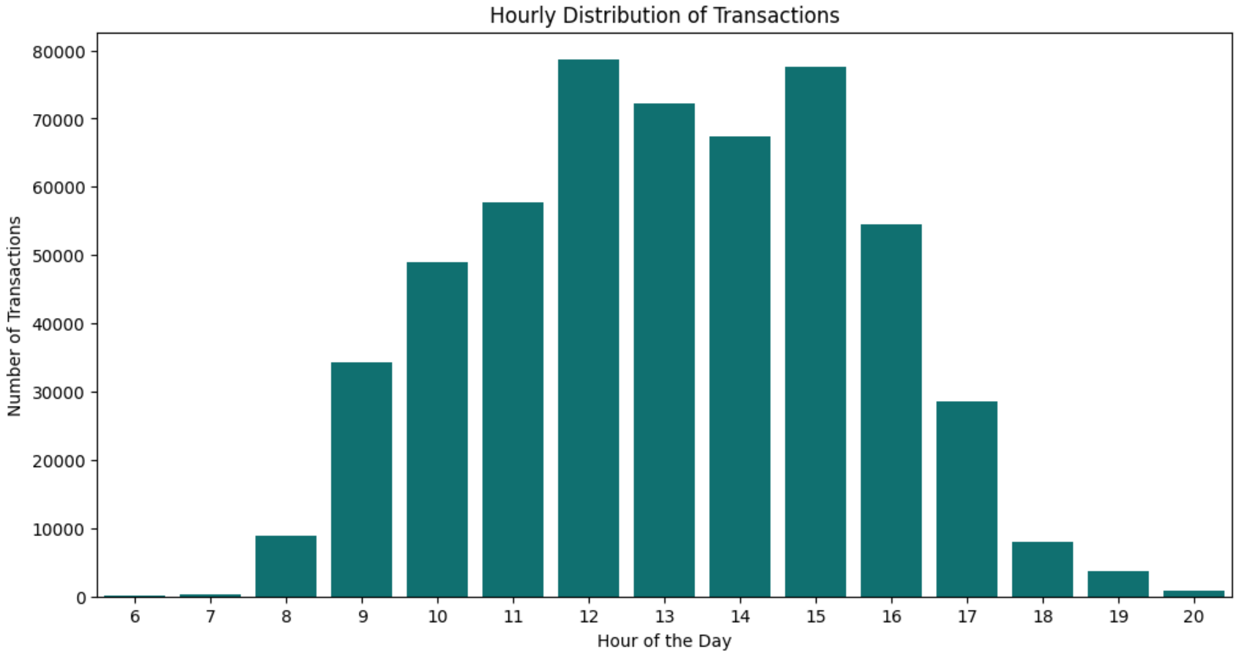
```
# Focusing on the top 5 countries by sales volume to understand where
most transactions occur
# This boxplot visualizes the distribution of quantities sold in these
countries, indicating market size or demand
df_top_countries = df[df['Country'].isin(top_countries)]
plt.figure(figsize=(14, 8))
sns.boxplot(x='Country', y='Quantity', data=df_top_countries,
showfliers=False, palette='viridis')
plt.title('Distribution of Transaction Quantities for Top 5
Countries')
plt.xlabel('Country')
plt.ylabel('Quantity')
plt.tight_layout()  # Adjusting the layout
plt.show()
```



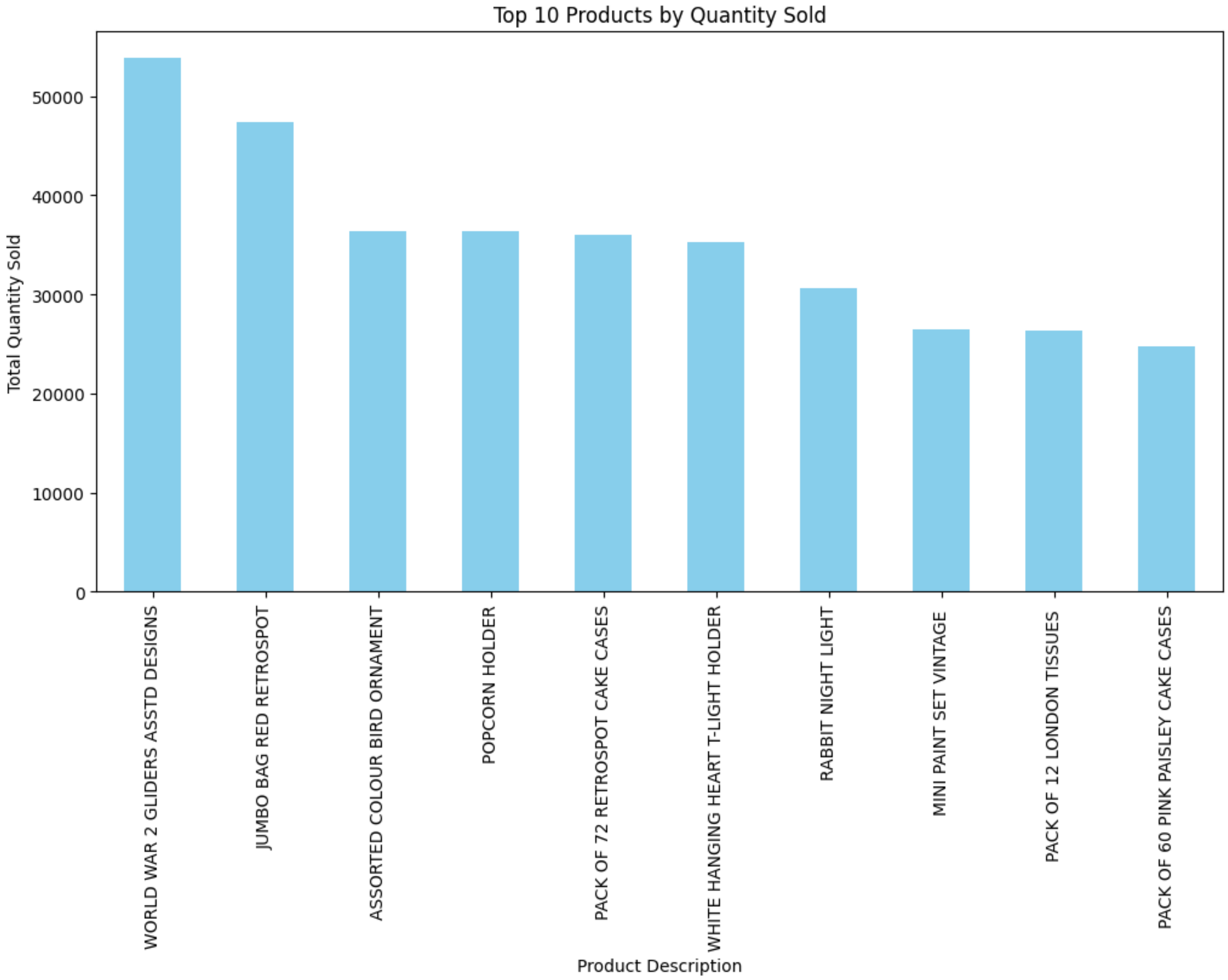
```
# Calculating the average total cost per transaction for each country
# This helps in understanding the average spending per transaction in
different markets
avg_total_cost_by_country = df.groupby('Country')
['TotalCost'].mean().sort_values(ascending=False)

# Visualizing the average total cost per transaction for each country
# A bar chart provides a clear comparison of average spending across
countries
plt.figure(figsize=(12, 6))
avg_total_cost_by_country.plot(kind='bar', color='darkorange')
plt.title('Average Total Cost per Transaction for Each Country')
plt.xlabel('Country')
plt.ylabel('Average Total Cost')
plt.show()
```



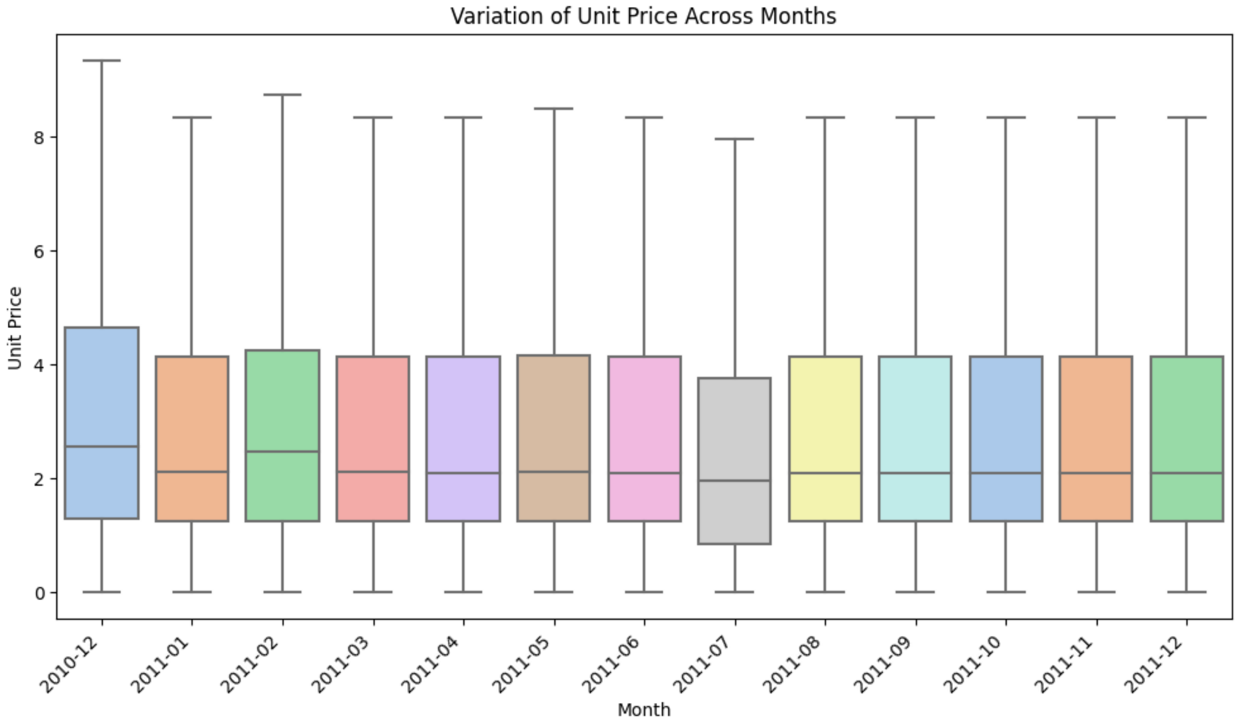
```
# Extracting the hour of day from 'InvoiceDate' and creating a new
column
