IMPORTING LIBRARIES

```
In [1]: import pandas as pd
        import numpy as np
        import matplotlib.pyplot as plt
        import seaborn as sns
```

IMPORTING FILES FOR ANALYSIS

```
In [2]: trans=pd.read_csv("Retail_Data_Transactions.csv")
        trans.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 125000 entries, 0 to 124999
Data columns (total 3 columns):
 #   Column       Non-Null Count   Dtype 
---  ------       --------------   ----- 
 0   customer_id  125000 non-null  object
 1   trans_date   125000 non-null  object
 2   tran_amount  125000 non-null  int64 
dtypes: int64(1), object(2)
memory usage: 2.9+ MB
```

```
In [3]: resp=pd.read_csv("Retail_Data_Response.csv")
        resp.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 6884 entries, 0 to 6883
Data columns (total 2 columns):
 #   Column       Non-Null Count  Dtype 
---  ------       --------------  ----- 
 0   customer_id  6884 non-null   object
 1   response     6884 non-null   int64 
dtypes: int64(1), object(1)
memory usage: 107.7+ KB
```

MERGING BOTH THE CSV(s)

```
In [4]: df=trans.merge(resp,on='customer_id',how='left')
        df
```

Out[4]:

	customer_id	trans_date	tran_amount	response
0	CS5295	2013-02-11	35	1.0
1	CS4768	2015-03-15	39	1.0
2	CS2122	2013-02-26	52	0.0
3	CS1217	2011-11-16	99	0.0
4	CS1850	2013-11-20	78	0.0
...	...	...	...	...
124995	CS8433	2011-06-26	64	0.0
124996	CS7232	2014-08-19	38	0.0
124997	CS8731	2014-11-28	42	0.0
124998	CS8133	2013-12-14	13	0.0
124999	CS7996	2014-12-13	36	0.0

125000 rows × 4 columns

In [5]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 125000 entries, 0 to 124999
Data columns (total 4 columns):
 #   Column       Non-Null Count   Dtype  
---  ------       --------------   -----  
 0   customer_id  125000 non-null  object 
 1   trans_date   125000 non-null  object 
 2   tran_amount  125000 non-null  int64  
 3   response     124969 non-null  float64
dtypes: float64(1), int64(1), object(2)
memory usage: 3.8+ MB
```

HANDELING MISSING VALUE(s)

In [6]:
```
df.isnull().sum()
```

Out[6]:
```
customer_id     0
trans_date      0
tran_amount     0
response       31
dtype: int64
```

In [7]:
```
df=df.dropna()
df.reset_index()
```

```
Out[7]:
```

	index	customer_id	trans_date	tran_amount	response
0	0	CS5295	2013-02-11	35	1.0
1	1	CS4768	2015-03-15	39	1.0
2	2	CS2122	2013-02-26	52	0.0
3	3	CS1217	2011-11-16	99	0.0
4	4	CS1850	2013-11-20	78	0.0
...	...	...	...	...	...
124964	124995	CS8433	2011-06-26	64	0.0
124965	124996	CS7232	2014-08-19	38	0.0
124966	124997	CS8731	2014-11-28	42	0.0
124967	124998	CS8133	2013-12-14	13	0.0
124968	124999	CS7996	2014-12-13	36	0.0

124969 rows × 5 columns

MANAGING DATA-TYPE(s)

```
In [8]:
df['trans_date']=df['trans_date'].astype(dtype='datetime64[ns]')
df['response']=df['response'].astype(dtype='int64')
df['tran_amount']=df['tran_amount'].astype(dtype='float64')
df
```

```
C:\Users\DELL\AppData\Local\Temp\ipykernel_1596\3299215634.py:1: SettingWithCopyW
arning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['trans_date']=df['trans_date'].astype(dtype='datetime64[ns]')
C:\Users\DELL\AppData\Local\Temp\ipykernel_1596\3299215634.py:2: SettingWithCopyW
arning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['response']=df['response'].astype(dtype='int64')
C:\Users\DELL\AppData\Local\Temp\ipykernel_1596\3299215634.py:3: SettingWithCopyW
arning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['tran_amount']=df['tran_amount'].astype(dtype='float64')
```

Out[8]:

	customer_id	trans_date	tran_amount	response
0	CS5295	2013-02-11	35.0	1
1	CS4768	2015-03-15	39.0	1
2	CS2122	2013-02-26	52.0	0
3	CS1217	2011-11-16	99.0	0
4	CS1850	2013-11-20	78.0	0
...	...	...	...	...
124995	CS8433	2011-06-26	64.0	0
124996	CS7232	2014-08-19	38.0	0
124997	CS8731	2014-11-28	42.0	0
124998	CS8133	2013-12-14	13.0	0
124999	CS7996	2014-12-13	36.0	0

124969 rows × 4 columns

SEARCHING FOR OUTLIER(s)

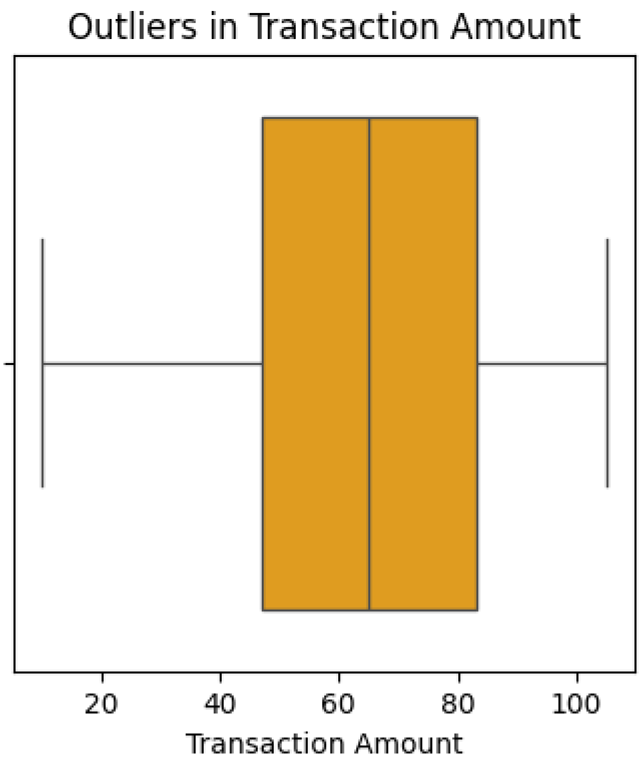
In [9]:
```
# Z-Score Method
z1_scores=(df['tran_amount']-df['tran_amount'].mean())/df['tran_amount'].std()
z1_threshold=3
outliers_1 = df[abs(z1_scores)>z1_threshold]
if outliers_1.empty:
    print("NO OUTLIERS PRESENT IN '{}' COLUMN".format('tran_amount'))
else:
    print("THE OUTLIERS PRESENT IN COLUMN '{}' ARE AS FOLLOWS \n".format('tran_a
    print(outliers_1)

