Data Manipulation by Pandas

In [3]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings("ignore")
```

In [16]:
```
df=pd.read_csv("C:\\Users\\Rc\\Downloads\\Python Data Analysis\\marketing_AB.csv")
df
```

Out[16]:

	Unnamed: 0	user id	test group	converted	total ads	most ads day	most ads hour
0	0	1069124	ad	False	130	Monday	20
1	1	1119715	ad	False	93	Tuesday	22
2	2	1144181	ad	False	21	Tuesday	18
3	3	1435133	ad	False	355	Tuesday	10
4	4	1015700	ad	False	276	Friday	14
...	...	...	...	...	...	...	...
588096	588096	1278437	ad	False	1	Tuesday	23
588097	588097	1327975	ad	False	1	Tuesday	23
588098	588098	1038442	ad	False	3	Tuesday	23
588099	588099	1496395	ad	False	1	Tuesday	23
588100	588100	1237779	ad	False	1	Tuesday	23

588101 rows × 7 columns

In [17]:
```
#check first few observation
df.head()
```

Out[17]:

	Unnamed: 0	user id	test group	converted	total ads	most ads day	most ads hour
0	0	1069124	ad	False	130	Monday	20
1	1	1119715	ad	False	93	Tuesday	22
2	2	1144181	ad	False	21	Tuesday	18
3	3	1435133	ad	False	355	Tuesday	10
4	4	1015700	ad	False	276	Friday	14

In [19]:
```
#Check if we have duplicates with respect to user_id
df.duplicated(subset = 'user id').sum()
```

Out[19]:
```
np.int64(0)
```

In [28]:
```
#Drop unwanted column
df.drop(['Unnamed: 0','user id'],axis = 1,inplace = True)
```

In [30]:
```
df.columns
```

Out[30]:
```
Index(['test group', 'converted', 'total ads', 'most ads day',
       'most ads hour'],
      dtype='object')
```

In [31]:
```
df.head()
```

Out[31]:

	test group	converted	total ads	most ads day	most ads hour
0	ad	False	130	Monday	20
1	ad	False	93	Tuesday	22
2	ad	False	21	Tuesday	18
3	ad	False	355	Tuesday	10
4	ad	False	276	Friday	14

In [32]:
```
df_cat = df[['test group','converted', 'most ads day', 'most ads hour']]
df_cat.nunique()
```

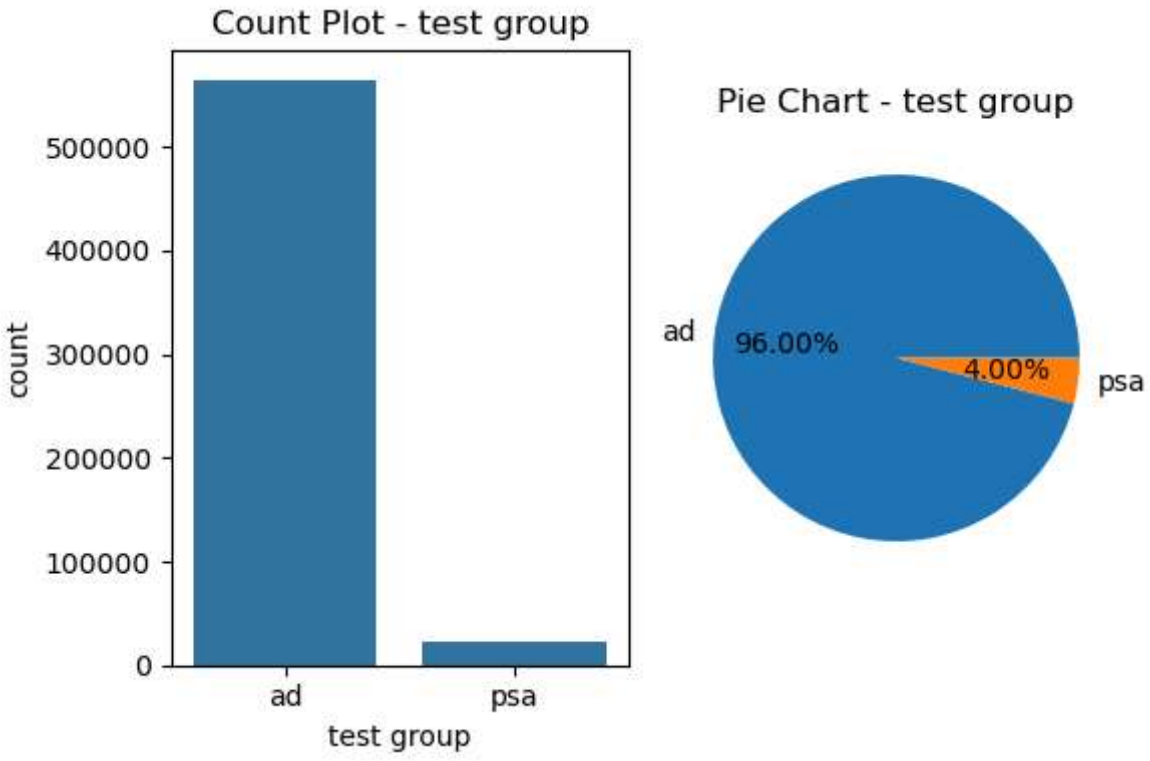
Out[32]:
```
test group        2
converted         2
most ads day      7
most ads hour    24
dtype: int64
```

In [33]:
```
#Check if the categorical variables have appropriate levels
for i in df_cat.columns:
    print(i.upper(),":",df_cat[i].unique())
```

