In [13]:
```
import pandas as pd
df = pd.read_csv("C:\\Users\\jeeva\\Downloads\\archive (12)\\ecommerce_customer_data_large.csv")
df.rename(columns={
    'Customer ID': 'CustomerID',
    'Purchase Date': 'PurchaseDate',
    'Product Category': 'ProductCategory',
    'Product Price': 'UnitPrice',
    'Total Purchase Amount': 'TotalAmount',
    'Payment Method': 'PaymentMethod',
    'Customer Age': 'CustomerAge',
    'Returns': 'Returns',
    'Customer Name': 'CustomerName',
    'Age': 'Age',
    'Gender': 'Gender',
    'Churn': 'Churn'
}, inplace=True)
```

In [14]:
```
df.head(5)
```

Out[14]:

	CustomerID	PurchaseDate	ProductCategory	UnitPrice	Quantity	TotalAmount	PaymentMethod	CustomerAge	Returns	Custon
0	44605	2023-05-03 21:30:02	Home	177	1	2427	PayPal	31	1.0	Jol
1	44605	2021-05-16 13:57:44	Electronics	174	3	2448	PayPal	31	1.0	Jol
2	44605	2020-07-13 06:16:57	Books	413	1	2345	Credit Card	31	1.0	Jol
3	44605	2023-01-17 13:14:36	Electronics	396	3	937	Cash	31	0.0	Jol
4	44605	2021-05-01 11:29:27	Books	259	4	2598	PayPal	31	1.0	Jol

In [15]:
```
#Convert data types
df['PurchaseDate'] = pd.to_datetime(df['PurchaseDate'])
df['UnitPrice'] = pd.to_numeric(df['UnitPrice'], errors='coerce')
df['Quantity'] = pd.to_numeric(df['Quantity'], errors='coerce')
df['TotalAmount'] = pd.to_numeric(df['TotalAmount'], errors='coerce')
```

In [16]:
```
df.dropna(subset=['CustomerID', 'PurchaseDate', 'UnitPrice', 'Quantity'], inplace=True)
```

In [17]:
```
df['TotalAmount'] = df['UnitPrice'] * df['Quantity']
```

In [18]:
```
df['TransactionDate'] = df['PurchaseDate'].dt.date
```

In [19]:
```
# RFM Analysis
NOW = df['PurchaseDate'].max()
rfm = df.groupby('CustomerID').agg({
    'PurchaseDate': lambda x: (NOW - x.max()).days,  # Recency: Days since last purchase
    'TransactionDate': 'nunique',  # Frequency: Number of unique dates (transactions)
    'TotalAmount': 'sum'  # Monetary: Total amount spent
}).reset_index()

rfm.columns = ['CustomerID', 'Recency', 'Frequency', 'Monetary']
```

In [20]:
```
df['Returned'] = df['Returns'].apply(lambda x: 1 if x == 'Yes' else 0)
return_rate = df.groupby('CustomerID')['Returned'].mean().reset_index()
rfm = rfm.merge(return_rate, on='CustomerID')
```

In [21]:
```
customer_info = df[['CustomerID', 'CustomerAge', 'Gender', 'Churn']].drop_duplicates()
rfm = rfm.merge(customer_info, on='CustomerID', how='left')
```

In [22]:
```
df['PurchaseMonth'] = df['PurchaseDate'].dt.month
df['DayOfWeek'] = df['PurchaseDate'].dt.day_name()
```

In [23]:
```
print(rfm.head())
```

```
   CustomerID  Recency  Frequency  Monetary  Returned  CustomerAge  Gender  \
0           1      288          3      5600       0.0           67  Female
1           2       72          6      6459       0.0           42  Female
2           3      222          4      3613       0.0           31    Male
3           4      441          5      4339       0.0           37    Male
4           5      424          5      2263       0.0           24  Female

   Churn
0      0
1      0
2      0
3      0
4      0
```

In [24]:
```
print(df.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 250000 entries, 0 to 249999
Data columns (total 17 columns):
 #   Column           Non-Null Count   Dtype
---  ------           --------------   -----
 0   CustomerID       250000 non-null  int64
 1   PurchaseDate     250000 non-null  datetime64[ns]
 2   ProductCategory  250000 non-null  object
 3   UnitPrice        250000 non-null  int64
 4   Quantity         250000 non-null  int64
 5   TotalAmount      250000 non-null  int64
 6   PaymentMethod    250000 non-null  object
 7   CustomerAge      250000 non-null  int64
 8   Returns          202618 non-null  float64
 9   CustomerName     250000 non-null  object
 10  Age              250000 non-null  int64
 11  Gender           250000 non-null  object
 12  Churn            250000 non-null  int64
 13  TransactionDate  250000 non-null  object
 14  Returned         250000 non-null  int64
 15  PurchaseMonth    250000 non-null  int32
 16  DayOfWeek        250000 non-null  object
dtypes: datetime64[ns](1), float64(1), int32(1), int64(8), object(6)
memory usage: 31.5+ MB
None
```

In [25]:
```
print(df.describe())
```

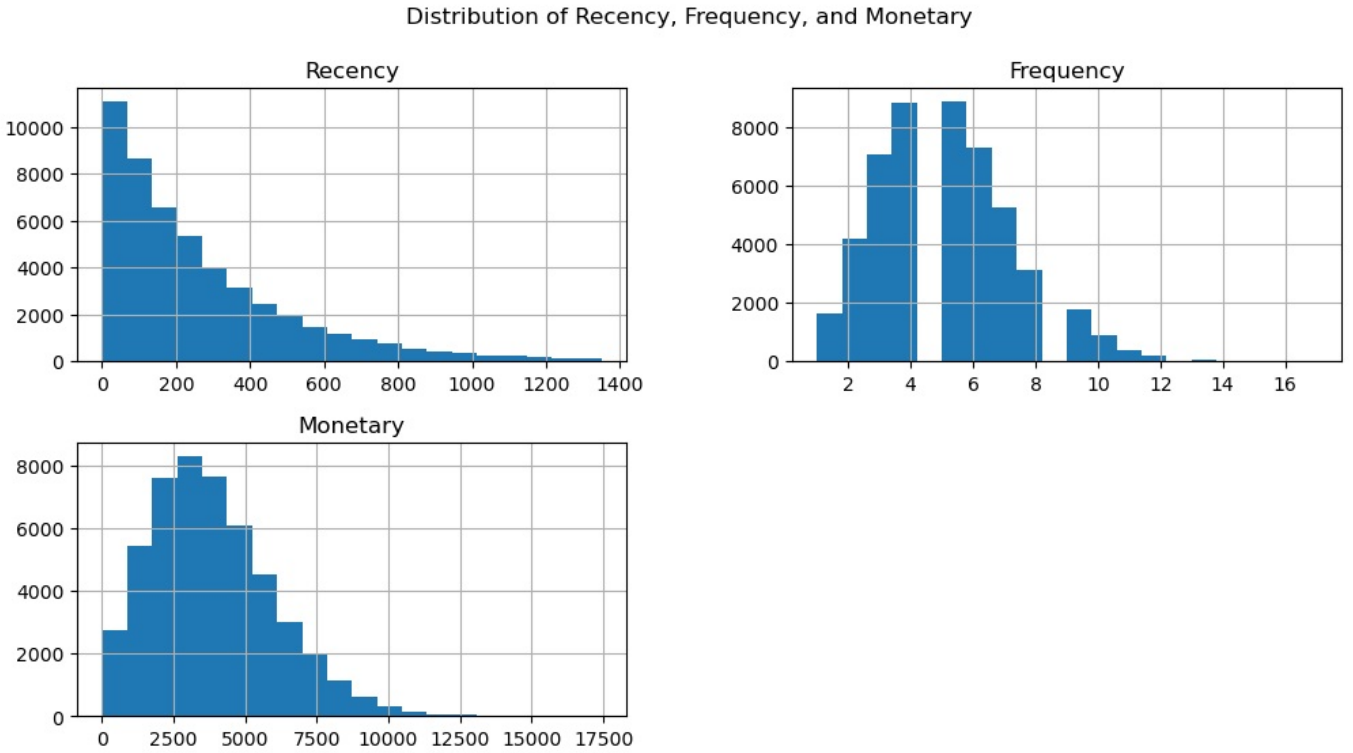
```
          CustomerID                    PurchaseDate      UnitPrice  \
count  250000.000000                          250000  250000.000000
mean    25017.632092  2021-11-06 19:26:22.286192384     254.742724
min         1.000000            2020-01-01 00:07:26      10.000000
25%     12590.000000            2020-12-03 08:10:12     132.000000
50%     25011.000000     2021-11-06 07:39:08.500000     255.000000
75%     37441.250000  2022-10-11 01:21:56.249999872     377.000000
max     50000.000000            2023-09-13 18:42:49     500.000000
std     14412.515718                            NaN     141.738104

            Quantity    TotalAmount    CustomerAge        Returns  \
count  250000.000000  250000.000000  250000.000000  202618.000000
mean        3.004936     765.954660      43.798276       0.500824
min         1.000000      10.000000      18.000000       0.000000
25%         2.000000     288.000000      30.000000       0.000000
50%         3.000000     604.000000      44.000000       1.000000
75%         4.000000    1135.000000      57.000000       1.000000
max         5.000000    2500.000000      70.000000       1.000000
std         1.414737     593.494204      15.364915       0.500001

                Age         Churn  Returned  PurchaseMonth
count  250000.000000  250000.00000  250000.0  250000.000000
mean       43.798276       0.20052       0.0       6.190376
min        18.000000       0.00000       0.0       1.000000
25%        30.000000       0.00000       0.0       3.000000
50%        44.000000       0.00000       0.0       6.000000
75%        57.000000       0.00000       0.0       9.000000
max        70.000000       1.00000       0.0      12.000000
std        15.364915       0.40039       0.0       3.353238
```

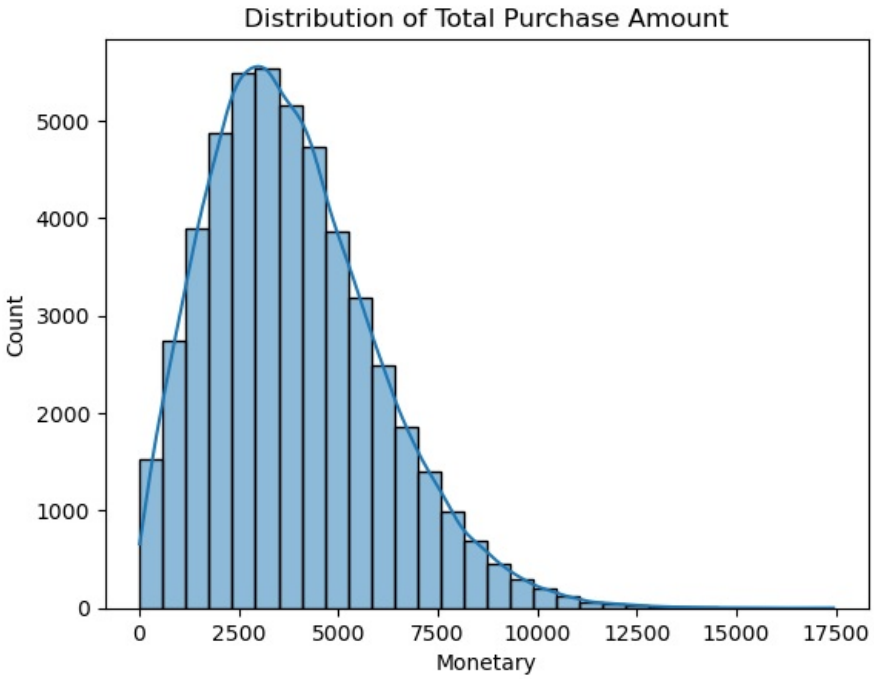
In [26]:
```
print(df.isnull().sum())
```

```
CustomerID             0
PurchaseDate           0
ProductCategory        0
UnitPrice              0
Quantity               0
TotalAmount            0
PaymentMethod          0
CustomerAge            0
Returns            47382
CustomerName           0
Age                    0
Gender                 0
Churn                  0
TransactionDate        0
Returned               0
PurchaseMonth          0
DayOfWeek              0
dtype: int64
```

In [27]:

```python
import matplotlib.pyplot as plt
import seaborn as sns

# Plot histograms for Recency, Frequency, and Monetary
rfm[['Recency', 'Frequency', 'Monetary']].hist(figsize=(12, 6), bins=20)
plt.suptitle('Distribution of Recency, Frequency, and Monetary')
plt.show()

# Plot TotalAmount distribution
sns.histplot(rfm['Monetary'], kde=True, bins=30)
plt.title('Distribution of Total Purchase Amount')
plt.show()
```





In [28]:
```
df = df.merge(rfm, on='CustomerID', how='left')
```

In [29]:
```
df.columns = df.columns.str.strip()  # Remove leading/trailing spaces from column names
```

In [30]:
```
print(df.columns.tolist())
```

```
['CustomerID', 'PurchaseDate', 'ProductCategory', 'UnitPrice', 'Quantity', 'TotalAmount', 'PaymentMethod', 'Cust
omerAge_x', 'Returns', 'CustomerName', 'Age', 'Gender_x', 'Churn_x', 'TransactionDate', 'Returned_x', 'PurchaseM
onth', 'DayOfWeek', 'Recency', 'Frequency', 'Monetary', 'Returned_y', 'CustomerAge_y', 'Gender_y', 'Churn_y']
```

In [31]:
```
df.columns = df.columns.str.strip().str.lower()
print(df.columns.tolist())
```

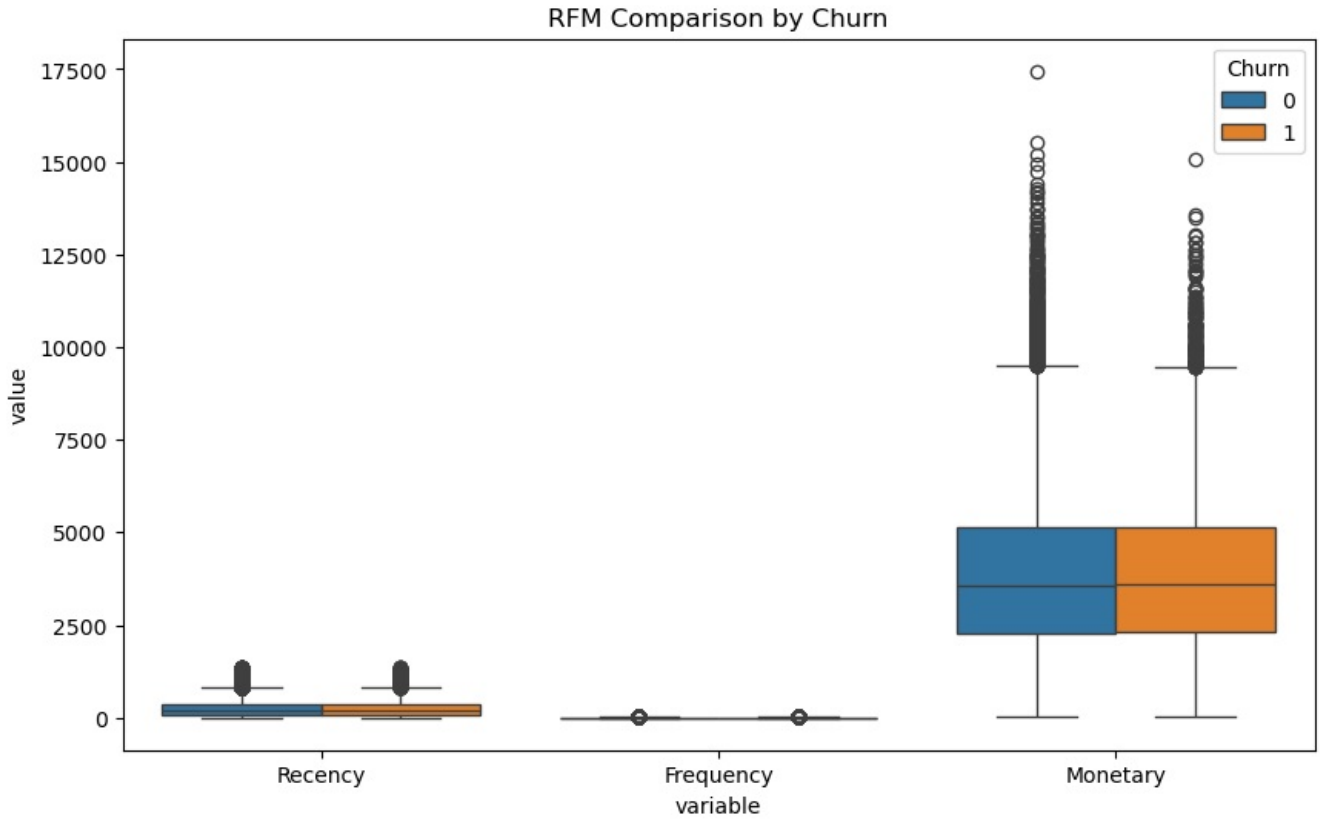
```
['customerid', 'purchasedate', 'productcategory', 'unitprice', 'quantity', 'totalamount', 'paymentmethod', 'cust
omerage_x', 'returns', 'customername', 'age', 'gender_x', 'churn_x', 'transactiondate', 'returned_x', 'purchasem
onth', 'dayofweek', 'recency', 'frequency', 'monetary', 'returned_y', 'customerage_y', 'gender_y', 'churn_y']
```

In [32]:
```
churn_analysis = df.groupby('churn_x').agg({
    'recency': 'mean',
    'frequency': 'mean',
    'monetary': 'mean'
}).reset_index()

print(churn_analysis)
```

```
   churn_x     recency  frequency     monetary
0        0  217.226953   5.979086  4587.678406
1        1  215.314881   5.994036  4606.886615
```

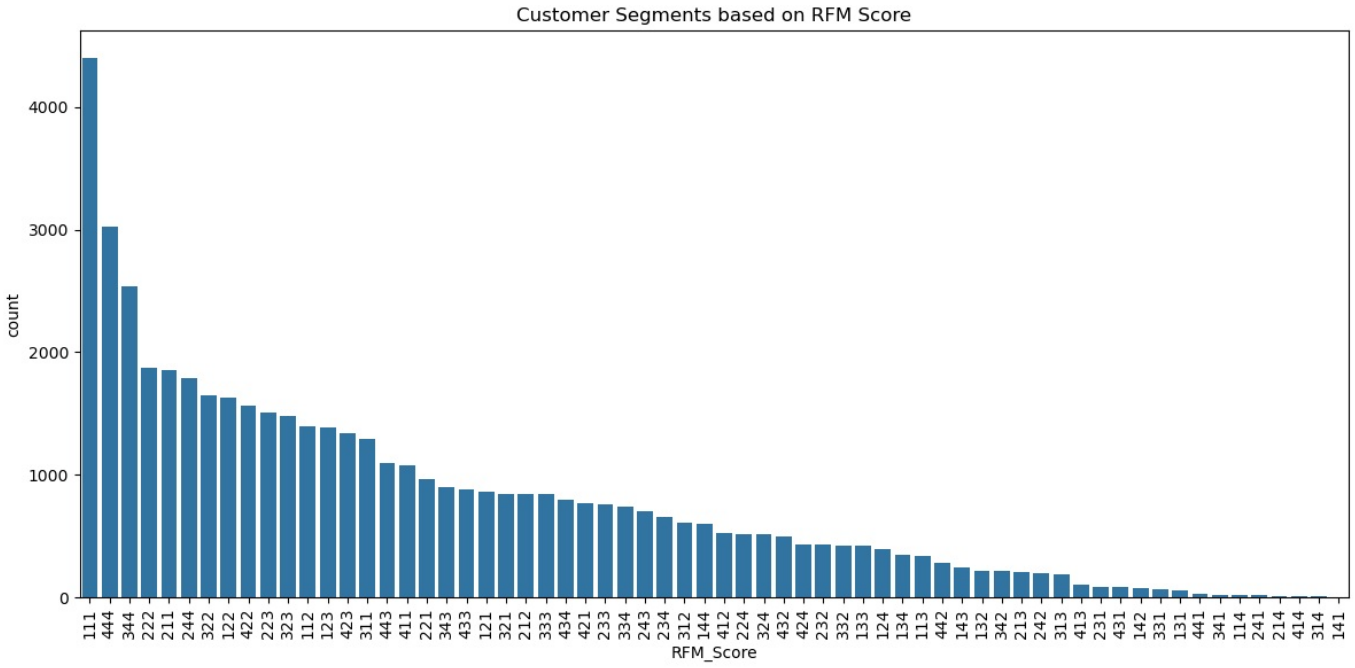
In [33]:
```
import seaborn as sns
import matplotlib.pyplot as plt

melted = rfm.melt(id_vars='Churn', value_vars=['Recency', 'Frequency', 'Monetary'])
```

```
plt.figure(figsize=(10,6))
sns.boxplot(x='variable', y='value', hue='Churn', data=melted)
plt.title('RFM Comparison by Churn')
plt.show()
```

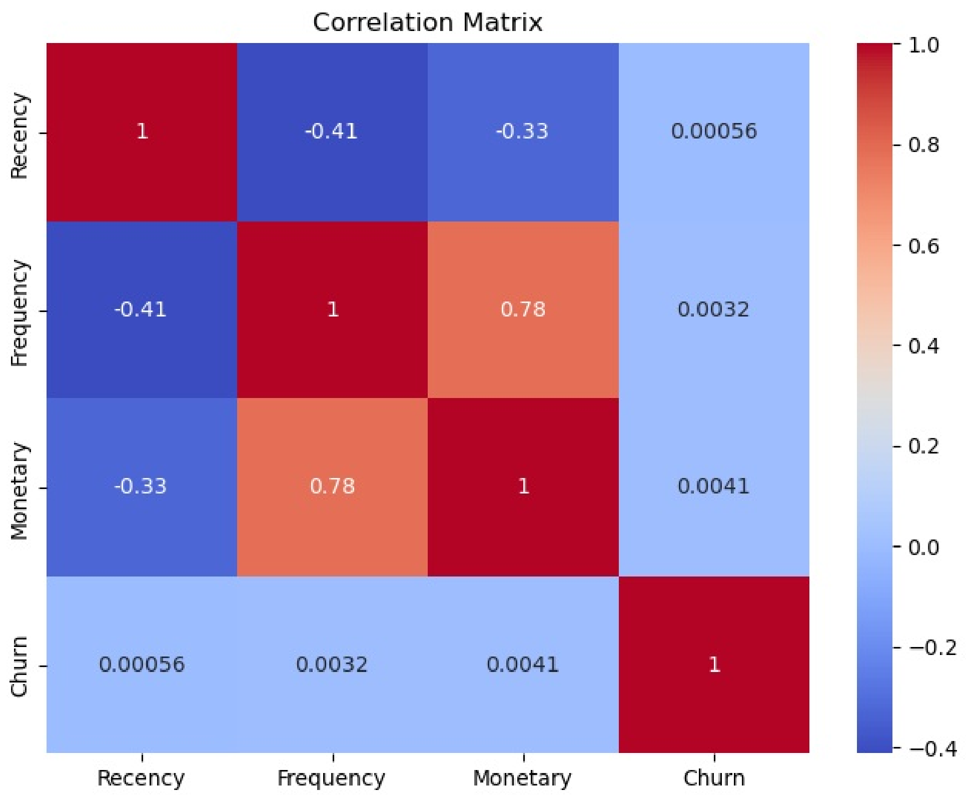


In [34]:
```
rfm['R_score'] = pd.qcut(rfm['Recency'], 4, labels=[4,3,2,1])
rfm['F_score'] = pd.qcut(rfm['Frequency'], 4, labels=[1,2,3,4])
rfm['M_score'] = pd.qcut(rfm['Monetary'], 4, labels=[1,2,3,4])

rfm['RFM_Score'] = rfm['R_score'].astype(str) + rfm['F_score'].astype(str) + rfm['M_score'].astype(str)
```

In [35]:
```
plt.figure(figsize=(12,6))
sns.countplot(x='RFM_Score', data=rfm, order=rfm['RFM_Score'].value_counts().index)
plt.xticks(rotation=90)
plt.title('Customer Segments based on RFM Score')
plt.tight_layout()
plt.show()
```



In [72]:
```
plt.figure(figsize=(8, 6))
sns.heatmap(rfm[['Recency', 'Frequency', 'Monetary', 'Churn']].corr(), annot=True, cmap='coolwarm')
plt.title('Correlation Matrix')
plt.show()
```



In [37]:

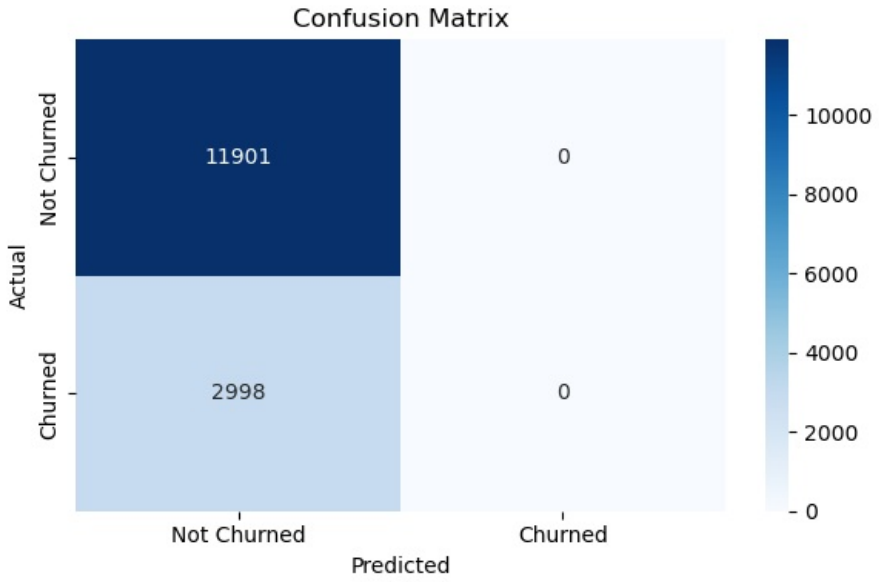
```
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report

X = rfm[['Recency', 'Frequency', 'Monetary']]
y = rfm['Churn']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)

model = LogisticRegression(max_iter=1000)
model.fit(X_train, y_train)
y_pred = model.predict(X_test)

print("Classification Report:\n")
print(classification_report(y_test, y_pred))
```

```
Classification Report:

              precision    recall  f1-score   support

           0       0.80      1.00      0.89     11901
           1       0.00      0.00      0.00      2998

    accuracy                           0.80     14899
   macro avg       0.40      0.50      0.44     14899
weighted avg       0.64      0.80      0.71     14899
```

```
C:\Users\jeeva\anaconda3\Lib\site-packages\sklearn\metrics\_classification.py:1531: UndefinedMetricWarning: Prec
ision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
C:\Users\jeeva\anaconda3\Lib\site-packages\sklearn\metrics\_classification.py:1531: UndefinedMetricWarning: Prec
ision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
C:\Users\jeeva\anaconda3\Lib\site-packages\sklearn\metrics\_classification.py:1531: UndefinedMetricWarning: Prec
ision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
```

In [38]:

```
from sklearn.metrics import confusion_matrix
plt.figure(figsize=(6, 4))
sns.heatmap(confusion_matrix(y_test, y_pred), annot=True, fmt="d", cmap="Blues",
            xticklabels=['Not Churned', 'Churned'], yticklabels=['Not Churned', 'Churned'])
plt.title("Confusion Matrix")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.tight_layout()
plt.show()
```



In [68]:
```
from sklearn.cluster import KMeans
kmeans = KMeans(n_clusters=4, random_state=42)
rfm['Cluster'] = kmeans.fit_predict(rfm[['Recency', 'Frequency', 'Monetary']])

sns.scatterplot(data=rfm, x='Recency', y='Monetary', hue='Cluster', palette='tab10')
plt.title('Customer Clusters (K-Means)')
plt.show()
```

In [74]:
```
rfm.to_csv("rfm_churn_segmented.csv", index=False)
print("Segmented RFM data saved as 'rfm_churn_segmented.csv'")
```

```
Segmented RFM data saved as 'rfm_churn_segmented.csv'
```

In [ ]: