In [9]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns


df = pd.read_csv('Customer_Churn.csv');
df.head()
```

Out[9]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneServ
0	7590-VHVEG	Female	0	Yes	No	1	
1	5575-GNVDE	Male	0	No	No	34	
2	3668-QPYBK	Male	0	No	No	2	
3	7795-CFOCW	Male	0	No	No	45	
4	9237-HQITU	Female	0	No	No	2	

5 rows × 21 columns

In [10]:
```
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
```

replacing blanks with 0 as tenure is 0 and 0 no total charges are recorded

In [11]:
```
df["TotalCharges"] = df["TotalCharges"].replace(" ","0")
df["TotalCharges"] = df["TotalCharges"].astype("float")
```

In [12]:
```
df["tenure"] = df["tenure"].replace(" ","0")
df["tenure"] = df["tenure"].astype("int")
```

In [13]:
```
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   float64
 20  Churn             7043 non-null   object 
dtypes: float64(2), int64(2), object(17)
memory usage: 1.1+ MB
```

```
In [14]: 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   float64
 20  Churn             7043 non-null   object 
dtypes: float64(2), int64(2), object(17)
memory usage: 1.1+ MB
```

In [15]:
```
df.isnull().sum().sum()
```

Out[15]:
```
np.int64(0)
```

In [16]:
```
df.describe()
```

Out[16]:

	SeniorCitizen	tenure	MonthlyCharges	TotalCharges
count	7043.000000	7043.000000	7043.000000	7043.000000
mean	0.162147	32.371149	64.761692	2279.734304
std	0.368612	24.559481	30.090047	2266.794470
min	0.000000	0.000000	18.250000	0.000000
25%	0.000000	9.000000	35.500000	398.550000
50%	0.000000	29.000000	70.350000	1394.550000
75%	0.000000	55.000000	89.850000	3786.600000
max	1.000000	72.000000	118.750000	8684.800000

In [17]:
```
df.duplicated().sum()
```

```
Out[17]: np.int64(0)
```

```
In [18]: df["customerID"].duplicated().sum()
```

```
Out[18]: np.int64(0)
```

```
In [19]: def conv(value):
             if value==1:
                 return "yes"
             else:
                 return "no"

         df['SeniorCitizen'] = df["SeniorCitizen"].apply(conv)
```

convert 0 and 1 values of senior citizen to yes/no get easier to understand

```
In [20]: df.head(40)
```

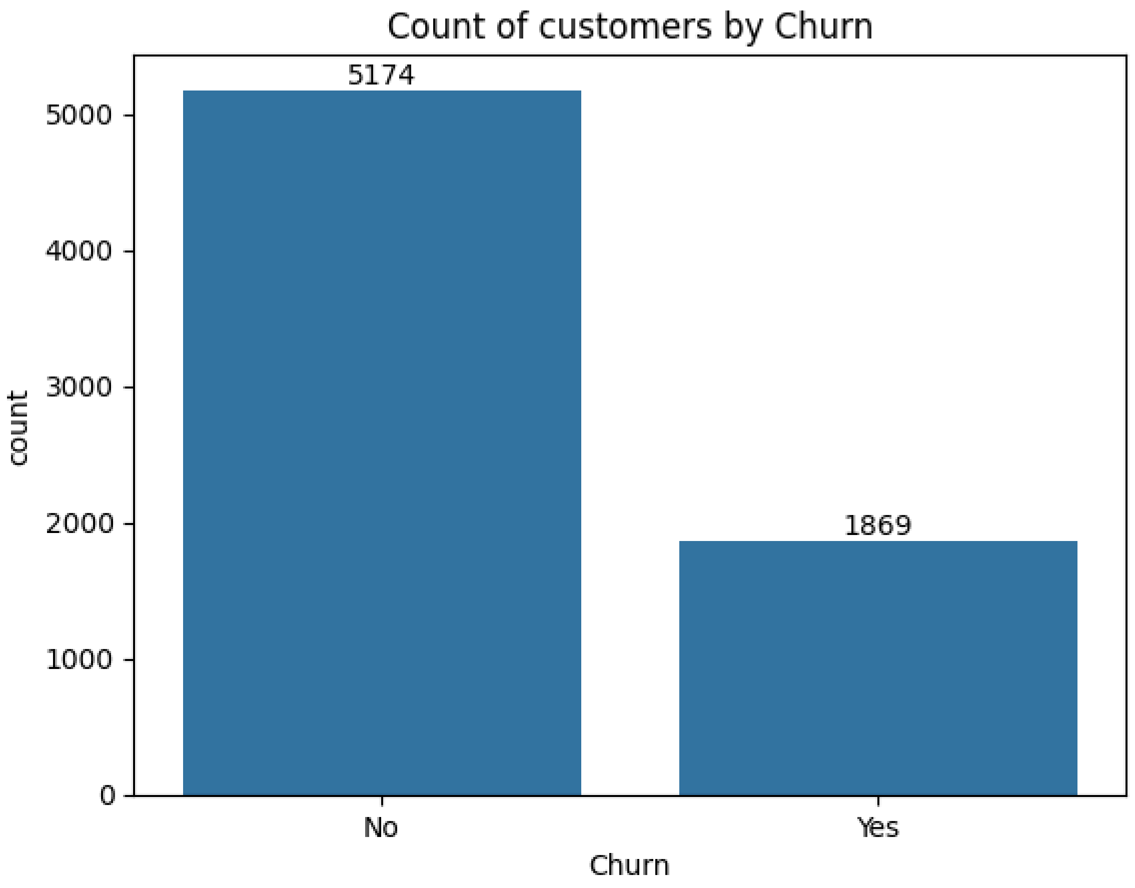
Out[20]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneSer
0	7590-VHVEG	Female	no	Yes	No	1	
1	5575-GNVDE	Male	no	No	No	34	
2	3668-QPYBK	Male	no	No	No	2	
3	7795-CFOCW	Male	no	No	No	45	
4	9237-HQITU	Female	no	No	No	2	
5	9305-CDSKC	Female	no	No	No	8	
6	1452-KIOVK	Male	no	No	Yes	22	
7	6713-OKOMC	Female	no	No	No	10	
8	7892-POOKP	Female	no	Yes	No	28	
9	6388-TABGU	Male	no	No	Yes	62	
10	9763-GRSKD	Male	no	Yes	Yes	13	
11	7469-LKBCI	Male	no	No	No	16	
12	8091-TTVAX	Male	no	Yes	No	58	
13	0280-XJGEX	Male	no	No	No	49	
14	5129-JLPIS	Male	no	No	No	25	
15	3655-SNQYZ	Female	no	Yes	Yes	69	
16	8191-XWSZG	Female	no	No	No	52	
17	9959-WOFKT	Male	no	No	Yes	71	
18	4190-MFLUW	Female	no	Yes	Yes	10	
19	4183-MYFRB	Female	no	No	No	21	
20	8779-QRDMV	Male	yes	No	No	1	

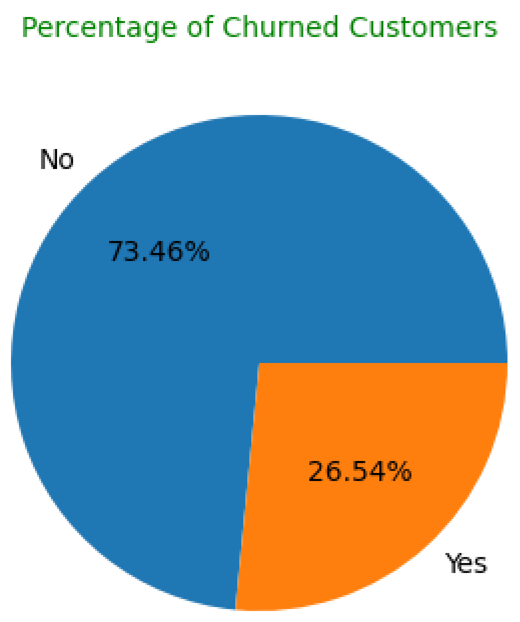
	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneSer
21	1680-VDCWW	Male	no	Yes	No	12	
22	1066-JKSGK	Male	no	No	No	1	
23	3638-WEABW	Female	no	Yes	No	58	
24	6322-HRPFA	Male	no	Yes	Yes	49	
25	6865-JZNKO	Female	no	No	No	30	
26	6467-CHFZW	Male	no	Yes	Yes	47	
27	8665-UTDHZ	Male	no	Yes	Yes	1	
28	5248-YGIJN	Male	no	Yes	No	72	
29	8773-HHUOZ	Female	no	No	Yes	17	
30	3841-NFECX	Female	yes	Yes	No	71	
31	4929-XIHVW	Male	yes	Yes	No	2	
32	6827-IEAUQ	Female	no	Yes	Yes	27	
33	7310-EGVHZ	Male	no	No	No	1	
34	3413-BMNZE	Male	yes	No	No	1	
35	6234-RAAPL	Female	no	Yes	Yes	72	
36	6047-YHPVI	Male	no	No	No	5	
37	6572-ADKRS	Female	no	No	No	46	
38	5380-WJKOV	Male	no	No	No	34	
39	8168-UQWWF	Female	no	No	No	11	

40 rows × 21 columns

In [22]:
```
ax = sns.countplot(x= 'Churn', data = df)