z2_scores=(df['response']-df['response'].mean())/df['response'].std()
z2_threshold=3
outliers_2 = df[abs(z2_scores)>z2_threshold]
if outliers_2.empty:
    print("NO OUTLIERS PRESENT IN '{}' COLUMN".format('response'))
else:
    print("THE OUTLIERS PRESENT IN COLUMN '{}' ARE AS FOLLOWS \n".format('respon
    print(outliers_2)
```

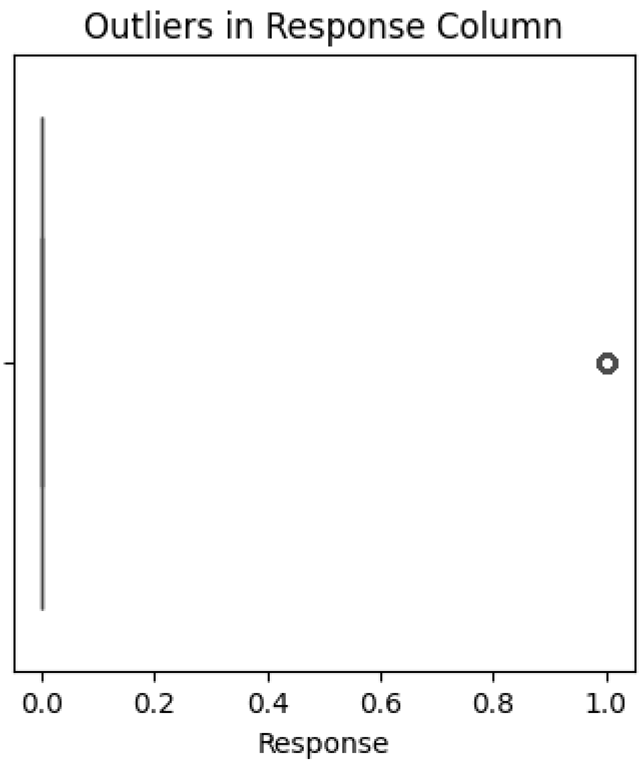
```
NO OUTLIERS PRESENT IN 'tran_amount' COLUMN
NO OUTLIERS PRESENT IN 'response' COLUMN
```

In [10]:
```
# IQR(Inter Quartile Range) Method
q1=df['tran_amount'].quantile(0.25)
q3=df['tran_amount'].quantile(0.75)
iqr_1=q3-q1
lower_thres1=q1-1.5*iqr_1
upper_thres1=q3+1.5*iqr_1
outliers_1=df[(df['tran_amount']<lower_thres1)|(df['tran_amount']>upper_thres1)]
if outliers_1.empty:
    print("NO OUTLIERS PRESENT IN '{}' COLUMN".format('tran_amount'))
else:
    print("THE OUTLIERS PRESENT IN COLUMN '{}' ARE AS FOLLOWS: \n".format('tran_
    print(outliers_1)

print("\n\n")

q1=df['response'].quantile(0.25)
q3=df['response'].quantile(0.75)
iqr_2=q3-q1
lower_thres2=q1-1.5*iqr_2
upper_thres2=q3+1.5*iqr_2
outliers_2=df[(df['response']<lower_thres2)|(df['response']>upper_thres2)]
if outliers_2.empty:
    print("NO OUTLIERS PRESENT IN '{}' COLUMN".format('response'))
else:
    print("THE OUTLIERS PRESENT IN COLUMN '{}' ARE AS FOLLOWS: \n".format('respo
    print(outliers_2)
```

```
NO OUTLIERS PRESENT IN 'tran_amount' COLUMN



THE OUTLIERS PRESENT IN COLUMN 'response' ARE AS FOLLOWS:

       customer_id trans_date  tran_amount  response
0           CS5295 2013-02-11         35.0         1
1           CS4768 2015-03-15         39.0         1
9           CS3802 2013-08-20         75.0         1
25          CS2748 2013-03-23         37.0         1
35          CS5514 2013-01-09         36.0         1
...            ...        ...          ...       ...
124922      CS7182 2011-07-07         45.0         1
124923      CS8845 2013-02-23         15.0         1
124946      CS8310 2014-04-23         19.0         1
124986      CS8580 2013-11-15         37.0         1
124988      CS7888 2013-10-19         35.0         1

[13842 rows x 4 columns]
```

In [11]:
```
plt.figure(figsize=(4,4))
sns.boxplot(x=df['tran_amount'],color='orange')
plt.title("Outliers in Transaction Amount")
plt.xlabel("Transaction Amount")
plt.show()

print("\n\n")
plt.figure(figsize=(4,4))
sns.boxplot(x=df['response'],color='red')
plt.title("Outliers in Response Column")
plt.xlabel("Response")
plt.show()
```





In [12]:
```
df['months']=df['trans_date'].dt.month
df
```

```
C:\Users\DELL\AppData\Local\Temp\ipykernel_1596\1941809520.py:1: SettingWithCopyW
arning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['months']=df['trans_date'].dt.month
```

Out[12]:

	customer_id	trans_date	tran_amount	response	months
0	CS5295	2013-02-11	35.0	1	2
1	CS4768	2015-03-15	39.0	1	3
2	CS2122	2013-02-26	52.0	0	2
3	CS1217	2011-11-16	99.0	0	11
4	CS1850	2013-11-20	78.0	0	11
...	...	...	...	...	...
124995	CS8433	2011-06-26	64.0	0	6
124996	CS7232	2014-08-19	38.0	0	8
124997	CS8731	2014-11-28	42.0	0	11
124998	CS8133	2013-12-14	13.0	0	12
124999	CS7996	2014-12-13	36.0	0	12

124969 rows × 5 columns

In [13]:
```
#Which 3 months have the highest transaction amount?
monthly_sales = df.groupby('months')['tran_amount'].sum().sort_values(ascending=
top3_months = monthly_sales.head(3)
print("Top 3 Months by Total Transaction Amount: \n{}".format(top3_months))
```