# This column is used to analyze transactions distribution across
different hours of the day
df['HourOfDay'] = df['InvoiceDate'].dt.hour

# Visualizing the hourly distribution of transactions
# A count plot shows how transaction frequency varies throughout the
day
plt.figure(figsize=(12, 6))
sns.countplot(x='HourOfDay', data=df, color='teal')
plt.title('Hourly Distribution of Transactions')
plt.xlabel('Hour of the Day')
plt.ylabel('Number of Transactions')
plt.show()
```



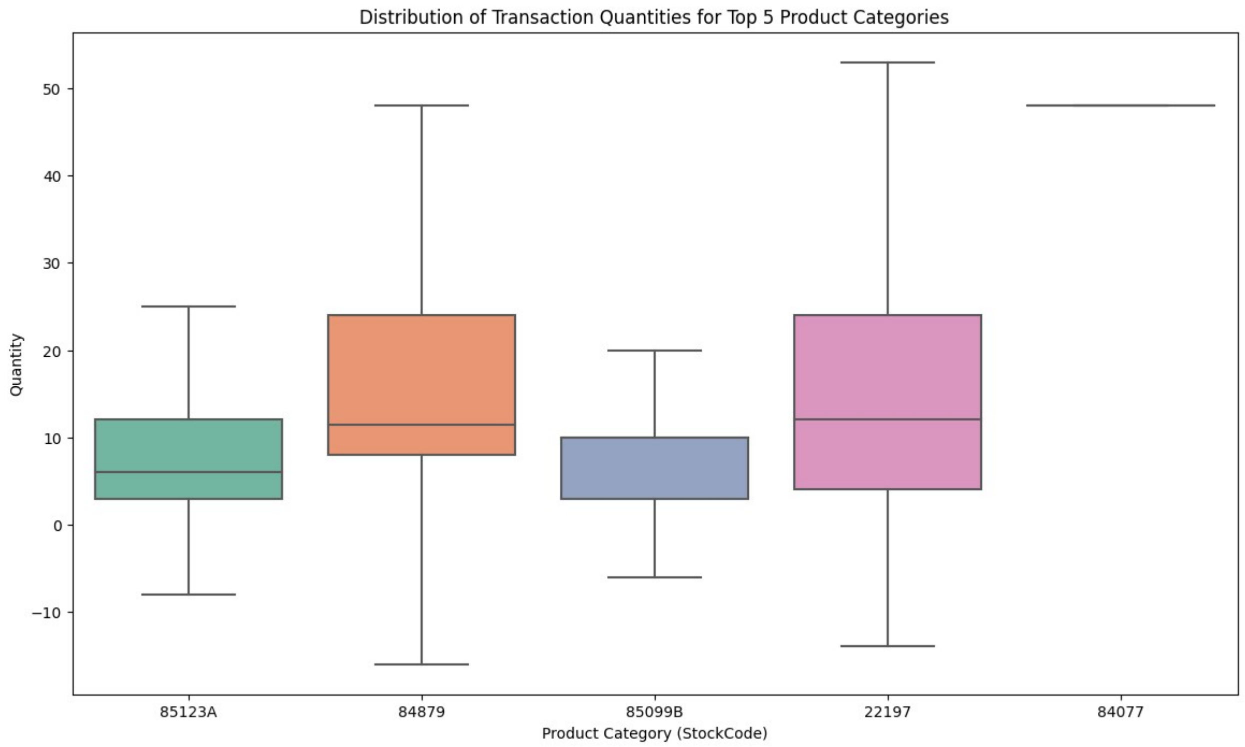
```
# Identifying the top 10 products by sales quantity
# This helps in understanding which products are the most popular or
most frequently sold
top_products_quantity = df.groupby('Description')
['Quantity'].sum().sort_values(ascending=False).head(10)

# Visualizing the top 10 products by quantity sold
# A bar chart displays the total quantity sold for each of these top
products
plt.figure(figsize=(12, 6))
top_products_quantity.plot(kind='bar', color='skyblue')
plt.title('Top 10 Products by Quantity Sold')
plt.xlabel('Product Description')
plt.ylabel('Total Quantity Sold')
plt.show()
```



```python
# Extracting the month from 'InvoiceDate' and creating a new column
# This column facilitates analyzing trends or variations across different months
df['Month'] = df['InvoiceDate'].dt.to_period("M")