ax.bar_label(ax.containers[0])
plt.title("Count of customers by Churn")
plt.show()
```



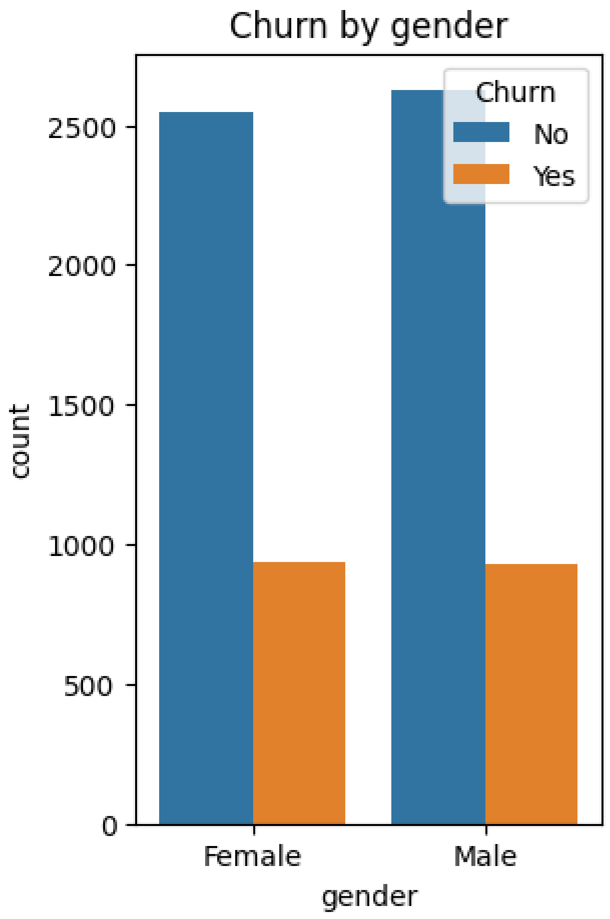
In [23]:
```
plt.figure(figsize = (4,6))
gb = df.groupby("Churn").agg({'Churn': "count"})
gb
plt.pie(gb['Churn'], labels = gb.index, autopct = "%1.2f%%")
plt.title("Percentage of Churned Customers", fontsize = 10, color = "green")
plt.show()
```



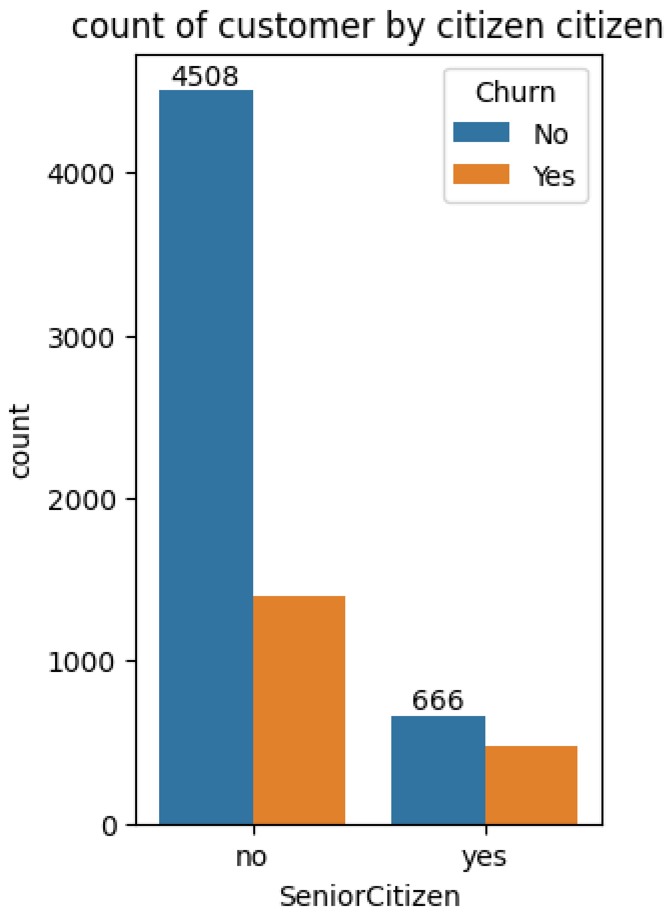
From the given pie chart we can conclude that 26.54% of our customers have churned out.