```
TEST GROUP : ['ad' 'psa']
CONVERTED : [False  True]
MOST ADS DAY : ['Monday' 'Tuesday' 'Friday' 'Saturday' 'Wednesday' 'Sunday' 'Thursda
y']
MOST ADS HOUR : [20 22 18 10 14 13 19 11 12 16 21  3 23  4  8  0  2 15  1  6 17  7
9  5]
```

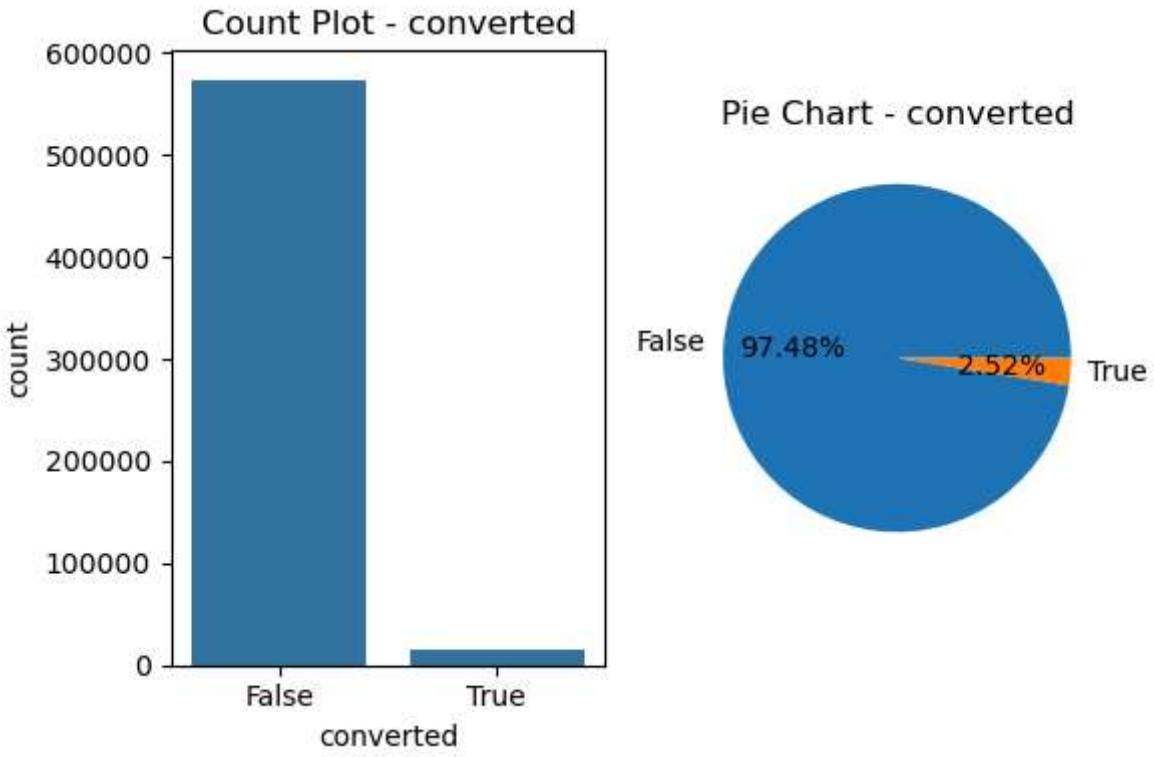
Univariate Analysis

In [36]:
```
variable = 'test group'
plt.figure(figsize= (6,4))
# Count plot
plt.subplot(1,2,1)
sns.countplot(x = variable,data = df_cat)
plt.title(f'Count Plot - {variable}')
#Pie chart
plt.subplot(1,2,2)
counts = df_cat[variable].value_counts()
plt.pie(counts,labels = counts.index,autopct = '%0.2f%%')
plt.title(f'Pie Chart - {variable}')
#Adjust layout
plt.tight_layout()
#Show the plots
plt.show()
```

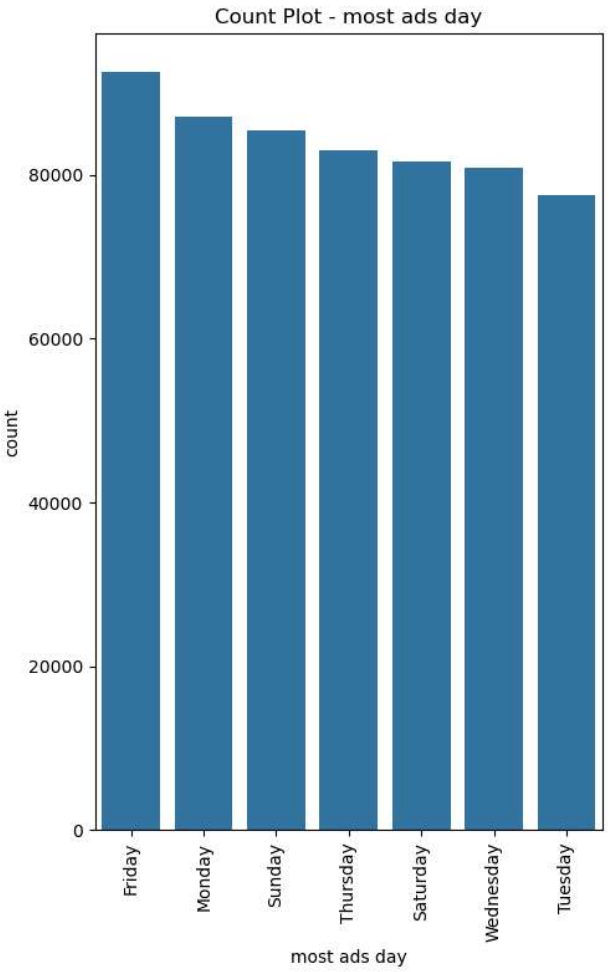


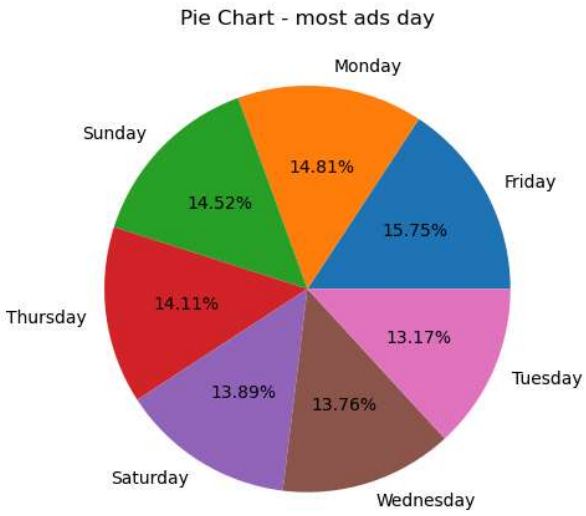
In [37]:
```
variable = 'converted'
plt.figure(figsize= (6,4))
# Count plot
plt.subplot(1,2,1)
sns.countplot(x = variable,data = df_cat)
```