# Visualizing the variation of unit price across months
# A box plot is used to display the distribution of unit prices for each month, showing median, quartiles, and outliers
plt.figure(figsize=(12, 6))
sns.boxplot(x='Month', y='UnitPrice', data=df, showfliers=False, palette='pastel')
plt.title('Variation of Unit Price Across Months')
plt.xlabel('Month')
plt.ylabel('Unit Price')
plt.xticks(rotation=45, ha='right')  # Rotate x-axis labels for better readability
plt.show()
```

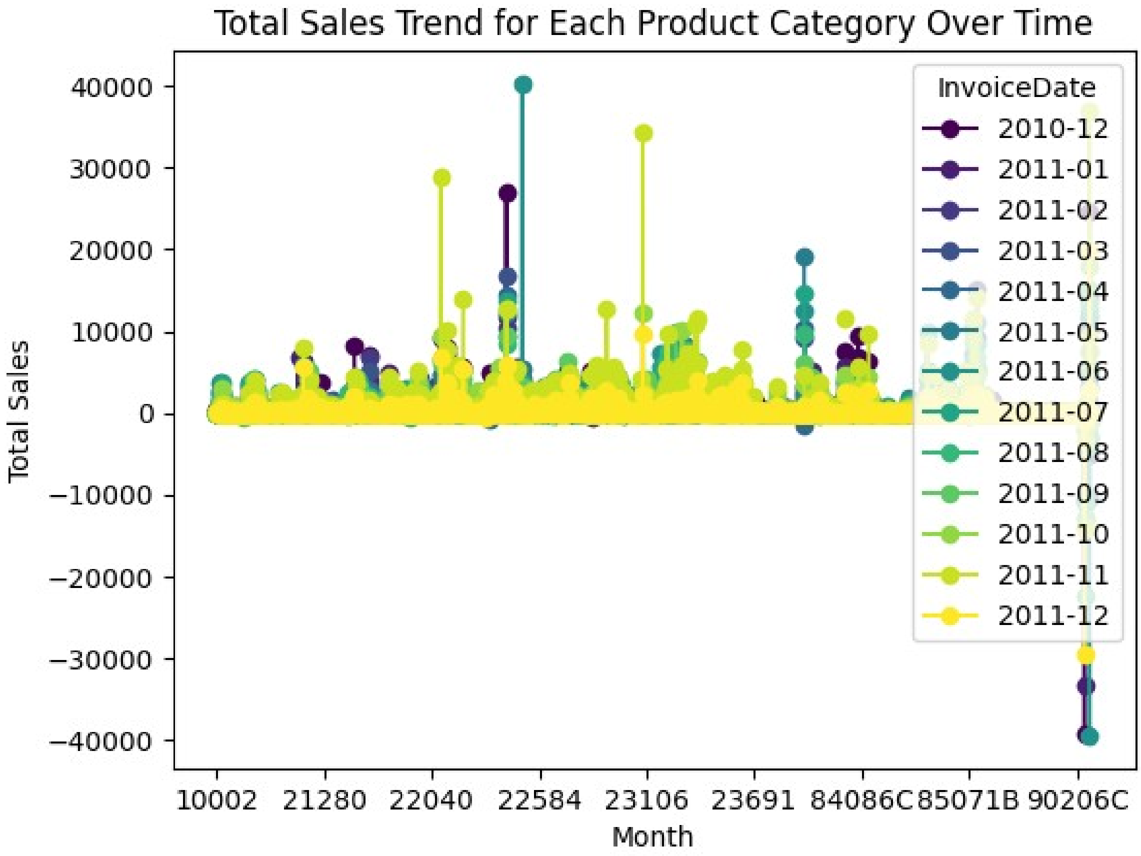


```
# Filtering the top 5 product categories with the highest sales volume
# This focuses the analysis on the most significant categories in
terms of quantity sold
top_categories_quantity = df.groupby('StockCode')
['Quantity'].sum().sort_values(ascending=False).head(5).index
df_top_categories_quantity =
df[df['StockCode'].isin(top_categories_quantity)]

# Visualizing the distribution of transaction quantities for the top 5
product categories
# A box plot shows the spread and central tendency of quantities for
each top category across transactions
plt.figure(figsize=(14, 8))
sns.boxplot(x='StockCode', y='Quantity',
data=df_top_categories_quantity, showfliers=False, palette='Set2')
plt.title('Distribution of Transaction Quantities for Top 5 Product
Categories')
plt.xlabel('Product Category (StockCode)')
plt.ylabel('Quantity')
plt.show()
```



```
# Calculating the total sales trend for each product category over
time
# This line plot helps in tracking how total sales for each category
evolve over different months
total_sales_by_category = df.groupby(['StockCode',
df['InvoiceDate'].dt.to_period("M")])['TotalCost'].sum().unstack()
plt.figure(figsize=(14, 8))
total_sales_by_category.plot(kind='line', marker='o',
colormap='viridis')
plt.title('Total Sales Trend for Each Product Category Over Time')
plt.xlabel('Month')
plt.ylabel('Total Sales')
plt.show()
```

```
<Figure size 1400x800 with 0 Axes>
```



```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call
last)
Cell In[53], line 3
      1 # ㅇㅛㅇㅣㄹㅂㅕㄹ ㄷㅏㄴ가 ㅂㅜㄴㅍㅗㄹㅡㄹ ㅅㅣㄱㅏㄱㅎㅘㅎㅏㅂㄴㅣㄷㅏ
      2 plt.figure(figsize=(12, 6))
----> 3 sns.boxplot(x='DayOfWeek', y='UnitPrice', data=df,
showfliers=False, palette='coolwarm')
      4 plt.title('Distribution of Unit Price Across Days of the
Week')
      5 plt.xlabel('Day of the Week')

File
/opt/conda/lib/python3.10/site-packages/seaborn/categorical.py:2231,
in boxplot(data, x, y, hue, order, hue_order, orient, color, palette,
saturation, width, dodge, fliersize, linewidth, whis, ax, **kwargs)
   2224 def boxplot(
   2225     data=None, *, x=None, y=None, hue=None, order=None,
hue_order=None,
   2226     orient=None, color=None, palette=None, saturation=.75,
width=.8,
   2227     dodge=True, fliersize=5, linewidth=None, whis=1.5,
ax=None,
   2228     **kwargs