```
Top 3 Months by Total Transaction Amount:
   months  tran_amount
0       8     726775.0
1      10     725058.0
2       1     724089.0
```

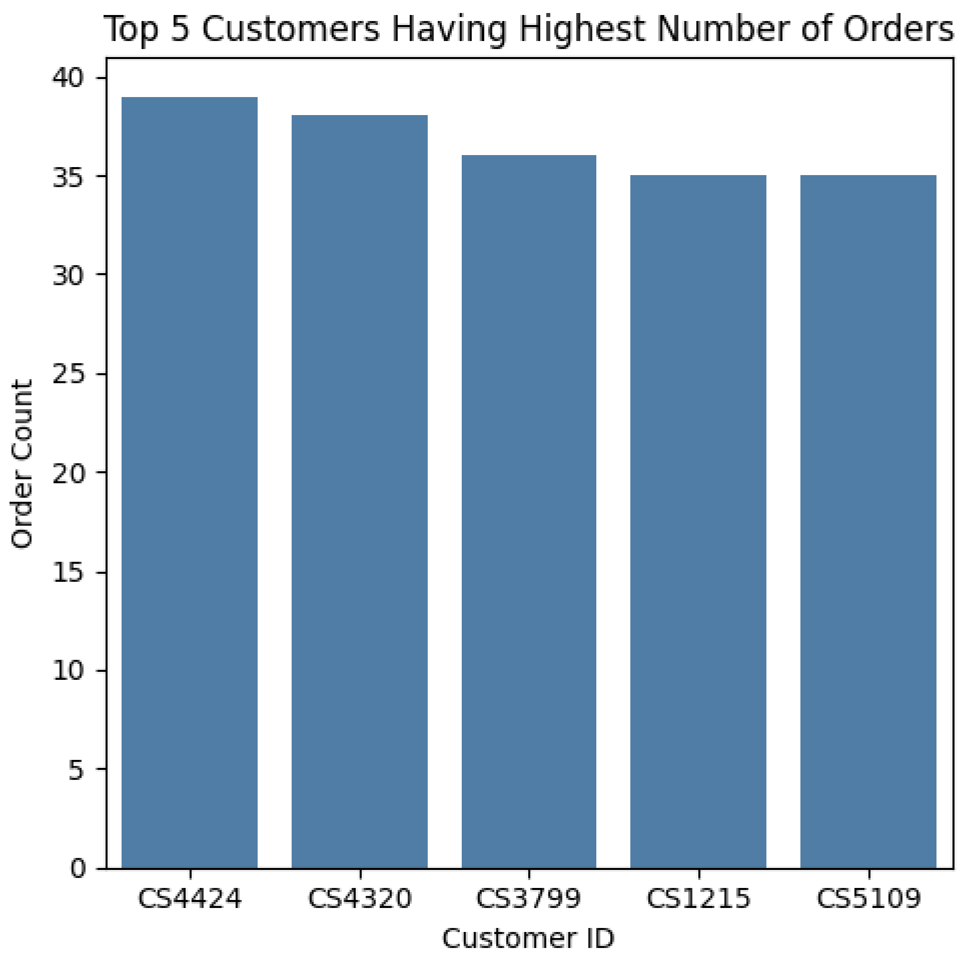
In [14]:
```
#Customers having highest number of orders?
customers = df['customer_id'].value_counts().reset_index()
customers.columns = ['customer_id', 'order_count']
top_customers = customers.head()
top_customers
```

Out[14]:

	customer_id	order_count
0	CS4424	39
1	CS4320	38
2	CS3799	36
3	CS1215	35
4	CS5109	35

In [15]:

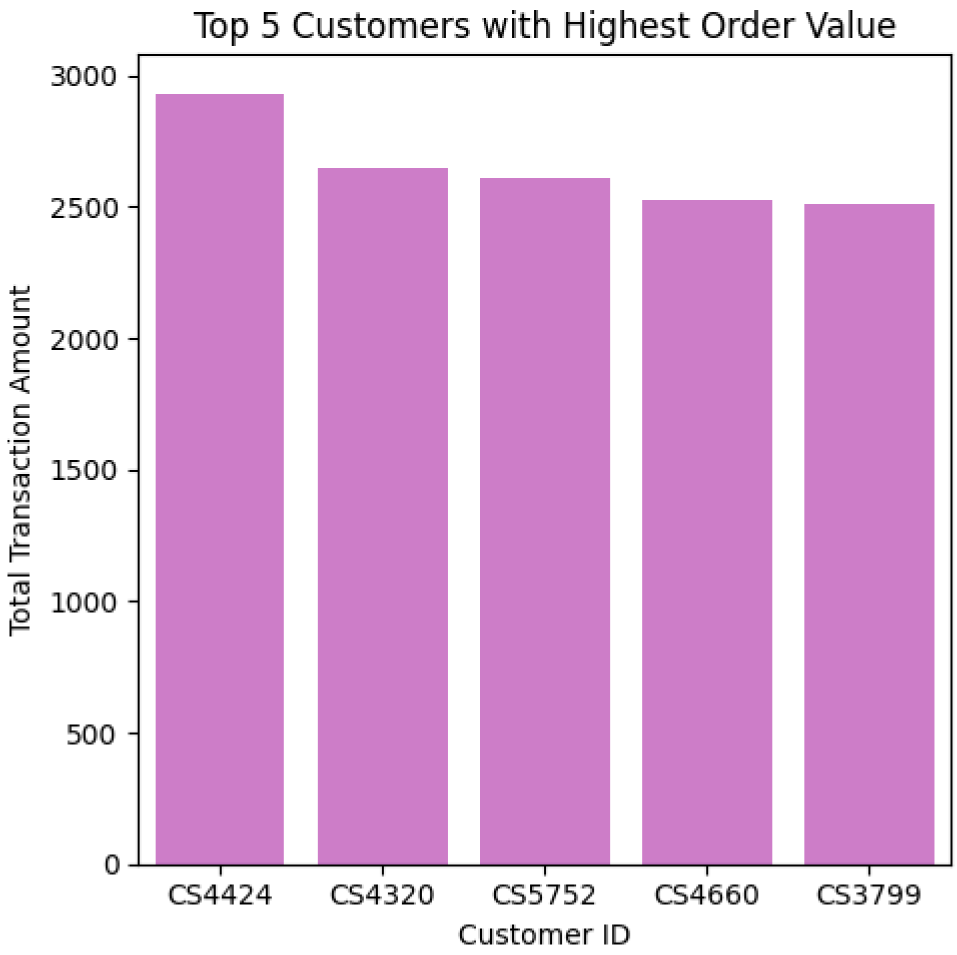
```
plt.figure(figsize=(5,5))
sns.barplot(x='customer_id', y='order_count', data=top_customers,color='steelblu
plt.title("Top 5 Customers Having Highest Number of Orders")
plt.xlabel("Customer ID")
plt.ylabel("Order Count")
plt.tight_layout()
plt.show()
```



In [16]:

```
#Customers having highest value of orders?
customers = df.groupby('customer_id')['tran_amount'].sum().sort_values(ascending
top_customers = customers.head(5)
print("Customers having highest value of orders are: \n{}".format(top_customers)
Customers having highest value of orders are:
  customer_id  tran_amount
0      CS4424       2933.0
1      CS4320       2647.0
2      CS5752       2612.0
3      CS4660       2527.0
4      CS3799       2513.0
```

In [17]:
```python
plt.figure(figsize=(5, 5))
sns.barplot(x='customer_id', y='tran_amount', data=top_customers,color='orchid')
plt.title("Top 5 Customers with Highest Order Value")
plt.xlabel("Customer ID")
plt.ylabel("Total Transaction Amount")
plt.tight_layout()
plt.show()
```



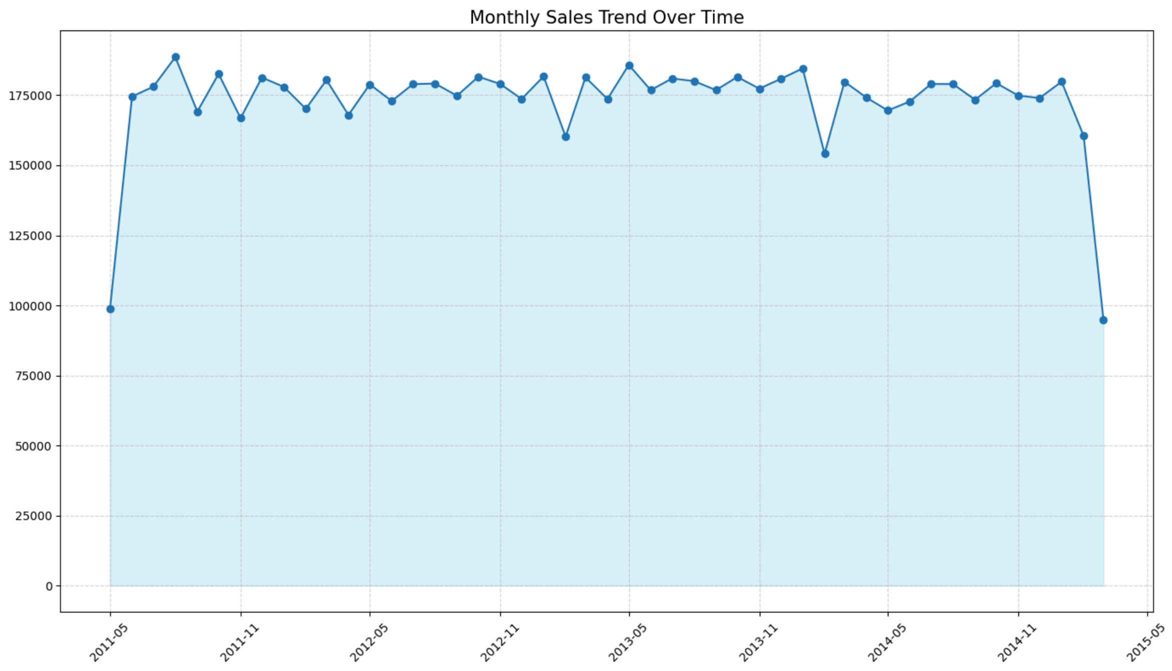
Advanced analysis

Time Series Analysis

In [18]:
```python
import matplotlib.dates as mdates
```

In [19]:
```python
df['month_year']=df['trans_date'].dt.to_period('M')
monthly_sales=df.groupby('month_year')['tran_amount'].sum()
monthly_sales.index=monthly_sales.index.to_timestamp()
print("\n")
plt.figure(figsize=(14,8))
plt.plot(monthly_sales.index,monthly_sales.values, marker='o', linestyle='-')
plt.fill_between(monthly_sales.index, monthly_sales.values, color='skyblue', alp
plt.gca().xaxis.set_major_formatter(mdates.DateFormatter('%Y-%m'))
plt.gca().xaxis.set_major_locator(mdates.MonthLocator(interval=6))
plt.title('Monthly Sales Trend Over Time', fontsize=15)
plt.xlable=('Month-Tear')
plt.ylable=('Monthly Sales')
plt.xticks(rotation=45)
plt.grid(True, linestyle='--', alpha=0.5)
plt.tight_layout()
plt.show()
```

```
C:\Users\DELL\AppData\Local\Temp\ipykernel_1596\3120432034.py:1: SettingWithCopyW
arning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['month_year']=df['trans_date'].dt.to_period('M')
```



Cohort Segmentation

In [26]:
```
#Recency
recency=df.groupby('customer_id')['trans_date'].max()

#Frequency
frequency=df.groupby('customer_id')['trans_date'].count()

#Monetary
monetary=df.groupby('customer_id')['tran_amount'].sum()

new=pd.DataFrame({'recency':recency,'frequency':frequency,'monetary':monetary})
new.reset_index(inplace=True)
new
```

Out[26]:

	customer_id	recency	frequency	monetary
0	CS1112	2015-01-14	15	1012.0
1	CS1113	2015-02-09	20	1490.0
2	CS1114	2015-02-12	19	1432.0
3	CS1115	2015-03-05	22	1659.0
4	CS1116	2014-08-25	13	857.0
...	...	...	...	...
6879	CS8996	2014-12-09	13	582.0
6880	CS8997	2014-06-28	14	543.0
6881	CS8998	2014-12-22	13	624.0
6882	CS8999	2014-07-02	12	383.0
6883	CS9000	2015-02-28	13	533.0

6884 rows × 4 columns

In [27]:

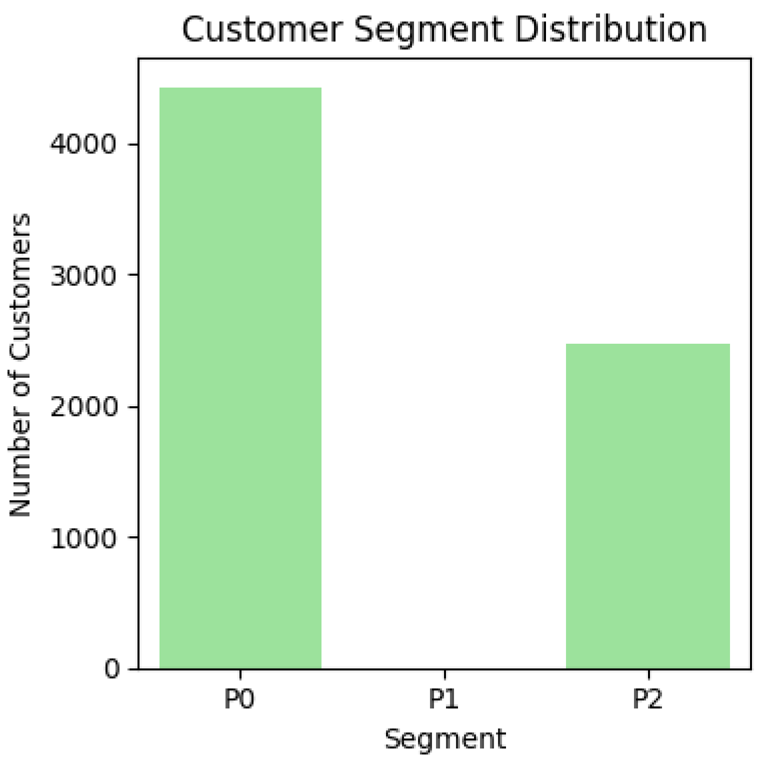
```
#Customer Segmentation
def segment_customer(row):
    if (row['recency'].year>=2012) and (row['frequency']>=15) and (row['monetary
        return 'P0'
    elif (2011<=row['recency'].year<2012) and (10<row['frequency']<15) and (500<
        return 'P1'
    else:
        return 'P2'
new['Segment']=new.apply(segment_customer,axis=1)
new
```

Out[27]:

	customer_id	recency	frequency	monetary	Segment
0	CS1112	2015-01-14	15	1012.0	P0
1	CS1113	2015-02-09	20	1490.0	P0
2	CS1114	2015-02-12	19	1432.0	P0
3	CS1115	2015-03-05	22	1659.0	P0
4	CS1116	2014-08-25	13	857.0	P2
...	...	...	...	...	...
6879	CS8996	2014-12-09	13	582.0	P2
6880	CS8997	2014-06-28	14	543.0	P2
6881	CS8998	2014-12-22	13	624.0	P2
6882	CS8999	2014-07-02	12	383.0	P2
6883	CS9000	2015-02-28	13	533.0	P2

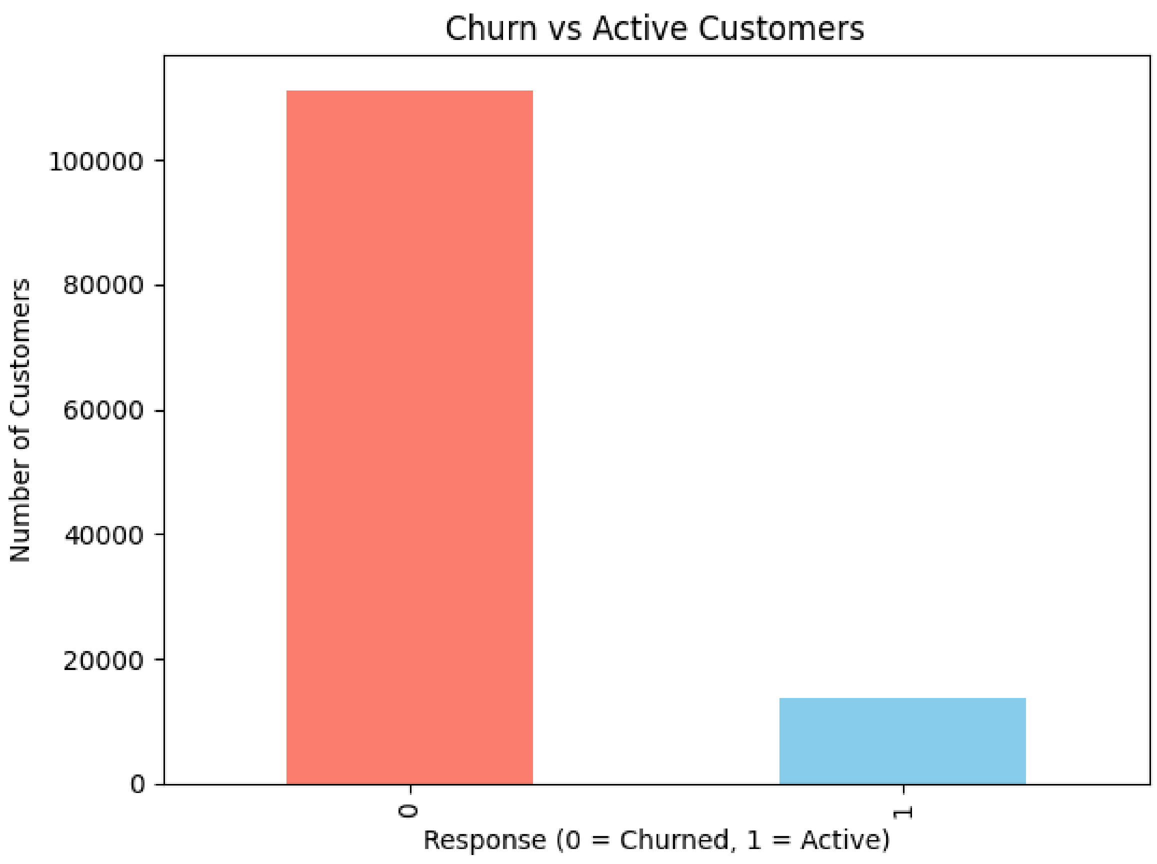
6884 rows × 5 columns

In [28]:
```
plt.figure(figsize=(4,4))
sns.countplot(x='Segment', data=new, order=['P0', 'P1', 'P2'], color='lightgreen
plt.title("Customer Segment Distribution")
plt.xlabel("Segment")
plt.ylabel("Number of Customers")
plt.tight_layout()
plt.show()
```



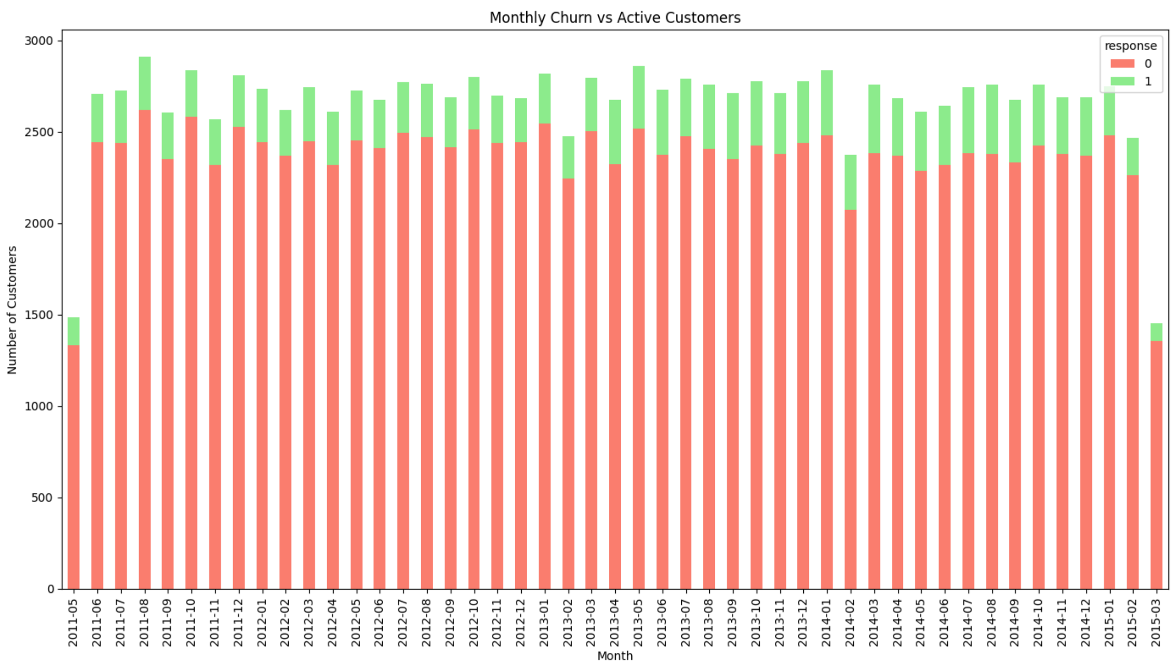
CHURN ANALYSIS

In [31]:
```
#Count the number of churned and active customers
import matplotlib.pyplot as plt

churn_counts = df['response'].value_counts()
churn_counts.plot(kind='bar', color=['salmon', 'skyblue'])

plt.title("Churn vs Active Customers")
plt.xlabel("Response (0 = Churned, 1 = Active)")
plt.ylabel("Number of Customers")
plt.tight_layout()
plt.show()
```



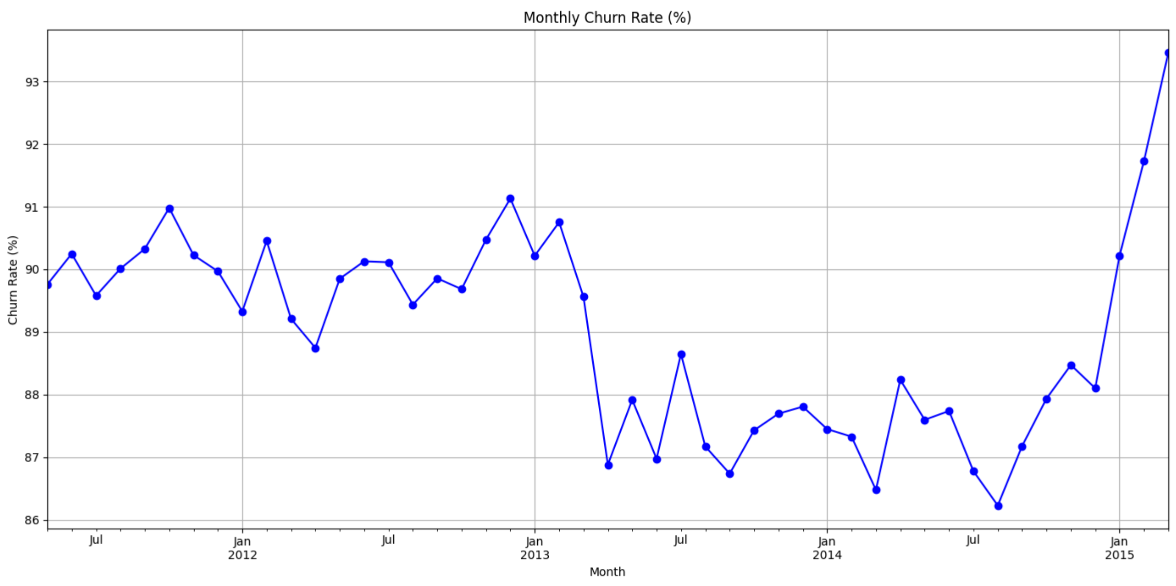
```
In [37]: df['trans_date'] = pd.to_datetime(df['trans_date'])
         df['Month'] = df['trans_date'].dt.to_period('M')
         monthly_churn = df.groupby(['Month', 'response']).size().unstack(fill_value=0)

         monthly_churn.plot(kind='bar', stacked=True, figsize=(14,8), color=['salmon','li
         plt.title("Monthly Churn vs Active Customers")
         plt.xlabel("Month")
         plt.ylabel("Number of Customers")
         plt.xticks(rotation=90)
         plt.tight_layout()
         plt.show()
```

```
C:\Users\DELL\AppData\Local\Temp\ipykernel_1596\3253399344.py:1: SettingWithCopyW
arning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['trans_date'] = pd.to_datetime(df['trans_date'])
C:\Users\DELL\AppData\Local\Temp\ipykernel_1596\3253399344.py:2: SettingWithCopyW
arning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['Month'] = df['trans_date'].dt.to_period('M')
```

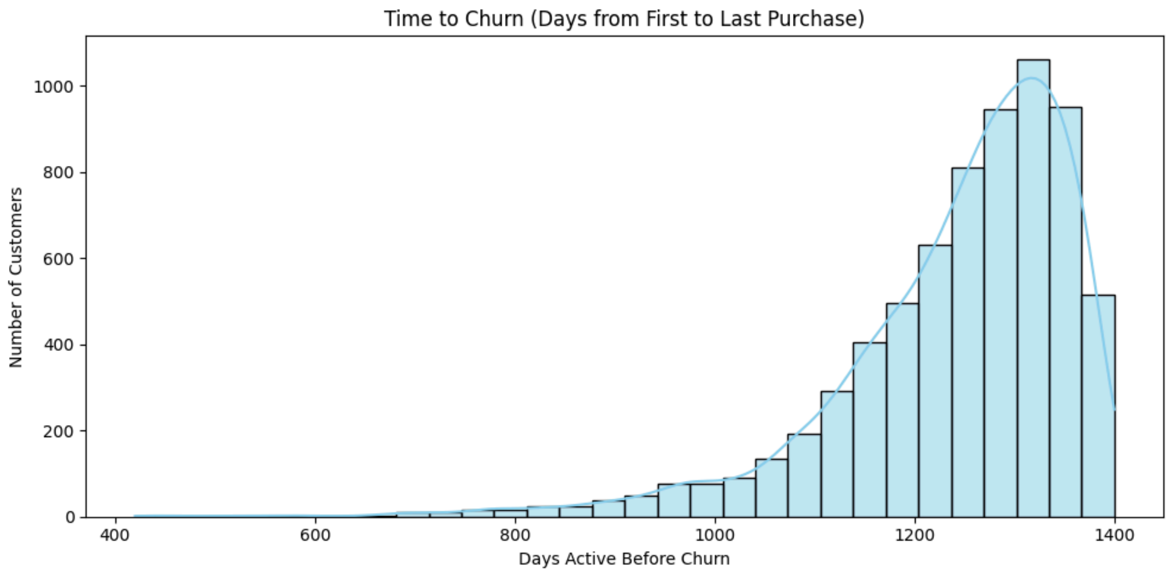


```
In [43]: df['trans_date'] = pd.to_datetime(df['trans_date'])
         df['Month'] = df['trans_date'].dt.to_period('M')

         monthly_counts = df.groupby(['Month', 'response']).size().unstack(fill_value=0)
         monthly_counts['Churn Rate (%)'] = monthly_counts[0] / (monthly_counts[0] + mont

         monthly_counts['Churn Rate (%)'].plot(kind='line', marker='o', figsize=(14,7), c
         plt.title("Monthly Churn Rate (%)")
         plt.xlabel("Month")
         plt.ylabel("Churn Rate (%)")
         plt.grid(True)
         plt.tight_layout()
         plt.show()
```

```
C:\Users\DELL\AppData\Local\Temp\ipykernel_1596\2235735469.py:1: SettingWithCopyW
arning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['trans_date'] = pd.to_datetime(df['trans_date'])
C:\Users\DELL\AppData\Local\Temp\ipykernel_1596\2235735469.py:2: SettingWithCopyW
arning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['Month'] = df['trans_date'].dt.to_period('M')
```

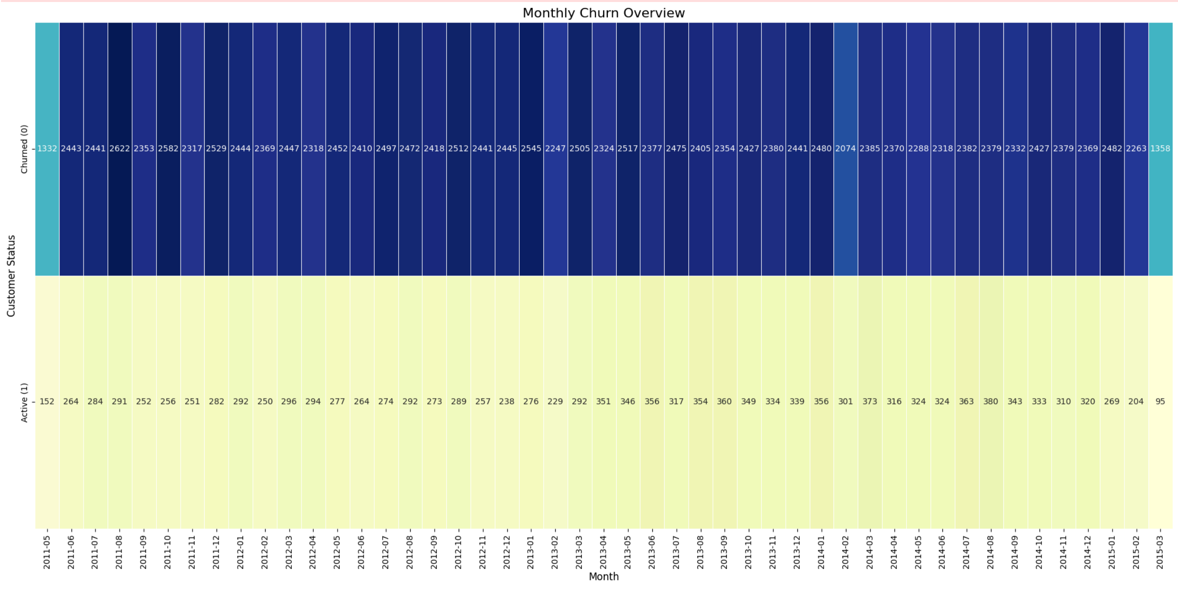


In [44]:
```python
last_purchase = df.groupby('customer_id')['trans_date'].max()
first_purchase = df.groupby('customer_id')['trans_date'].min()
time_to_churn = (last_purchase - first_purchase).dt.days

plt.figure(figsize=(10, 5))
sns.histplot(time_to_churn, bins=30, kde=True, color='skyblue')
plt.title("Time to Churn (Days from First to Last Purchase)")
plt.xlabel("Days Active Before Churn")
plt.ylabel("Number of Customers")
plt.tight_layout()
plt.show()
```



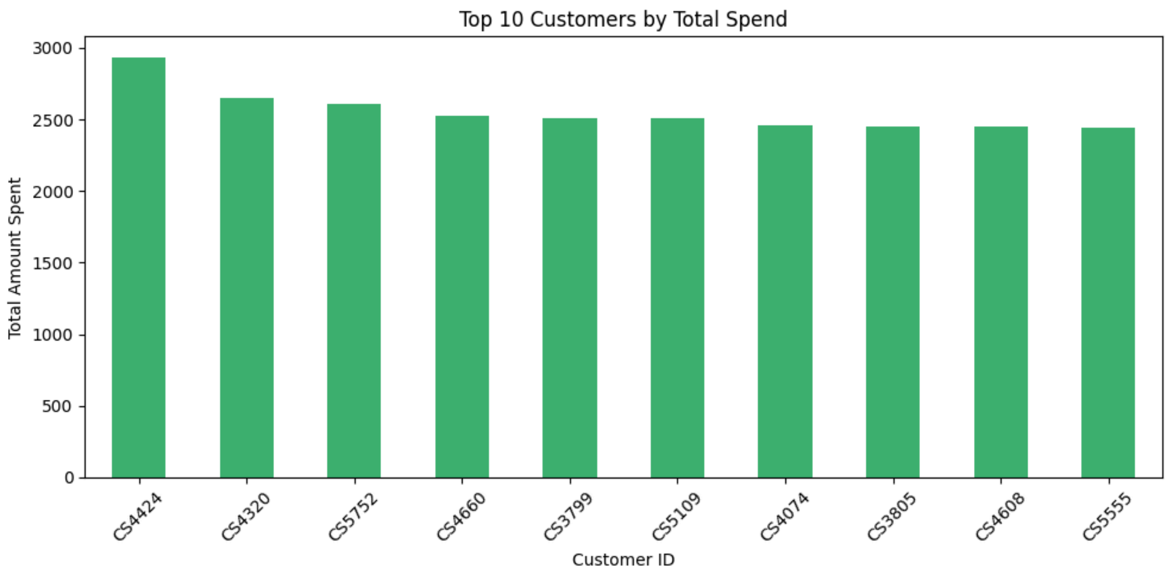
In [55]:
```python
import matplotlib.pyplot as plt
import seaborn as sns

df['trans_date'] = pd.to_datetime(df['trans_date'])
df['Month'] = df['trans_date'].dt.to_period('M')

churn_table = df.groupby(['Month', 'response']).size().unstack(fill_value=0)
churn_table.columns = ['Churned (0)', 'Active (1)']
churn_table.index = churn_table.index.astype(str)

plt.figure(figsize=(20,10))
sns.heatmap(churn_table.T, annot=True, fmt='d', cmap='YlGnBu', linewidths=0.6, c
plt.title("Monthly Churn Overview", fontsize=16)
plt.xlabel("Month", fontsize=12)
plt.ylabel("Customer Status", fontsize=12)
plt.xticks(rotation=90)
plt.tight_layout()
plt.show()
```

```
C:\Users\DELL\AppData\Local\Temp\ipykernel_1596\1818809005.py:4: SettingWithCopyW
arning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['trans_date'] = pd.to_datetime(df['trans_date'])
C:\Users\DELL\AppData\Local\Temp\ipykernel_1596\1818809005.py:5: SettingWithCopyW
arning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['Month'] = df['trans_date'].dt.to_period('M')
```

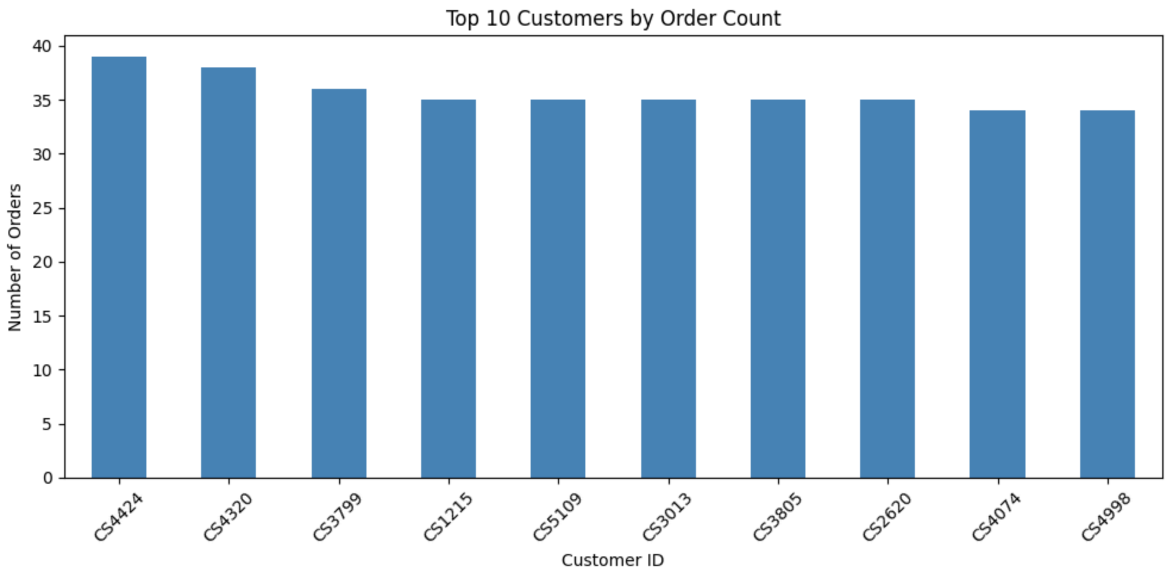


ANALYSING THE TOP CUSTOMERS

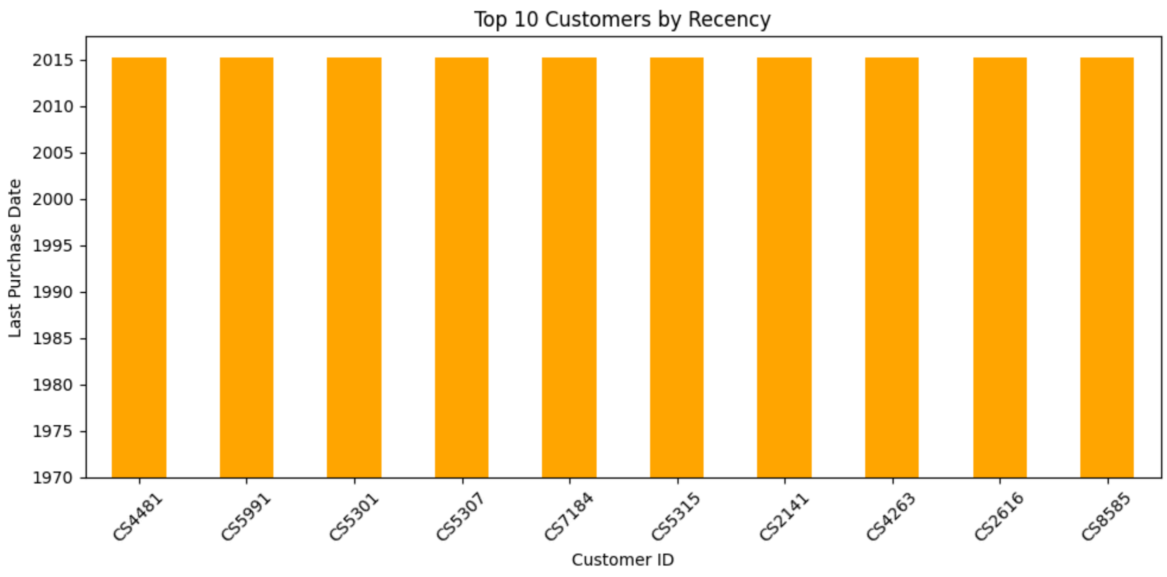
In [56]:
```python
top_spenders = df.groupby('customer_id')['tran_amount'].sum().sort_values(ascend

plt.figure(figsize=(10, 5))
top_spenders.plot(kind='bar', color='mediumseagreen')
plt.title("Top 10 Customers by Total Spend")
plt.xlabel("Customer ID")
plt.ylabel("Total Amount Spent")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



In [57]:
```python
top_frequent = df['customer_id'].value_counts().head(10)

plt.figure(figsize=(10, 5))
top_frequent.plot(kind='bar', color='steelblue')
plt.title("Top 10 Customers by Order Count")
plt.xlabel("Customer ID")
plt.ylabel("Number of Orders")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



In [58]:
```python
recent = df.groupby('customer_id')['trans_date'].max().sort_values(ascending=Fal

plt.figure(figsize=(10, 5))
recent.index = recent.index.astype(str)
recent = recent.sort_values()  # So most recent is rightmost
recent.plot(kind='bar', color='orange')
plt.title("Top 10 Customers by Recency")
plt.xlabel("Customer ID")
plt.ylabel("Last Purchase Date")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



```
In [63]: df.to_csv('MainData.csv')
```

```
In [65]: new.to_csv('AdditionalAnalysis.csv')
```

```
In [ ]:
```