```
plt.title(f'Count Plot - {variable}')
#Pie chart
plt.subplot(1,2,2)
counts = df_cat[variable].value_counts()
plt.pie(counts,labels = counts.index,autopct = '%0.2f%%')
plt.title(f'Pie Chart - {variable}')
#Adjust layout
plt.tight_layout()
#Show the plots
plt.show()
```

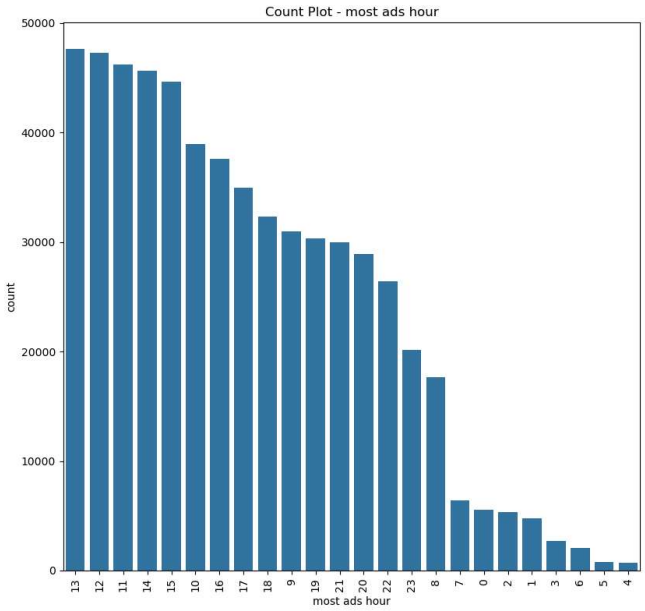


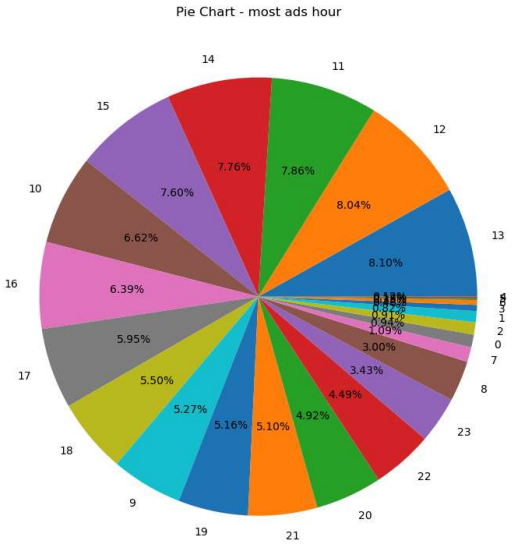
In [40]:
```
variable =  'most ads day'
plt.figure(figsize= (10,8))
# Count plot
plt.subplot(1,2,1)
sns.countplot(x = variable,data = df_cat,order = df_cat['most ads day'].value_count
plt.title(f'Count Plot - {variable}')
plt.xticks(rotation = 90)

#Pie chart
plt.subplot(1,2,2)
counts = df_cat[variable].value_counts()
plt.pie(counts,labels = counts.index,autopct = '%0.2f%%')
plt.title(f'Pie Chart - {variable}')
#Adjust layout
plt.tight_layout()
#Show the plots
plt.show()
```





In [51]:
```
variable =  'most ads hour'
plt.figure(figsize= (16,8))
# Count plot
plt.subplot(1,2,1)
sns.countplot(x = variable,data = df_cat,order = df_cat['most ads hour'].value_coun
plt.title(f'Count Plot - {variable}')
plt.xticks(rotation = 90)

#Pie chart
plt.subplot(1,2,2)
counts = df_cat[variable].value_counts()
plt.pie(counts,labels = counts.index,autopct = '%0.2f%%')
plt.title(f'Pie Chart - {variable}')
#Adjust layout
plt.tight_layout()
#Show the plots
plt.show()
```

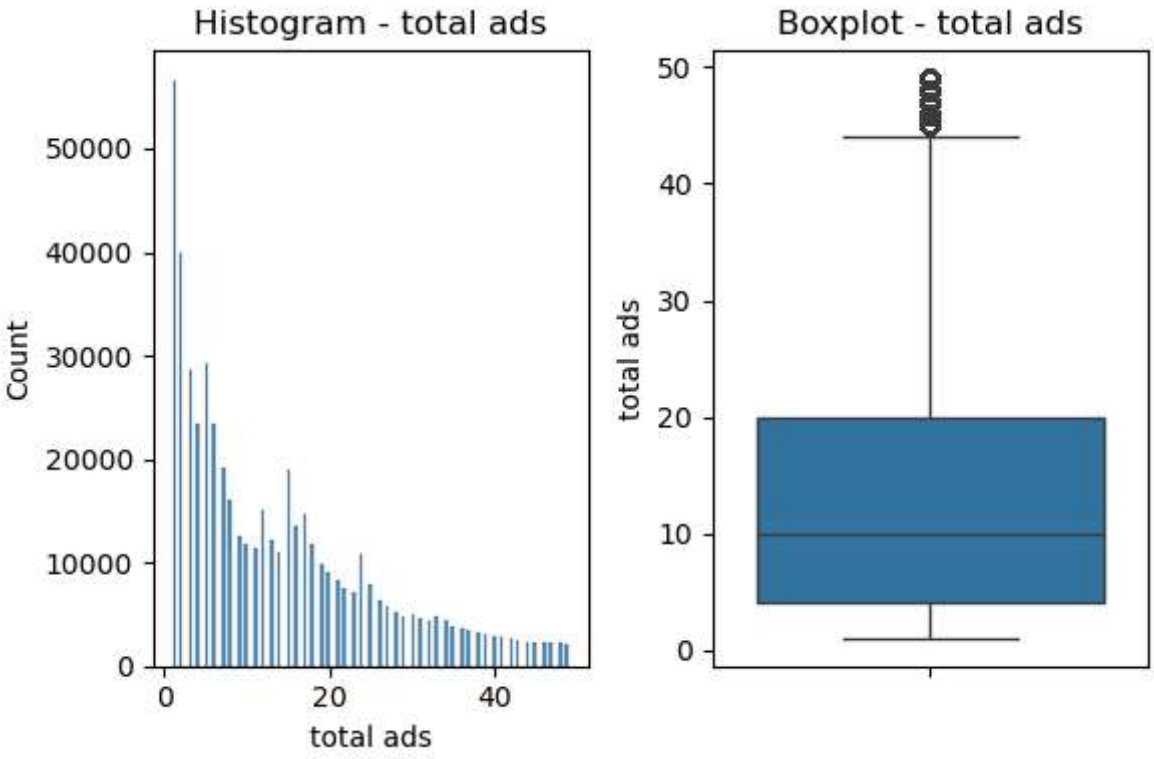




In [52]:
```
# Let's check the descriptive stats of this feature
df['total ads'].describe()
```

Out[52]:
```
count    588101.000000
mean         24.820876
std          43.715181
min           1.000000
25%           4.000000
50%          13.000000
75%          27.000000
max        2065.000000
Name: total ads, dtype: float64
```

In [53]:
```
variable =  'total ads'
plt.figure(figsize= (6,4))