   2229 ):
-> 2231     plotter = _BoxPlotter(x, y, hue, data, order, hue_order,
   2232                           orient, color, palette, saturation,
   2233                           width, dodge, fliersize, linewidth)
   2235     if ax is None:
   2236         ax = plt.gca()

File
/opt/conda/lib/python3.10/site-packages/seaborn/categorical.py:785, in
_BoxPlotter.__init__(self, x, y, hue, data, order, hue_order, orient,
color, palette, saturation, width, dodge, fliersize, linewidth)
    781 def __init__(self, x, y, hue, data, order, hue_order,
    782              orient, color, palette, saturation,
    783              width, dodge, fliersize, linewidth):
--> 785     self.establish_variables(x, y, hue, data, orient, order,
hue_order)
    786     self.establish_colors(color, palette, saturation)
    788     self.dodge = dodge

File
/opt/conda/lib/python3.10/site-packages/seaborn/categorical.py:541, in
_CategoricalPlotter.establish_variables(self, x, y, hue, data, orient,
order, hue_order, units)
    539     if isinstance(var, str):
    540         err = f"Could not interpret input '{var}'"
--> 541         raise ValueError(err)
    543 # Figure out the plotting orientation
    544 orient = infer_orient(
    545     x, y, orient, require_numeric=self.require_numeric
    546 )

ValueError: Could not interpret input 'DayOfWeek'

<Figure size 1200x600 with 0 Axes>
```