now let's explore the reason behind it.

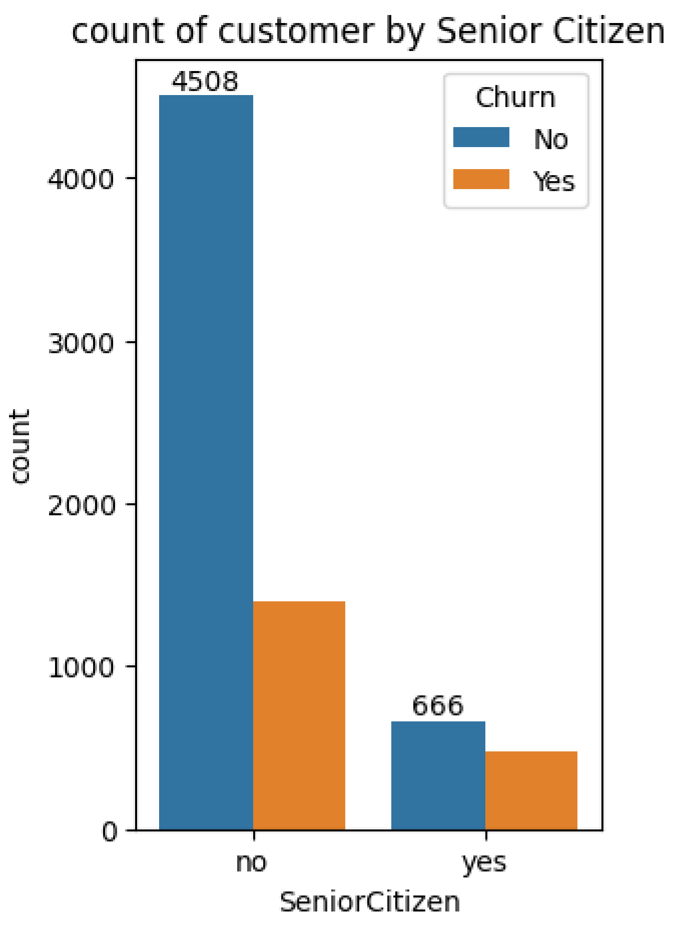
In [24]:
```
plt.figure(figsize = (3,5))
sns.countplot(x = "gender", data = df, hue = "Churn")
plt.title("Churn by gender")
plt.show()
```



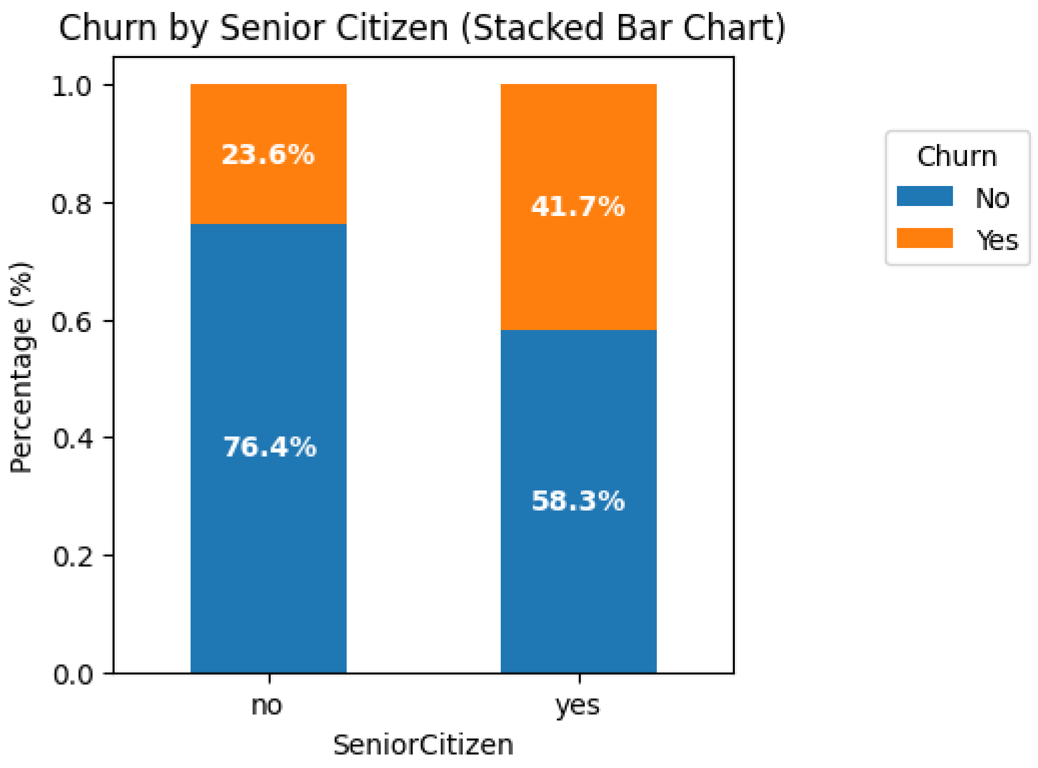
```
In [35]: plt.figure(figsize = (3,5))
         ax=sns.countplot(x = "SeniorCitizen", data = df, hue = "Churn")
         ax.bar_label(ax.containers[0])
         plt.title("count of customer by citizen citizen")
         plt.show()
```



