In [1]:
```
import numpy as np
import pandas as pd
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
import matplotlib.pyplot as plt
```

In [2]:
```
# Load and prepare data (reuse from previous code)
customers = pd.read_csv("Customers.csv")
products=pd.read_csv("Products.csv")
transactions = pd.read_csv("Transactions.csv")
df = transactions.merge(customers, on='CustomerID').merge(products,on="Pr
```

In [3]:
```
df.head()
```

Out[3]:

	TransactionID	CustomerID	ProductID	TransactionDate	Quantity	TotalValue	P
0	T00001	C0199	P067	2024-08-25 12:38:23	1	300.68	
1	T00112	C0146	P067	2024-05-27 22:23:54	1	300.68	
2	T00166	C0127	P067	2024-04-25 07:38:55	1	300.68	
3	T00272	C0087	P067	2024-03-26 22:55:37	2	601.36	
4	T00363	C0070	P067	2024-03-21 15:10:10	3	902.04	

In [4]:
```
df['Price_x']==df['Price_y']
```

Out[4]:
```
0      True
1      True
2      True
3      True
4      True
       ...
995    True
996    True
997    True
998    True
999    True
Length: 1000, dtype: bool
```

In [5]:
```
df=df.drop(columns="Price_x").rename(columns={"Price_y":"Price"})
```

In [6]:
```
# Aggregate features
customer_features=df.groupby('CustomerID').agg({
    'TransactionID': 'count',
    'Quantity': 'sum',
    'TotalValue': 'sum',
```

```
    'Price': 'mean',
    'Category': lambda x: len(set(x)),
}).reset_index()
```

In [7]:
```
customer_features
```

Out[7]:

	CustomerID	TransactionID	Quantity	TotalValue	Price	Category
0	C0001	5	12	3354.52	278.334000	3
1	C0002	4	10	1862.74	208.920000	2
2	C0003	4	14	2725.38	195.707500	3
3	C0004	8	23	5354.88	240.636250	3
4	C0005	3	7	2034.24	291.603333	2
...	...	...	...	...	...	...
194	C0196	4	12	4982.88	416.992500	3
195	C0197	3	9	1928.65	227.056667	2
196	C0198	2	3	931.83	239.705000	2
197	C0199	4	9	1979.28	250.610000	2
198	C0200	5	16	4758.60	296.506000	4

199 rows × 6 columns

In [8]:
```
customer_features.columns = ['CustomerID', 'TotalTransactions', 'TotalQua
                             'TotalValue', 'AvgTransactionValue', 'Unique
```

In [9]:
```
customer_features
```

Out[9]:

	CustomerID	TotalTransactions	TotalQuantity	TotalValue	AvgTransactionValue
0	C0001	5	12	3354.52	278.334000
1	C0002	4	10	1862.74	208.920000
2	C0003	4	14	2725.38	195.707500
3	C0004	8	23	5354.88	240.636250
4	C0005	3	7	2034.24	291.603333
...	...	...	...	...	..
194	C0196	4	12	4982.88	416.992500
195	C0197	3	9	1928.65	227.056667
196	C0198	2	3	931.83	239.705000
197	C0199	4	9	1979.28	250.610000
198	C0200	5	16	4758.60	296.506000

199 rows × 6 columns

In [10]:
```
customers['RegionEncoded'] = customers['Region'].astype('category').cat.c
customer_features = customer_features.merge(customers[['CustomerID', 'Reg
```

In [11]:
```
customer_features
```

Out[11]:

	CustomerID	TotalTransactions	TotalQuantity	TotalValue	AvgTransactionValue
0	C0001	5	12	3354.52	278.334000
1	C0002	4	10	1862.74	208.920
2	C0003	4	14	2725.38	195.707
3	C0004	8	23	5354.88	240.636250
4	C0005	3	7	2034.24	291.603333
...	...	...	...	...	..
194	C0196	4	12	4982.88	416.992500
195	C0197	3	9	1928.65	227.056667
196	C0198	2	3	931.83	239.705000
197	C0199	4	9	1979.28	250.610000
198	C0200	5	16	4758.60	296.506000

199 rows × 7 columns

In [12]:
```
sc=StandardScaler()
scaled=sc.fit_transform(customer_features.drop(columns="CustomerID"))
```

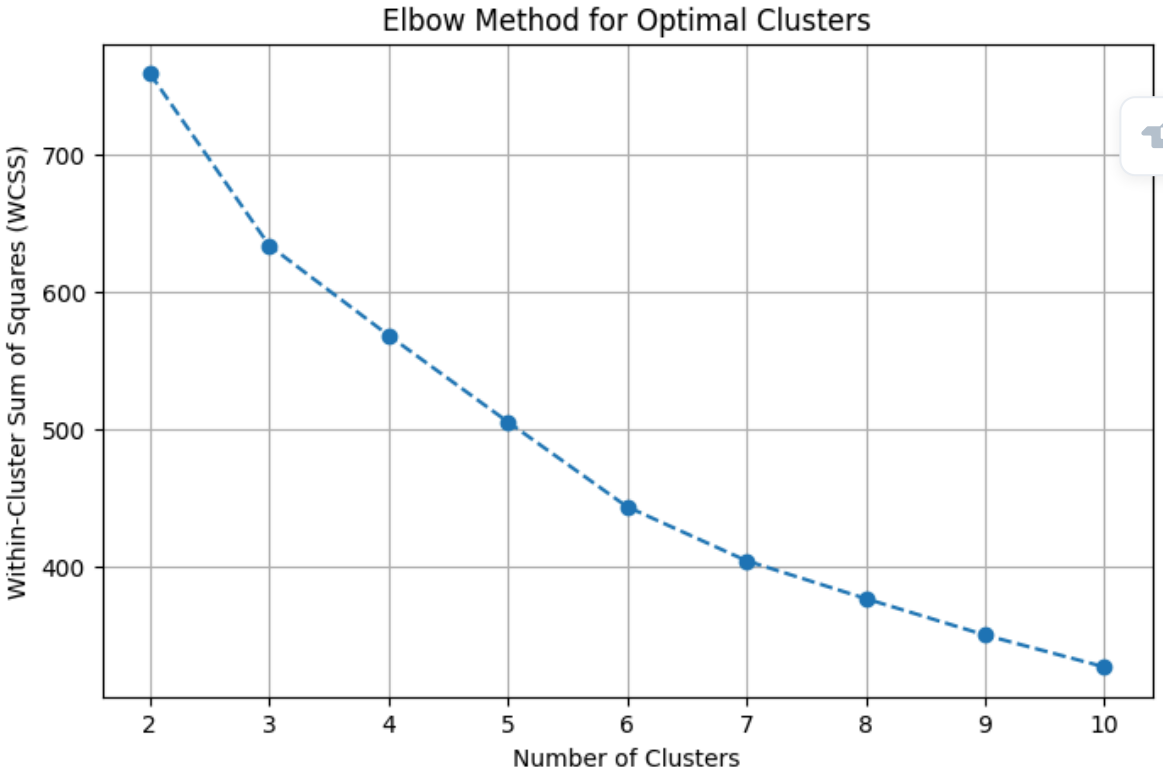
In [13]:
```
scaled
```

Out[13]:
```
array([[-0.01145819, -0.12203296, -0.06170143,  0.09467022,  0.16054032,
         1.23740234],
       [-0.46749414, -0.44800021, -0.87774353, -0.90401592, -0.90437716,
        -1.41989693],
       [-0.46749414,  0.20393428, -0.40585722, -1.09410928,  0.16054032,
         1.23740234],
       ...,
       [-1.37956603, -1.58888557, -1.38697529, -0.46110018, -0.90437716,
        -0.53413051],
       [-0.46749414, -0.61098383, -0.81399315, -0.30420572, -0.90437716,
        -0.53413051],
       [-0.01145819,  0.52990153,  0.70636652,  0.35611784,  1.22545781,
        -1.41989693]])
```

In [14]:
```
wcss = []
cluster_range = range(2, 11)  # Testing between 2 and 10 clusters
for n_clusters in cluster_range:
    kmeans = KMeans(n_clusters=n_clusters, random_state=42)
    kmeans.fit(scaled)
    wcss.append(kmeans.inertia_)
```

In [15]:
```
# Plot the Elbow Chart
plt.figure(figsize=(8, 5))
plt.plot(cluster_range, wcss, marker='o', linestyle='--')
```

```
plt.title('Elbow Method for Optimal Clusters')
plt.xlabel('Number of Clusters')
plt.ylabel('Within-Cluster Sum of Squares (WCSS)')
plt.xticks(cluster_range)
plt.grid()
plt.show()
```



In [ ]:

In [16]:
```
kmeans = KMeans(n_clusters=3, random_state=42)
customer_features['Cluster'] = kmeans.fit_predict(scaled)
```

In [17]:
```
customer_features
```

Out[17]:

	CustomerID	TotalTransactions	TotalQuantity	TotalValue	AvgTransactionValue
0	C0001	5	12	3354.52	278.334000
1	C0002	4	10	1862.74	208.920000
2	C0003	4	14	2725.38	195.707500
3	C0004	8	23	5354.88	240.636250
4	C0005	3	7	2034.24	291.603333
...	...	...	...	...	
194	C0196	4	12	4982.88	416.992500
195	C0197	3	9	1928.65	227.056667
196	C0198	2	3	931.83	239.705000
197	C0199	4	9	1979.28	250.610000
198	C0200	5	16	4758.60	296.506000

199 rows × 8 columns

In [18]:
```
from sklearn.metrics.cluster import davies_bouldin_score
```

In [19]:
```
db_index = davies_bouldin_score(scaled, customer_features['Cluster'])
print(f"Davies-Bouldin Index: {db_index}")
```

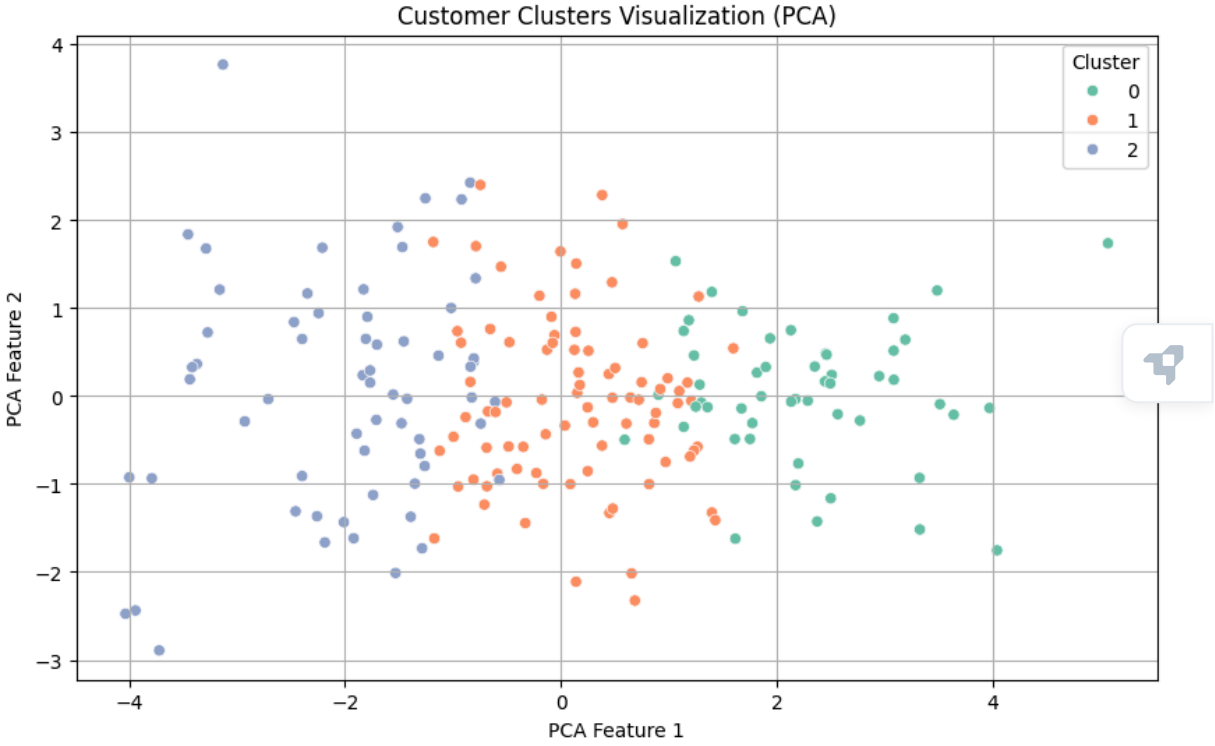
```
Davies-Bouldin Index: 1.4339619357540592
```

In [20]:
```
from sklearn.decomposition import PCA
import seaborn as sns
```

In [21]:
```
# Visualize clusters using PCA
pca = PCA(n_components=2)
pca_features = pca.fit_transform(scaled)

plt.figure(figsize=(10, 6))
sns.scatterplot(x=pca_features[:, 0], y=pca_features[:, 1], hue=customer_
plt.title("Customer Clusters Visualization (PCA)")
plt.xlabel("PCA Feature 1")
plt.ylabel("PCA Feature 2")
plt.legend(title='Cluster')
plt.grid()
plt.show()


# Analyze cluster characteristics
```



In [22]:
```
# Save clustering results
customer_features.to_csv("Tushar_Clustering.csv", index=False)
```

In [23]:
```
cluster_summary = customer_features.groupby('Cluster').agg({
    'TotalTransactions': 'mean',
    'TotalQuantity': 'mean',
    'TotalValue': 'mean',
    'AvgTransactionValue': 'mean',
    'UniqueCategories': 'mean',
    'RegionEncoded': 'mean'
}).reset_index()
```

In [24]:
```
print("Cluster Summary:")
print(cluster_summary)

# Save cluster summary
cluster_summary.to_csv("Tushar_Cluster_Summary.csv", index=False)
```

```
Cluster Summary:
   Cluster  TotalTransactions  TotalQuantity   TotalValue  \
0        0           7.549020      20.549020  5719.850196
1        1           5.142857      12.452381  3439.460595
2        2           2.859375       6.921875  1708.882969

   AvgTransactionValue  UniqueCategories  RegionEncoded
0           278.539669          3.666667       1.274510
1           282.455424          3.059524       2.190476
2           252.300789          1.921875       1.093750
```

In [ ]: