In [1]:

```python
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns

import warnings
warnings.filterwarnings('ignore')
```

In [2]:

```python
#Importing of Data
df = pd.read_csv('retail_sales_dataset_with_marketing.csv')

#First 5 rows
df.head(5)
```

Out [2]:

	Transaction ID	Date	Customer ID	Gender	Age	Product Category	Quantity	Price per Unit	Total Amount	Marketing Spend
0	1	2023-11-24	cust001	male	34	beauty	3	50	150	30.0
1	2	2023-02-27	cust002	female	26	clothing	2	500	1000	110.0
2	3	2023-01-13	cust003	male	50	electronics	1	30	30	8.0
3	4	2023-05-21	cust004	male	37	clothing	1	500	500	55.0
4	5	2023-05-06	cust005	male	30	beauty	2	50	100	20.0

In [3]:

```python
#For statistical Analysis
df.describe()
```

Out [3]:

	Transaction ID	Age	Quantity	Price per Unit	Total Amount	Marketing Spend
count	1000.000000	1000.00000	1000.000000	1000.000000	1000.000000	1000.000000
mean	500.500000	41.39200	2.514000	179.890000	456.000000	58.170000

	Transaction ID	Age	Quantity	Price per Unit	Total Amount	Marketing Spend
std	288.819436	13.68143	1.132734	189.681356	559.997632	58.353266
min	1.000000	18.00000	1.000000	25.000000	25.000000	7.500000
25%	250.750000	29.00000	1.000000	30.000000	60.000000	16.000000
50%	500.500000	42.00000	3.000000	50.000000	135.000000	32.000000
75%	750.250000	53.00000	4.000000	300.000000	900.000000	105.000000
max	1000.000000	64.00000	4.000000	500.000000	2000.000000	220.000000

In [4]:
```
#Size of dataset
df.shape
```

Out [4]:
```
(1000, 10)
```

In [5]:
```
#Column headers
df.columns
```

Out [5]:
```
Index(['Transaction ID', 'Date', 'Customer ID', 'Gender', 'Age',
       'Product Category', 'Quantity', 'Price per Unit', 'Total Amount',
       'Marketing Spend'],
      dtype='object')
```

In [6]:
```
#Checking Any Null Values
df.isnull().sum()
```

Out [6]:
```
Transaction ID      0
Date                0
Customer ID         0
Gender              0
Age                 0
Product Category    0
Quantity            0
Price per Unit      0
Total Amount        0
Marketing Spend     0
dtype: int64
```

In [7]:
```
#Checking Any Duplicate Values
df.duplicated().sum()
```

Out [7]:
```
0
```

In [8]:
```
#Checking Data Types
df.dtypes
```

Out [8]:
```
Transaction ID       int64
Date                object
Customer ID         object
Gender              object
Age                  int64
Product Category    object
Quantity             int64
Price per Unit       int64
Total Amount         int64
Marketing Spend    float64
dtype: object
```

In [9]:
```
#Correcting date data type from object to datetime
df['Date'] = pd.to_datetime(df['Date'],format='%Y-%m-%d')
```

In [10]:
```
df.dtypes
```

Out [10]:
```
Transaction ID               int64
Date                datetime64[ns]
Customer ID                 object
Gender                      object
Age                          int64
Product Category            object
Quantity                     int64
Price per Unit               int64
Total Amount                 int64
Marketing Spend            float64
dtype: object
```

In [11]:
```
# Ensure consistency in categorical columns
df['Customer ID'] = df['Customer ID'].str.strip().str.lower()
df['Gender'] = df['Gender'].str.strip().str.lower()
df['Product Category'] = df['Product Category'].str.strip().str.lower()
```

In [12]:
```
#Distinct Counts
cols = ['Gender','Product Category','Quantity']

for col in cols:
    print(f'Value counts for "{col}":')
    print(df[col].value_counts())
```

```
Value counts for "Gender":
Gender
female    510
male      490
Name: count, dtype: int64
Value counts for "Product Category":
Product Category
clothing       351
electronics    342
beauty         307
Name: count, dtype: int64
Value counts for "Quantity":
Quantity
4    263
1    253
2    243
3    241
Name: count, dtype: int64
```

In [13]:

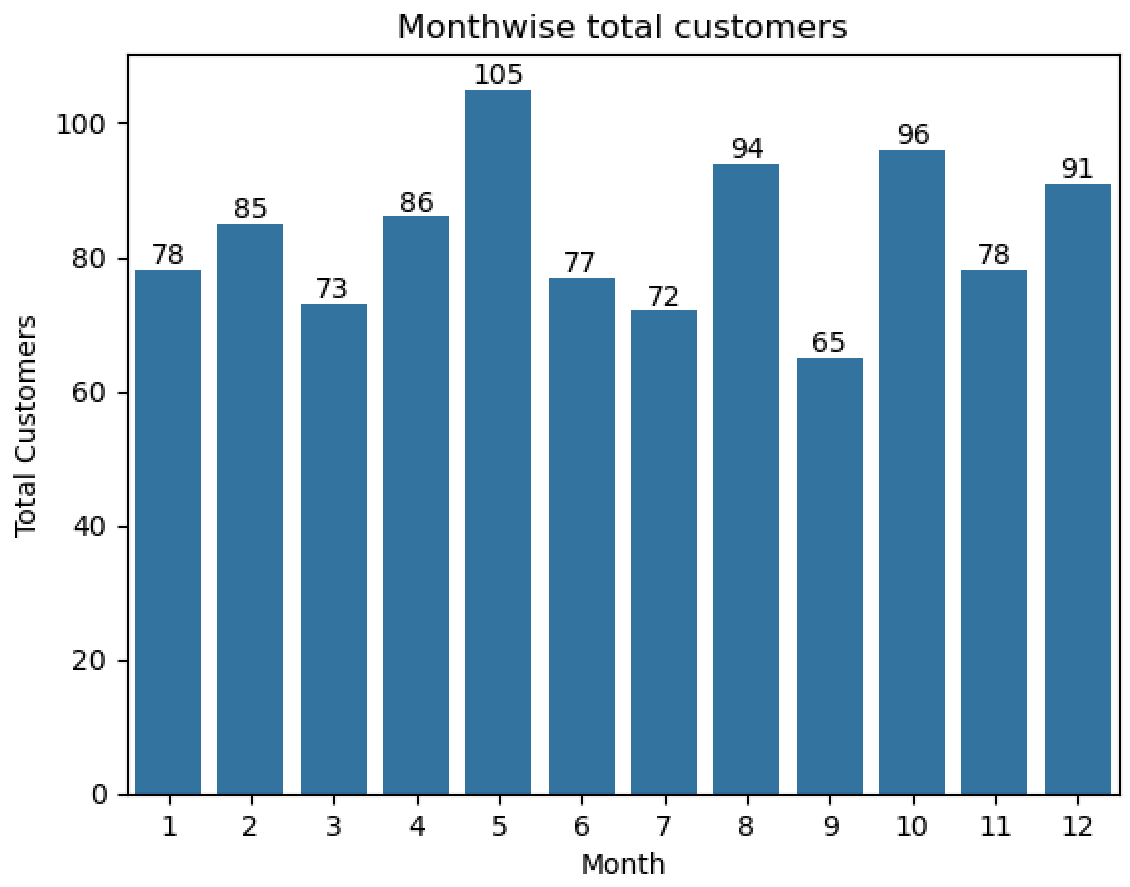
```
#Monthwise total customers
month = df.groupby(df['Date'].dt.month)['Customer ID'].size().reset_index(name='Total Customers').sort_va
month.head(5)
```

Out [13]:

	Date	Total Customers
4	5	105
9	10	96
7	8	94
11	12	91
3	4	86

In [14]:

```
ax = sns.barplot(x='Date',y='Total Customers',data=month,)
for bars in ax.containers:
    ax.bar_label(bars)
plt.title('Monthwise total customers')
plt.xlabel('Month')
plt.ylabel('Total Customers')
plt.show()
```



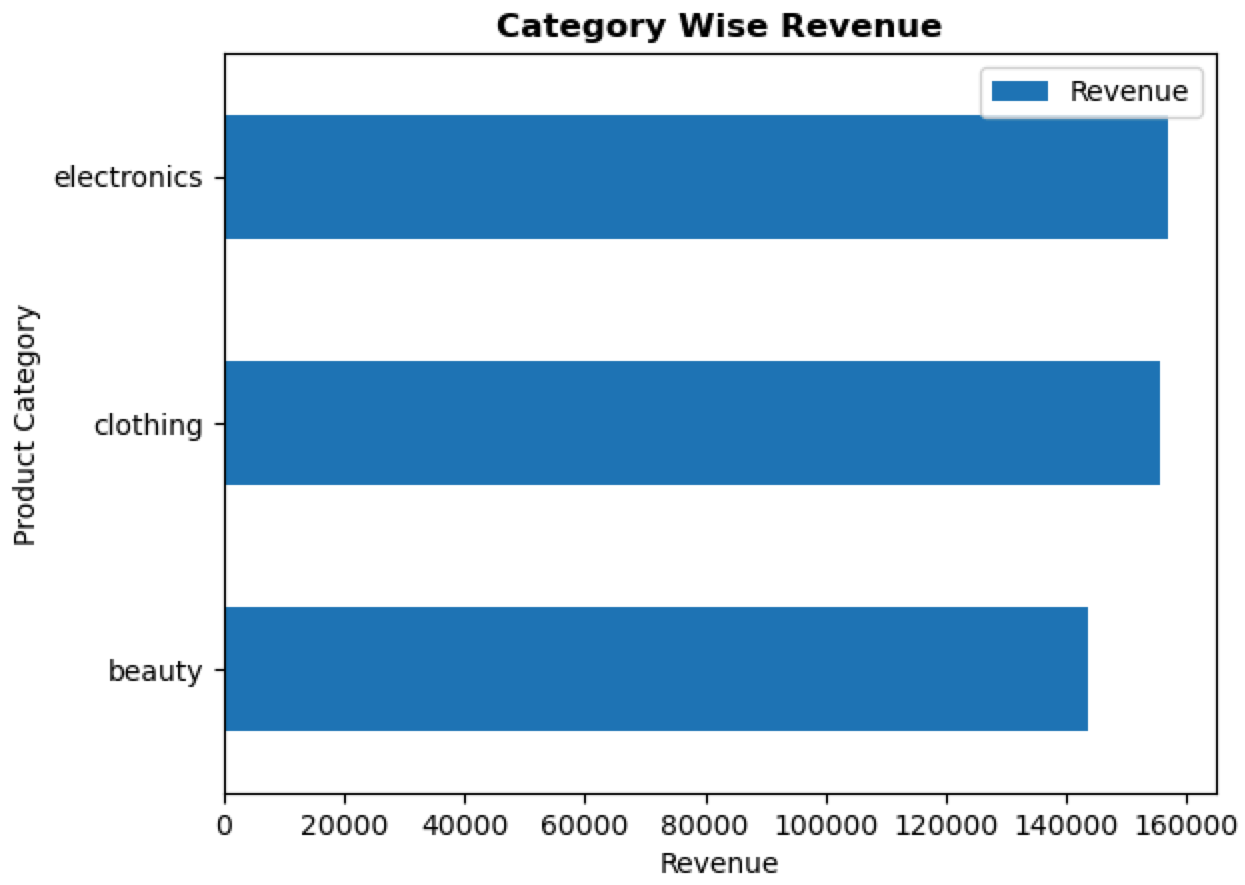
In [15]:
```
#Find the total revenue for each product Category.

product_Revenue = df.groupby('Product Category')['Total Amount'].sum().reset_index(name='Revenue')
product_Revenue
```

Out [15]:

	Product Category	Revenue
0	beauty	143515
1	clothing	155580
2	electronics	156905

In [16]:
```
product_Revenue.plot(kind= 'barh',y ='Revenue',x='Product Category')
plt.title('Category Wise Revenue',fontweight='bold')
plt.xlabel('Revenue')
plt.ylabel('Product Category')
```

```
Out [16]: Text(0, 0.5, 'Product Category')
```



```
In [17]: pd.pivot_table(df,values='Total Amount',index='Product Category',columns='Gender',aggfunc='mean')
```

Out [17]:

Gender	female	male
Product Category		
beauty	450.783133	487.127660
clothing	467.097701	419.802260
electronics	451.382353	466.104651

```
In [18]: #Weekly Quantity sold

         weekly_qty_sold = df.groupby(['Product Category',pd.Grouper(key='Date',freq='W')])['Quantity'].sum().rese
         weekly_qty = weekly_qty_sold.sort_values(by='Weekly Qty Sold',ascending=False)
         weekly_qty.head()
```

Out [18]:

	Product Category	Date	Weekly Qty Sold
110	electronics	2023-02-05	35
74	clothing	2023-05-28	35
125	electronics	2023-05-21	33
154	electronics	2023-12-10	33
65	clothing	2023-03-26	33

In [19]:

```
#Compute average weekly units sold for Product A and Product B

beauty = weekly_qty[weekly_qty['Product Category'] == 'beauty']['Weekly Qty Sold'].mean()
print(f'The beauty Avg weekly sold are',beauty)

electronics = weekly_qty[weekly_qty['Product Category'] == 'electronics']['Weekly Qty Sold'].mean()
print(f'The electronicss Avg weekly sold are',electronics)
```

```
The beauty Avg weekly sold are 14.547169811320755
The electronicss Avg weekly sold are 16.0188679245283
```

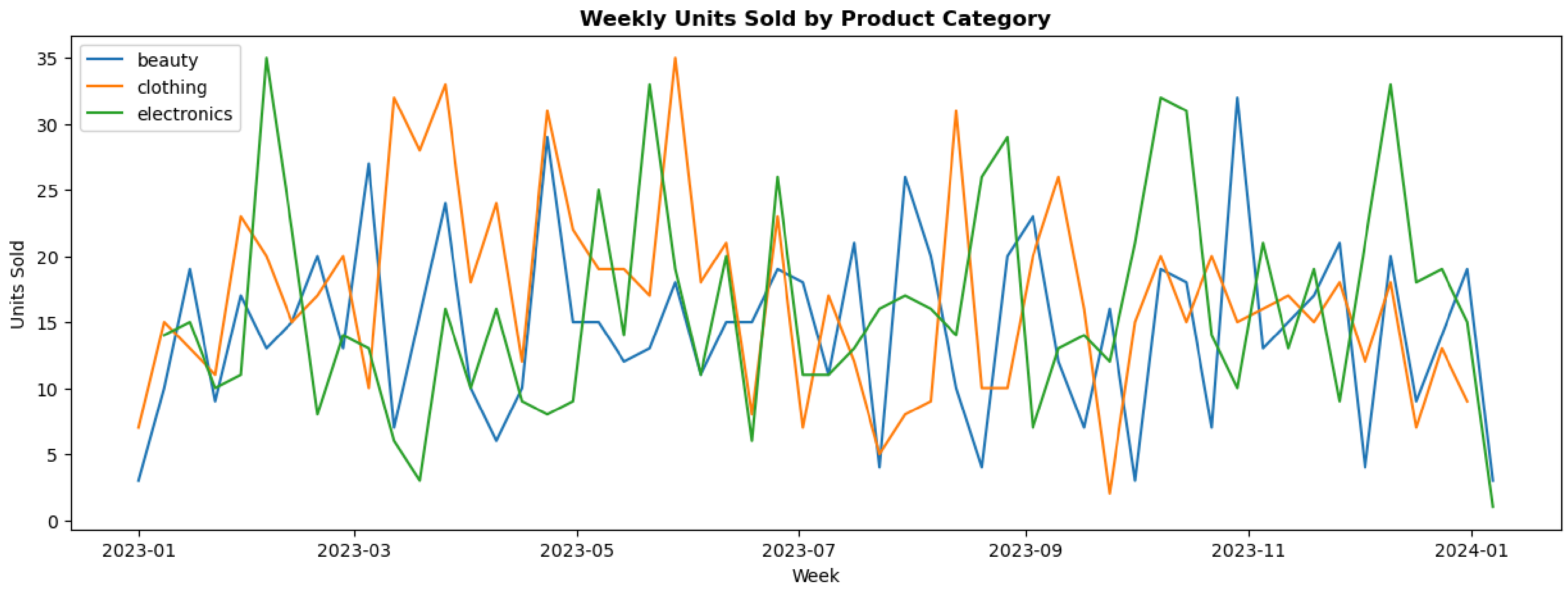
In [20]:

```
#Identify which week had the highest sales overall.

weekly_revenue = df.groupby(pd.Grouper(key='Date',freq='W'))['Total Amount'].sum()
max_week = weekly_revenue.idxmax()
max_revenue = weekly_revenue.max()
print(f'The Revenue max is in week',max_week,'& max revenue is',max_revenue)
```

```
The Revenue max is in week 2023-05-21 00:00:00 & max revenue is 17515
```

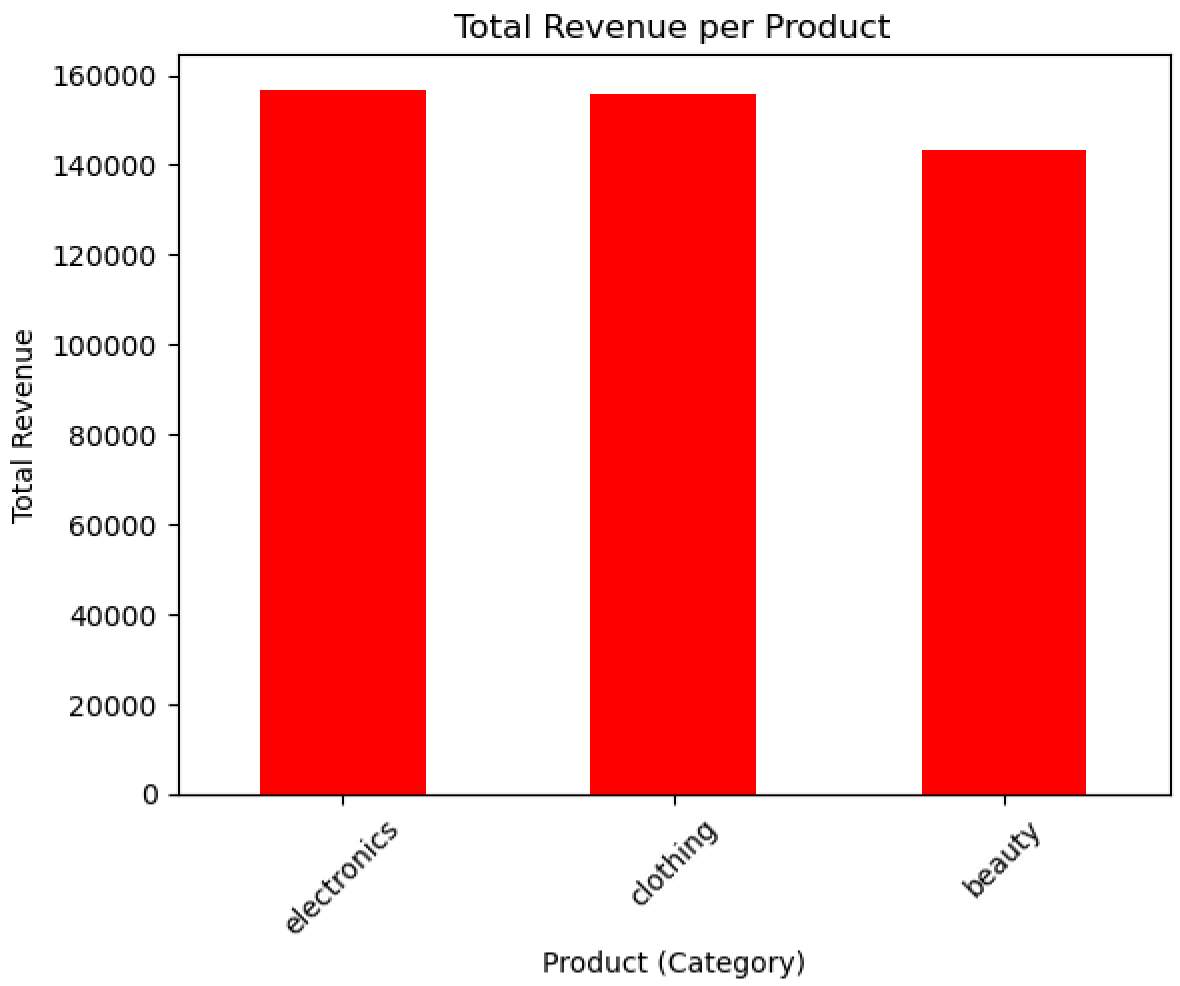
In [21]:

```
#Line chart of weekly units sold for each product.

product_category = ['beauty', 'clothing', 'electronics']

plt.figure(figsize=(15,5))
for cat in product_category:
    data = weekly_qty_sold[weekly_qty_sold['Product Category'] == cat]
    plt.plot(data['Date'], data['Weekly Qty Sold'], label=cat)
plt.xlabel('Week')
plt.ylabel('Units Sold')
plt.title('Weekly Units Sold by Product Category',fontweight='bold')
plt.legend()
plt.show()
```



In [22]:

```
#Bar chart showing total revenue per product.

product_revenue = df.groupby('Product Category')['Total Amount'].sum().sort_values(ascending=False)
product_revenue.plot(kind='bar',color='red')
plt.title('Total Revenue per Product')
plt.xlabel('Product (Category)')
plt.ylabel('Total Revenue')
plt.xticks(rotation=45)
plt.show()
```



In [23]:
```
#Checking any of sample rows
df.sample(5)
```

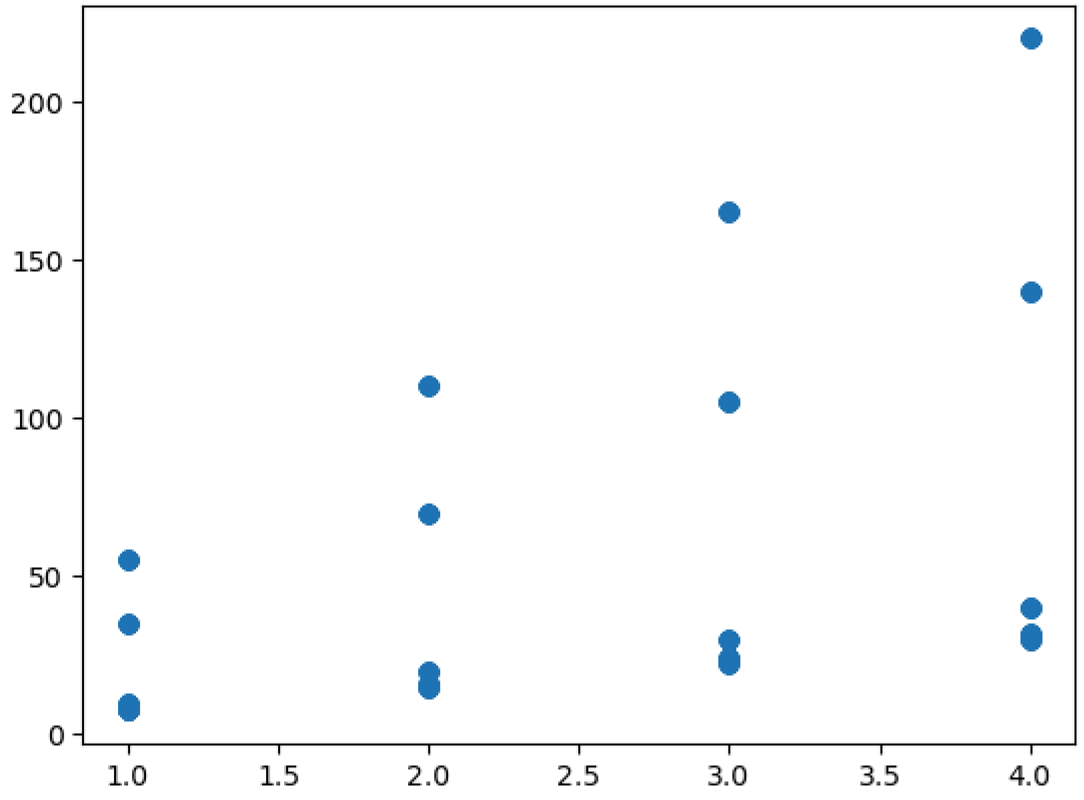
Out [23]:

	Transaction ID	Date	Customer ID	Gender	Age	Product Category	Quantity	Price per Unit	Total Amount	Marketing Spend
453	454	2023-02-22	cust454	female	46	beauty	1	25	25	7.5
9	10	2023-10-07	cust010	female	52	clothing	4	50	200	40.0
55	56	2023-05-31	cust056	female	26	clothing	3	300	900	105.0
327	328	2023-03-22	cust328	male	39	beauty	2	50	100	20.0

	Transaction ID	Date	Customer ID	Gender	Age	Product Category	Quantity	Price per Unit	Total Amount	Marketing Spend
10	11	2023-02-14	cust011	male	23	clothing	2	50	100	20.0

In [24]:
```
# Scatter plot: Marketing Spend vs Units Sold.

plt.scatter(df['Quantity'],df['Marketing Spend'])
```

Out [24]:
```
<matplotlib.collections.PathCollection at 0x2b3ec149bb0>
```



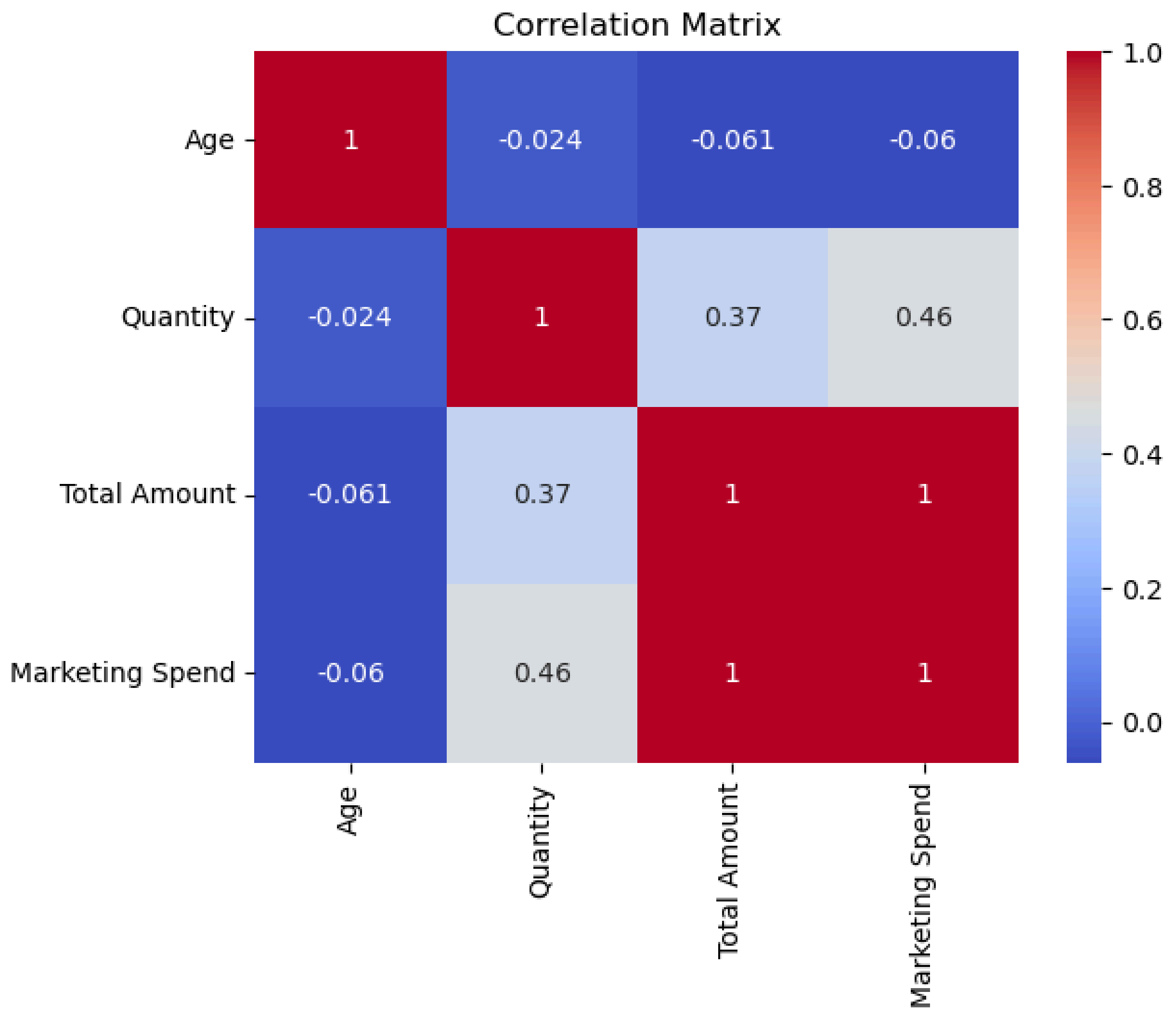
In [25]:
```
#Does higher marketing spend correlate with more units sold?

df[['Quantity','Marketing Spend']].corr()
```

Out [25]:

	Quantity	Marketing Spend
Quantity	1.000000	0.455693

	Quantity	Marketing Spend
Marketing Spend	0.455693	1.000000

In [26]:
```
#Heatmap for Correlations checking

corr_matrix = df[['Age', 'Quantity', 'Total Amount', 'Marketing Spend']].corr()
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm')
plt.title('Correlation Matrix')
plt.show()
```



In [27]:
```python
# Which product shows greater growth over the four weeks?

#Calculate Weekly Units Sold ---
weekly_sales = df.groupby(
    ['Product Category', pd.Grouper(key='Date', freq='W')]
)['Quantity'].sum().reset_index(name='Weekly Units Sold')

# Assign Week Number
weekly_sales['Week_Number'] = weekly_sales['Date'].dt.isocalendar().week.astype(int)

print(weekly_sales['Week_Number'])

print(pd.Series(weekly_sales['Week_Number'].unique()).sort_values(ascending=False).head(4))

print(pd.Series(weekly_sales['Week_Number'].unique()).sort_values(ascending=True).head(4))
```

```
0      52
1       1
2       2
3       3
4       4
       ..
154    49
155    50
156    51
157    52
158     1
Name: Week_Number, Length: 159, dtype: int32
0     52
50    51
49    50
48    49
dtype: int32
1    1
2    2
3    3
4    4
dtype: int32
```

In [28]:
```python
# Calculate Average Sales for Start (Wk 1-4) and End (Wk 49-52) ---
WEEKS_START = [1, 2, 3, 4]
WEEKS_END = [49, 50, 51, 52]

# Average for First 4 Weeks
soy_sales = weekly_sales[weekly_sales['Week_Number'].isin(WEEKS_START)]
```

```
avg_soy_sales = soy_sales.groupby('Product Category')['Weekly Units Sold'].mean().rename('Avg_Wk1_4')

# Average for Last 4 Weeks
eoy_sales = weekly_sales[weekly_sales['Week_Number'].isin(WEEKS_END)]
avg_eoy_sales = eoy_sales.groupby('Product Category')['Weekly Units Sold'].mean().rename('Avg_Wk49_52')

print(f'Average of week1-4',avg_soy_sales)

print(f'Average of week49-52',avg_eoy_sales)
```

```
Average of week1-4 Product Category
beauty         11.6
clothing       15.5
electronics    10.2
Name: Avg_Wk1_4, dtype: float64
Average of week49-52 Product Category
beauty         13.00
clothing       10.80
electronics    21.25
Name: Avg_Wk49_52, dtype: float64
```

In [29]:

```
#Calculate Growth ---
growth_df = pd.merge(avg_soy_sales, avg_eoy_sales, on='Product Category').reset_index()
growth_df['Growth_Wk49-52_minus_Wk1-4'] = growth_df['Avg_Wk49_52'] - growth_df['Avg_Wk1_4']

# Find Greatest Growth ---
max_growth_value = growth_df['Growth_Wk49-52_minus_Wk1-4'].max()
tied_products = growth_df[growth_df['Growth_Wk49-52_minus_Wk1-4'] == max_growth_value]['Product Category'

print(growth_df['Growth_Wk49-52_minus_Wk1-4'])

print(f"Tied for greatest growth ({max_growth_value:.2f} units/week): {', '.join([p.capitalize() for p in
```

```
0     1.40
1    -4.70
2    11.05
Name: Growth_Wk49-52_minus_Wk1-4, dtype: float64
Tied for greatest growth (11.05 units/week): Electronics
```

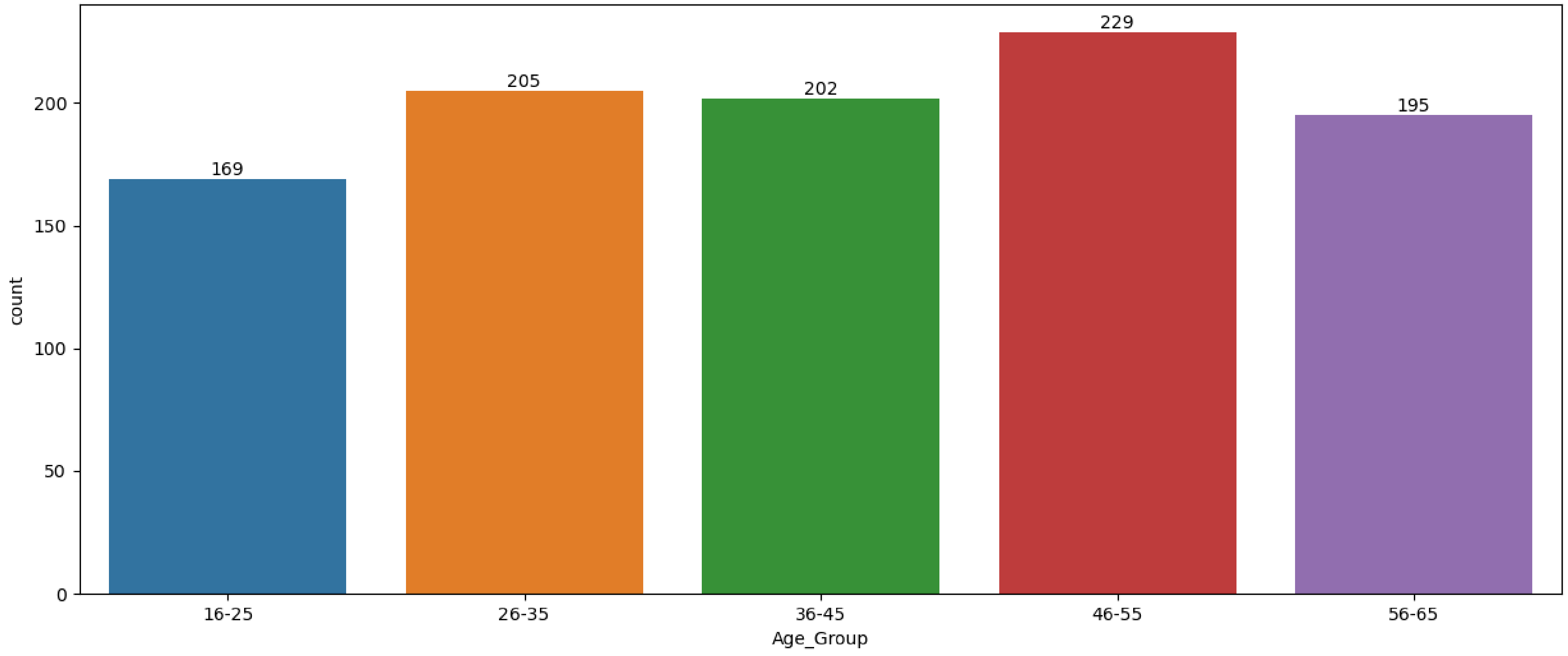
In [30]:

```
#Age distrubution
```

```
df_age = df['Age'].value_counts().sort_values(ascending=False)
df_age.head()
```

Out [30]:
```
Age
43    31
64    31
57    30
51    30
34    28
Name: count, dtype: int64
```

In [31]:
```
# Create age groups
bins = [16, 26, 36, 46, 56,65]  # Define age range boundaries
labels = ['16-25', '26-35', '36-45', '46-55','56-65']  # Labels for age groups
df['Age_Group'] = pd.cut(df['Age'], bins=bins, labels=labels, right=False)

# Create bar plot with age groups
plt.figure(figsize=(15, 6))
ax = sns.countplot(x='Age_Group', data=df,palette=sns.color_palette("tab10"))
for bars in ax.containers:
    ax.bar_label(bars)
plt.show()
```



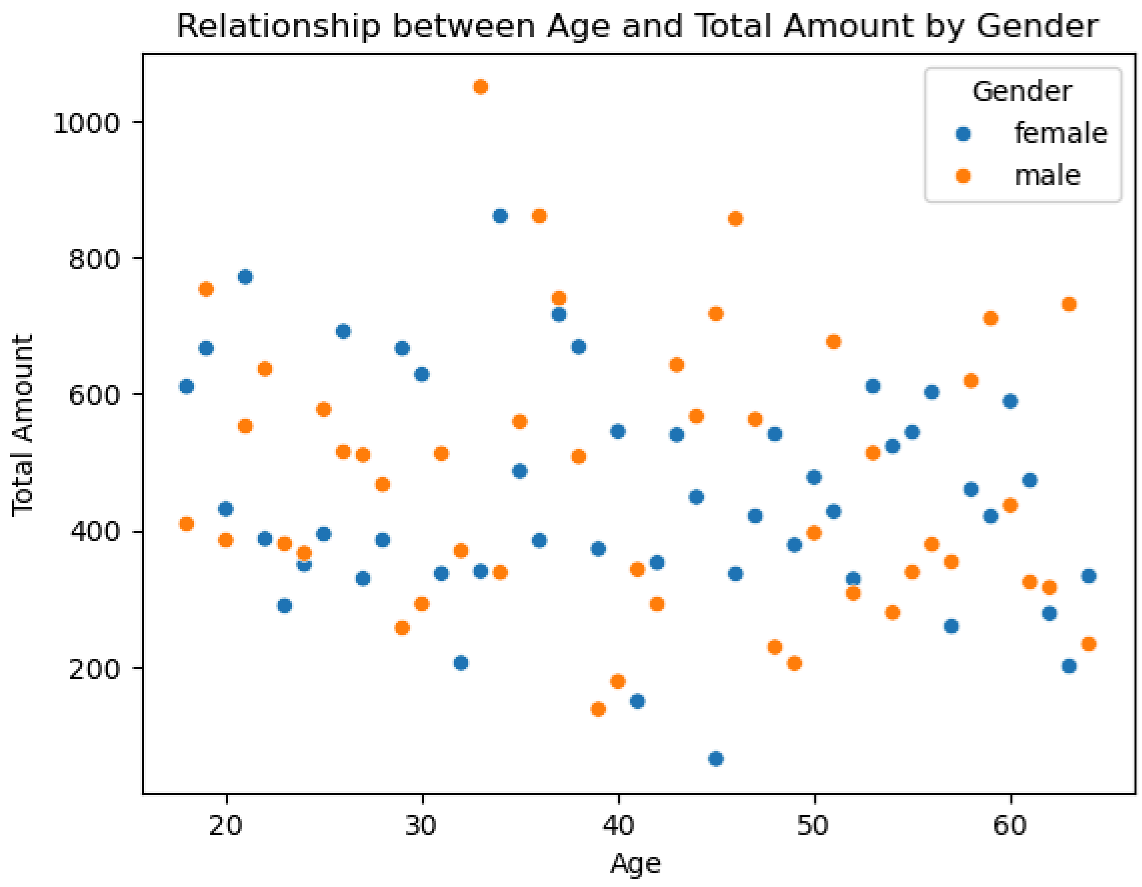
In [32]:
```
#Relationship between Age and Total Amount by Gender

df_age_to = df.groupby(['Age', 'Gender'])['Total Amount'].mean().reset_index()
df_age_to.sample(5)
```

Out [32]:

	Age	Gender	Total Amount
80	58	female	460.000000
69	52	male	307.777778
75	55	male	338.750000
61	48	male	228.750000
37	36	male	860.714286

In [33]:
```
sns.scatterplot(x='Age', y='Total Amount', hue='Gender', data=df_age_to)
plt.xlabel('Age')
plt.ylabel('Total Amount')
plt.title('Relationship between Age and Total Amount by Gender')
```

```
Out [33]: Text(0.5, 1.0, 'Relationship between Age and Total Amount by Gender')
```



```
In [34]: Q1 = df['Age'].quantile(.25)
         Q3 = df['Age'].quantile(.75)
         IQR = Q3 - Q1
         up = Q3 + 1.5 * (IQR)
         lw = Q1 - 1.5 * (IQR)
```

```
In [35]: print(IQR)
         print(f'the Upper Bound is {up} ')
         print(f'the lower Bound is {lw} ')
```

```
24.0
the Upper Bound is 89.0
the lower Bound is -7.0
```

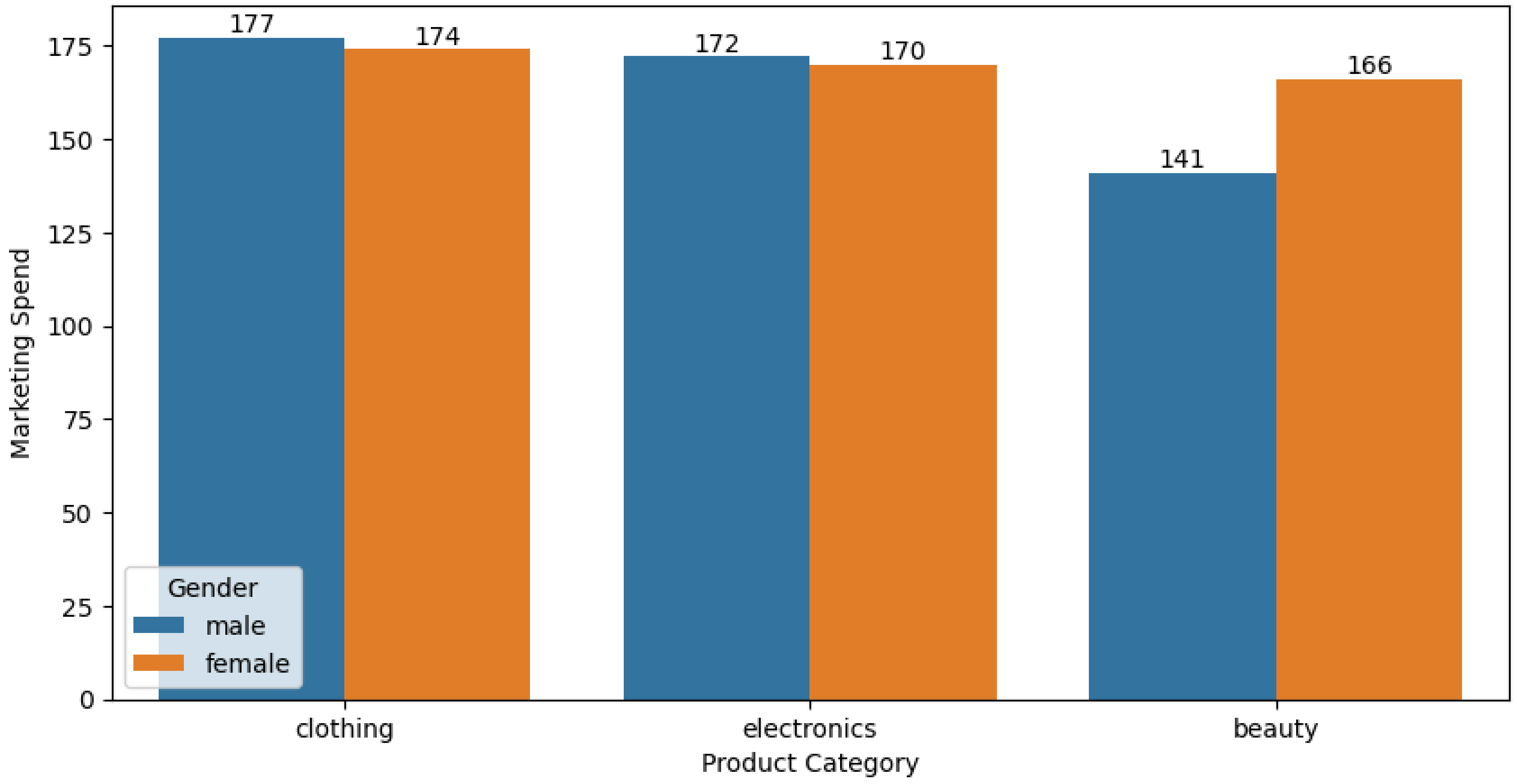
Product

In [37]:
```
#Marketing spend whether depend on product category and gender
df_top_Cat = df.groupby(['Product Category','Gender'],as_index=False)['Marketing Spend'].count().sort_valu
df_top_Cat
```

Out [37]:

	Product Category	Gender	Marketing Spend
3	clothing	male	177
2	clothing	female	174
5	electronics	male	172
4	electronics	female	170
0	beauty	female	166
1	beauty	male	141

In [38]:
```
plt.figure(figsize=(10,5))
ax = sns.barplot(x='Product Category',y='Marketing Spend',hue='Gender',data=df_top_Cat)
for bars in ax.containers:
    ax.bar_label(bars)
plt.show()
```



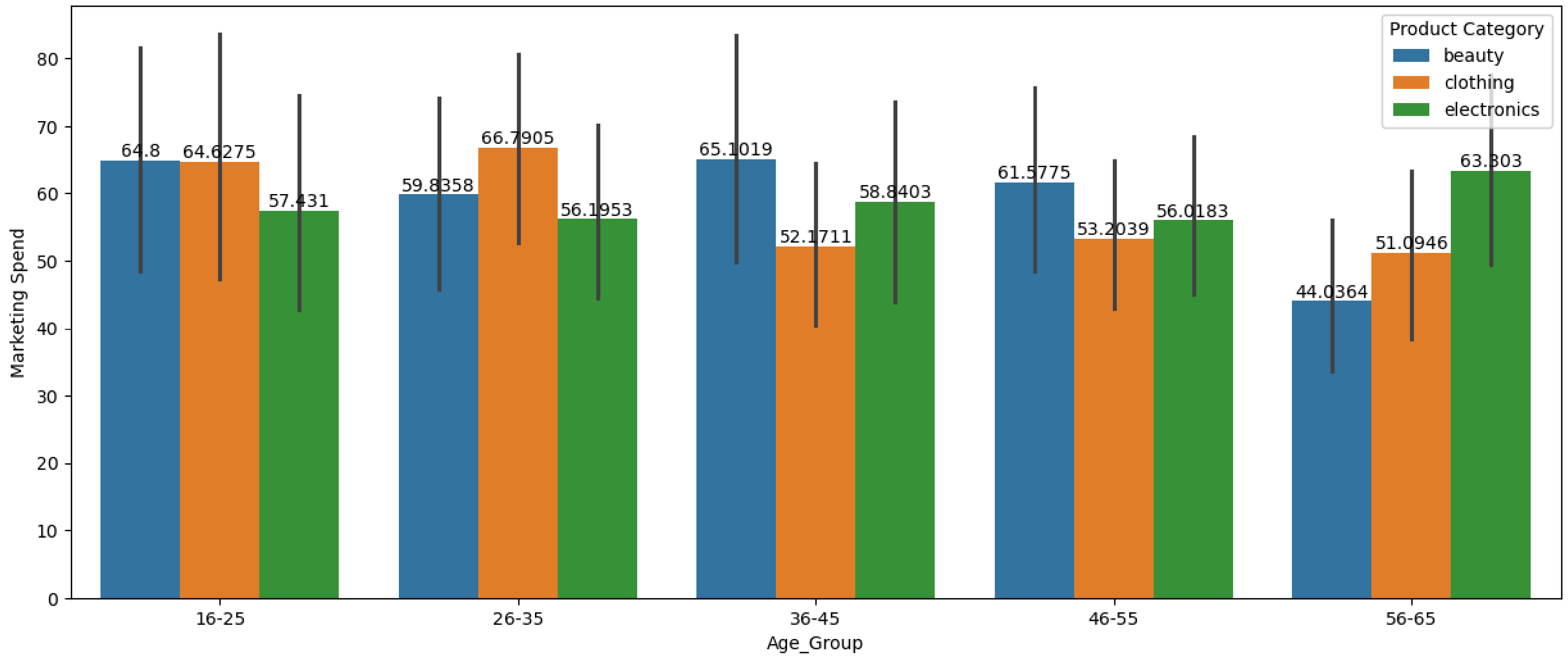
In [39]:
```python
df_top_Cat = df.groupby(['Product Category','Age'],as_index=False)['Marketing Spend'].count().sort_values
df_top_Cat.head(5)
```

Out [39]:

	Product Category	Age	Marketing Spend
127	electronics	51	14
107	electronics	31	13
93	clothing	64	13
72	clothing	43	13
28	beauty	46	13

In [40]:
```python
# Create age groups
bins = [16, 26, 36, 46, 56,65]  # Define age range boundaries
labels = ['16-25', '26-35', '36-45', '46-55','56-65']  # Labels for age groups
df['Age_Group'] = pd.cut(df['Age'], bins=bins, labels=labels, right=False)
```

```
# Create bar plot with age groups
plt.figure(figsize=(15, 6))
ax = sns.barplot(x='Age_Group',y='Marketing Spend',hue='Product Category', data=df)
for bars in ax.containers:
    ax.bar_label(bars)
plt.show()
```

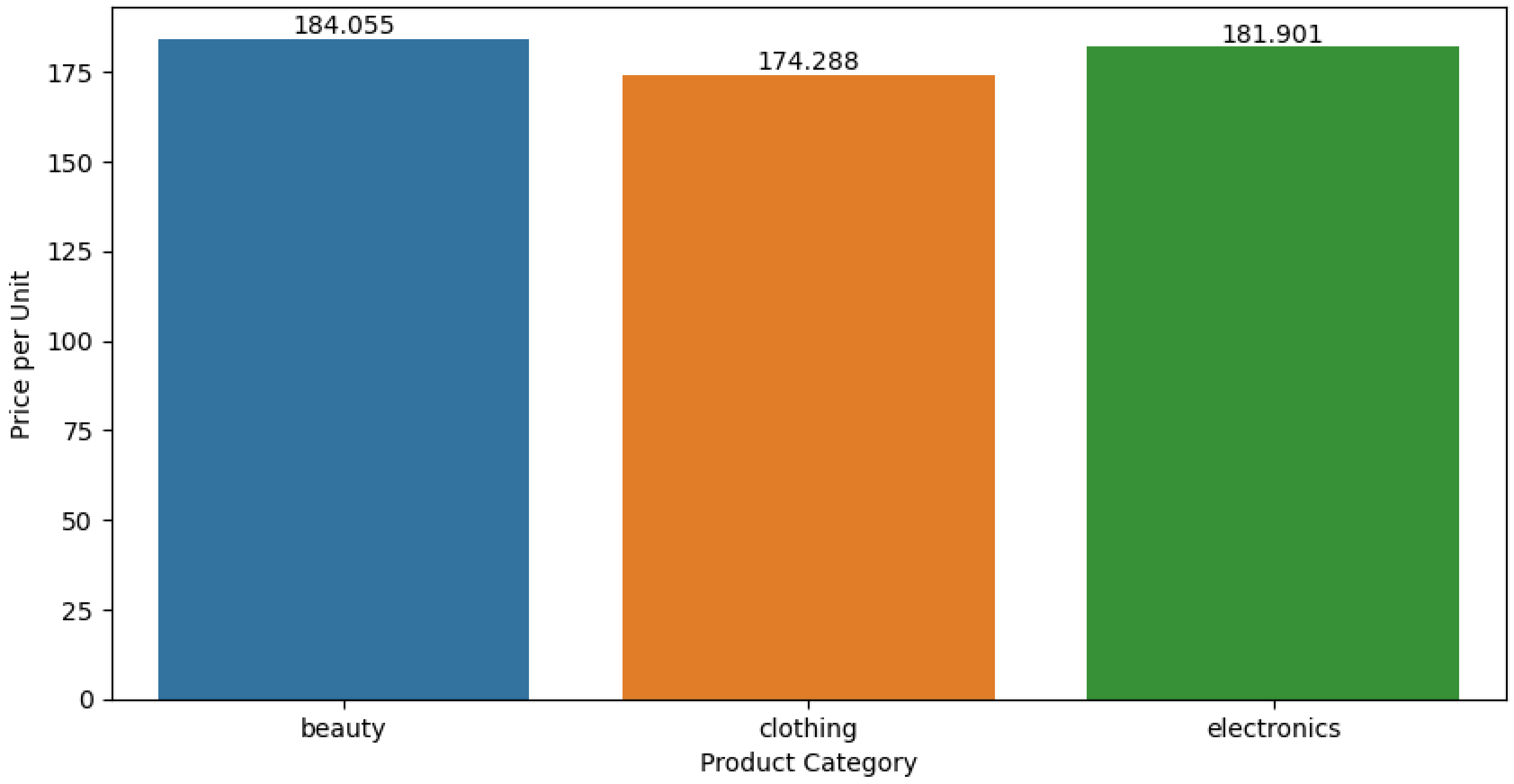


In [41]:
```
#Product wise unit price
df_pri = df.groupby(['Product Category'],as_index=False)['Price per Unit'].mean()
df_pri
```

Out [41]:

	Product Category	Price per Unit
0	beauty	184.055375
1	clothing	174.287749
2	electronics	181.900585

In [42]:
```
plt.figure(figsize=(10,5))
ax = sns.barplot(x='Product Category',y='Price per Unit',data=df_pri,palette=sns.color_palette("tab10"))
for bars in ax.containers:
    ax.bar_label(bars)
plt.show()
```



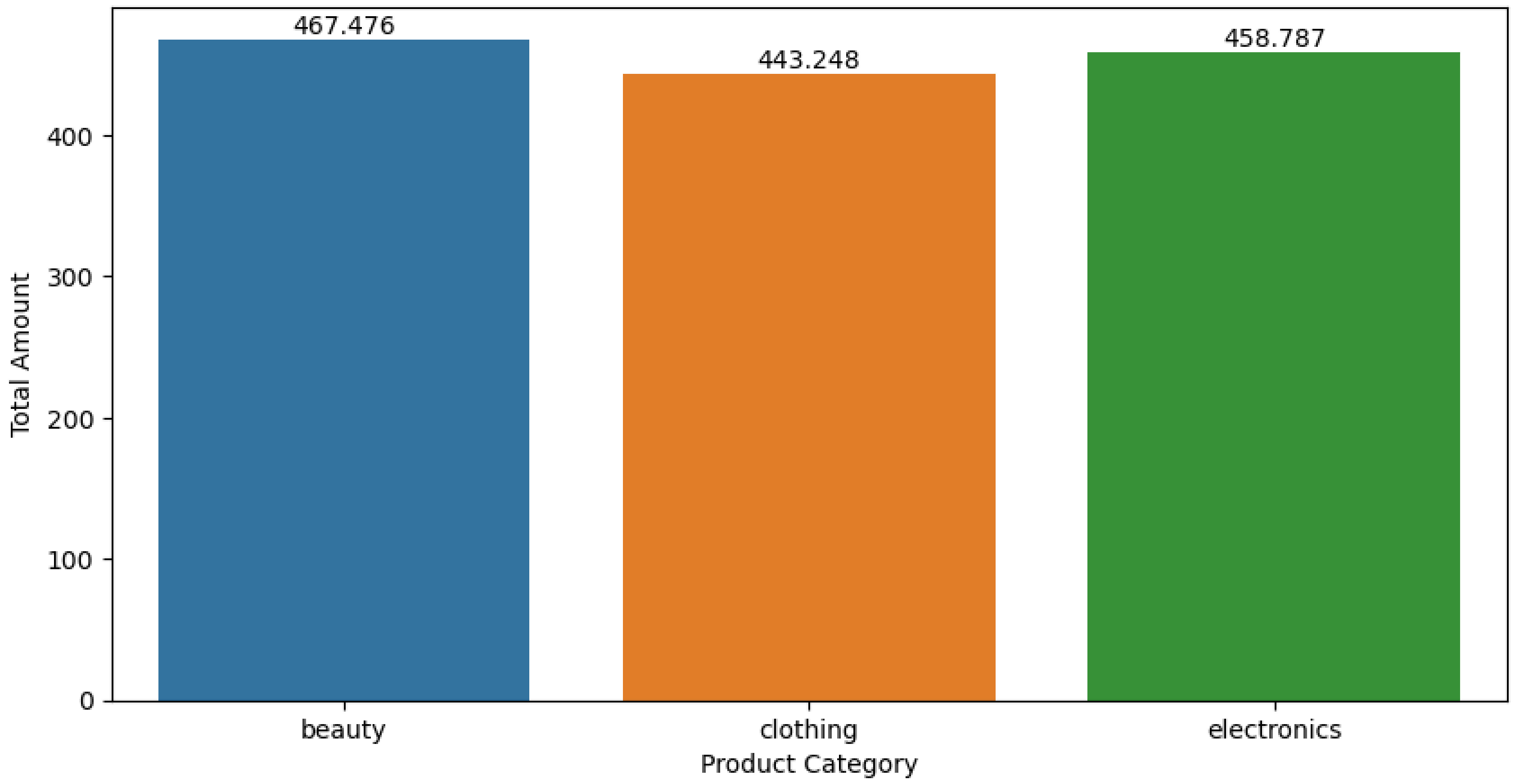
In [43]:
```
#Product category wise total amount
df_tot = df.groupby(['Product Category'],as_index=False)['Total Amount'].mean()
df_tot
```

Out [43]:

	Product Category	Total Amount
0	beauty	467.475570
1	clothing	443.247863

	Product Category	Total Amount
2	electronics	458.786550

In [44]:
```
plt.figure(figsize=(10,5))
ax = sns.barplot(x='Product Category',y='Total Amount',data=df_tot,palette=sns.color_palette("tab10"))
for bars in ax.containers:
    ax.bar_label(bars)
plt.show()
```



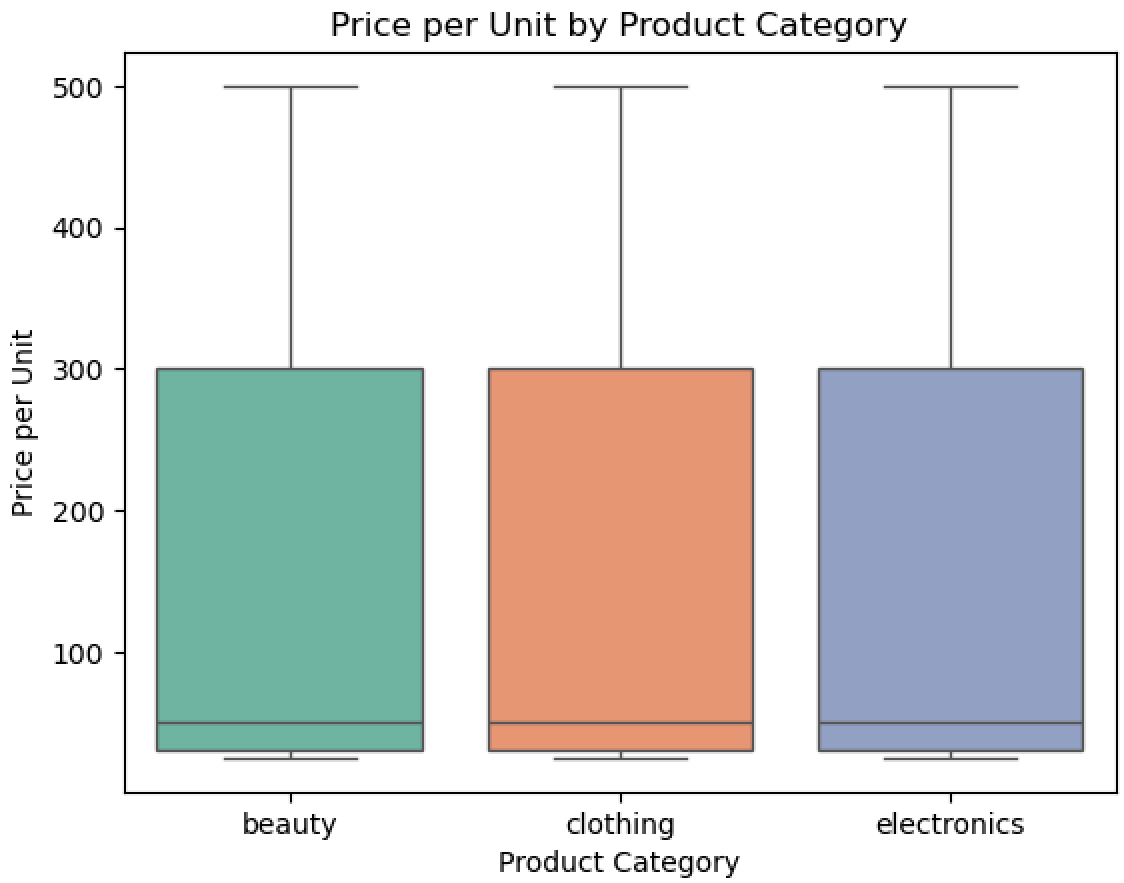
In [45]:
```
#Marketing Efficiency

df['Spend_to_Sales_Ratio'] = df['Marketing Spend'] / df['Total Amount']
ratio_by_category = df.groupby('Product Category')['Spend_to_Sales_Ratio'].mean()
print(ratio_by_category)
```

```
Product Category
beauty         0.198360
clothing       0.200209
electronics    0.197963
Name: Spend_to_Sales_Ratio, dtype: float64
```

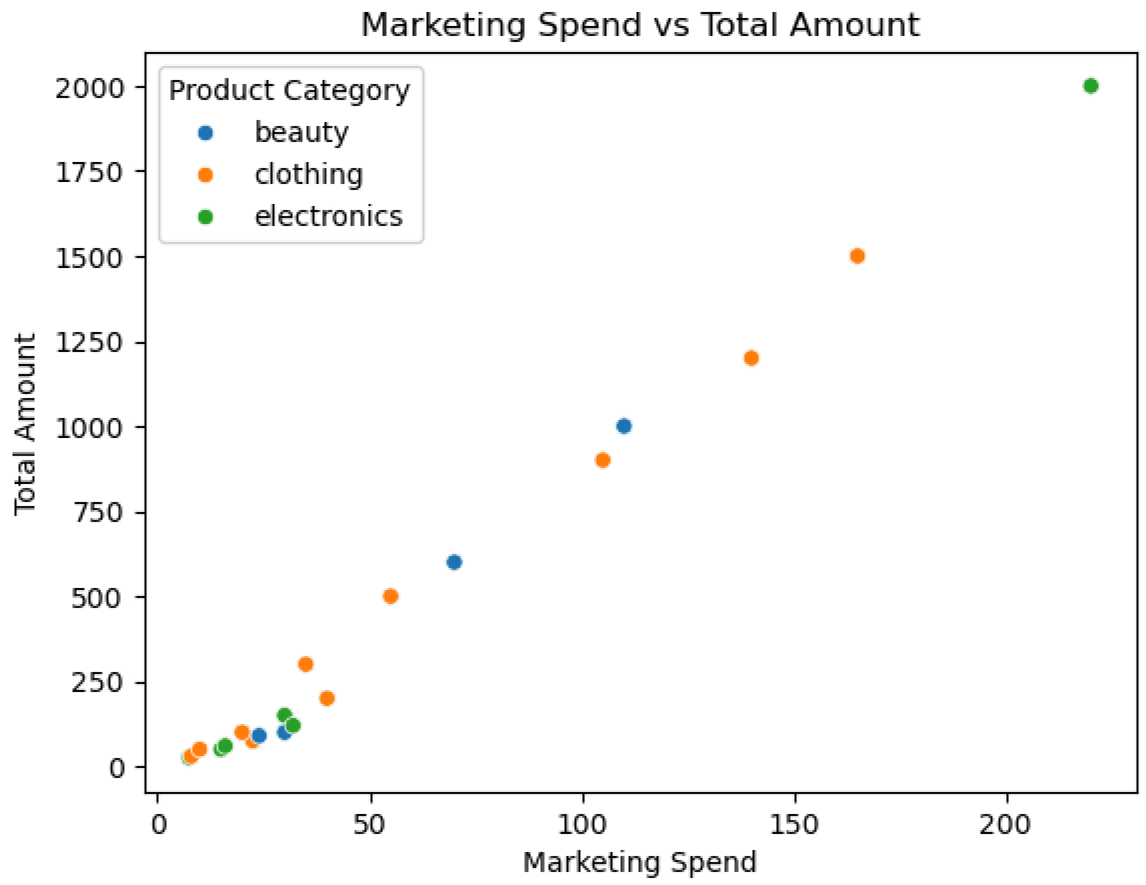
In [46]:
```
#Top Customers

top_customers = df.groupby('Customer ID').agg({
    'Total Amount': 'sum',
    'Age': 'mean',
    'Product Category': lambda x: x.mode()[0]
}).nlargest(5, 'Total Amount')
print(top_customers)
```

```
             Total Amount   Age Product Category
Customer ID
cust015              2000  42.0      electronics
cust065              2000  51.0      electronics
cust072              2000  20.0      electronics
cust074              2000  18.0           beauty
cust089              2000  55.0      electronics
```

In [47]:
```

sns.boxplot(x='Product Category', y='Price per Unit', data=df, palette='Set2')
plt.title('Price per Unit by Product Category')
plt.show()
```



In [48]:
```
sns.scatterplot(x='Marketing Spend', y='Total Amount', hue='Product Category', data=df)
plt.title('Marketing Spend vs Total Amount')
plt.show()
```


Marketing Spend vs Total Amount
Product Category
beauty
clothing
electronics
Total Amount
Marketing Spend
0
250
500
750
1000
1250
1500
1750
2000
0
50
100
150
200