#For numerical Variable Histogram and Boxplot

# Histogram
plt.subplot(1,2,1)
#Filtering the data for a value close to 75th percentile only for better visualizat
sns.histplot(x = variable,data = df[df['total ads']<50])
plt.title(f'Histogram - {variable}')

#Boxplot
plt.subplot(1,2,2)
sns.boxplot(y = variable,data = df[df['total ads']<50])
plt.title(f'Boxplot - {variable}')

#Adjust layout
plt.tight_layout()
#Show the plots
plt.show()
```



Bivariate Analysis

In [54]:
```
df.columns
```

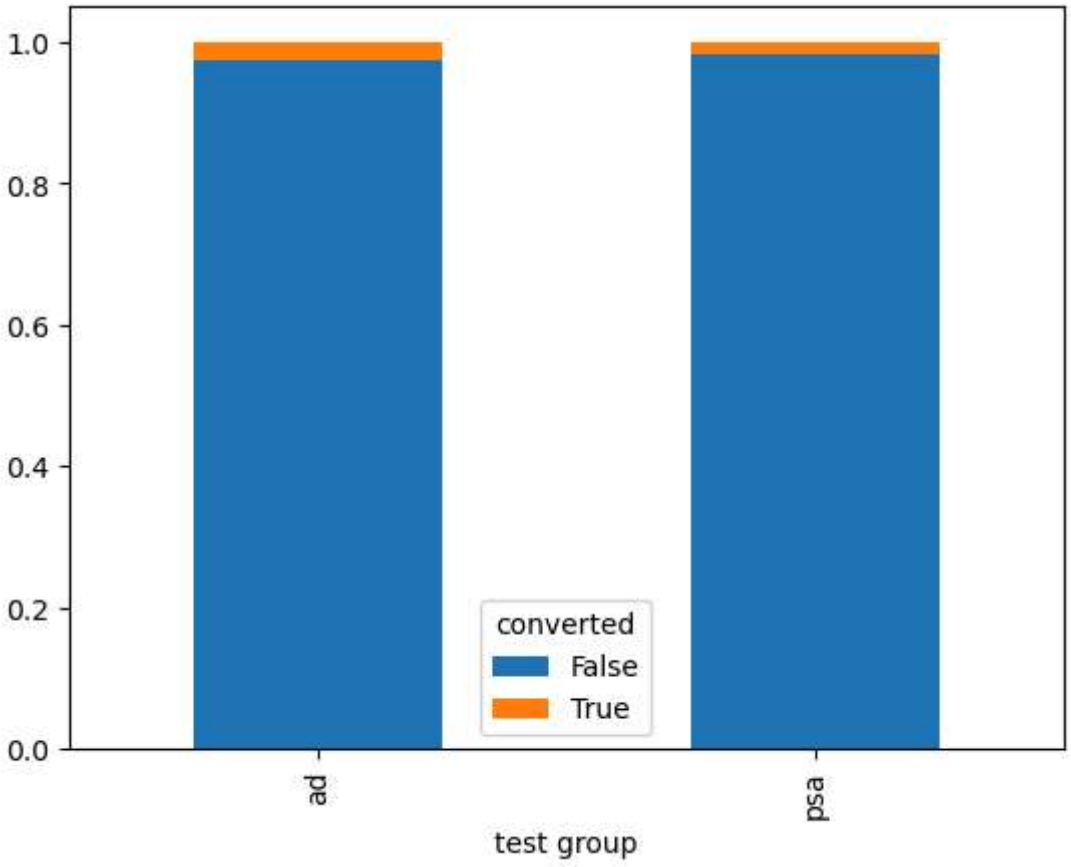
Out[54]:
```
Index(['test group', 'converted', 'total ads', 'most ads day',
       'most ads hour'],
      dtype='object')
```

In [55]:
```
ct_conversion_test_group = pd.crosstab(df['test group'],df['converted'],normalize =
ct_conversion_test_group
```

Out[55]:

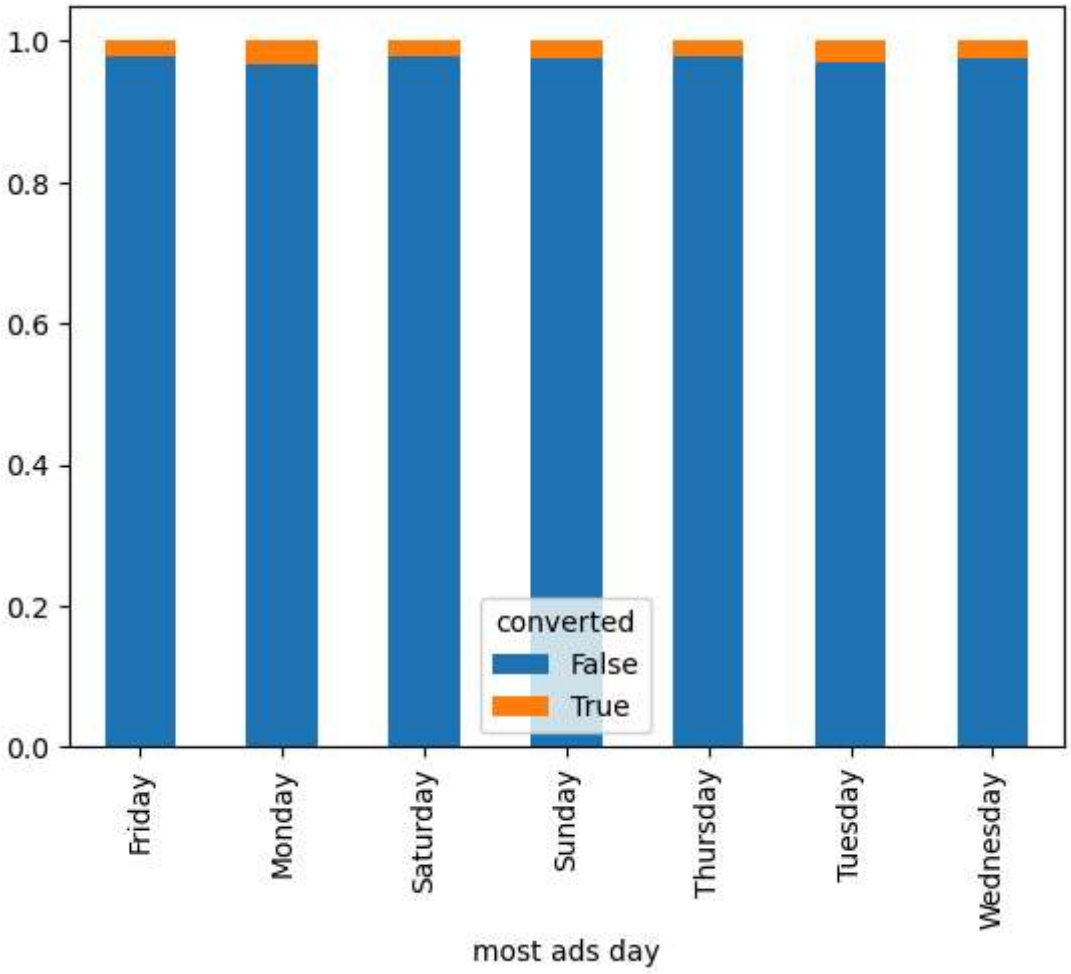
converted	False	True
test group		
ad	0.974453	0.025547
psa	0.982146	0.017854

In [57]:
```
#Stacked Bar Chart
ct_conversion_test_group.plot.bar(stacked = True);
```



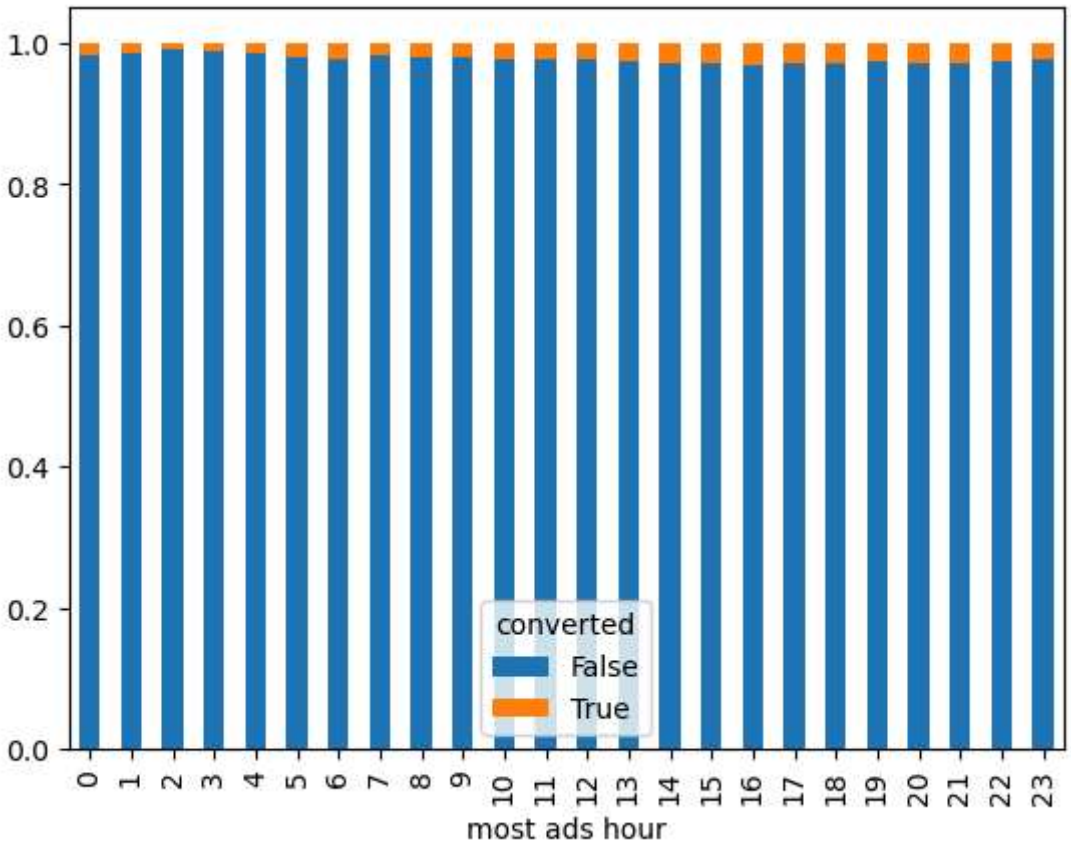
In [60]:
```
ct_conversion_day =pd.crosstab(df['most ads day'],df['converted'],normalize = 'inde
print(ct_conversion_day.sort_values(by = True,ascending = False))
ct_conversion_day.plot.bar(stacked = True);
```

```
converted        False     True
most ads day
Monday        0.967188  0.032812
Tuesday       0.970160  0.029840
Wednesday     0.975058  0.024942
Sunday        0.975524  0.024476
Friday        0.977788  0.022212
Thursday      0.978429  0.021571
Saturday      0.978949  0.021051
```

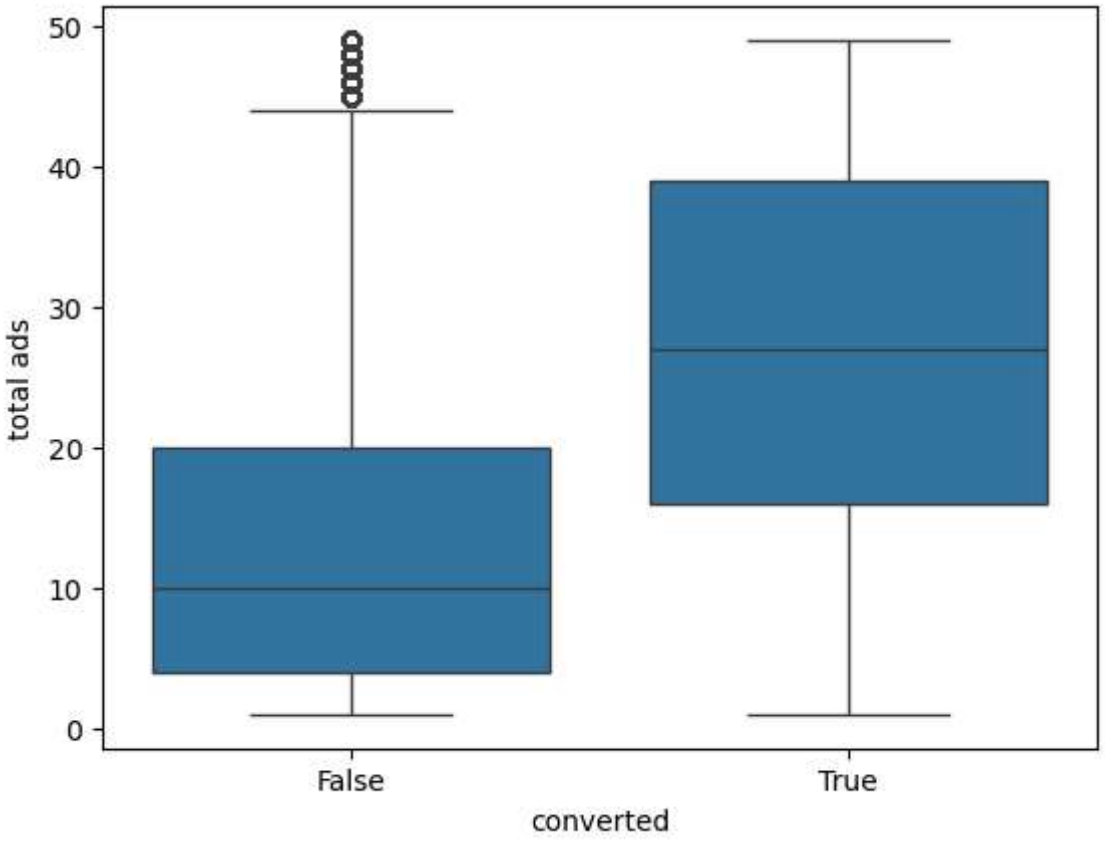


In [61]:
```
ct_conversion_hour=pd.crosstab(df['most ads hour'],df['converted'],normalize = 'ind
print(ct_conversion_hour.sort_values(by = True,ascending = False))
ct_conversion_hour.plot.bar(stacked = True);
```

converted	False	True
most ads hour		
16	0.969228	0.030772
20	0.970197	0.029803
15	0.970347	0.029653
21	0.971077	0.028923
17	0.971790	0.028210
14	0.971937	0.028063
18	0.972620	0.027380
19	0.973280	0.026720
22	0.973895	0.026105
13	0.975323	0.024677
12	0.976172	0.023828
23	0.977338	0.022662
6	0.977756	0.022244
11	0.977884	0.022116
10	0.978479	0.021521
5	0.979085	0.020915
8	0.980484	0.019516
9	0.980809	0.019191
0	0.981575	0.018425
7	0.981889	0.018111
4	0.984765	0.015235
1	0.987089	0.012911
3	0.989548	0.010452
2	0.992687	0.007313



In [62]:
```
sns.boxplot(x = 'converted', y='total ads',data = df[df['total ads']<50]);
```



Statistical Tests

In [63]:
```
from scipy.stats import chi2_contingency
alpha = 0.05
for variable in df_cat.columns:
    if variable !='converted':
        #Created a contingency table(cross-tabulation)
        contingency_table =pd.crosstab(df_cat[variable],df_cat['converted'])
        #Perform chi-squared test
        chi2, p, _, _ = chi2_contingency(  contingency_table)
        # Display the results
        print(f"\nchi-squared test for {variable} vs.converted;")
        print(f"Chi-Squared value : {chi2}")
        print(f"p-value:{p}")

        #Check for significance
        if p<alpha:
            print(f"The difference in conversion rates across {variable} is statist
        else:
            print(f"There is no significat difference in conversion rates across{va
```

```
chi-squared test for test group vs.converted;
Chi-Squared value : 54.005823883685245
p-value:1.9989623063390075e-13
The difference in conversion rates across test group is statistically significant.

chi-squared test for most ads day vs.converted;
Chi-Squared value : 410.0478857936585
p-value:1.932184379244731e-85
The difference in conversion rates across most ads day is statistically significant.

chi-squared test for most ads hour vs.converted;
Chi-Squared value : 430.76869230822086
p-value:8.027629823696771e-77
The difference in conversion rates across most ads hour is statistically significan
t.
```

In [65]:
```
df_cat.columns
```

Out[65]:
```
Index(['test group', 'converted', 'most ads day', 'most ads hour'], dtype='objec
t')
```

In [69]:
```
import pandas as pd
from scipy.stats import shapiro, levene, ttest_ind, mannwhitneyu

# Step 1: Check Assumptions
# Normality Test
shapiro_stat_true, shapiro_p_value_true = shapiro(df[df['converted'] == True]['tota
shapiro_stat_false, shapiro_p_value_false = shapiro(df[df['converted'] == False]['t

print(f"Shapiro-Wilk test (Converted = True): p-value = {shapiro_p_value_true}")
print(f"Shapiro-Wilk test (Converted = False): p-value = {shapiro_p_value_false}")

# Equality of variances assumption (Levene's test)
levene_stat, levene_p_value = levene(
    df[df['converted'] == True]['total ads'],
    df[df['converted'] == False]['total ads']
)

print(f"Levene's test for equality of variances: p-value = {levene_p_value}")
```

```
Shapiro-Wilk test (Converted = True): p-value = 1.638680987007771e-98
Shapiro-Wilk test (Converted = False): p-value = 9.883049430735801e-204
Levene's test for equality of variances: p-value = 0.0
```

In [70]:
```
# Step 2 :Perform a Suitable Test
alpha =0.05
if shapiro_p_value_true>alpha and shapiro_p_value_false >alpha and levene_p_value >
    #Assumption met -use t-test for means
    t_stat,t_p_value = ttest_ind(df[df['converted']]['tatal ads'],df[~df['converted
    print(f"Independent two-sample t-test:p-value = {t_p_value}")
else:
    #Assumption not met - Use Mann Whitney U test for medians
    u_stat,u_p_value = mannwhitneyu(df[df['converted']]['total ads'],df[~df['conver
    print(f"Mann-Whitney U test: p-value = {u_p_value}")
```

```
Mann-Whitney U test: p-value = 0.0
```

In [ ]: