In [125…

```
import pandas as pd
df = pd.read_csv('WA_Fn-UseC_-Telco-Customer-Churn.csv')
df
```

Out[125]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	InternetService	OnlineSecurity	...	Devi
0	7590-VHVEG	Female	0	Yes	No	1	No	No phone service	DSL	No	...	
1	5575-GNVDE	Male	0	No	No	34	Yes	No	DSL	Yes	...	
2	3668-QPYBK	Male	0	No	No	2	Yes	No	DSL	Yes	...	
3	7795-CFOCW	Male	0	No	No	45	No	No phone service	DSL	Yes	...	
4	9237-HQITU	Female	0	No	No	2	Yes	No	Fiber optic	No	...	
...	...	...	...	...	...	...	...	...	...	...	...	
7038	6840-RESVB	Male	0	Yes	Yes	24	Yes	Yes	DSL	Yes	...	
7039	2234-XADUH	Female	0	Yes	Yes	72	Yes	Yes	Fiber optic	No	...	
7040	4801-JZAZL	Female	0	Yes	Yes	11	No	No phone service	DSL	Yes	...	
7041	8361-LTMKD	Male	1	Yes	No	4	Yes	Yes	Fiber optic	No	...	
7042	3186-AJIEK	Male	0	No	No	66	Yes	No	Fiber optic	Yes	...	

7043 rows × 21 columns

In [126…

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7043 entries, 0 to 7042
Data columns (total 21 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   customerID        7043 non-null   object 
 1   gender            7043 non-null   object 
 2   SeniorCitizen     7043 non-null   int64  
 3   Partner           7043 non-null   object 
 4   Dependents        7043 non-null   object 
 5   tenure            7043 non-null   int64  
 6   PhoneService      7043 non-null   object 
 7   MultipleLines     7043 non-null   object 
 8   InternetService   7043 non-null   object 
 9   OnlineSecurity    7043 non-null   object 
 10  OnlineBackup      7043 non-null   object 
 11  DeviceProtection  7043 non-null   object 
 12  TechSupport       7043 non-null   object 
 13  StreamingTV       7043 non-null   object 
 14  StreamingMovies   7043 non-null   object 
 15  Contract          7043 non-null   object 
 16  PaperlessBilling  7043 non-null   object 
 17  PaymentMethod     7043 non-null   object 
 18  MonthlyCharges    7043 non-null   float64
 19  TotalCharges      7043 non-null   object 
 20  Churn             7043 non-null   object 
dtypes: float64(1), int64(2), object(18)
memory usage: 1.1+ MB
```

In [127…

```
df.isna()
```

Out[127]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	InternetService	OnlineSecurity	...	Devi
0	False	False	False	False	False	False	False	False	False	False	...	
1	False	False	False	False	False	False	False	False	False	False	...	
2	False	False	False	False	False	False	False	False	False	False	...	
3	False	False	False	False	False	False	False	False	False	False	...	
4	False	False	False	False	False	False	False	False	False	False	...	
...	...	...	...	...	...	...	...	...	...	...	...	
7038	False	False	False	False	False	False	False	False	False	False	...	
7039	False	False	False	False	False	False	False	False	False	False	...	
7040	False	False	False	False	False	False	False	False	False	False	...	
7041	False	False	False	False	False	False	False	False	False	False	...	
7042	False	False	False	False	False	False	False	False	False	False	...	

7043 rows × 21 columns

In [128…

```
df.dropna()
```

Out[128]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	InternetService	OnlineSecurity	...	Devi
0	7590-VHVEG	Female	0	Yes	No	1	No	No phone service	DSL	No	...	
1	5575-GNVDE	Male	0	No	No	34	Yes	No	DSL	Yes	...	
2	3668-QPYBK	Male	0	No	No	2	Yes	No	DSL	Yes	...	
3	7795-CFOCW	Male	0	No	No	45	No	No phone service	DSL	Yes	...	
4	9237-HQITU	Female	0	No	No	2	Yes	No	Fiber optic	No	...	
...	...	...	...	...	...	...	...	...	...	...	...	
7038	6840-RESVB	Male	0	Yes	Yes	24	Yes	Yes	DSL	Yes	...	
7039	2234-XADUH	Female	0	Yes	Yes	72	Yes	Yes	Fiber optic	No	...	
7040	4801-JZAZL	Female	0	Yes	Yes	11	No	No phone service	DSL	Yes	...	
7041	8361-LTMKD	Male	1	Yes	No	4	Yes	Yes	Fiber optic	No	...	
7042	3186-AJIEK	Male	0	No	No	66	Yes	No	Fiber optic	Yes	...	

7043 rows × 21 columns

In [129…

```
df
```

Out[129]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	InternetService	OnlineSecurity	...	Devi
0	7590-VHVEG	Female	0	Yes	No	1	No	No phone service	DSL	No	...	
1	5575-GNVDE	Male	0	No	No	34	Yes	No	DSL	Yes	...	
2	3668-QPYBK	Male	0	No	No	2	Yes	No	DSL	Yes	...	
3	7795-CFOCW	Male	0	No	No	45	No	No phone service	DSL	Yes	...	
4	9237-HQITU	Female	0	No	No	2	Yes	No	Fiber optic	No	...	
...	...	...	...	...	...	...	...	...	...	...	...	
7038	6840-RESVB	Male	0	Yes	Yes	24	Yes	Yes	DSL	Yes	...	
7039	2234-XADUH	Female	0	Yes	Yes	72	Yes	Yes	Fiber optic	No	...	
7040	4801-JZAZL	Female	0	Yes	Yes	11	No	No phone service	DSL	Yes	...	
7041	8361-LTMKD	Male	1	Yes	No	4	Yes	Yes	Fiber optic	No	...	
7042	3186-AJIEK	Male	0	No	No	66	Yes	No	Fiber optic	Yes	...	

7043 rows × 21 columns

In [130…

```
df.describe()
```

Out[130]:

	SeniorCitizen	tenure	MonthlyCharges
count	7043.000000	7043.000000	7043.000000
mean	0.162147	32.371149	64.761692
std	0.368612	24.559481	30.090047
min	0.000000	0.000000	18.250000
25%	0.000000	9.000000	35.500000
50%	0.000000	29.000000	70.350000
75%	0.000000	55.000000	89.850000
max	1.000000	72.000000	118.750000

In [131…

```
df.columns
```

Out[131]:

```
Index(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
       'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
       'OnlineSecurity', 'OnlineBackup', 'DeviceProtection', 'TechSupport',
       'StreamingTV', 'StreamingMovies', 'Contract', 'PaperlessBilling',
       'PaymentMethod', 'MonthlyCharges', 'TotalCharges', 'Churn'],
      dtype='object')
```

In [132…

```
df
```

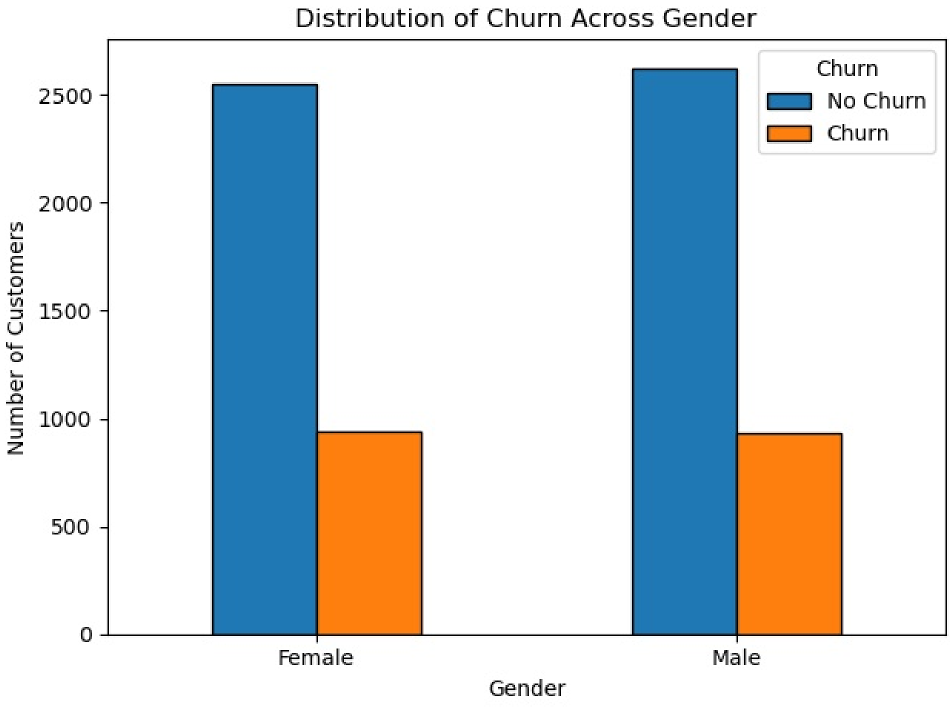
Out[132]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	InternetService	OnlineSecurity	...	Devi
0	7590-VHVEG	Female	0	Yes	No	1	No	No phone service	DSL	No	...	
1	5575-GNVDE	Male	0	No	No	34	Yes	No	DSL	Yes	...	
2	3668-QPYBK	Male	0	No	No	2	Yes	No	DSL	Yes	...	
3	7795-CFOCW	Male	0	No	No	45	No	No phone service	DSL	Yes	...	
4	9237-HQITU	Female	0	No	No	2	Yes	No	Fiber optic	No	...	
...	...	...	...	...	...	...	...	...	...	...	...	
7038	6840-RESVB	Male	0	Yes	Yes	24	Yes	Yes	DSL	Yes	...	
7039	2234-XADUH	Female	0	Yes	Yes	72	Yes	Yes	Fiber optic	No	...	
7040	4801-JZAZL	Female	0	Yes	Yes	11	No	No phone service	DSL	Yes	...	
7041	8361-LTMKD	Male	1	Yes	No	4	Yes	Yes	Fiber optic	No	...	
7042	3186-AJIEK	Male	0	No	No	66	Yes	No	Fiber optic	Yes	...	

7043 rows × 21 columns

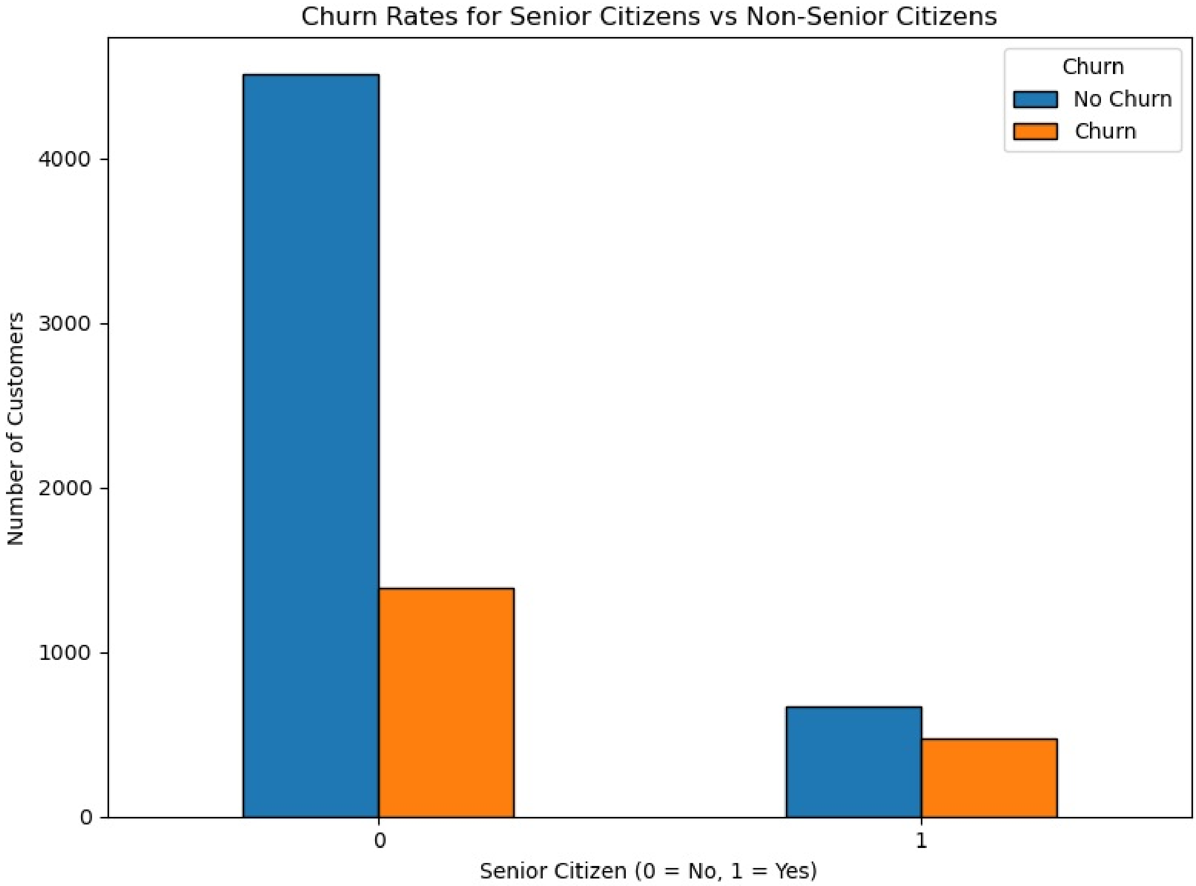
In [133…

```
#What is the distribution of churn across gender?

gender_churn = df.groupby(['gender', 'Churn']).size().unstack()

import matplotlib.pyplot as plt
gender_churn.plot(kind='bar', color=['#1f77b4', '#ff7f0e'], edgecolor='black')
plt.title("Distribution of Churn Across Gender")
plt.xlabel("Gender")
plt.ylabel("Number of Customers")
plt.xticks(rotation=0)
plt.legend(["No Churn", "Churn"], title="Churn")
plt.tight_layout()
plt.show()
```



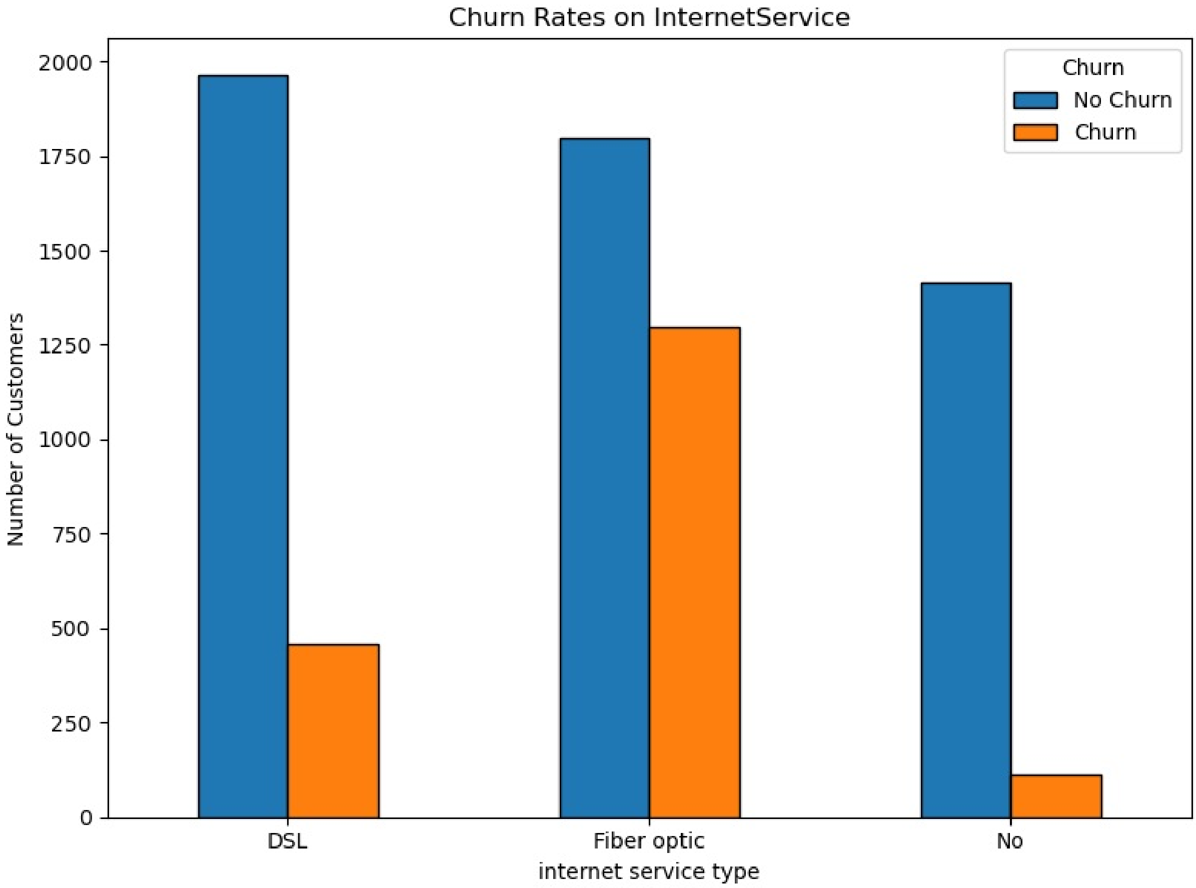
In [134…

```
#How does being a Senior Citizen affect churn rates?
senior_churn = df.groupby(['SeniorCitizen', 'Churn']).size().unstack()


fig, ax = plt.subplots(figsize=(8, 6))
senior_churn.plot(kind='bar', ax=ax, color=['#1f77b4', '#ff7f0e'], edgecolor='black')
plt.title("Churn Rates for Senior Citizens vs Non-Senior Citizens")
plt.xlabel("Senior Citizen (0 = No, 1 = Yes)")
plt.ylabel("Number of Customers")
plt.xticks(rotation=0)
plt.legend(["No Churn", "Churn"], title="Churn")
plt.tight_layout()
plt.show()
```



In [135…

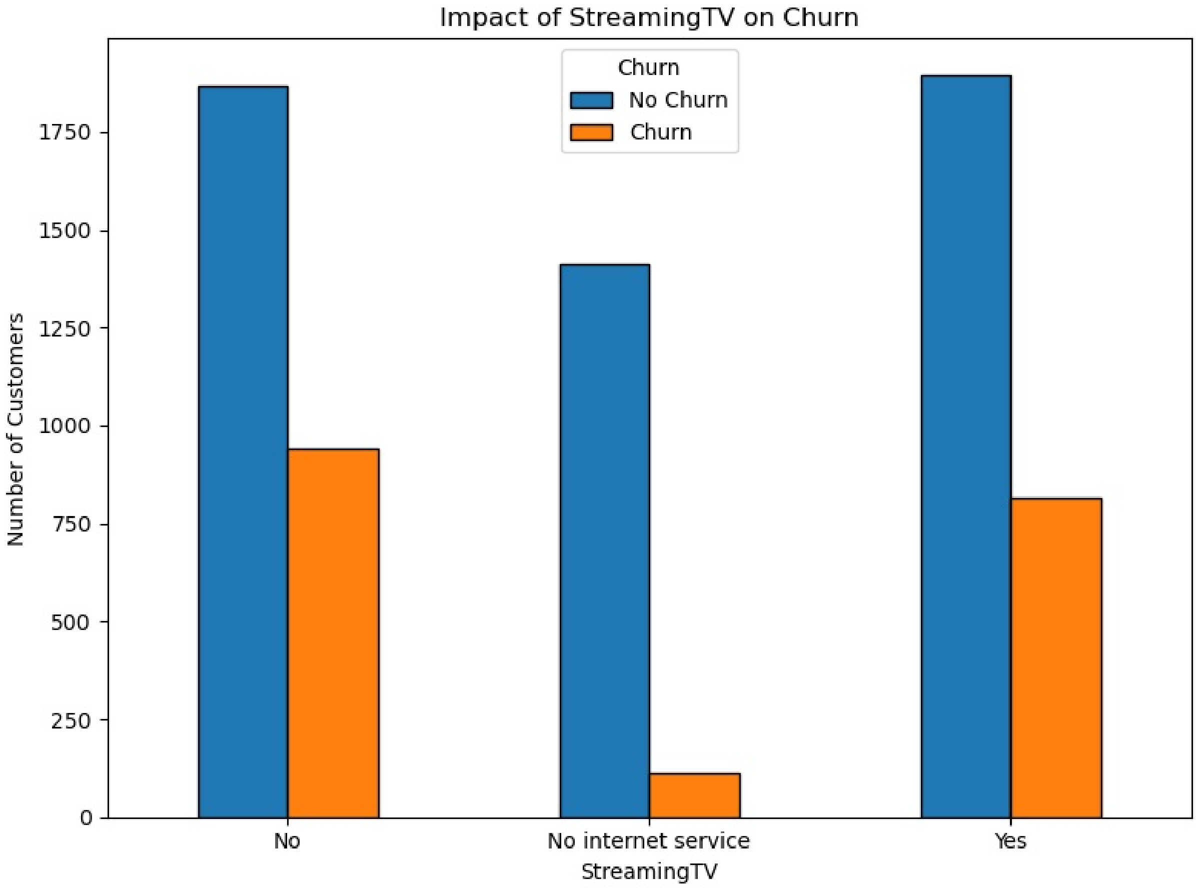
```
#Does having InternetService (DSL, Fiber optic, or None) impact churn?

internet_churn = df.groupby(['InternetService', 'Churn']).size().unstack()

fig, ax = plt.subplots(figsize=(8, 6))
internet_churn.plot(kind='bar', ax=ax, color=['#1f77b4', '#ff7f0e'], edgecolor='black')
plt.title("Churn Rates on InternetService")
plt.xlabel("internet service type")
plt.ylabel("Number of Customers")
plt.xticks(rotation=0)
plt.legend(["No Churn", "Churn"], title="Churn")
plt.tight_layout()
plt.show()
```

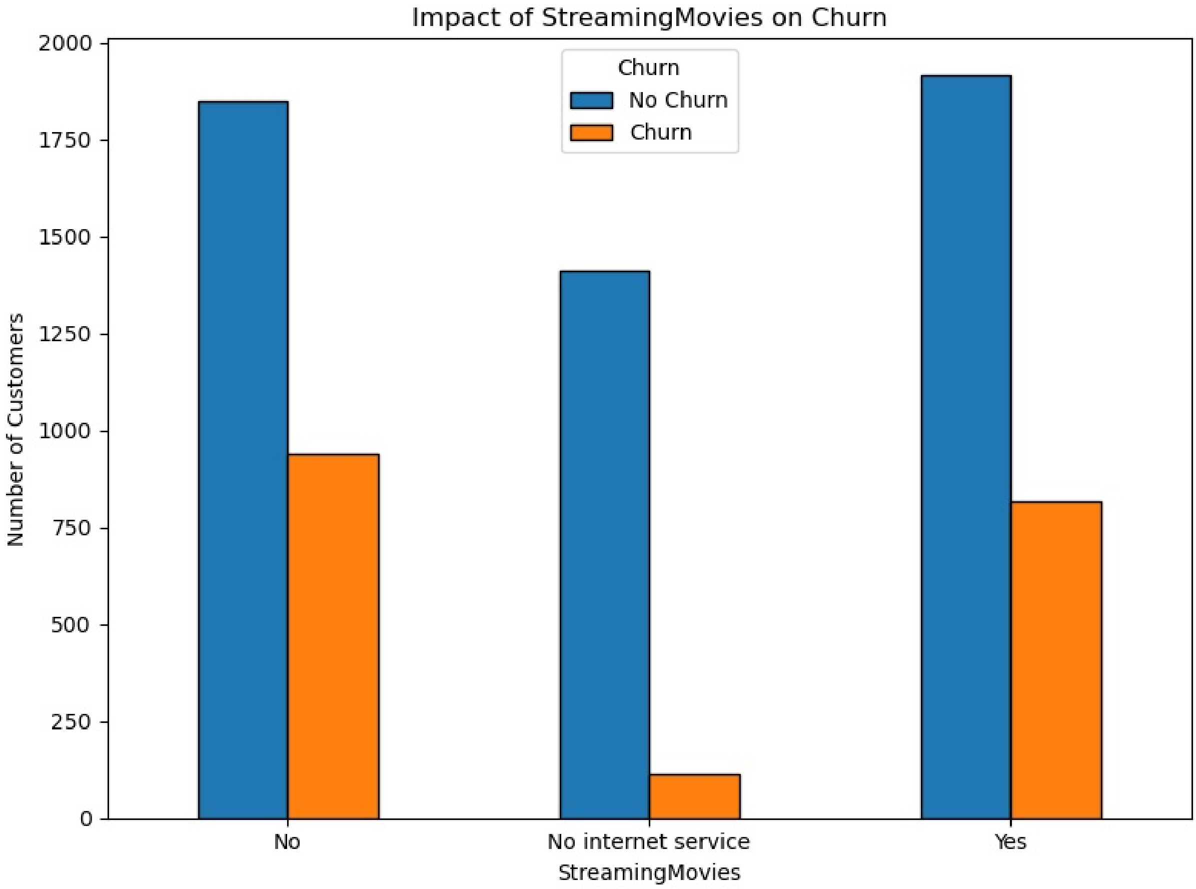


In [ ]:

In [136…

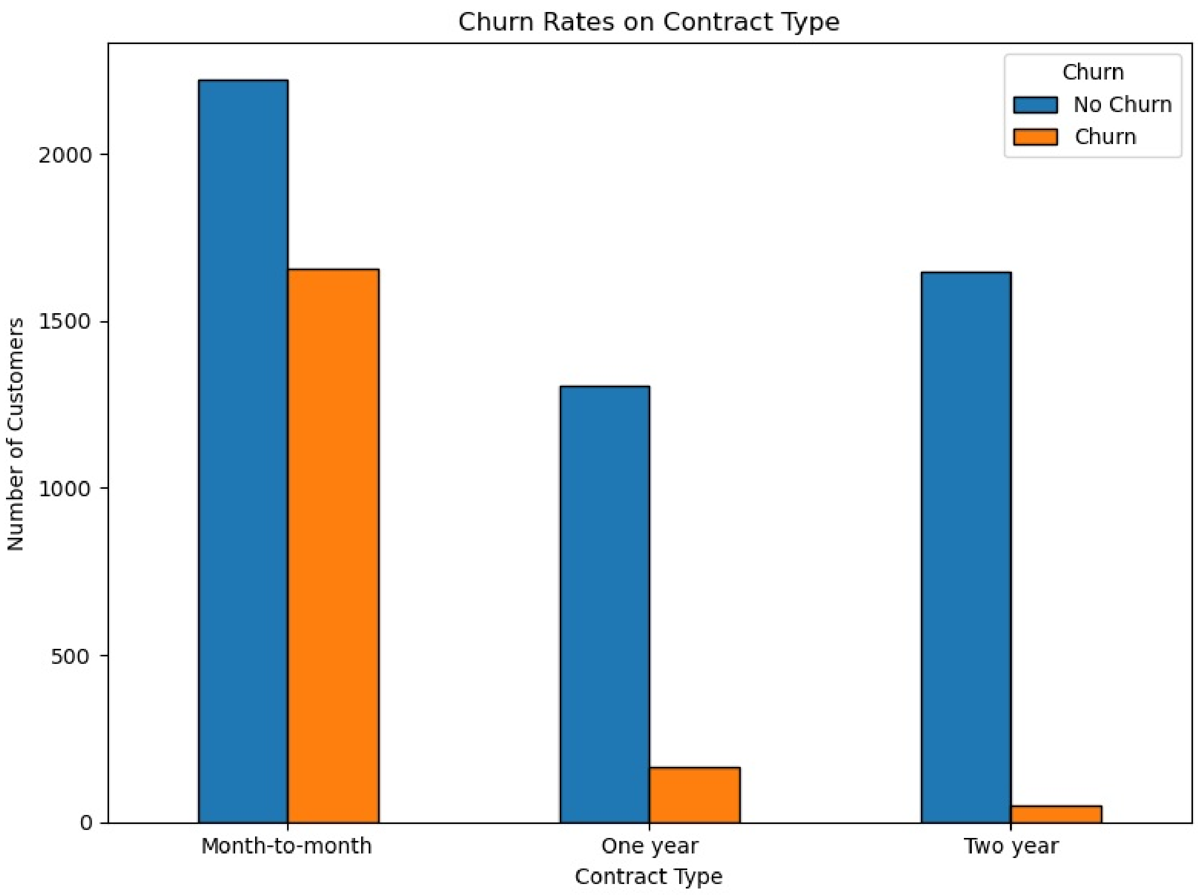
```
#Do customers with multiple services like StreamingTV or StreamingMovies churn more?


def plot_churn_by_service(service_column, title):
    service_churn = df.groupby([service_column, 'Churn']).size().unstack()

    fig, ax = plt.subplots(figsize=(8, 6))
    service_churn.plot(kind='bar', ax=ax, color=['#1f77b4', '#ff7f0e'], edgecolor='black')

    plt.title(title)
    plt.xlabel(f"{service_column}")
    plt.ylabel("Number of Customers")
    plt.xticks(rotation=0)
    plt.legend(["No Churn", "Churn"], title="Churn")
    plt.tight_layout()
    plt.show()

plot_churn_by_service('StreamingTV', "Impact of StreamingTV on Churn")
plot_churn_by_service('StreamingMovies', "Impact of StreamingMovies on Churn")
```





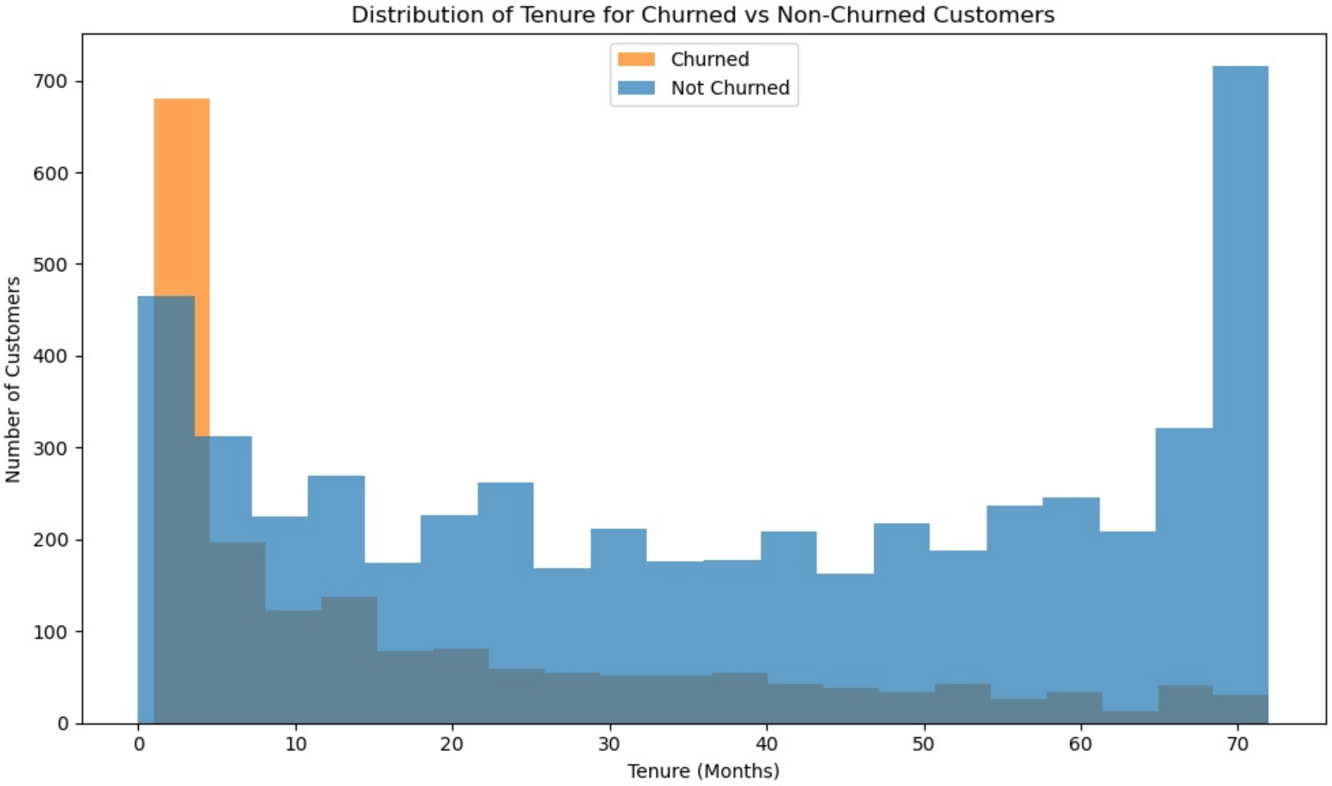
In [137…

```
#What is the relationship between Contract type and churn?

contract_churn = df.groupby(['Contract', 'Churn']).size().unstack()

fig, ax = plt.subplots(figsize=(8, 6))
contract_churn.plot(kind='bar', ax=ax, color=['#1f77b4', '#ff7f0e'], edgecolor='black')
plt.title("Churn Rates on Contract Type")
plt.xlabel("Contract Type")
plt.ylabel("Number of Customers")
plt.xticks(rotation=0)
plt.legend(["No Churn", "Churn"], title="Churn")
plt.tight_layout()
plt.show()
```



In [138…

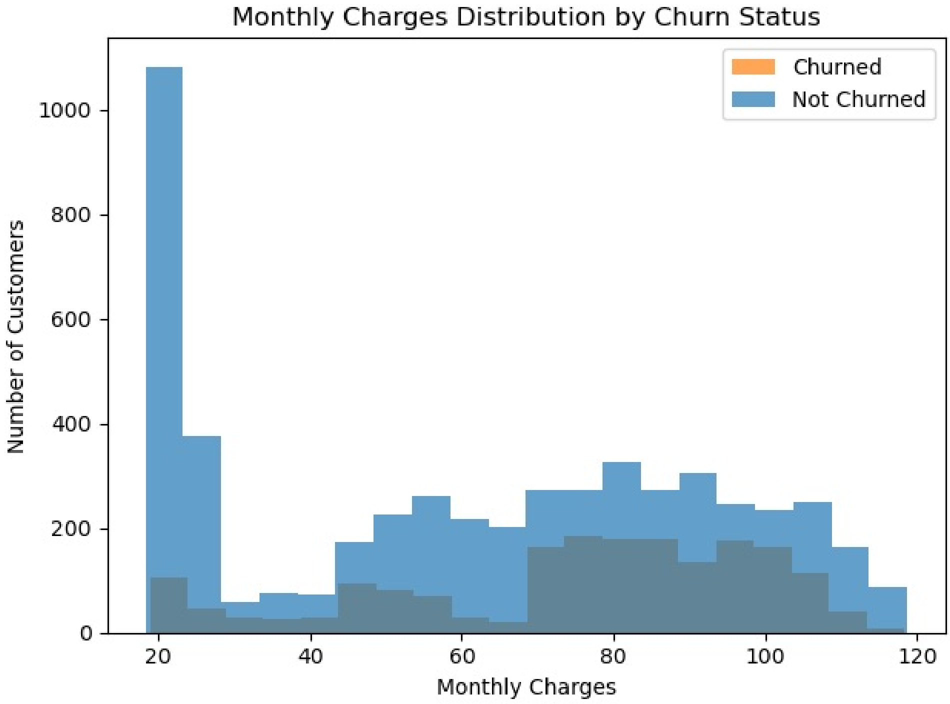
```
#How does tenure (number of months as a customer) relate to churn?

churned = df[df['Churn'] == 'Yes']
not_churned = df[df['Churn'] == 'No']

fig, ax = plt.subplots(figsize=(10, 6))
ax.hist(churned['tenure'], bins=20, color='#ff7f0e', alpha=0.7, label='Churned')
ax.hist(not_churned['tenure'], bins=20, color='#1f77b4', alpha=0.7, label='Not Churned')
plt.title("Distribution of Tenure for Churned vs Non-Churned Customers")
plt.xlabel("Tenure (Months)")
plt.ylabel("Number of Customers")
plt.legend()
plt.tight_layout()
plt.show()
```



In [139…

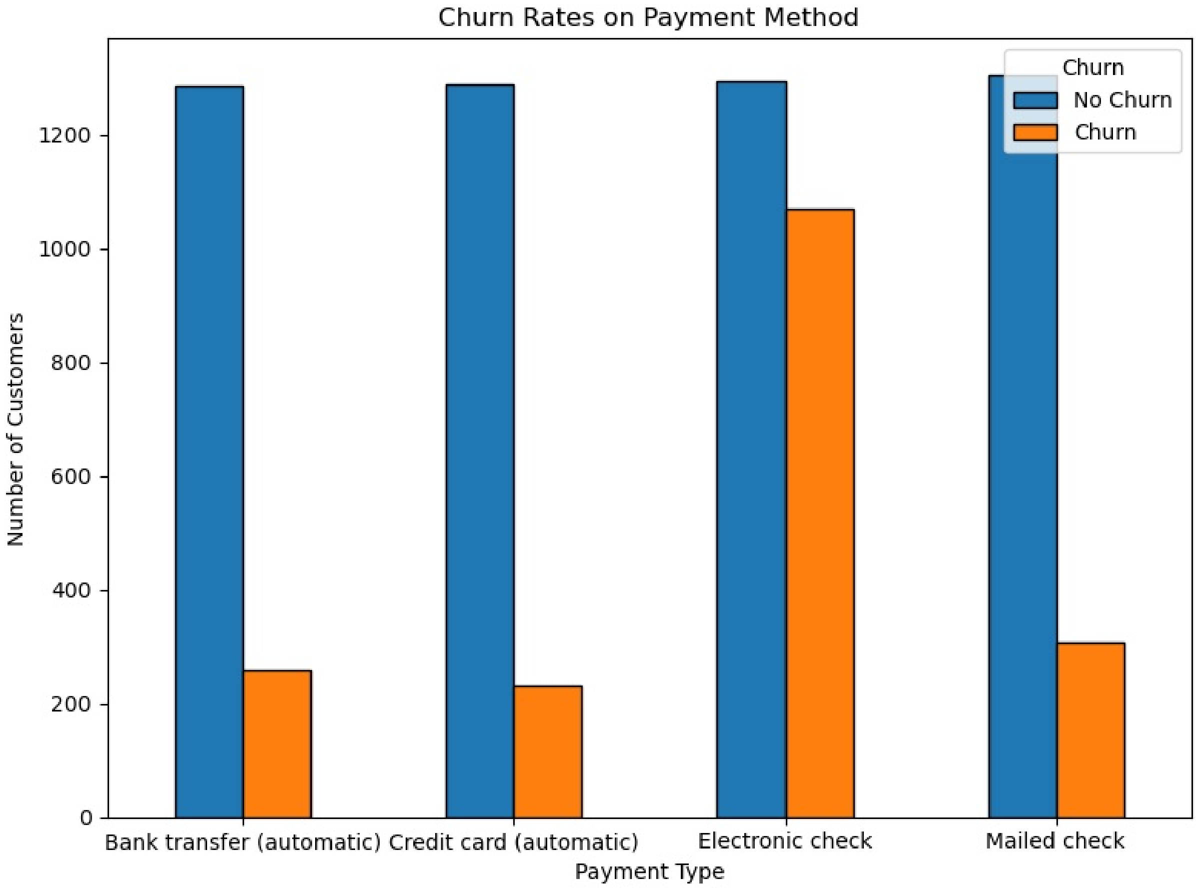
```
#Do higher MonthlyCharges lead to higher churn?
```

```
plt.hist(df[df['Churn'] == 'Yes']['MonthlyCharges'], bins=20, color='#ff7f0e', alpha=0.7, label='Churned')
plt.hist(df[df['Churn'] == 'No']['MonthlyCharges'], bins=20, color='#1f77b4', alpha=0.7, label='Not Churned')

plt.title("Monthly Charges Distribution by Churn Status")
plt.xlabel("Monthly Charges")
plt.ylabel("Number of Customers")
plt.legend()
plt.tight_layout()
plt.show()
```



In [140…

```
#How does PaymentMethod affect churn?

payment_churn = df.groupby(['PaymentMethod', 'Churn']).size().unstack()

fig, ax = plt.subplots(figsize=(8, 6))
payment_churn.plot(kind='bar', ax=ax, color=['#1f77b4', '#ff7f0e'], edgecolor='black')
plt.title("Churn Rates on Payment Method")
plt.xlabel("Payment Type")
plt.ylabel("Number of Customers")
plt.xticks(rotation=0)
plt.legend(["No Churn", "Churn"], title="Churn")
plt.tight_layout()
plt.show()
```



In [141…

```
df
```

Out[141]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	InternetService	OnlineSecurity	...	Devi
0	7590-VHVEG	Female	0	Yes	No	1	No	No phone service	DSL	No	...	
1	5575-GNVDE	Male	0	No	No	34	Yes	No	DSL	Yes	...	
2	3668-QPYBK	Male	0	No	No	2	Yes	No	DSL	Yes	...	
3	7795-CFOCW	Male	0	No	No	45	No	No phone service	DSL	Yes	...	
4	9237-HQITU	Female	0	No	No	2	Yes	No	Fiber optic	No	...	
...	...	...	...	...	...	...	...	...	...	...	...	
7038	6840-RESVB	Male	0	Yes	Yes	24	Yes	Yes	DSL	Yes	...	
7039	2234-XADUH	Female	0	Yes	Yes	72	Yes	Yes	Fiber optic	No	...	
7040	4801-JZAZL	Female	0	Yes	Yes	11	No	No phone service	DSL	Yes	...	
7041	8361-LTMKD	Male	1	Yes	No	4	Yes	Yes	Fiber optic	No	...	
7042	3186-AJIEK	Male	0	No	No	66	Yes	No	Fiber optic	Yes	...	

7043 rows × 21 columns

In [150…

```
df
```

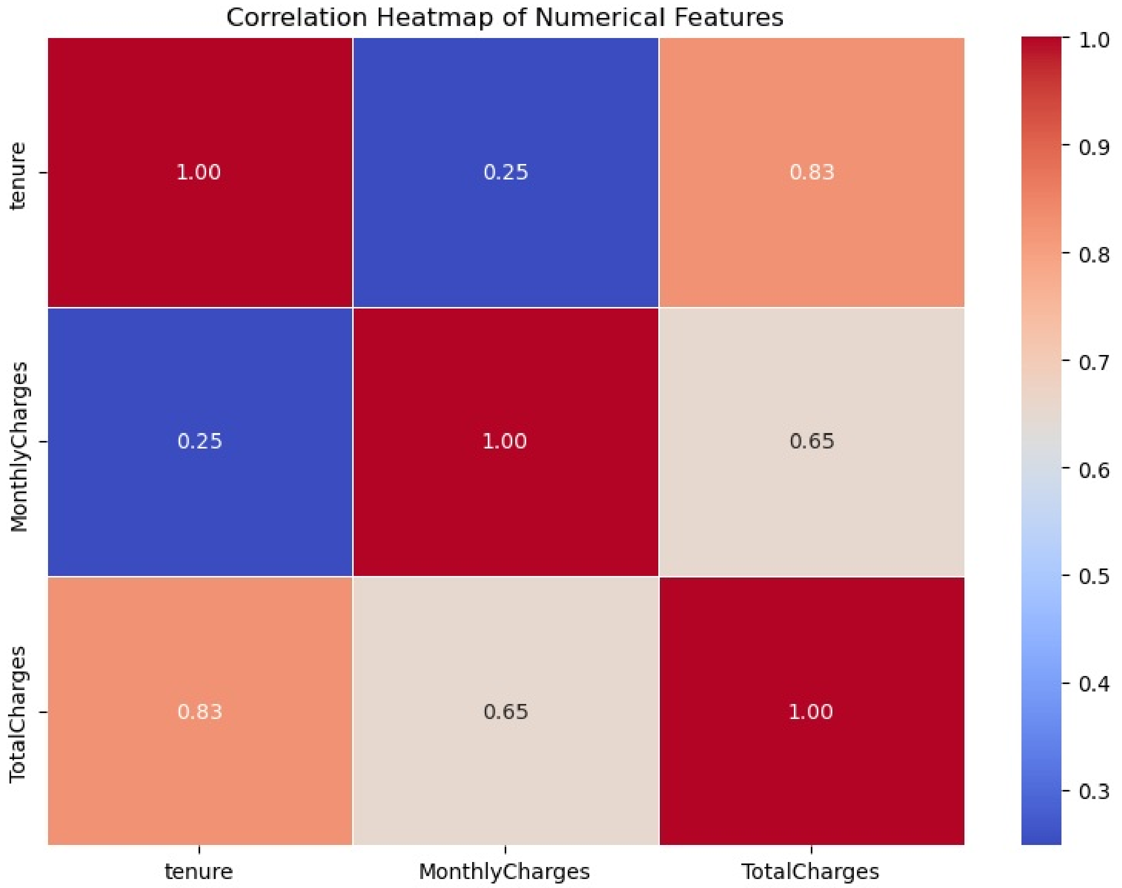
Out[150]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	InternetService	OnlineSecurity	...	Tech
0	7590-VHVEG	Female	0	Yes	No	1	No	No phone service	DSL	No	...	
1	5575-GNVDE	Male	0	No	No	34	Yes	No	DSL	Yes	...	
2	3668-QPYBK	Male	0	No	No	2	Yes	No	DSL	Yes	...	
3	7795-CFOCW	Male	0	No	No	45	No	No phone service	DSL	Yes	...	
4	9237-HQITU	Female	0	No	No	2	Yes	No	Fiber optic	No	...	
...	...	...	...	...	...	...	...	...	...	...	...	
7038	6840-RESVB	Male	0	Yes	Yes	24	Yes	Yes	DSL	Yes	...	
7039	2234-XADUH	Female	0	Yes	Yes	72	Yes	Yes	Fiber optic	No	...	
7040	4801-JZAZL	Female	0	Yes	Yes	11	No	No phone service	DSL	Yes	...	
7041	8361-LTMKD	Male	1	Yes	No	4	Yes	Yes	Fiber optic	No	...	
7042	3186-AJIEK	Male	0	No	No	66	Yes	No	Fiber optic	Yes	...	

7043 rows × 22 columns

In [158…

```
#Use a heatmap to show correlations between numerical features like tenure, MonthlyCharges, and TotalCharges.
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

df['Churn_Numeric'] = df['Churn'].apply(lambda x: 1 if x == 'Yes' else 0)
df['TotalCharges'] = pd.to_numeric(df['TotalCharges'], errors='coerce')
df['TotalCharges'].fillna(df['TotalCharges'].median(), inplace=True)
numerical_features = ['tenure', 'MonthlyCharges', 'TotalCharges']

correlation_matrix = df[numerical_features].corr()

plt.figure(figsize=(8, 6))

sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f", linewidths=0.5)

plt.title("Correlation Heatmap of Numerical Features")
plt.tight_layout()
plt.show()
```

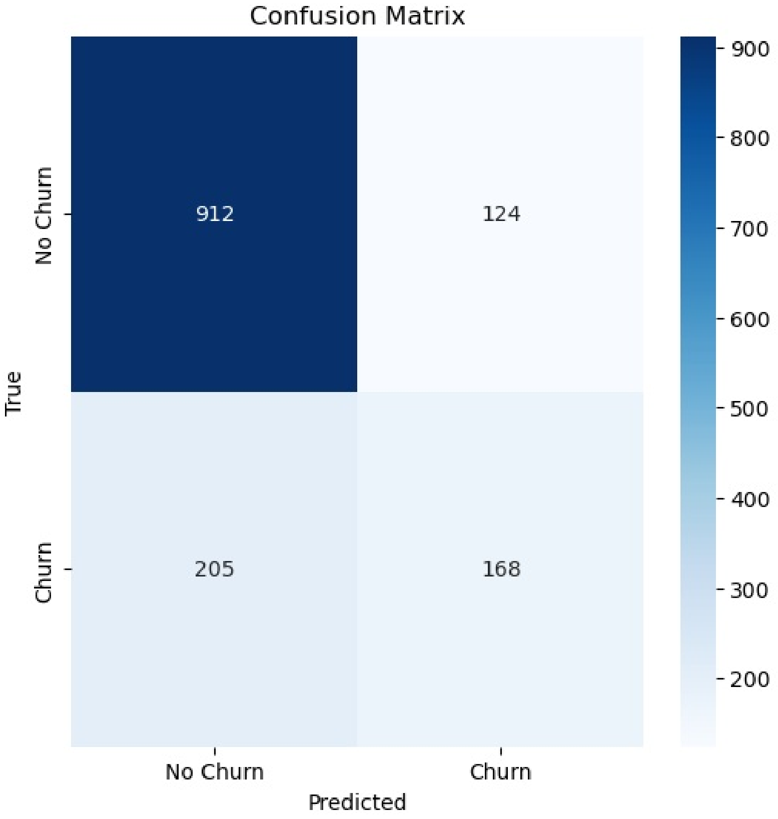


In [ ]:

In [163…

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report, accuracy_score, confusion_matrix
import seaborn as sns
import matplotlib.pyplot as plt

X = df[['tenure', 'MonthlyCharges', 'TotalCharges']]
y = df['Churn_Numeric']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)


model = RandomForestClassifier(random_state=42)
model.fit(X_train_scaled, y_train)


y_pred = model.predict(X_test_scaled)


accuracy = accuracy_score(y_test, y_pred)
print(f'Accuracy: {accuracy:.2f}')
print(classification_report(y_test, y_pred))


cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(6, 6))
sns.heatmap(cm, annot=True, fmt="d", cmap="Blues", xticklabels=['No Churn', 'Churn'], yticklabels=['No Churn',
plt.title('Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()
```

```
Accuracy: 0.77
              precision    recall  f1-score   support

           0       0.82      0.88      0.85      1036
           1       0.58      0.45      0.51       373

    accuracy                           0.77      1409
   macro avg       0.70      0.67      0.68      1409
weighted avg       0.75      0.77      0.76      1409
```



```
In [ ]:
```

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