Importing Libraries

In [1]:

```
# Suppress unnecessary warnings for cleaner output
import warnings
warnings.filterwarnings("ignore")

## Data Manipulation
import numpy as np
import pandas as pd

# Data Visualization
import matplotlib.pyplot as plt
from matplotlib.ticker import FuncFormatter
import seaborn as sns


# Display Utilities
from IPython.display import display
from tabulate import tabulate
```

Loading the DataSet

In [2]:

```
Df = pd.read_csv("retail_sales_dataset.csv")
Df.head()
```

Out[2]:

	Transaction ID	Date	Customer ID	Gender	Age	Product Category	Quantity	Price per Unit	Total Amount
0	1	2023-11-24	CUST001	Male	34	Beauty	3	50	150
1	2	2023-02-27	CUST002	Female	26	Clothing	2	500	1000
2	3	2023-01-13	CUST003	Male	50	Electronics	1	30	30
3	4	2023-05-21	CUST004	Male	37	Clothing	1	500	500
4	5	2023-05-06	CUST005	Male	30	Beauty	2	50	100

Data Cleaning

In [3]:

```
Df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 9 columns):
 #   Column            Non-Null Count  Dtype 
---  ------            --------------  ----- 
 0   Transaction ID    1000 non-null   int64 
 1   Date              1000 non-null   object
 2   Customer ID       1000 non-null   object
 3   Gender            1000 non-null   object
 4   Age               1000 non-null   int64 
 5   Product Category  1000 non-null   object
 6   Quantity          1000 non-null   int64 
 7   Price per Unit    1000 non-null   int64 
 8   Total Amount      1000 non-null   int64 
dtypes: int64(5), object(4)
memory usage: 70.4+ KB
```

In [4]:

```
## Checking for missing value

# counting missing values per column
missing_values = Df.isnull().sum()

# Display results
print("\n🔍 Missing Values Check:")
print(missing_values)

if missing_values.sum() == 0:
    print("no missing values detected.")
else:
     print("missing values found- need cleaninig before analysis.")
```

```
🔍 Missing Values Check:
Transaction ID      0
Date                0
Customer ID         0
Gender              0
Age                 0
Product Category    0
Quantity            0
Price per Unit      0
Total Amount        0
dtype: int64
no missing values detected.
```

In [5]:

```
# fixing Data Type


## Convert "date" Column from object ( string) to datetime
# This enables time-based analysis ( monthly trends, seasonality, etc)

Df['Date'] = pd.to_datetime(Df['Date'])
print(Df['Date'].head())
```

```
0   2023-11-24
1   2023-02-27
2   2023-01-13
3   2023-05-21
4   2023-05-06
Name: Date, dtype: datetime64[ns]
```

In [6]:
```python
Df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 9 columns):
 #   Column            Non-Null Count  Dtype         
---  ------            --------------  -----         
 0   Transaction ID    1000 non-null   int64         
 1   Date              1000 non-null   datetime64[ns]
 2   Customer ID       1000 non-null   object        
 3   Gender            1000 non-null   object        
 4   Age               1000 non-null   int64         
 5   Product Category  1000 non-null   object        
 6   Quantity          1000 non-null   int64         
 7   Price per Unit    1000 non-null   int64         
 8   Total Amount      1000 non-null   int64         
dtypes: datetime64[ns](1), int64(5), object(3)
memory usage: 70.4+ KB
```

In [7]:
```python
## Unique Value per column

unique_counts = Df.nunique()
print(unique_counts)
```

```
Transaction ID      1000
Date                 345
Customer ID         1000
Gender                 2
Age                   47
Product Category       3
Quantity               4
Price per Unit         5
Total Amount          18
dtype: int64
```

- There are 1000 distinct Transaction IDs and 1000 distinct customers (customer Ids) - There are only 345 unique dates; some customers likely made purchases on the same dates - We have just three product categories, which are Beauty, Clothing and Electronics

In [ ]:
```python

```

In [ ]:
```python

```

In [8]:
```python
Total_revenue = Df["Total Amount"].sum()
Total_Transaction = Df['Transaction ID'].sum()
Avg_Transaction_value = Df['Total Amount'].mean()


print(f"Total Revenue: ${Total_revenue:,.2f}")
print(f"Total Transactions: {Total_Transaction}")
print(f"Average Transaction Value: ${Avg_Transaction_value:,.2f}")
```

```
Total Revenue: $456,000.00
Total Transactions: 500500
Average Transaction Value: $456.00
```

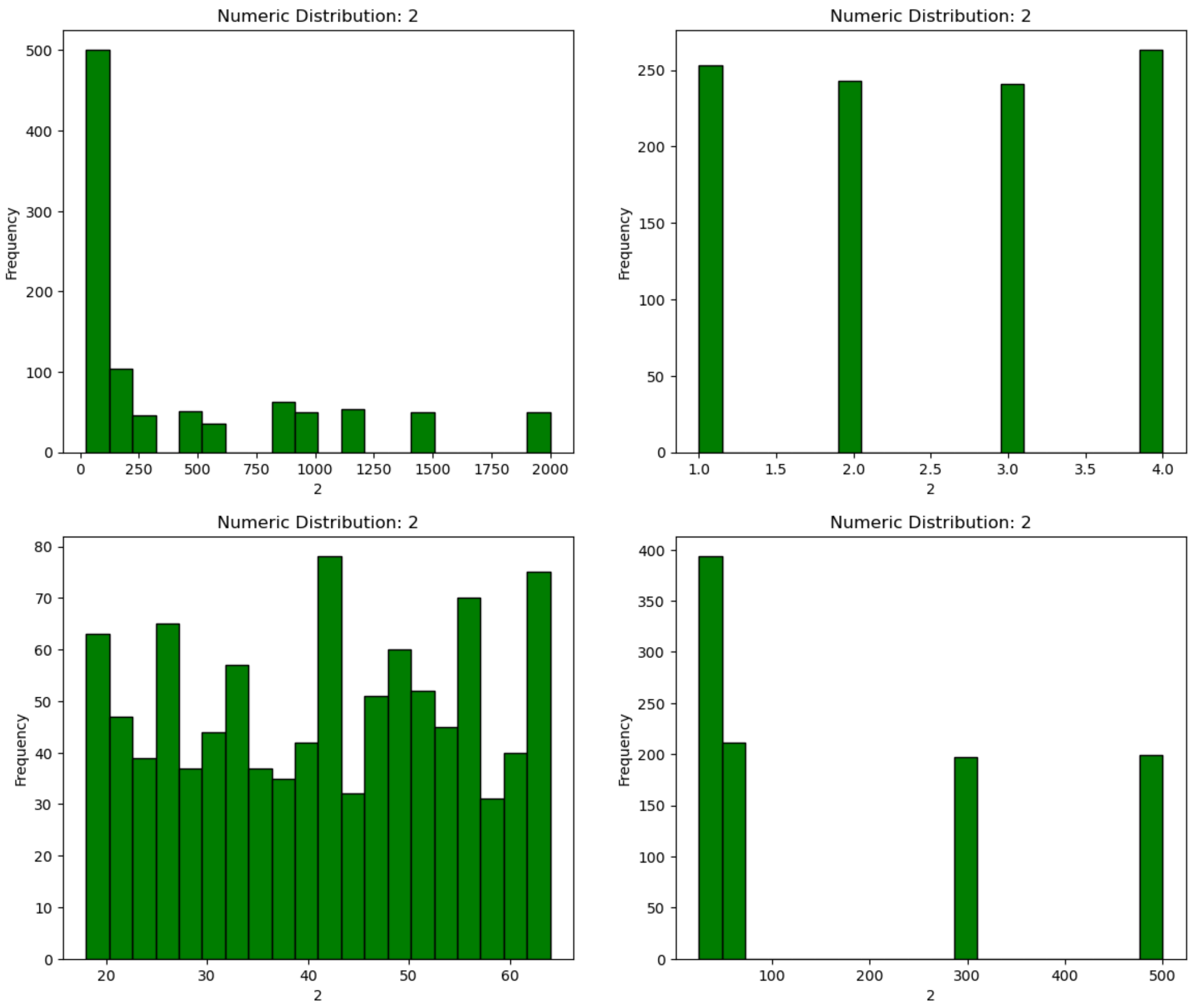
In [9]:

```
# Get Ranges for customer demographic & Spending
Min_age = Df['Age'].min()
Max_age = Df['Age'].max()
Min_price_per_unit = Df['Age'].min()
Max_price_per_unit = Df['Age'].max()
Min_transaction_amount = Df.groupby ('Transaction ID')['Total Amount'].sum().min()
Max_transaction_amount = Df.groupby ('Transaction ID')['Total Amount'].sum().max()
print(f"Min_age: {Min_age}")
print(f"Max_age: {Max_age}")
print(f"Min_price_per_unit: {Min_price_per_unit}")
print(f"Max_price_per_unit: {Max_price_per_unit}")
print(f"Min_transaction_amount: {Min_transaction_amount}")
print(f"Max_transaction_amount: {Max_transaction_amount}")
```

```
Min_age: 18
Max_age: 64
Min_price_per_unit: 18
Max_price_per_unit: 64
Min_transaction_amount: 25
Max_transaction_amount: 2000
```