```
In [36]: plt.figure(figsize = (3,5))
         ax=sns.countplot(x = "SeniorCitizen", data = df, hue = "Churn")
         ax.bar_label(ax.containers[0])
         plt.title("count of customer by Senior Citizen")
         plt.show()
```

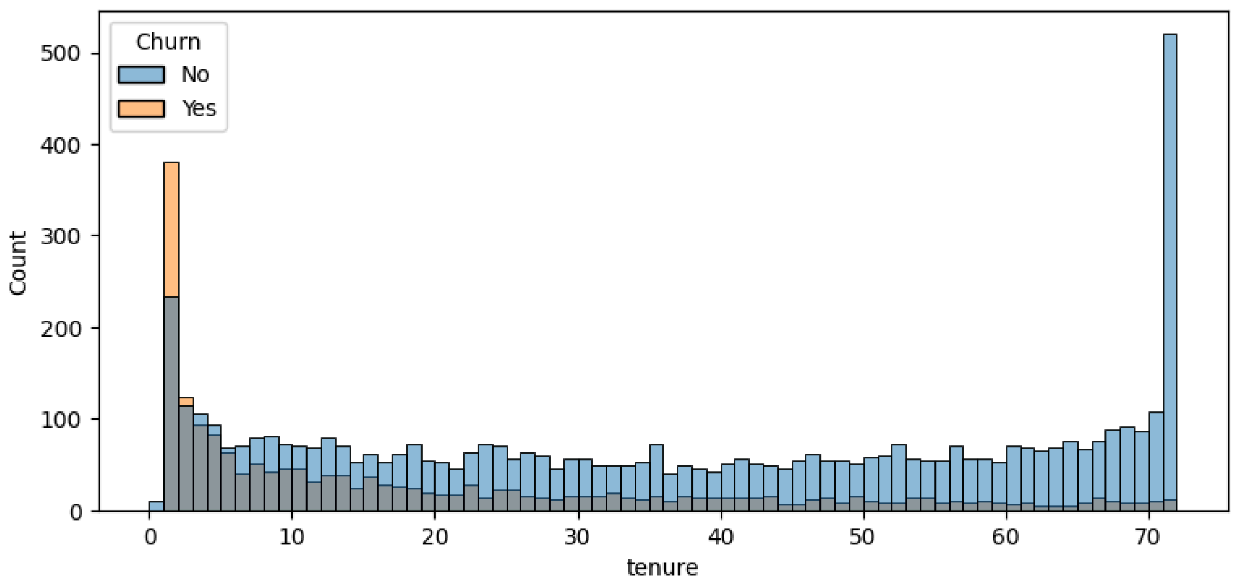


In [47]:
```python
import pandas as pd
import matplotlib.pyplot as plt

total_counts = df.groupby('SeniorCitizen')['Churn'].value_counts(normalize=Tru

# plot
fig, ax = plt.subplots(figsize=(4, 4))  # Adjust figsize for better visualizat

# plots for bars (stacked)
total_counts.plot(kind='bar', stacked=True, ax=ax, color=['#1f77b4', '#ff7f0e'

# Add percentage labels on the bars
for p in ax.patches:
    width, height = p.get_width(), p.get_height()
    x, y = p.get_xy()
    if height > 0:  # sirf non-zero bars pe label lagao
        ax.text(x + width / 2, y + height / 2,
                f'{height * 100:.1f}%',  # % me convert
                ha='center', va='center', color='white', fontsize=10, fontweig

plt.title('Churn by Senior Citizen (Stacked Bar Chart)')
plt.xlabel('SeniorCitizen')
plt.ylabel('Percentage (%)')
plt.xticks(rotation=0)
plt.legend(title='Churn', bbox_to_anchor =(1.5,0.9), loc='upper right')  # cus
plt.show()
```



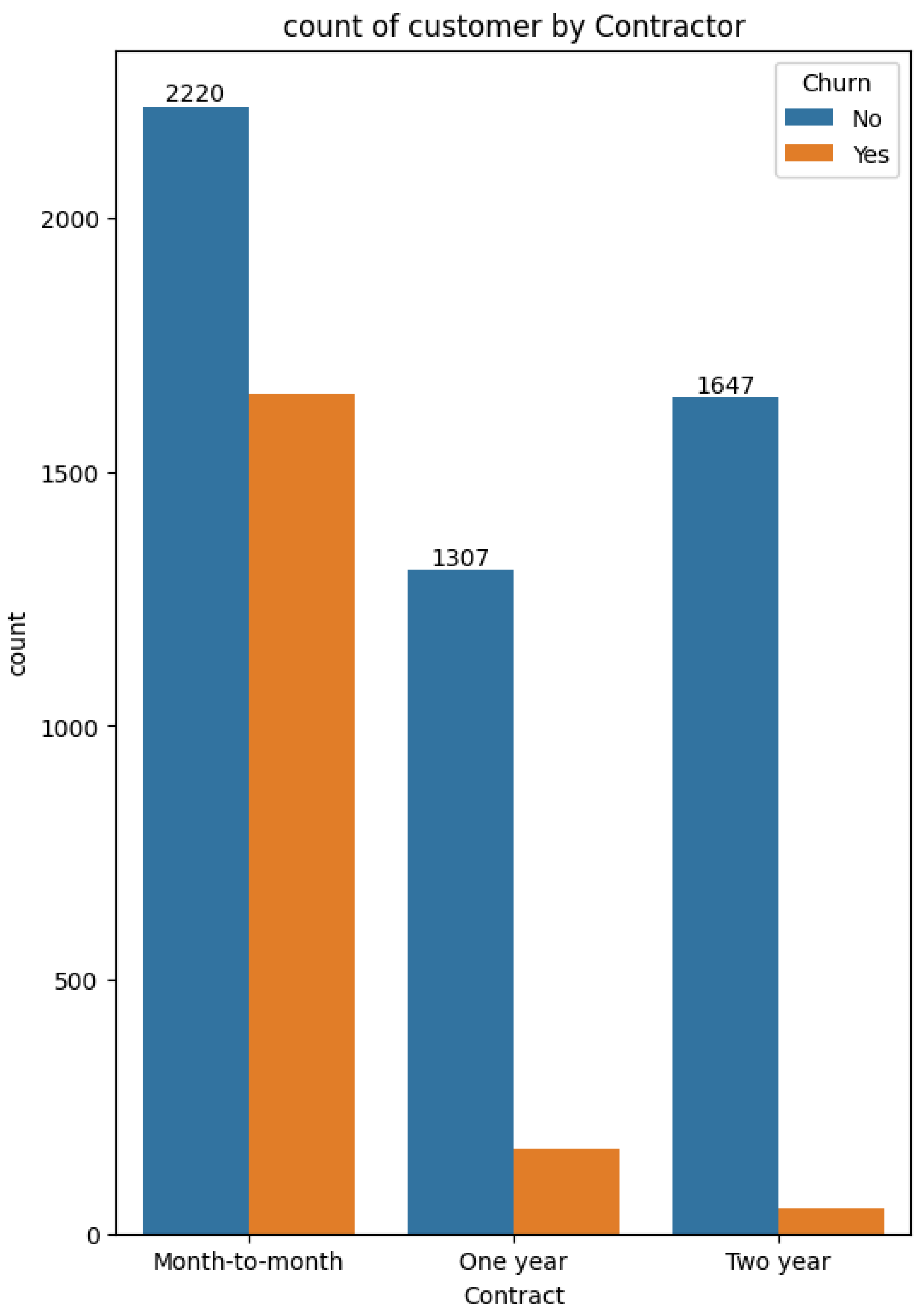
comparative a greated percentage of people in senoir citizen category have churned

In [53]:
```
plt.figure(figsize =(9,4))
sns.histplot(x ="tenure", data = df, bins=72, hue='Churn')

plt.show()
```



people who have used our services for a long time have stayed and people who have used our services have churned

In [56]:
```
plt.figure(figsize = (6,9))
ax=sns.countplot(x = "Contract", data = df, hue = "Churn")
ax.bar_label(ax.containers[0])
plt.title("count of customer by Contractor")
plt.show()
```

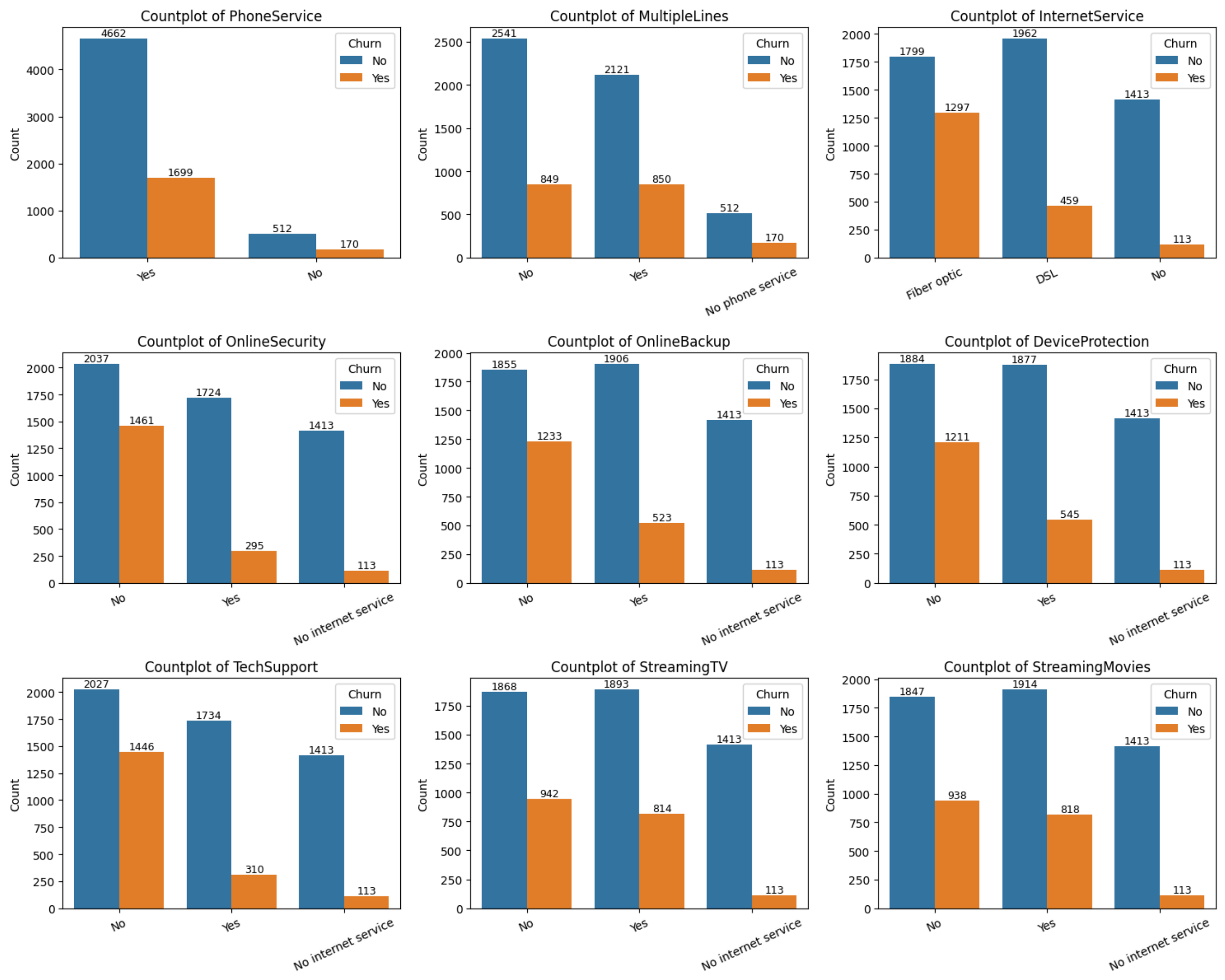

count of customer by Contractor
Churn
No
Yes
2220
1307
1647
2000
1500
1000
500
0
count
Month-to-month
One year
Two year
Contract

people who have month to month contract are likely to churn then from those who have 1 and 2 years or contract

In [57]:
```
df.columns.values
```

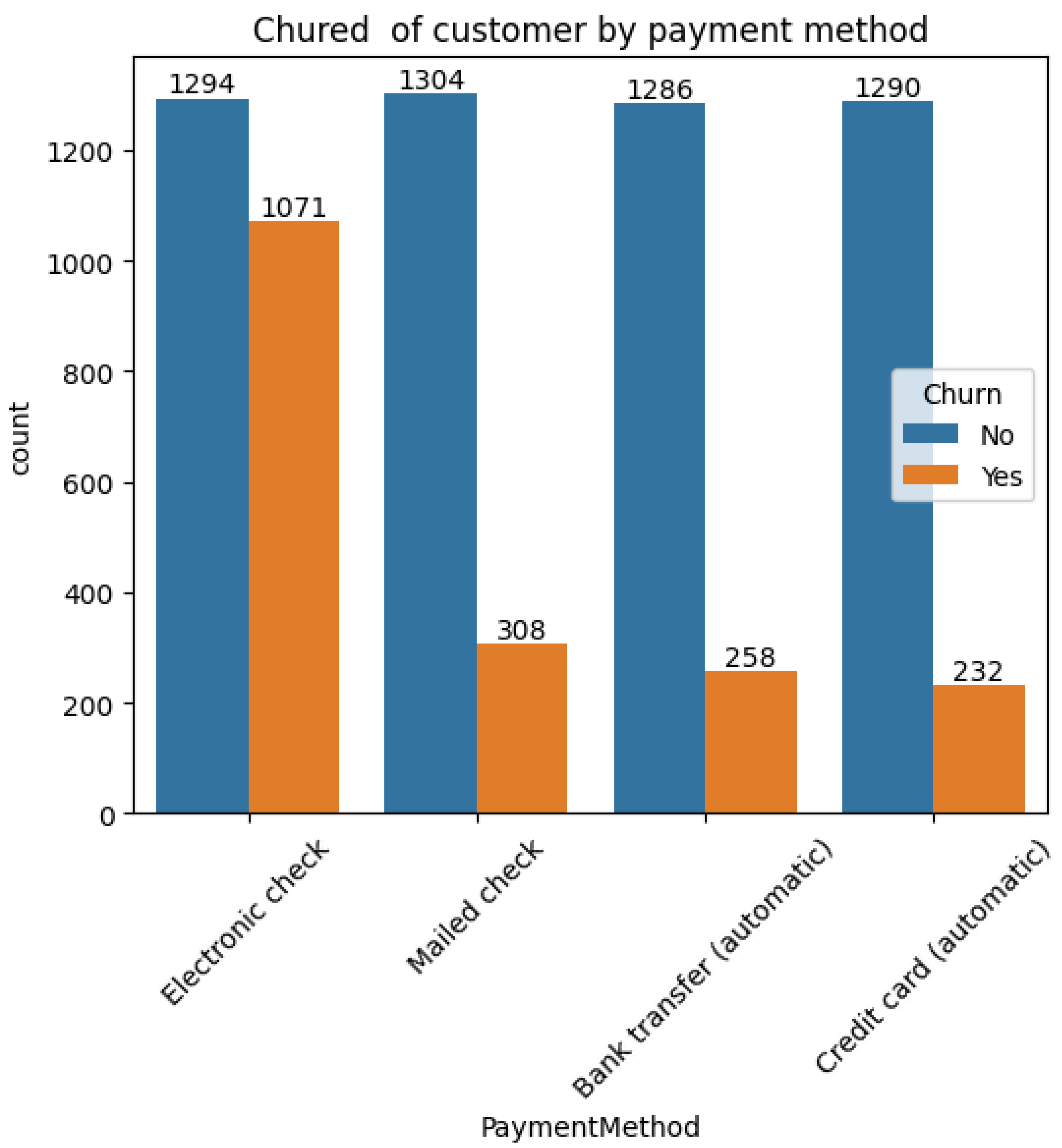
Out[57]:
```
array(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
       'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
       'OnlineSecurity', 'OnlineBackup', 'DeviceProtection',
       'TechSupport', 'StreamingTV', 'StreamingMovies', 'Contract',
       'PaperlessBilling', 'PaymentMethod', 'MonthlyCharges',
       'TotalCharges', 'Churn'], dtype=object)
```

In [60]:
```
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd

cols = ['PhoneService', 'MultipleLines', 'InternetService',
        'OnlineSecurity', 'OnlineBackup', 'DeviceProtection',
        'TechSupport', 'StreamingTV', 'StreamingMovies']

# --- sanity checks ---
missing_cols = [c for c in cols if c not in df.columns]
if missing_cols:
    print("Warning: these columns not found in df and will be skipped:", missi

cols = [c for c in cols if c in df.columns]
if len(cols) == 0:
    raise ValueError("No valid columns found to plot. Check column names in `c

# layout: 3 columns (change ncols if you prefer different grid)
n = len(cols)
ncols = 3
nrows = (n + ncols - 1) // ncols

fig, axes = plt.subplots(nrows, ncols, figsize=(5 * ncols, 4 * nrows))
axes = axes.flatten()

for i, col in enumerate(cols):
    ax = axes[i]
    # safe-guard: convert to string and fillna so countplot won't fail on weir
    df[col] = df[col].fillna('Missing').astype(str)

    # keep categories ordered by frequency (optional)
    order = df[col].value_counts().index

    try:
        sns.countplot(data=df, x=col, ax=ax, order=order, hue=df["Churn"])   #
        ax.set_title(f"Countplot of {col}")
        ax.set_xlabel("")
        ax.set_ylabel("Count")
        ax.tick_params(axis='x', rotation=25)

        # annotate bar heights
        for p in ax.patches:
            h = p.get_height()
            if h > 0:
                ax.annotate(f'{int(h)}',
                            (p.get_x() + p.get_width() / 2., h),
                            ha='center', va='bottom', fontsize=9)
    except Exception as e:
        # show error message inside the subplot instead of crashing
        ax.text(0.5, 0.5, f"Error plotting {col}:\n{e}", ha='center', va='cent
        ax.set_xticks([])
        ax.set_yticks([])

# remove any unused axes
for j in range(i + 1, len(axes)):
    fig.delaxes(axes[j])

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



The analysis of service-related features highlights clear patterns in customer churn behavior. Customers without internet services dominate the dataset, while those who subscribe to value-added services such as OnlineSecurity, TechSupport, and DeviceProtection show significantly different churn tendencies. In particular, customers lacking these protective or support services exhibit much higher churn rates. Although PhoneService is nearly universal, variations in multiple lines and additional internet-based services reveal stronger associations with customer attrition, underscoring the role of bundled digital services in reducing churn.

```
In [67]: plt.figure(figsize = (6,5))
         ax=sns.countplot(x = "PaymentMethod", data = df, hue = "Churn")
         ax.bar_label(ax.containers[0])
         ax.bar_label(ax.containers[1])
         plt.title("Chured  of customer by payment method")
         plt.xticks(rotation=45)
         plt.show()
```



Customers is likely to churn when he is using electronic check as a payment method.

```
In [ ]:
```