In [10]:

```
# Purpose: Exploring numeric and Categorical distribution to spot patterns



# Column Grouping
numeric_cols = ['Total Amount','Quantity', 'Age','Price per Unit']
categorical_cols = ['Gender', 'Product Category']

# Plotting Distributions
# histograms for all numeric columns in the dataset to analyze their distributions.
total_plots = len(numeric_cols) + len(categorical_cols)
cols = 2
rows = (total_plots + 1) // cols
plt.figure(figsize=(14, 6*rows))

# Numeric distributions (histograms)
for i, col in enumerate(numeric_cols, 1):
    plt.subplot(rows, cols, i)
    plt.hist(Df[col].dropna(), bins=20, color='green', edgecolor='black')
    plt.title(f'Numeric Distribution: {cols}')
    plt.xlabel(cols)
    plt.ylabel('Frequency')
```

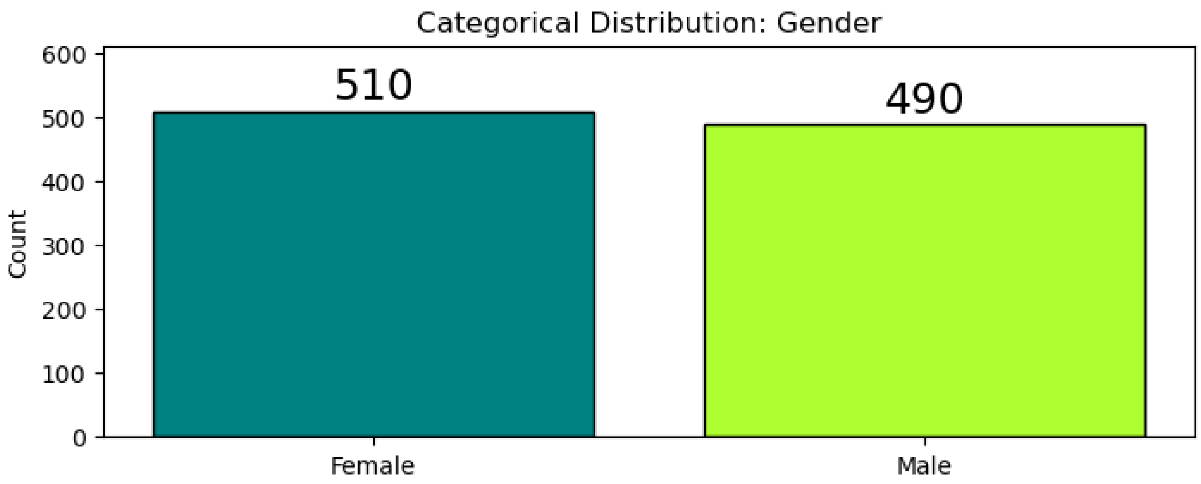


In [11]:

```
# Gender
plt.figure(figsize=(18, 10))
plt.subplot(rows, cols, len(numeric_cols)+1)
gender_counts = Df['Gender'].value_counts()
colors = ['#008080', '#adff2f']  # Blue for Male, Orange for Female (adjust as need
bars = plt.bar(gender_counts.index, gender_counts.values, color=colors, edgecolor='
plt.title('Categorical Distribution: Gender')
plt.ylabel('Count')
for bar in bars:
    height = bar.get_height()
    plt.text(bar.get_x() + bar.get_width()/2, height + 5, str(int(height)), ha='cen

ax = plt.gca()
max_height = gender_counts.max()
ax.set_ylim(0, max_height * 1.2)  # add 20% space at the top
```

Out[11]:

```
(0.0, 612.0)
```

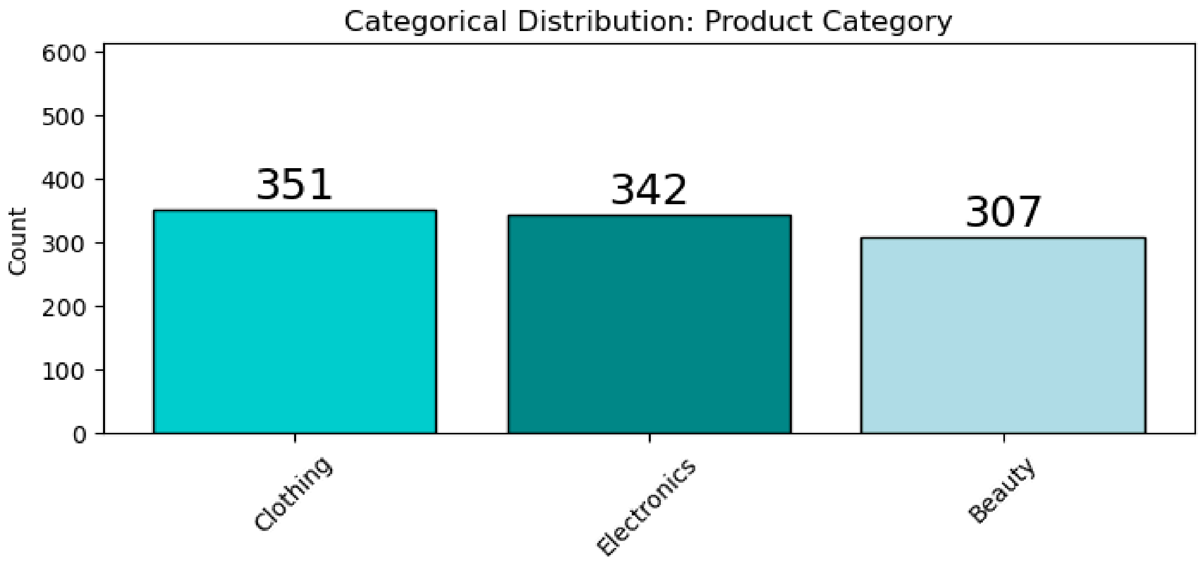


In [12]:

```python
# Categorical: Product Category
plt.figure(figsize=(18, 10))
plt.subplot(rows, cols, len(numeric_cols)+2)
product_counts = Df['Product Category'].value_counts()
colors = ['#00ced1', '#008b8b', '#b0e0e6']  # Different colors per category
bars = plt.bar(product_counts.index, product_counts.values, color=colors, edgecolor
plt.title('Categorical Distribution: Product Category')
plt.ylabel('Count')
plt.xticks(rotation=45)
for bar in bars:
    height = bar.get_height()
    plt.text(bar.get_x() + bar.get_width()/2, height + 5, str(int(height)), ha='cen

ax = plt.gca()
max_height = gender_counts.max()
ax.set_ylim(0, max_height * 1.2)  # add 20% space at the top
```

Out[12]:

```
(0.0, 612.0)
```



Most Valuable Customer

Identying top customer by revenue and analyze their profile and purchasing behavior

In [13]:

```python
# Summarizing revenue & transaction statistics per customer

customer_summary = Df.groupby('Customer ID').agg(
    Total_Revenue=('Total Amount', 'sum'),
    Total_Transactions=('Transaction ID', 'nunique'),
    Avg_Transaction_Value=('Total Amount', 'mean'),
    Total_Quantity=('Quantity', 'sum'),
    Age=('Age', 'first'),  # Assuming age is same per customer
    Gender=('Gender', 'first'),  # Assuming gender is same per customer
    Top_Product_Category=('Product Category', lambda x: x.mode()[0])  # Most freque
).reset_index()
customer_summary
```

Out[13]:

	Customer ID	Total_Revenue	Total_Transactions	Avg_Transaction_Value	Total_Quantity	A
0	CUST001	150	1	150.0	3	
1	CUST002	1000	1	1000.0	2	
2	CUST003	30	1	30.0	1	
3	CUST004	500	1	500.0	1	
4	CUST005	100	1	100.0	2	
...	...	...	...	...	...	
995	CUST995	30	1	30.0	1	
996	CUST996	50	1	50.0	1	
997	CUST997	90	1	90.0	3	
998	CUST998	100	1	100.0	4	
999	CUST999	150	1	150.0	3	

1000 rows × 8 columns

In [14]:

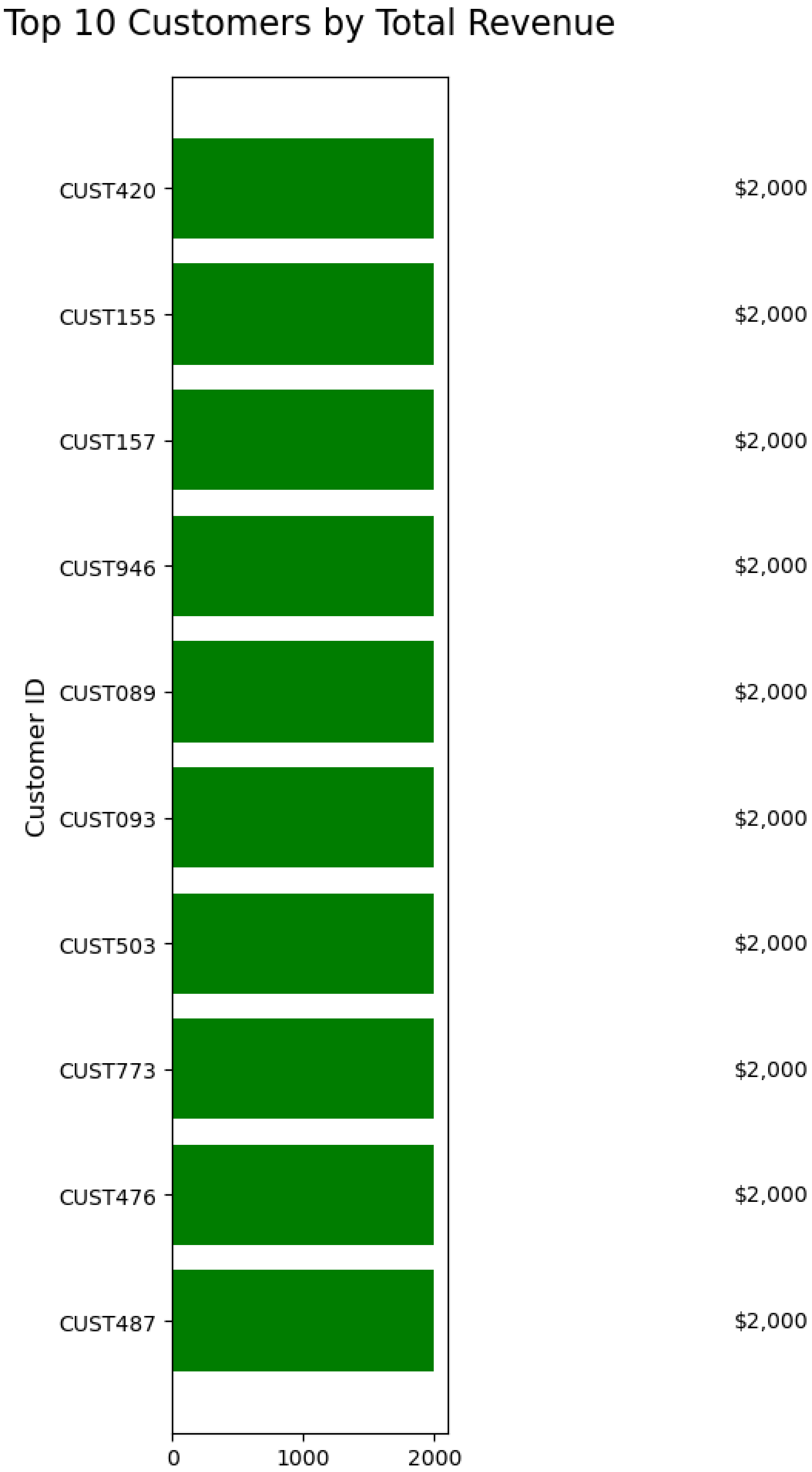
```python
# Extracting top 10 customers by revenue

top_customers = customer_summary.sort_values(by='Total_Revenue', ascending=False).h


print(" Top 10 Customers by Revenue")
display(top_customers[['Customer ID', 'Gender', 'Age', 'Top_Product_Category',
                       'Total_Transactions', 'Total_Quantity', 'Total_Revenue', 'Av
```

```
Top 10 Customers by Revenue
```

	Customer ID	Gender	Age	Top_Product_Category	Total_Transactions	Total_Quantity	Tota
487	CUST487	Male	44	Clothing	1	4	
476	CUST476	Female	27	Clothing	1	4	
773	CUST773	Male	25	Electronics	1	4	
503	CUST503	Male	45	Beauty	1	4	
92	CUST093	Female	35	Beauty	1	4	
88	CUST089	Female	55	Electronics	1	4	
946	CUST946	Male	62	Electronics	1	4	
157	CUST157	Male	62	Electronics	1	4	
155	CUST155	Male	31	Electronics	1	4	
420	CUST420	Female	22	Clothing	1	4	

In [15]:

```python
# Visualize them with a Bar Chart

top_customers_sorted = top_customers.sort_values(by='Total_Revenue', ascending=True

fig, ax = plt.subplots(figsize=(18,10))
bars = ax.barh(
    top_customers_sorted['Customer ID'],
    top_customers_sorted['Total_Revenue'],
    color='green'
)

# Add labels showing revenue value at bar ends
for bar in bars:
    width = bar.get_width()
    ax.text(
        width + Total_revenue*0.005,
        bar.get_y() + bar.get_height()/2,
        f"${width:,.0f}",
        ha='left',
        va='center',
        fontsize=10
    )

ax.set_title('Top 10 Customers by Total Revenue', fontsize=16, pad=20)
ax.set_xlabel('Total Revenue', fontsize=12)
ax.set_ylabel('Customer ID', fontsize=12)
plt.tight_layout()
plt.show()
```


Top 10 Customers by Total Revenue
Customer ID
CUST420
CUST155
CUST157
CUST946
CUST089
CUST093
CUST503
CUST773
CUST476
CUST487
$2,000
$2,000
$2,000
$2,000
$2,000
$2,000
$2,000
$2,000
$2,000
$2,000
0
1000
2000

Total Revenue

How does customer age and gender influence purchasing behavior?

spending patterns by age

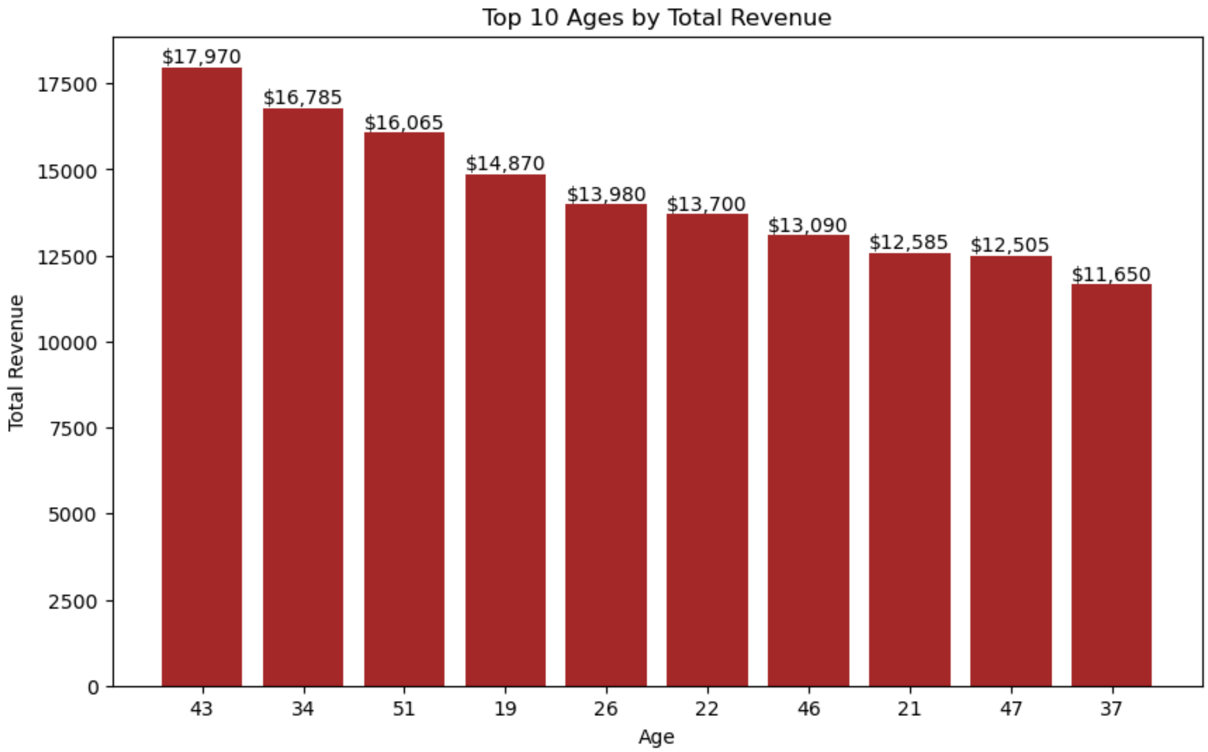
In [16]:
```
# Exploring spending patterns by age


# Aggregate revenue and transactions by age
age_summary = Df.groupby('Age').agg(
    Total_Revenue=('Total Amount', 'sum'),
    Total_Transactions=('Transaction ID', 'nunique'),
    Avg_Transaction_Value=('Total Amount', 'mean'),
    Num_Customers=('Customer ID', 'nunique')
).reset_index()
```

In [17]:
```
# Step 2: Extract top 10 ages by revenue
top_age_summary = age_summary.sort_values(by='Total_Revenue', ascending=False).head
print(" Top 10 Ages by Total Revenue")
display(top_age_summary)
```

```
Top 10 Ages by Total Revenue
```

	Age	Total_Revenue	Total_Transactions	Avg_Transaction_Value	Num_Customers
25	43	17970	31	579.677419	31
16	34	16785	28	599.464286	28
33	51	16065	30	535.500000	30
1	19	14870	21	708.095238	21
8	26	13980	22	635.454545	22
4	22	13700	27	507.407407	27
28	46	13090	25	523.600000	25
3	21	12585	20	629.250000	20
29	47	12505	26	480.961538	26
19	37	11650	16	728.125000	16

In [18]:
```
plt.figure(figsize=(10,6))
bars = plt.bar(top_age_summary['Age'].astype(str), top_age_summary['Total_Revenue']
for bar in bars:
    plt.text(bar.get_x() + bar.get_width()/2, bar.get_height(), f"${bar.get_height(
plt.title('Top 10 Ages by Total Revenue')
plt.xlabel('Age')
plt.ylabel('Total Revenue')
plt.show()
```

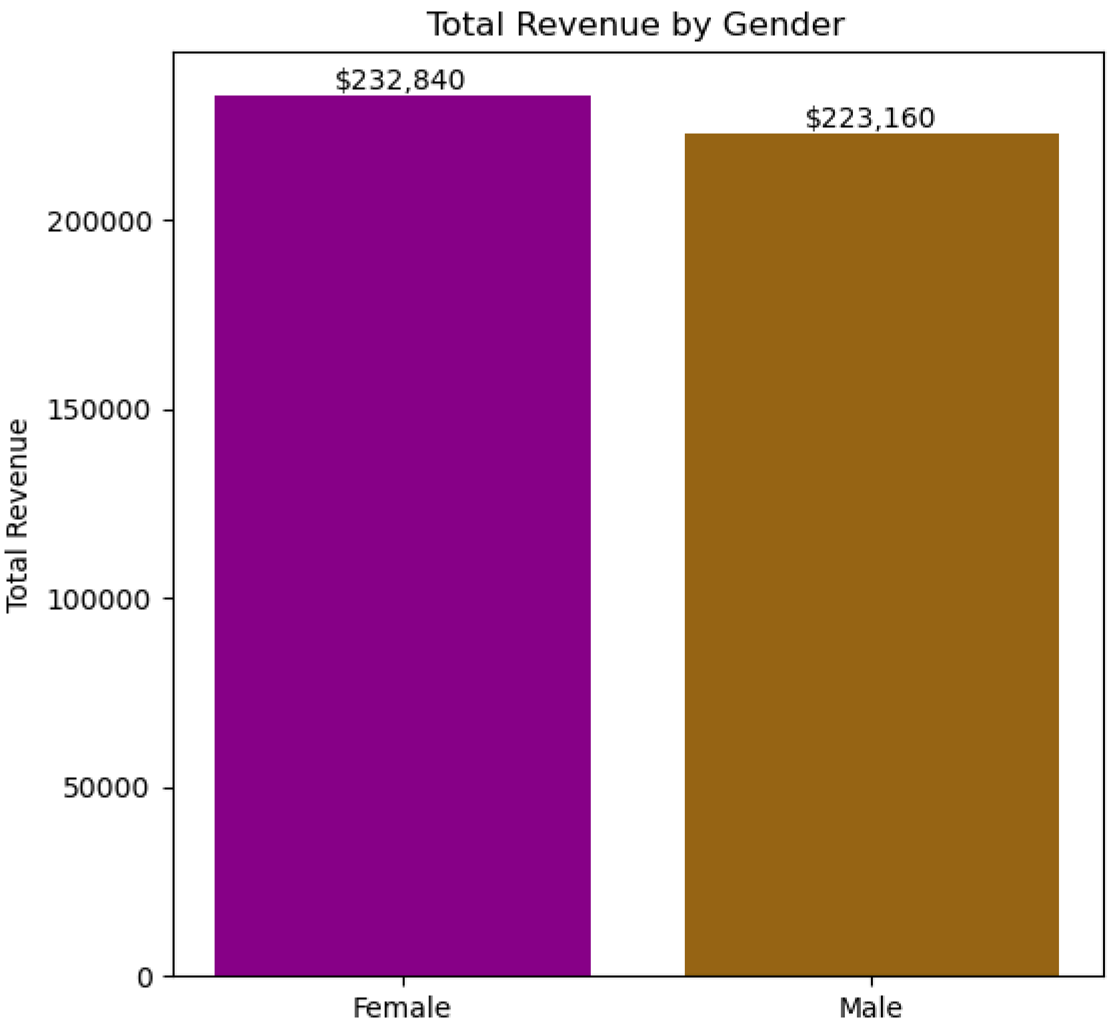


Spending by Gender

```
In [19]: gender_summary = Df.groupby('Gender').agg(
             Total_Revenue=('Total Amount', 'sum'),
             Total_Transactions=('Transaction ID', 'nunique'),
             Avg_Transaction_Value=('Total Amount', 'mean'),
             Num_Customers=('Customer ID', 'nunique')
         ).reset_index()

         # Step 2: Display table
         print("Spending Summary by Gender")
         display(gender_summary)

         # Step 3: Visualize with bar chart
         plt.figure(figsize=(6,6))
         colors = ['#8b008b' if g=='Female' else '#996515' for g in gender_summary['Gender']]
         bars = plt.bar(gender_summary['Gender'], gender_summary['Total_Revenue'], color=col
         for bar in bars:
             plt.text(bar.get_x() + bar.get_width()/2, bar.get_height(), f"${bar.get_height(
         plt.title('Total Revenue by Gender')
         plt.ylabel('Total Revenue')
         plt.show()
```

```
Spending Summary by Gender
```

	Gender	Total_Revenue	Total_Transactions	Avg_Transaction_Value	Num_Customers
0	Female	232840	510	456.549020	510
1	Male	223160	490	455.428571	490



Spending by Age & Gender (stacked Bar)

In [20]:

```
# Step 1: Aggregate by age + gender
age_gender_summary = Df.groupby(['Age','Gender']).agg(
    Total_Revenue=('Total Amount', 'sum'),
    Total_Transactions=('Transaction ID', 'nunique'),
    Avg_Transaction_Value=('Total Amount', 'mean'),
    Num_Customers=('Customer ID', 'nunique')
).reset_index()
```

In [21]:

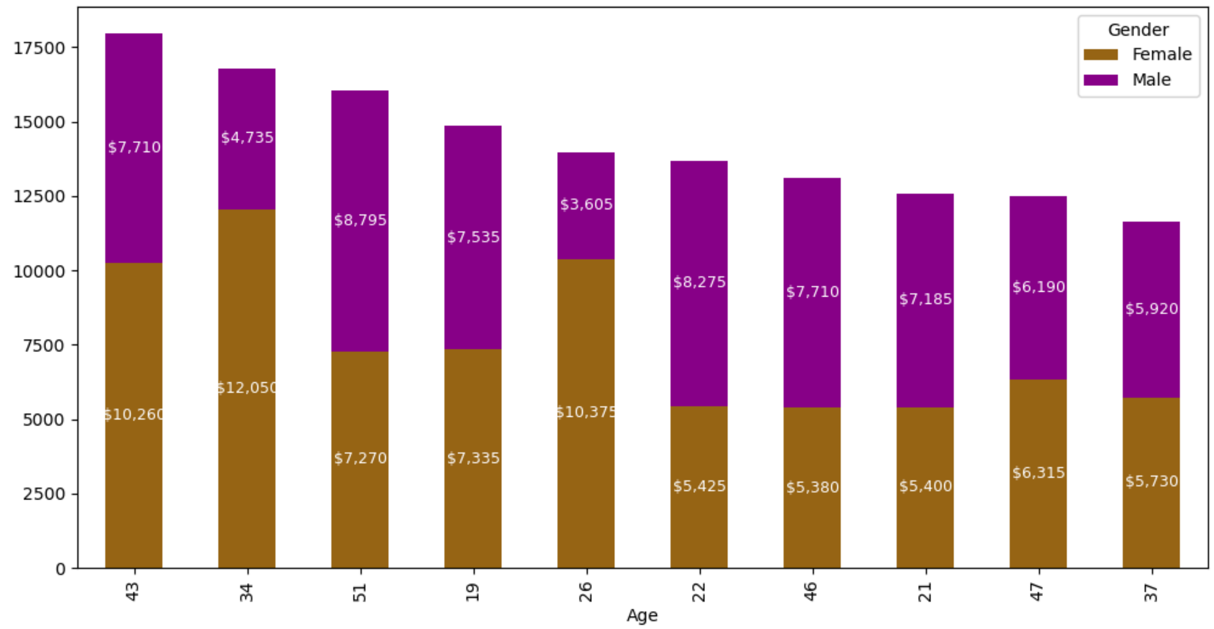
```
#Show top 10 age-gender combos by revenue
print(" Age & Gender Combinations by Total Revenue")
top_age_gender_table = age_gender_summary.sort_values(by='Total_Revenue', ascending
display(top_age_gender_table)
```

```
Age & Gender Combinations by Total Revenue
```

	Age	Gender	Total_Revenue	Total_Transactions	Avg_Transaction_Value	Num_Customers
32	34	Female	12050	14	860.714286	14
16	26	Female	10375	15	691.666667	15
50	43	Female	10260	19	540.000000	19
67	51	Male	8795	13	676.538462	13
9	22	Male	8275	13	636.538462	13
27	31	Male	8200	16	512.500000	16
91	63	Male	8045	11	731.363636	11
0	18	Female	7940	13	610.769231	13
57	46	Male	7710	9	856.666667	9
51	43	Male	7710	12	642.500000	12

In [22]:

```
# Step 3: Prepare data for stacked bar chart
stacked_data = age_gender_summary.pivot(index='Age', columns='Gender', values='Tota
top_ages = stacked_data.sum(axis=1).sort_values(ascending=False).head(10).index
stacked_data_top = stacked_data.loc[top_ages]

# Step 4: Visualize stacked bar chart
fig, ax = plt.subplots(figsize=(12,6))
stacked_data_top.plot(kind='bar', stacked=True, ax=ax, color=['#996515', '#8b008b']

# Add labels inside the bars
for i, age in enumerate(stacked_data_top.index):
    bottom = 0
    for gender in stacked_data_top.columns:
        val = stacked_data_top.loc[age, gender]
        ax.text(i, bottom + val/2, f"${val:,.0f}", ha='center', va='center', fontsi
        bottom += val
```



Product Categories that drive the most revenue

which Product Categories drives the most revenue? We identify the top revenue generating product and analyze by gender/age Revenue & Number of Customers per Product Category

In [23]:

```
# Aggregate revenue, customer count, and average transaction value per product
product_summary = Df.groupby('Product Category').agg(
    Total_Revenue=('Total Amount', 'sum'),
    Number_of_Customers=('Customer ID', 'nunique'),
    Avg_Transaction_Value=('Total Amount','mean')
).reset_index()
```

In [24]:

```
product_summary = product_summary.sort_values(by='Total_Revenue', ascending=False)
print("Revenue, Number of Customers, and Average Transaction Value per Product Cate
display(product_summary)
```

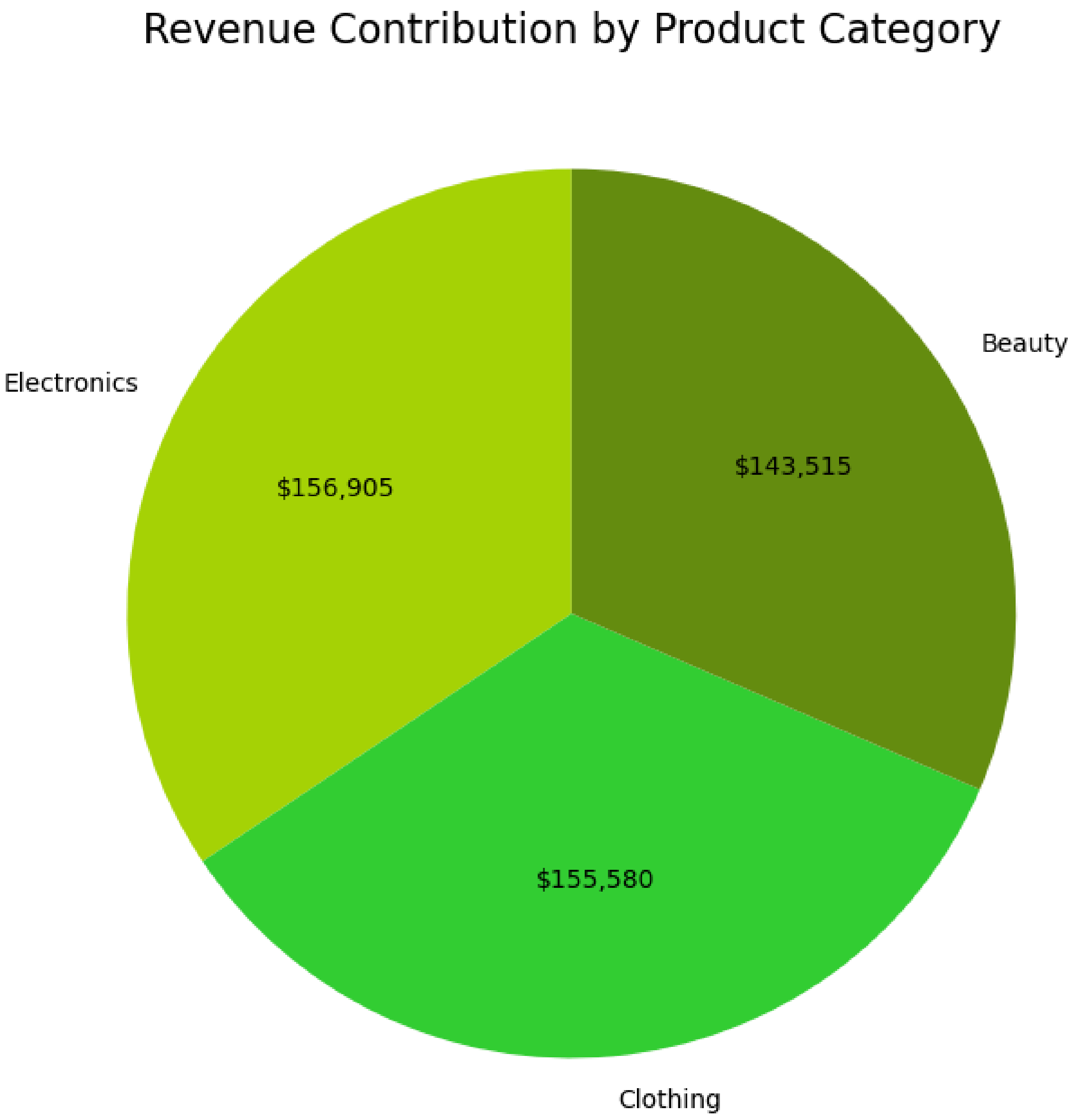
```
Revenue, Number of Customers, and Average Transaction Value per Product Category
```

	Product Category	Total_Revenue	Number_of_Customers	Avg_Transaction_Value
2	Electronics	156905	342	458.786550
1	Clothing	155580	351	443.247863
0	Beauty	143515	307	467.475570

In [25]:

```
# Step 4: Visualize revenue distribution as a pie chart
fig, ax = plt.subplots(figsize=(8,8))
ax.pie(
    product_summary['Total_Revenue'],
    labels=product_summary['Product Category'],
    autopct=lambda p: f"${p*product_summary['Total_Revenue'].sum()/100:,.0f}",
    colors=['#a6d608','#32cd32','#648c11'],
    startangle=90
)
```

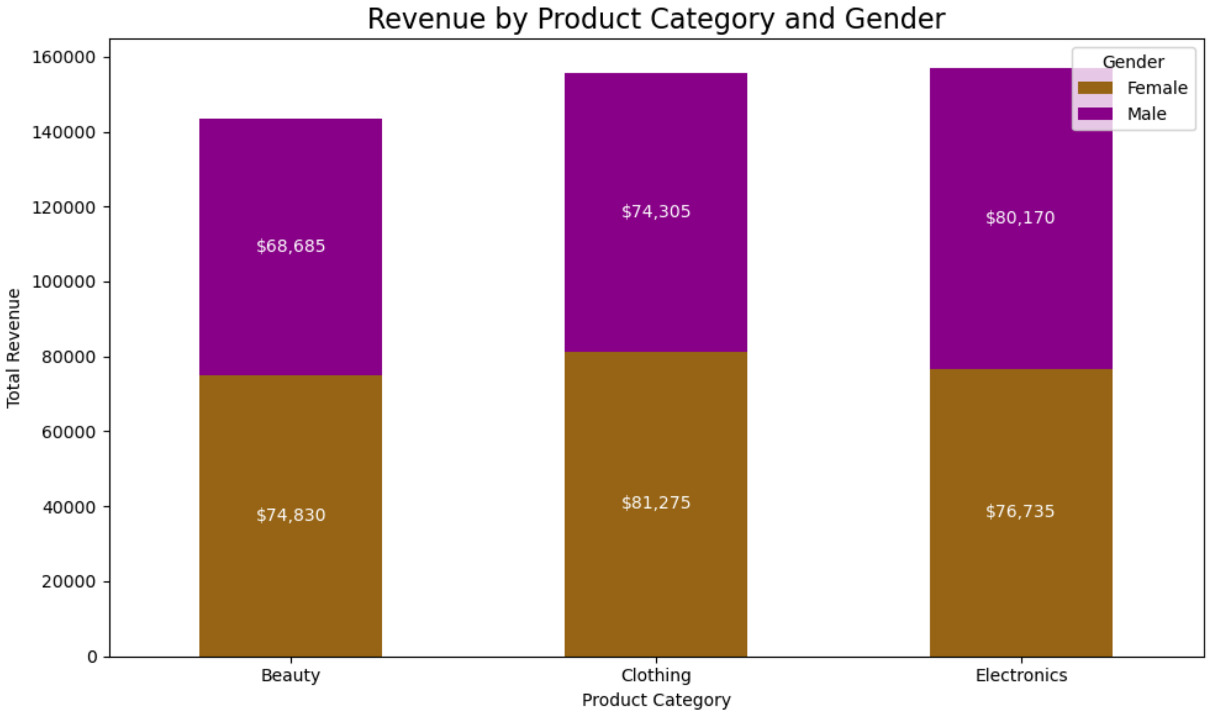
```python
ax.set_title('Revenue Contribution by Product Category', fontsize=16)
plt.show()
```



In [26]:

```python
#Revenue by Product Category & Gender

# Aggregate revenue and customer count per product & gender
product_gender_summary = Df.groupby(['Product Category','Gender']).agg(
    Total_Revenue=('Total Amount','sum'),
    Number_of_Customers=('Customer ID','nunique'),
    Avg_Transaction_Value=('Total Amount','mean')
).reset_index()

# stacked bar chart
stacked_product_gender = product_gender_summary.pivot(index='Product Category', col

# Visualize revenue split by gender for each product
fig, ax = plt.subplots(figsize=(10,6))
stacked_product_gender.plot(kind='bar', stacked=True, ax=ax, color=['#996515', '#8b
display(product_gender_summary.sort_values(by='Total_Revenue', ascending=False))
# Add labels inside bars
for i, product in enumerate(stacked_product_gender.index):
    bottom = 0
    for gender in stacked_product_gender.columns:
        val = stacked_product_gender.loc[product, gender]
        ax.text(i, bottom + val/2, f"${val:,.0f}", ha='center', va='center', fontsi
        bottom += val

ax.set_title('Revenue by Product Category and Gender', fontsize=16)
ax.set_ylabel('Total Revenue')
ax.set_xlabel('Product Category')
plt.xticks(rotation=0)
plt.tight_layout()
plt.show()

#Display table with heading
print()
print("Revenue, Number of Customers, and Average Transaction Value by Product Categ
```

	Product Category	Gender	Total_Revenue	Number_of_Customers	Avg_Transaction_Value
2	Clothing	Female	81275	174	467.097701
5	Electronics	Male	80170	172	466.104651
4	Electronics	Female	76735	170	451.382353
0	Beauty	Female	74830	166	450.783133
3	Clothing	Male	74305	177	419.802260
1	Beauty	Male	68685	141	487.127660



```
Revenue, Number of Customers, and Average Transaction Value by Product Category & Ge
nder
```

Age & Gender Combinations per Product

In [27]:

```python
#Aggregate revenue per product, age, and gender
age_gender_product_summary = Df.groupby(['Product Category','Age','Gender']).agg(
    Total_Revenue=('Total Amount','sum'),
    Number_of_Customers=('Customer ID','nunique')
).reset_index()
```

In [28]:

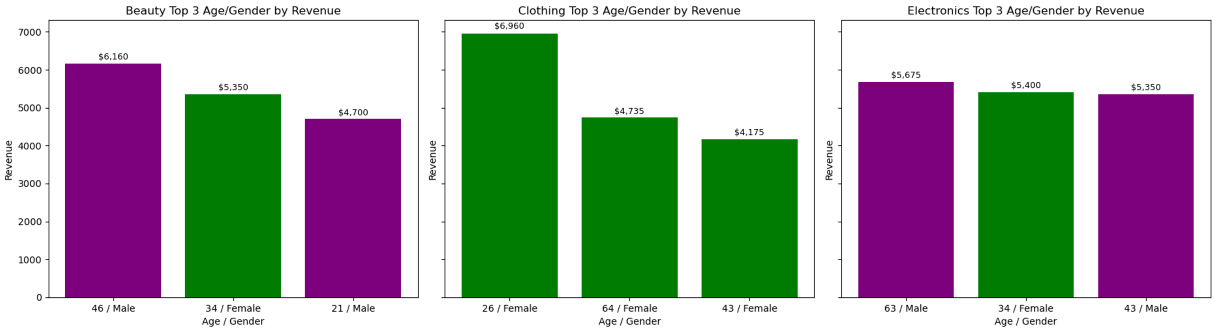
```python
# Extract top 3 age/gender combos for each product
top3_age_gender_per_product = age_gender_product_summary.groupby('Product Category'
    lambda x: x.sort_values(by='Total_Revenue', ascending=False).head(3)
).reset_index(drop=True)

print()
print("Table 3C: Top 3 Age & Gender Combinations by Revenue per Product")
display(top3_age_gender_per_product.sort_values(by=['Product Category','Total_Reven
```

```
Table 3C: Top 3 Age & Gender Combinations by Revenue per Product
```

	Product Category	Age	Gender	Total_Revenue	Number_of_Customers
0	Beauty	46	Male	6160	6
1	Beauty	34	Female	5350	7
2	Beauty	21	Male	4700	4
3	Clothing	26	Female	6960	7
4	Clothing	64	Female	4735	10
5	Clothing	43	Female	4175	7
6	Electronics	63	Male	5675	7
7	Electronics	34	Female	5400	5
8	Electronics	43	Male	5350	5

In [29]:

```python
# Grouped bar chart per product
fig, axs = plt.subplots(1, 3, figsize=(18,5), sharey=True)

for i, product in enumerate(top3_age_gender_per_product['Product Category'].unique(
    data = top3_age_gender_per_product[top3_age_gender_per_product['Product Categor
    labels = data['Age'].astype(str) + ' / ' + data['Gender']
    axs[i].bar(labels, data['Total_Revenue'], color=['Green' if g=='Female' else 'P
    axs[i].set_title(f"{product} Top 3 Age/Gender by Revenue")
    axs[i].set_xlabel('Age / Gender')
    axs[i].set_ylabel('Revenue')
    for idx, val in enumerate(data['Total_Revenue']):
        axs[i].text(idx, val + val*0.01, f"${val:,.0f}", ha='center', va='bottom',

plt.tight_layout()
plt.show()
```



Monthly Sales and Transaction

We identify seasonality patterns in revenue and transactions

In [32]:

```
# Aggregate Monthly sales Metric

# Extract Month from the transaction Date

Df['Month'] = Df['Date'].dt.month
```

In [41]:

```
# Aggregate revenue & transaction by month

Monthly_sales = Df.groupby('Month').agg(
    Total_Revenue=('Total Amount', 'sum'),
    Total_Transaction=('Transaction ID','nunique')).reset_index()
```

In [44]:

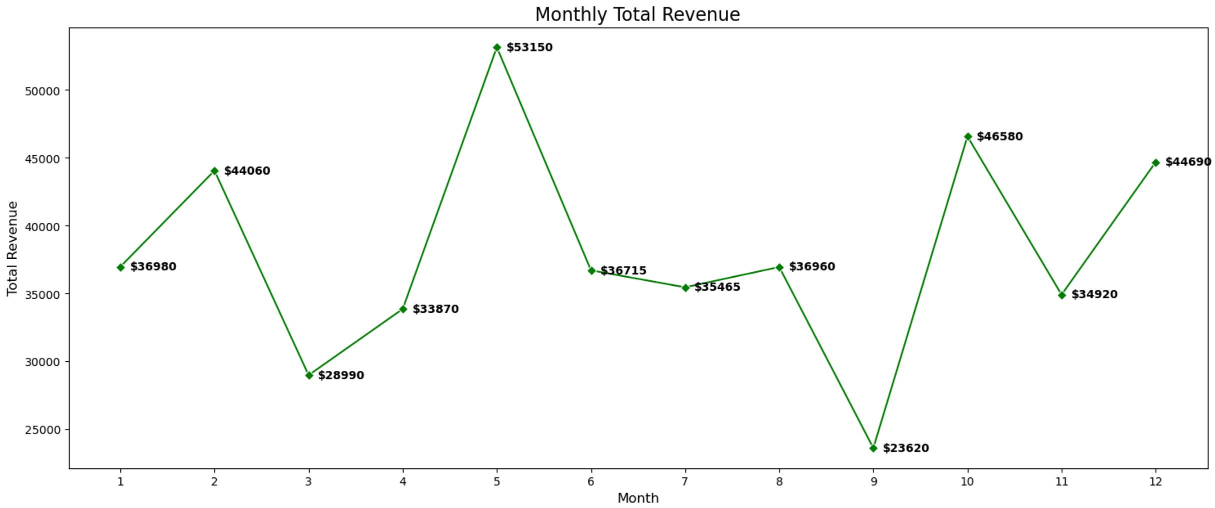
```
# Average Transaction Value
Monthly_sales['Avg_Transaction_Value'] = Monthly_sales['Total_Revenue'] / Monthly_s
print("Monthly Sales Table")
display(Monthly_sales)
```

```
Monthly Sales Table
```

	Month	Total_Revenue	Total_Transaction	Avg_Transaction_Value
0	1	36980	78	474.102564
1	2	44060	85	518.352941
2	3	28990	73	397.123288
3	4	33870	86	393.837209
4	5	53150	105	506.190476
5	6	36715	77	476.818182
6	7	35465	72	492.569444
7	8	36960	94	393.191489
8	9	23620	65	363.384615
9	10	46580	96	485.208333
10	11	34920	78	447.692308
11	12	44690	91	491.098901

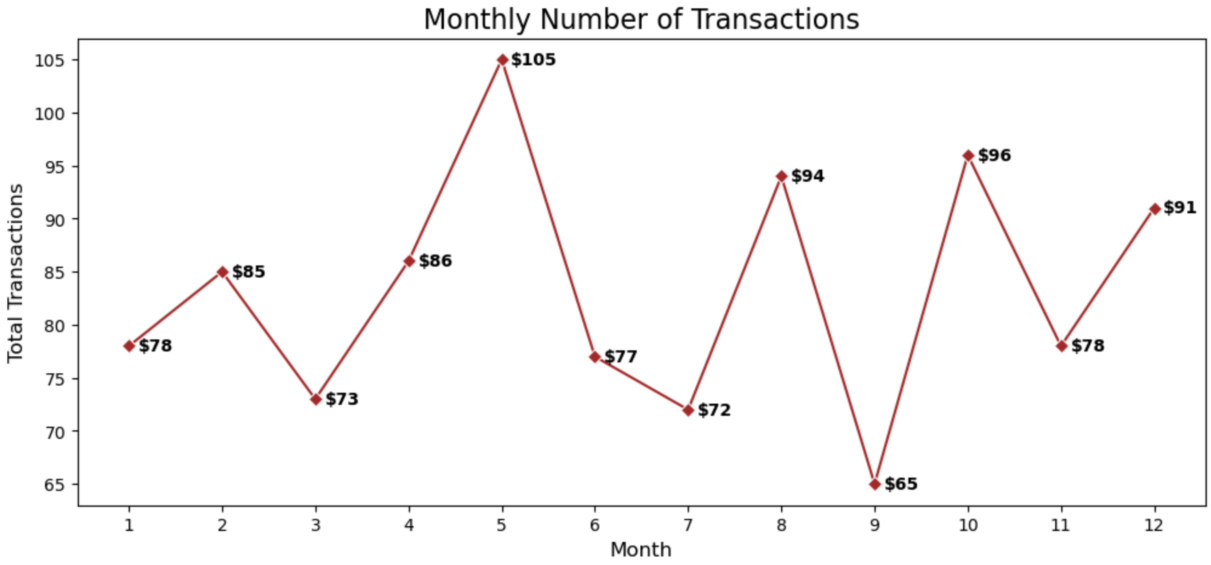
In [54]:

```
# The Monthly Revenue
plt.figure(figsize=(18,7))
sns.lineplot(data=Monthly_sales, x='Month', y='Total_Revenue', marker='D', color='g
plt.title('Monthly Total Revenue', fontsize=16)
plt.xlabel('Month', fontsize=12)
plt.ylabel('Total Revenue', fontsize=12)
plt.xticks(Monthly_sales['Month'])
plt.grid(False)

for x, y in zip(Monthly_sales['Month'], Monthly_sales['Total_Revenue']):
    plt.text(
        x + 0.1,        # shift right (adjust if needed)
        y,
        f'${y:.0f}',
        ha='left',
        va='center',
        fontsize=10,
        fontweight='bold',
        color='black'
    )
```



In [59]:

```
# Montly Transaction

plt.figure(figsize=(12,5))
sns.lineplot(data=Monthly_sales, x='Month', y='Total_Transaction', marker='D', colo
plt.title('Monthly Number of Transactions', fontsize=16)
plt.xlabel('Month', fontsize=12)
plt.ylabel('Total Transactions', fontsize=12)
plt.xticks(Monthly_sales['Month'])
plt.grid(False)


for x, y in zip(Monthly_sales['Month'], Monthly_sales['Total_Transaction']):
    plt.text(
        x + 0.1,        # shift right (adjust if needed)
        y,
        f'${y:.0f}',
        ha='left',
        va='center',
        fontsize=10,
        fontweight='bold',
        color='black'
    )
```



Patterns in Purchase Quantity Per Transaction

In [62]:
```
# seaborn Style for simplicity

sns.set_style("whitegrid")
```

Average Quantity per Transaction

In [66]:
```
Avg_quantity = Df['Quantity'].mean()

print(f"Average Quantity per Transaction: {Avg_quantity:.2f}")
```

```
Average Quantity per Transaction : 2.51
```

average quantity by product category

In [68]:
```
avg_quantity_by_product = Df.groupby('Product Category')['Quantity'].mean().reset_i
print()
print("Table 5A: Average Quantity per Transaction by Product Category:")
display(avg_quantity_by_product)
```

```
Table 5A: Average Quantity per Transaction by Product Category:
```

	Product Category	Quantity
0	Beauty	2.511401
1	Clothing	2.547009
2	Electronics	2.482456

Average Quantity per Transaction by Product and Month

In [71]:
```
# group Average Quantity by Month & Product Categories

avg_qty_month_product = Df.groupby(['Month','Product Category']).agg(
    Avg_Quantity=('Quantity', 'mean')
).reset_index()
```

```


# Pivot table: Months as rows, Products as columns, values = Avg_Quantity
avg_qty_pivot = avg_qty_month_product.pivot(
    index='Month',
    columns='Product Category',
    values='Avg_Quantity'
)
```

In [79]:

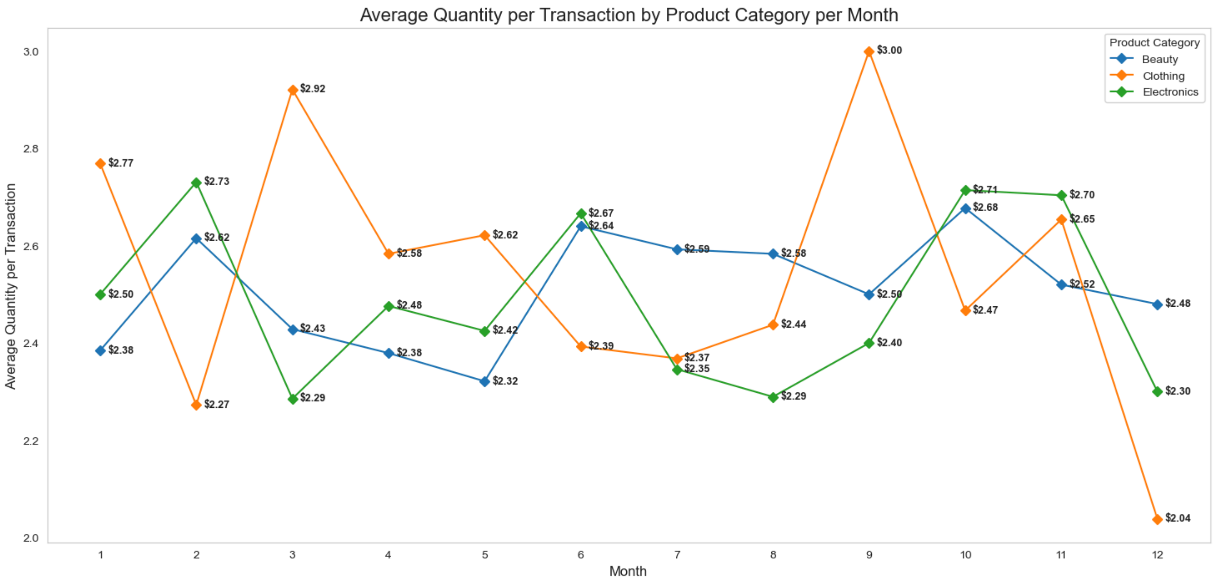
```
# checking for missing values

avg_qty_pivot.isnull()

# checking my values
avg_qty_pivot

# Fill missing values with 0 (if any) and round to 2 decimals
avg_qty_pivot = avg_qty_pivot.fillna(0).round(2)

print(" Average Quantity per Transaction by Product and Month")
display(avg_qty_pivot)
```

```
 Average Quantity per Transaction by Product and Month
```

Product Category	Beauty	Clothing	Electronics
Month			
1	2.38	2.77	2.50
2	2.62	2.27	2.73
3	2.43	2.92	2.29
4	2.38	2.58	2.48
5	2.32	2.62	2.42
6	2.64	2.39	2.67
7	2.59	2.37	2.35
8	2.58	2.44	2.29
9	2.50	3.00	2.40
10	2.68	2.47	2.71
11	2.52	2.65	2.70
12	2.48	2.04	2.30

In [113…

```
sns.set_style("whitegrid")
plt.figure(figsize=(18,8))

for product in avg_qty_month_product['Product Category'].unique():
    product_data = avg_qty_month_product[avg_qty_month_product['Product Category']]

    # Plot line without markers
    plt.plot(product_data['Month'], product_data['Avg_Quantity'], label=product, ma

    # Annotate highest point
    max_idx = product_data['Avg_Quantity'].idxmax()
    max_month = product_data.loc[max_idx, 'Month']
    max_val = product_data.loc[max_idx, 'Avg_Quantity']
    #plt.annotate(f"{max_val:.2f}",
                # xy=(max_month, max_val),
                # xytext=(0, 5),
                # textcoords='offset points',
                # ha='center', va='bottom',
               #  fontsize=10, color='black',
               #  fontweight='bold')

    # Annotate lowest point
    min_idx = product_data['Avg_Quantity'].idxmin()
    min_month = product_data.loc[min_idx, 'Month']
    min_val = product_data.loc[min_idx, 'Avg_Quantity']
    #plt.annotate(f"{min_val:.2f}",
                # xy=(min_month, min_val),
                # xytext=(0, -10),
               #  textcoords='offset points',
                # ha='center', va='top',
                # fontsize=10, color='black',
                # fontweight='bold')

#Add numbers BESIDE each marker
    for x, y in zip(product_data['Month'], product_data['Avg_Quantity']):
        plt.text(
            x + 0.08,          # shift right
            y,
            f"${y:.2f}",
            ha='left',
            va='center',
            fontsize=9,
            fontweight='bold'
        )


plt.title('Average Quantity per Transaction by Product Category per Month', fontsiz
plt.xlabel('Month', fontsize=12)
plt.ylabel('Average Quantity per Transaction', fontsize=12)
plt.xticks(range(1,13))
plt.legend(title='Product Category')
plt.grid(False)
plt.show()
```



# Annotate highest point max_idx = product_data['Avg_Quantity'].idxmax() max_month = product_data.loc[max_idx, 'Month'] max_val = product_data.loc[max_idx, 'Avg_Quantity'] plt.annotate(f"{max_val:.2f}", xy=(max_month, max_val), xytext=(0, 5), textcoords='offset points', ha='center', va='bottom', fontsize=10, color='black', fontweight='bold') # Annotate lowest point min_idx = product_data['Avg_Quantity'].idxmin() min_month = product_data.loc[min_idx, 'Month'] min_val = product_data.loc[min_idx, 'Avg_Quantity'] plt.annotate(f"{min_val:.2f}", xy=(min_month, min_val), xytext=(0, -10), textcoords='offset points', ha='center', va='top', fontsize=10, color='black', fontweight='bold') How does Pricing affect Purchasing behavior?

In [120…

```
# we get our Pricing Summary

price_summary = Df.groupby('Price per Unit').agg(
    Total_Revenue=('Total Amount', 'sum'),
    Total_Transactions=('Transaction ID', 'nunique'),
    Avg_Quantity=('Quantity', 'mean')
).reset_index()

print("Pricing Summary Table")
display(price_summary)
```

```
Pricing Summary Table
```

	Price per Unit	Total_Revenue	Total_Transactions	Avg_Quantity
0	25	13050	210	2.485714
1	30	13350	183	2.431694
2	50	26700	211	2.530806
3	300	155400	197	2.629442
4	500	247500	199	2.487437

In [126…

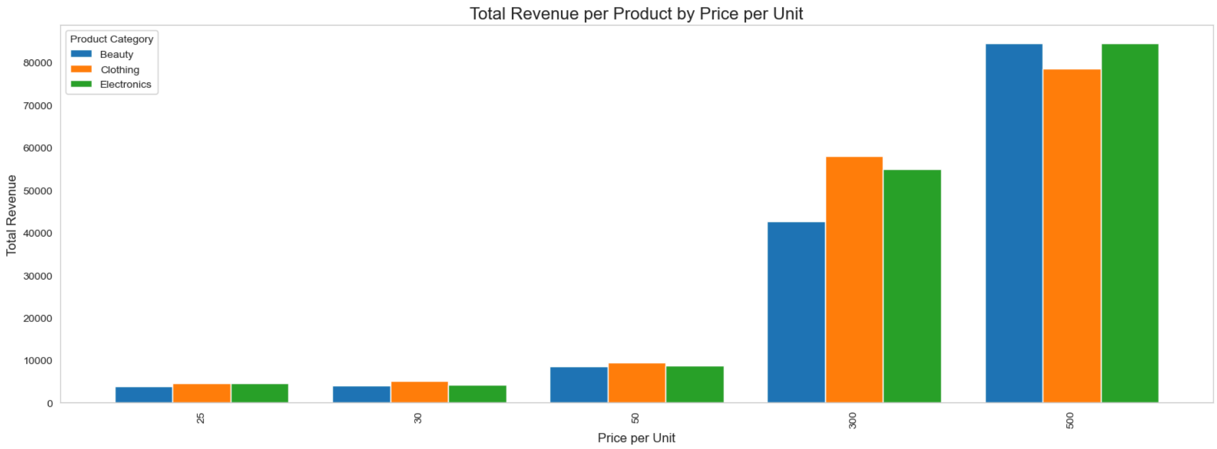
```
#Aggregate metrics by Price per Unit and Product Category
price_product_summary = Df.groupby(['Price per Unit', 'Product Category']).agg(
    Total_Revenue=('Total Amount', 'sum'),
    Total_Transactions=('Transaction ID', 'nunique'),
    Avg_Quantity=('Quantity', 'mean')
).reset_index()

revenue_pivot = price_product_summary.pivot(index='Price per Unit', columns='Produc
revenue_pivot = revenue_pivot.fillna(0)  # fill missing values
revenue_pivot = revenue_pivot.applymap(lambda x: f"${x:,.0f}")  # format as currenc

print()
print("Total Revenue per Product by Price")
display(revenue_pivot)
```

```
Total Revenue per Product by Price
```

Product Category	**Beauty**	**Clothing**	**Electronics**
Price per Unit			
25	$3,925	$4,600	$4,525
30	$3,990	$5,130	$4,230
50	$8,500	$9,450	$8,750
300	$42,600	$57,900	$54,900
500	$84,500	$78,500	$84,500

In [129…

```
# Numeric pivot (for plotting)
revenue_pivot_num = price_product_summary.pivot(
    index='Price per Unit',
    columns='Product Category',
    values='Total_Revenue'
).fillna(0)


revenue_pivot_num.plot(
    kind='bar',
    figsize=(16,6),
    width=0.8
)

plt.title('Total Revenue per Product by Price per Unit', fontsize=16)
plt.xlabel('Price per Unit', fontsize=12)
plt.ylabel('Total Revenue', fontsize=12)
plt.legend(title='Product Category')
plt.grid(False)
plt.tight_layout()
plt.show()
```


Total Revenue per Product by Price per Unit
Product Category
Beauty
Clothing
Electronics
Total Revenue
0
10000
20000
30000
40000
50000
60000
70000
80000
25
30
50
300
500
Price per Unit

In [ ]: