

```
In [ ]: #data_exploration_and_analysis
```

```
In [1]: import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings("ignore")
```

```
In [5]: dataset = pd.read_csv(r"D:\Next hike 5-project-March-25\telcom_data.csv")
```

```
In [7]: dataset
```

Out[7]:

	Bearer Id	Start	Start ms	End	End ms	Dur. (ms)	IMSI	MSISDN
0	1.311450e+19	4/4/19 12:01	770.0	4/25/19 14:35	662.0	1823652.0	2.082014e+14	3.36
1	1.311450e+19	4/9/19 13:04	235.0	4/25/19 8:15	606.0	1365104.0	2.082019e+14	3.36
2	1.311450e+19	4/9/19 17:42	1.0	4/25/19 11:58	652.0	1361762.0	2.082003e+14	3.37
3	1.311450e+19	4/10/19 0:31	486.0	4/25/19 7:36	171.0	1321509.0	2.082014e+14	3.37
4	1.311450e+19	4/12/19 20:10	565.0	4/25/19 10:40	954.0	1089009.0	2.082014e+14	3.36
...
149996	7.277830e+18	4/29/19 7:28	451.0	4/30/19 6:02	214.0	81230.0	2.082022e+14	3.36
149997	7.349880e+18	4/29/19 7:28	483.0	4/30/19 10:41	187.0	97970.0	2.082019e+14	3.36
149998	1.311450e+19	4/29/19 7:28	283.0	4/30/19 10:46	810.0	98249.0	2.082017e+14	3.36
149999	1.311450e+19	4/29/19 7:28	696.0	4/30/19 10:40	327.0	97910.0	2.082021e+14	3.36
150000		NaN	NaN	NaN	NaN	NaN	NaN	NaN

150001 rows × 55 columns



```
In [9]: dataset.head(5)
```

Out[9]:

	Bearer Id	Start	Start ms	End	End ms	Dur. (ms)	IMSI	MSISDN/Num
0	1.311450e+19	4/4/19 12:01	770.0	4/25/19 14:35	662.0	1823652.0	2.082014e+14	3.366496e
1	1.311450e+19	4/9/19 13:04	235.0	4/25/19 8:15	606.0	1365104.0	2.082019e+14	3.368185e
2	1.311450e+19	4/9/19 17:42	1.0	4/25/19 11:58	652.0	1361762.0	2.082003e+14	3.376063e
3	1.311450e+19	4/10/19 0:31	486.0	4/25/19 7:36	171.0	1321509.0	2.082014e+14	3.375034e
4	1.311450e+19	4/12/19 20:10	565.0	4/25/19 10:40	954.0	1089009.0	2.082014e+14	3.369980e

5 rows × 55 columns

In [11]: `dataset.columns`

```
Out[11]: Index(['Bearer Id', 'Start', 'Start ms', 'End', 'End ms', 'Dur. (ms)', 'IMSI',
       'MSISDN/Number', 'IMEI', 'Last Location Name', 'Avg RTT DL (ms)',
       'Avg RTT UL (ms)', 'Avg Bearer TP DL (kbps)', 'Avg Bearer TP UL (kbps)',
       'TCP DL Retrans. Vol (Bytes)', 'TCP UL Retrans. Vol (Bytes)',
       'DL TP < 50 Kbps (%)', '50 Kbps < DL TP < 250 Kbps (%)',
       '250 Kbps < DL TP < 1 Mbps (%)', 'DL TP > 1 Mbps (%)',
       'UL TP < 10 Kbps (%)', '10 Kbps < UL TP < 50 Kbps (%)',
       '50 Kbps < UL TP < 300 Kbps (%)', 'UL TP > 300 Kbps (%)',
       'HTTP DL (Bytes)', 'HTTP UL (Bytes)', 'Activity Duration DL (ms)',
       'Activity Duration UL (ms)', 'Dur. (ms).1', 'Handset Manufacturer',
       'Handset Type', 'Nb of sec with 125000B < Vol DL',
       'Nb of sec with 1250B < Vol UL < 6250B',
       'Nb of sec with 31250B < Vol DL < 125000B',
       'Nb of sec with 37500B < Vol UL',
       'Nb of sec with 6250B < Vol DL < 31250B',
       'Nb of sec with 6250B < Vol UL < 37500B',
       'Nb of sec with Vol DL < 6250B', 'Nb of sec with Vol UL < 1250B',
       'Social Media DL (Bytes)', 'Social Media UL (Bytes)',
       'Google DL (Bytes)', 'Google UL (Bytes)', 'Email DL (Bytes)',
       'Email UL (Bytes)', 'Youtube DL (Bytes)', 'Youtube UL (Bytes)',
       'Netflix DL (Bytes)', 'Netflix UL (Bytes)', 'Gaming DL (Bytes)',
       'Gaming UL (Bytes)', 'Other DL (Bytes)', 'Other UL (Bytes)',
       'Total UL (Bytes)', 'Total DL (Bytes)'],
      dtype='object')
```

In [15]: `dataset.info()`

```

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150001 entries, 0 to 150000
Data columns (total 55 columns):
 #   Column           Non-Null Count Dtype
 ---  -- 
 0   Bearer Id        149010 non-null float64
 1   Start            150000 non-null object
 2   Start ms         150000 non-null float64
 3   End              150000 non-null object
 4   End ms           150000 non-null float64
 5   Dur. (ms)        150000 non-null float64
 6   IMSI             149431 non-null float64
 7   MSISDN/Number    148935 non-null float64
 8   IMEI             149429 non-null float64
 9   Last Location Name 148848 non-null object
 10  Avg RTT DL (ms) 122172 non-null float64
 11  Avg RTT UL (ms) 122189 non-null float64
 12  Avg Bearer TP DL (kbps) 150000 non-null float64
 13  Avg Bearer TP UL (kbps) 150000 non-null float64
 14  TCP DL Retrans. Vol (Bytes) 61855 non-null float64
 15  TCP UL Retrans. Vol (Bytes) 53352 non-null float64
 16  DL TP < 50 Kbps (%) 149247 non-null float64
 17  50 Kbps < DL TP < 250 Kbps (%) 149247 non-null float64
 18  250 Kbps < DL TP < 1 Mbps (%) 149247 non-null float64
 19  DL TP > 1 Mbps (%) 149247 non-null float64
 20  UL TP < 10 Kbps (%) 149209 non-null float64
 21  10 Kbps < UL TP < 50 Kbps (%) 149209 non-null float64
 22  50 Kbps < UL TP < 300 Kbps (%) 149209 non-null float64
 23  UL TP > 300 Kbps (%) 149209 non-null float64
 24  HTTP DL (Bytes) 68527 non-null float64
 25  HTTP UL (Bytes) 68191 non-null float64
 26  Activity Duration DL (ms) 150000 non-null float64
 27  Activity Duration UL (ms) 150000 non-null float64
 28  Dur. (ms).1 150000 non-null float64
 29  Handset Manufacturer 149429 non-null object
 30  Handset Type 149429 non-null object
 31  Nb of sec with 125000B < Vol DL 52463 non-null float64
 32  Nb of sec with 1250B < Vol UL < 6250B 57107 non-null float64
 33  Nb of sec with 31250B < Vol DL < 125000B 56415 non-null float64
 34  Nb of sec with 37500B < Vol UL 19747 non-null float64
 35  Nb of sec with 6250B < Vol DL < 31250B 61684 non-null float64
 36  Nb of sec with 6250B < Vol UL < 37500B 38158 non-null float64
 37  Nb of sec with Vol DL < 6250B 149246 non-null float64
 38  Nb of sec with Vol UL < 1250B 149208 non-null float64
 39  Social Media DL (Bytes) 150001 non-null float64
 40  Social Media UL (Bytes) 150001 non-null float64
 41  Google DL (Bytes) 150001 non-null float64
 42  Google UL (Bytes) 150001 non-null float64
 43  Email DL (Bytes) 150001 non-null float64
 44  Email UL (Bytes) 150001 non-null float64
 45  Youtube DL (Bytes) 150001 non-null float64
 46  Youtube UL (Bytes) 150001 non-null float64
 47  Netflix DL (Bytes) 150001 non-null float64
 48  Netflix UL (Bytes) 150001 non-null float64
 49  Gaming DL (Bytes) 150001 non-null float64
 50  Gaming UL (Bytes) 150001 non-null float64
 51  Other DL (Bytes) 150001 non-null float64
 52  Other UL (Bytes) 150001 non-null float64
 53  Total UL (Bytes) 150000 non-null float64
 54  Total DL (Bytes) 150000 non-null float64

```

```
dtypes: float64(50), object(5)
memory usage: 62.9+ MB
```

```
In [17]: dataset.shape
```

```
Out[17]: (150001, 55)
```

```
In [19]: dataset.describe()
```

```
Out[19]:
```

	Bearer Id	Start ms	End ms	Dur. (ms)	IMSI	MSISD
count	1.490100e+05	150000.000000	150000.000000	1.500000e+05	1.494310e+05	1.4
mean	1.013887e+19	499.188200	498.800880	1.046086e+05	2.082016e+14	4.1
std	2.893170e+18	288.611834	288.097653	8.103762e+04	2.148809e+10	2.4
min	6.917540e+18	0.000000	0.000000	7.142000e+03	2.040471e+14	3.3
25%	7.349880e+18	250.000000	251.000000	5.744050e+04	2.082014e+14	3.3
50%	7.349880e+18	499.000000	500.000000	8.639900e+04	2.082015e+14	3.3
75%	1.304240e+19	749.000000	750.000000	1.324302e+05	2.082018e+14	3.3
max	1.318650e+19	999.000000	999.000000	1.859336e+06	2.140743e+14	8.8

8 rows × 50 columns

```
In [21]: missing_values = dataset.isnull().sum()
missing_values[missing_values > 0]
```

```
Out[21]:   Bearer Id          991
             Start              1
             Start ms             1
             End                1
             End ms              1
             Dur. (ms)            1
             IMSI                 570
             MSISDN/Number        1066
             IMEI                 572
             Last Location Name   1153
             Avg RTT DL (ms)      27829
             Avg RTT UL (ms)      27812
             Avg Bearer TP DL (kbps) 1
             Avg Bearer TP UL (kbps) 1
             TCP DL Retrans. Vol (Bytes) 88146
             TCP UL Retrans. Vol (Bytes) 96649
             DL TP < 50 Kbps (%)    754
             50 Kbps < DL TP < 250 Kbps (%) 754
             250 Kbps < DL TP < 1 Mbps (%) 754
             DL TP > 1 Mbps (%)     754
             UL TP < 10 Kbps (%)    792
             10 Kbps < UL TP < 50 Kbps (%) 792
             50 Kbps < UL TP < 300 Kbps (%) 792
             UL TP > 300 Kbps (%)   792
             HTTP DL (Bytes)       81474
             HTTP UL (Bytes)       81810
             Activity Duration DL (ms) 1
             Activity Duration UL (ms) 1
             Dur. (ms).1            1
             Handset Manufacturer   572
             Handset Type            572
             Nb of sec with 125000B < Vol DL 97538
             Nb of sec with 1250B < Vol UL < 6250B 92894
             Nb of sec with 31250B < Vol DL < 125000B 93586
             Nb of sec with 37500B < Vol UL           130254
             Nb of sec with 6250B < Vol DL < 31250B 88317
             Nb of sec with 6250B < Vol UL < 37500B 111843
             Nb of sec with Vol DL < 6250B          755
             Nb of sec with Vol UL < 1250B          793
             Total UL (Bytes)            1
             Total DL (Bytes)            1
             dtype: int64
```

```
In [23]: # Filling numerical missing values with median
numerical_cols = dataset.select_dtypes(include=['float64', 'int64']).columns
dataset[numerical_cols] = dataset[numerical_cols].apply(lambda x: x.fillna(x.median))

In [25]: # Filling categorical missing values with 'Unknown'
categorical_cols = dataset.select_dtypes(include=['object']).columns
dataset[categorical_cols] = dataset[categorical_cols].apply(lambda x: x.fillna('Unknown'))

In [27]: dataset['Start'] = dataset['Start'].fillna('2019-04-29 07:08:38')

In [29]: dataset['End'] = dataset['End'].fillna('2019-04-25 00:01:32')

In [31]: dataset.isnull().sum().iloc[0:55]
```

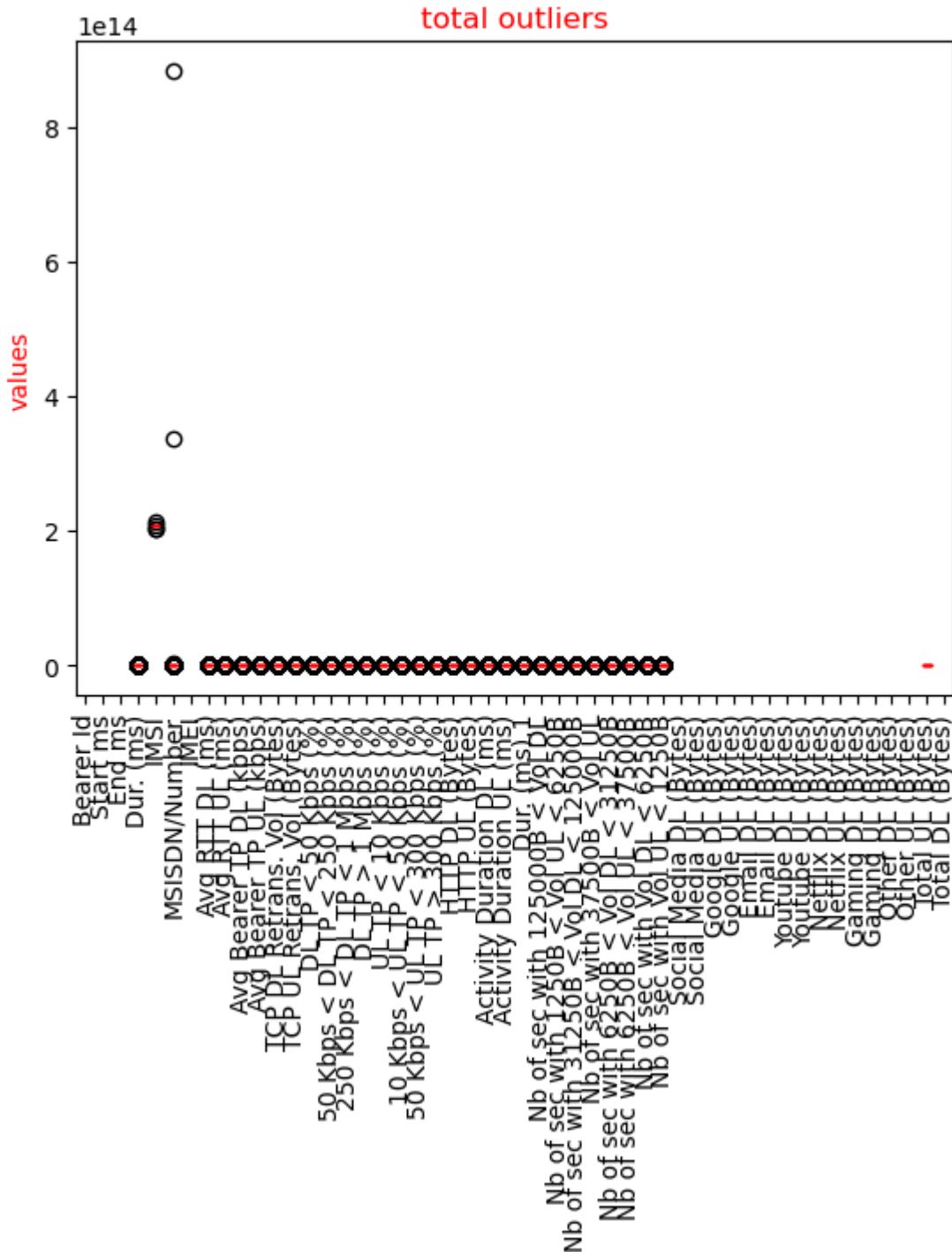
```
Out[31]: Bearer Id          0
Start                  0
Start ms                0
End                   0
End ms                 0
Dur. (ms)              0
IMSI                  0
MSISDN/Number          0
IMEI                  0
Last Location Name     0
Avg RTT DL (ms)        0
Avg RTT UL (ms)        0
Avg Bearer TP DL (kbps) 0
Avg Bearer TP UL (kbps) 0
TCP DL Retrans. Vol (Bytes) 0
TCP UL Retrans. Vol (Bytes) 0
DL TP < 50 Kbps (%)    0
50 Kbps < DL TP < 250 Kbps (%) 0
250 Kbps < DL TP < 1 Mbps (%)   0
DL TP > 1 Mbps (%)      0
UL TP < 10 Kbps (%)     0
10 Kbps < UL TP < 50 Kbps (%) 0
50 Kbps < UL TP < 300 Kbps (%) 0
UL TP > 300 Kbps (%)    0
HTTP DL (Bytes)         0
HTTP UL (Bytes)         0
Activity Duration DL (ms) 0
Activity Duration UL (ms) 0
Dur. (ms).1             0
Handset Manufacturer     0
Handset Type             0
Nb of sec with 125000B < Vol DL 0
Nb of sec with 1250B < Vol UL < 6250B 0
Nb of sec with 31250B < Vol DL < 125000B 0
Nb of sec with 37500B < Vol UL       0
Nb of sec with 6250B < Vol DL < 31250B 0
Nb of sec with 6250B < Vol UL < 37500B 0
Nb of sec with Vol DL < 6250B       0
Nb of sec with Vol UL < 1250B       0
Social Media DL (Bytes)           0
Social Media UL (Bytes)          0
Google DL (Bytes)               0
Google UL (Bytes)               0
Email DL (Bytes)                0
Email UL (Bytes)                0
Youtube DL (Bytes)              0
Youtube UL (Bytes)              0
Netflix DL (Bytes)              0
Netflix UL (Bytes)              0
Gaming DL (Bytes)               0
Gaming UL (Bytes)               0
Other DL (Bytes)                0
Other UL (Bytes)                0
Total UL (Bytes)                0
Total DL (Bytes)                0
dtype: int64
```

```
In [35]: Q1 = dataset[numerical_cols].quantile(0.25)
Q3 = dataset[numerical_cols].quantile(0.75)
IQR = Q3 - Q1
```

```
lower_bound = Q1 - 1.5*IQR  
upper_bound = Q3 + 1.5*IQR  
  
outliers = dataset[(dataset[numerical_cols] < lower_bound) | (dataset[numerical_
```

```
In [37]: plt.figure(figsize=(12,3),dpi=200)
outliers.plot(kind = 'box',color = 'red')
plt.xticks(rotation = 90)
plt.title('total outliers', color = 'red')
plt.ylabel('values',color = 'red')
plt.show()
```

<Figure size 2400x600 with 0 Axes>



```
In [39]: dataset.rename(columns={"Bearer Id": "Bearer Id"}, inplace=True)
```

```
In [41]: dataset.duplicated().sum()
```

Out[41]: 0

In [43]: dataset.to_csv(r"D:\Next hike 5-project-March-25\cleaned_telcom_data.csv", index=

In []: # Task-1_User_Overview_Analysis

In [47]: dataset = pd.read_csv(r"D:\Next hike 5-project-March-25\cleaned_telcom_data.csv")

In [49]: dataset

Out[49]:

	Bearer_Id	Start	Start ms	End	End ms	Dur. (ms)	IMSI	MSISDN
0	1.311450e+19	4/4/19 12:01	770.0	4/25/19 14:35	662.0	1823652.0	2.082014e+14	31999999999999999999999999999999
1	1.311450e+19	4/9/19 13:04	235.0	4/25/19 8:15	606.0	1365104.0	2.082019e+14	31999999999999999999999999999999
2	1.311450e+19	4/9/19 17:42	1.0	4/25/19 11:58	652.0	1361762.0	2.082003e+14	31999999999999999999999999999999
3	1.311450e+19	4/10/19 0:31	486.0	4/25/19 7:36	171.0	1321509.0	2.082014e+14	31999999999999999999999999999999
4	1.311450e+19	4/12/19 20:10	565.0	4/25/19 10:40	954.0	1089009.0	2.082014e+14	31999999999999999999999999999999
...
149996	7.277830e+18	4/29/19 7:28	451.0	4/30/19 6:02	214.0	81230.0	2.082022e+14	31999999999999999999999999999999
149997	7.349880e+18	4/29/19 7:28	483.0	4/30/19 10:41	187.0	97970.0	2.082019e+14	31999999999999999999999999999999
149998	1.311450e+19	4/29/19 7:28	283.0	4/30/19 10:46	810.0	98249.0	2.082017e+14	31999999999999999999999999999999
149999	1.311450e+19	4/29/19 7:28	696.0	4/30/19 10:40	327.0	97910.0	2.082021e+14	31999999999999999999999999999999
150000	7.349880e+18	Unknown	499.0	Unknown	500.0	86399.0	2.082015e+14	31999999999999999999999999999999

150001 rows × 55 columns



In [51]: dataset.head(5)

Out[51]:

	Bearer_Id	Start	Start_ms	End	End_ms	Dur. (ms)	IMSI	MSISDN/Num
0	1.311450e+19	4/4/19 12:01	770.0	4/25/19 14:35	662.0	1823652.0	2.082014e+14	3.366496e
1	1.311450e+19	4/9/19 13:04	235.0	4/25/19 8:15	606.0	1365104.0	2.082019e+14	3.368185e
2	1.311450e+19	4/9/19 17:42	1.0	4/25/19 11:58	652.0	1361762.0	2.082003e+14	3.376063e
3	1.311450e+19	4/10/19 0:31	486.0	4/25/19 7:36	171.0	1321509.0	2.082014e+14	3.375034e
4	1.311450e+19	4/12/19 20:10	565.0	4/25/19 10:40	954.0	1089009.0	2.082014e+14	3.369980e

5 rows × 55 columns

In [53]: `dataset.shape`

Out[53]: (150001, 55)

In [55]: `dataset.isnull().sum()`

```
Out[55]: Bearer_Id          0
Start                0
Start_ms              0
End                  0
End_ms                0
Dur. (ms)             0
IMSI                 0
MSISDN/Number         0
IMEI                 0
Last Location Name    0
Avg RTT DL (ms)       0
Avg RTT UL (ms)       0
Avg Bearer TP DL (kbps) 0
Avg Bearer TP UL (kbps) 0
TCP DL Retrans. Vol (Bytes) 0
TCP UL Retrans. Vol (Bytes) 0
DL TP < 50 Kbps (%)    0
50 Kbps < DL TP < 250 Kbps (%) 0
250 Kbps < DL TP < 1 Mbps (%)   0
DL TP > 1 Mbps (%)      0
UL TP < 10 Kbps (%)     0
10 Kbps < UL TP < 50 Kbps (%) 0
50 Kbps < UL TP < 300 Kbps (%) 0
UL TP > 300 Kbps (%)    0
HTTP DL (Bytes)         0
HTTP UL (Bytes)         0
Activity Duration DL (ms) 0
Activity Duration UL (ms) 0
Dur. (ms).1              0
Handset Manufacturer     0
Handset Type              0
Nb of sec with 125000B < Vol DL 0
Nb of sec with 1250B < Vol UL < 6250B 0
Nb of sec with 31250B < Vol DL < 125000B 0
Nb of sec with 37500B < Vol UL      0
Nb of sec with 6250B < Vol DL < 31250B 0
Nb of sec with 6250B < Vol UL < 37500B 0
Nb of sec with Vol DL < 6250B      0
Nb of sec with Vol UL < 1250B      0
Social Media DL (Bytes)            0
Social Media UL (Bytes)           0
Google DL (Bytes)                0
Google UL (Bytes)                0
Email DL (Bytes)                 0
Email UL (Bytes)                 0
Youtube DL (Bytes)               0
Youtube UL (Bytes)               0
Netflix DL (Bytes)               0
Netflix UL (Bytes)               0
Gaming DL (Bytes)                0
Gaming UL (Bytes)                0
Other DL (Bytes)                 0
Other UL (Bytes)                 0
Total UL (Bytes)                 0
Total DL (Bytes)                 0
dtype: int64
```

```
In [57]: top_10_handsets = dataset['Handset Type'].value_counts().head(10)
print("Top 10 Handsets:")
```

```
print(top_10_handsets)
```

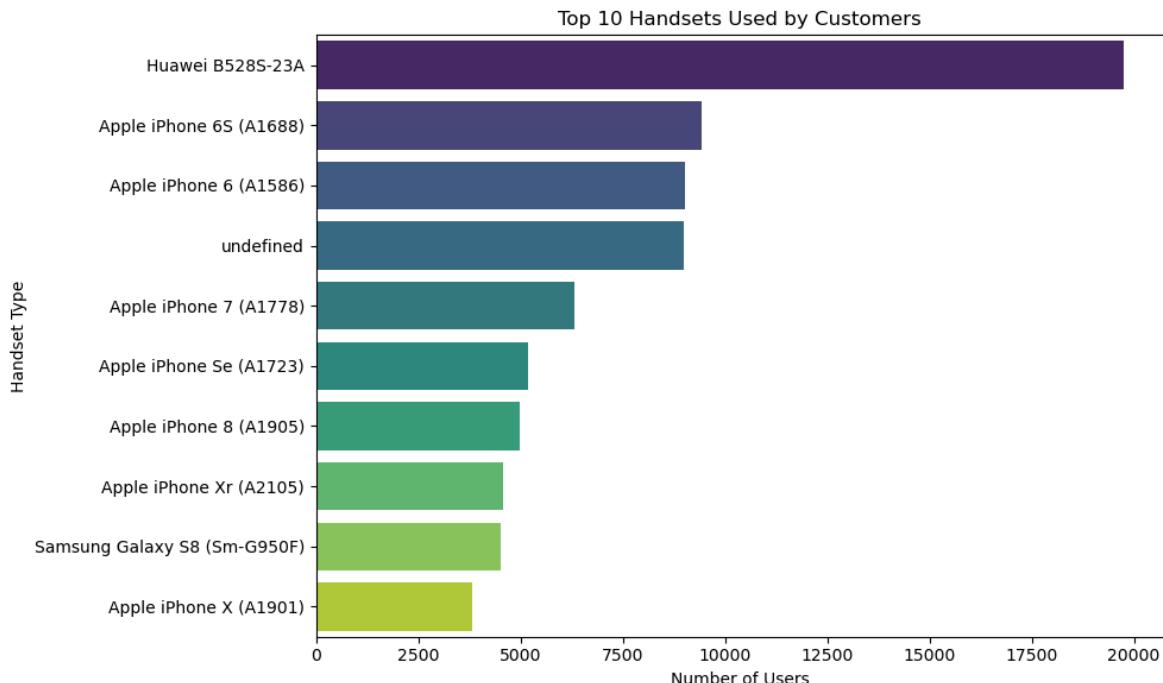
Top 10 Handsets:

Handset Type	Count
Huawei B528S-23A	19752
Apple iPhone 6S (A1688)	9419
Apple iPhone 6 (A1586)	9023
undefined	8987
Apple iPhone 7 (A1778)	6326
Apple iPhone Se (A1723)	5187
Apple iPhone 8 (A1905)	4993
Apple iPhone Xr (A2105)	4568
Samsung Galaxy S8 (Sm-G950F)	4520
Apple iPhone X (A1901)	3813

Name: count, dtype: int64

```
In [59]: top_10_handsets.to_csv(r"D:\Next hike 5-project-March-25\top_10_handsets.csv", index=False)
```

```
In [61]: plt.figure(figsize=(10, 6))
sns.barplot(x=top_10_handsets.values, y=top_10_handsets.index, palette='viridis')
plt.title('Top 10 Handsets Used by Customers')
plt.xlabel('Number of Users')
plt.ylabel('Handset Type')
plt.tight_layout()
plt.show()
```



```
In [65]: top_3_manufacturers = dataset['Handset Manufacturer'].value_counts().head(3)
print("Top 3 Handset Manufacturers:")
print(top_3_manufacturers)
```

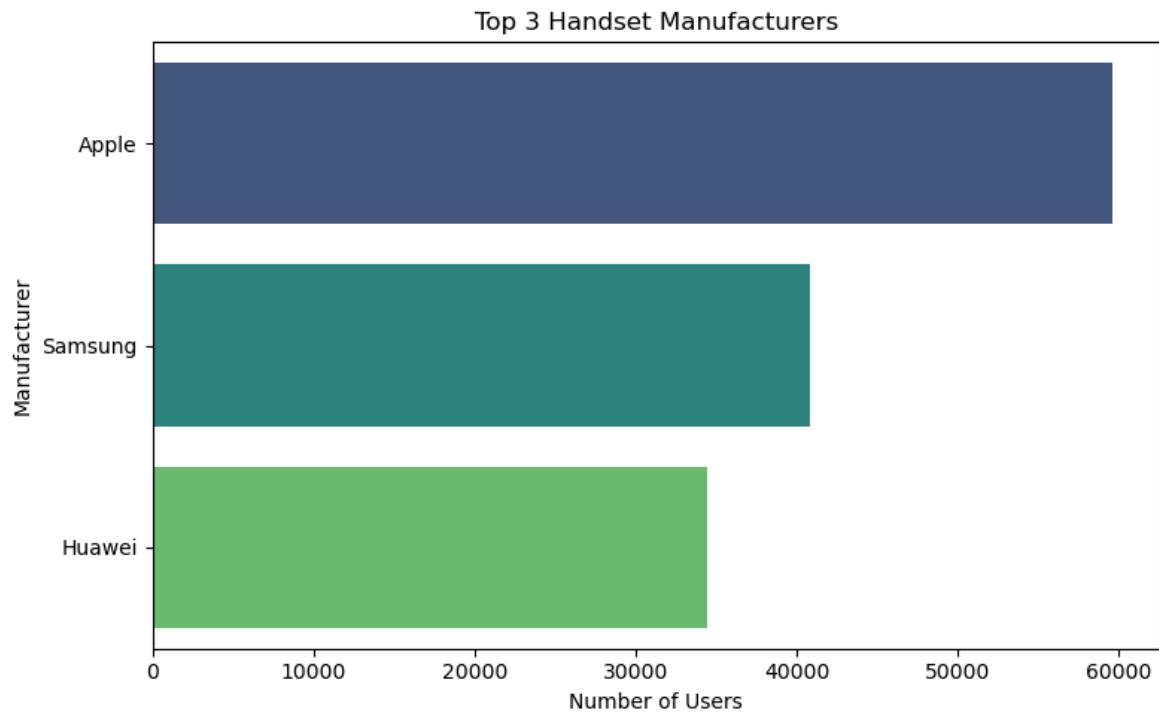
Top 3 Handset Manufacturers:

Handset Manufacturer	Count
Apple	59565
Samsung	40839
Huawei	34423

Name: count, dtype: int64

```
In [67]: top_3_manufacturers.to_csv(r"D:\Next hike 5-project-March-25\top_3_manufacturers.csv", index=False)
```

```
In [69]: plt.figure(figsize=(8, 5))
sns.barplot(x=top_3_manufacturers.values, y=top_3_manufacturers.index, palette=''
plt.title('Top 3 Handset Manufacturers')
plt.xlabel('Number of Users')
plt.ylabel('Manufacturer')
plt.tight_layout()
plt.show()
```



```
In [73]: top_5_handsets_per_manufacturer = {}
for manufacturer in top_3_manufacturers.index:
    top_5_handsets = dataset[dataset['Handset Manufacturer'] == manufacturer][['H
    top_5_handsets_per_manufacturer[manufacturer] = top_5_handsets
print("Top 5 Handsets per Top 3 Manufacturers:")
```

Top 5 Handsets per Top 3 Manufacturers:
 Top 5 Handsets per Top 3 Manufacturers:
 Top 5 Handsets per Top 3 Manufacturers:

```
In [75]: for manufacturer, handsets in top_5_handsets_per_manufacturer.items():
    print(f"\nManufacturer: {manufacturer}")
    print(handsets)
```

Manufacturer: Apple

Handset Type

Apple iPhone 6S (A1688)	9419
Apple iPhone 6 (A1586)	9023
Apple iPhone 7 (A1778)	6326
Apple iPhone Se (A1723)	5187
Apple iPhone 8 (A1905)	4993

Name: count, dtype: int64

Manufacturer: Samsung

Handset Type

Samsung Galaxy S8 (Sm-G950F)	4520
Samsung Galaxy A5 Sm-A520F	3724
Samsung Galaxy J5 (Sm-J530)	3696
Samsung Galaxy J3 (Sm-J330)	3484
Samsung Galaxy S7 (Sm-G930X)	3199

Name: count, dtype: int64

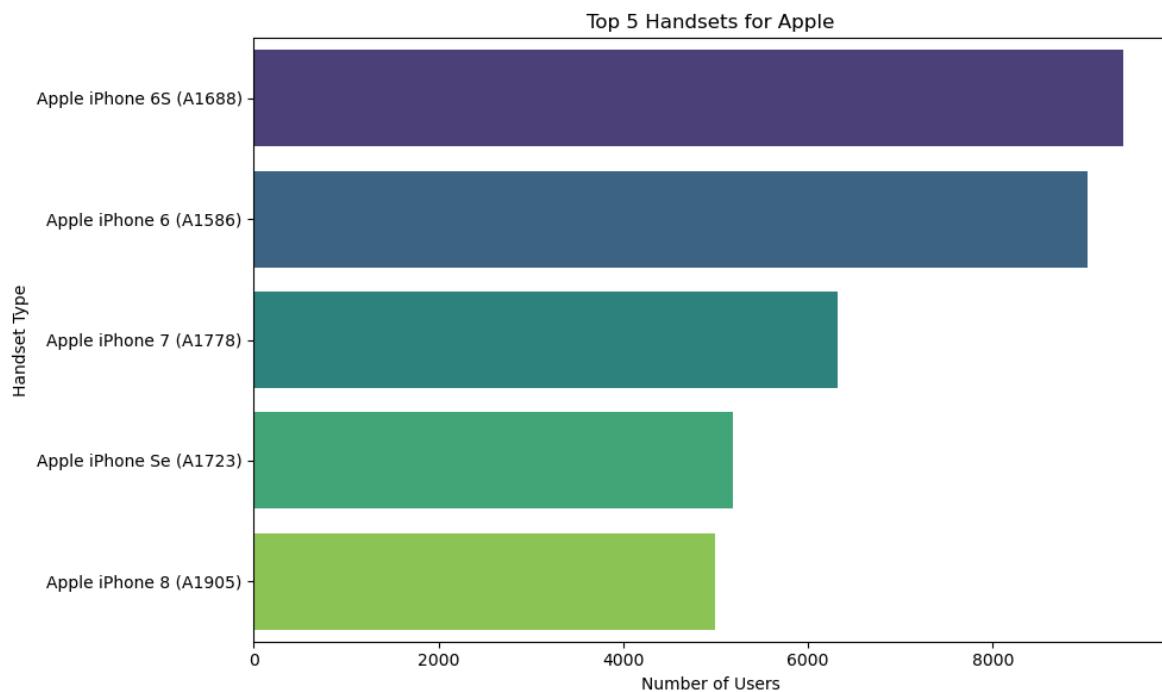
Manufacturer: Huawei

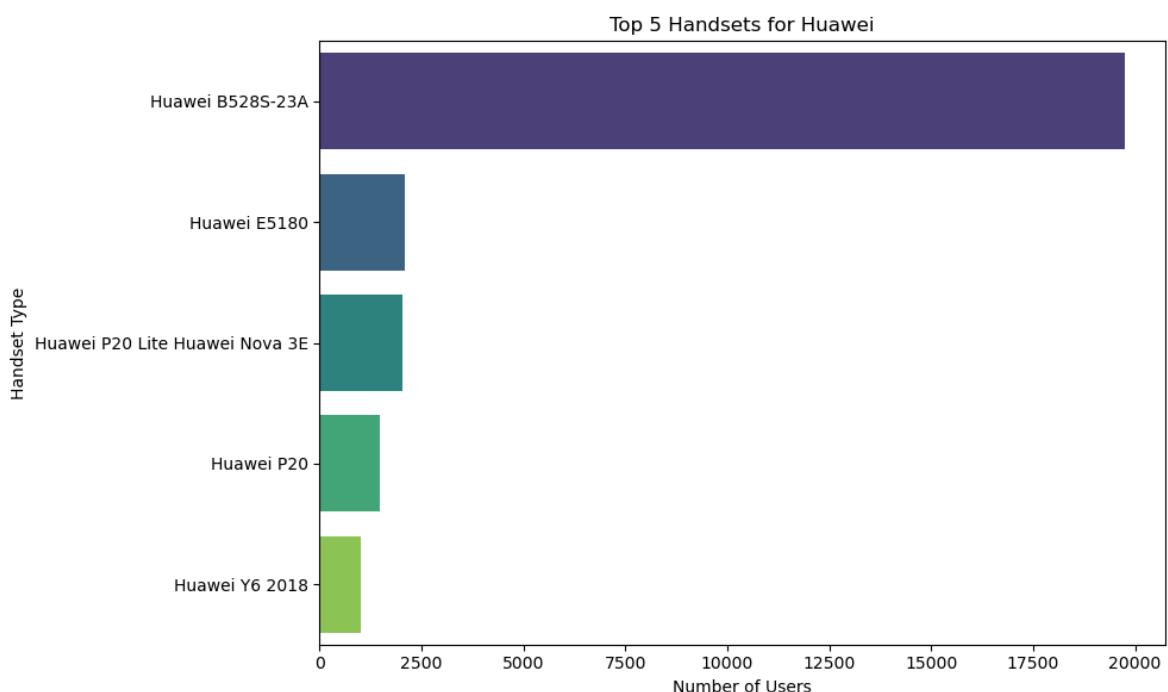
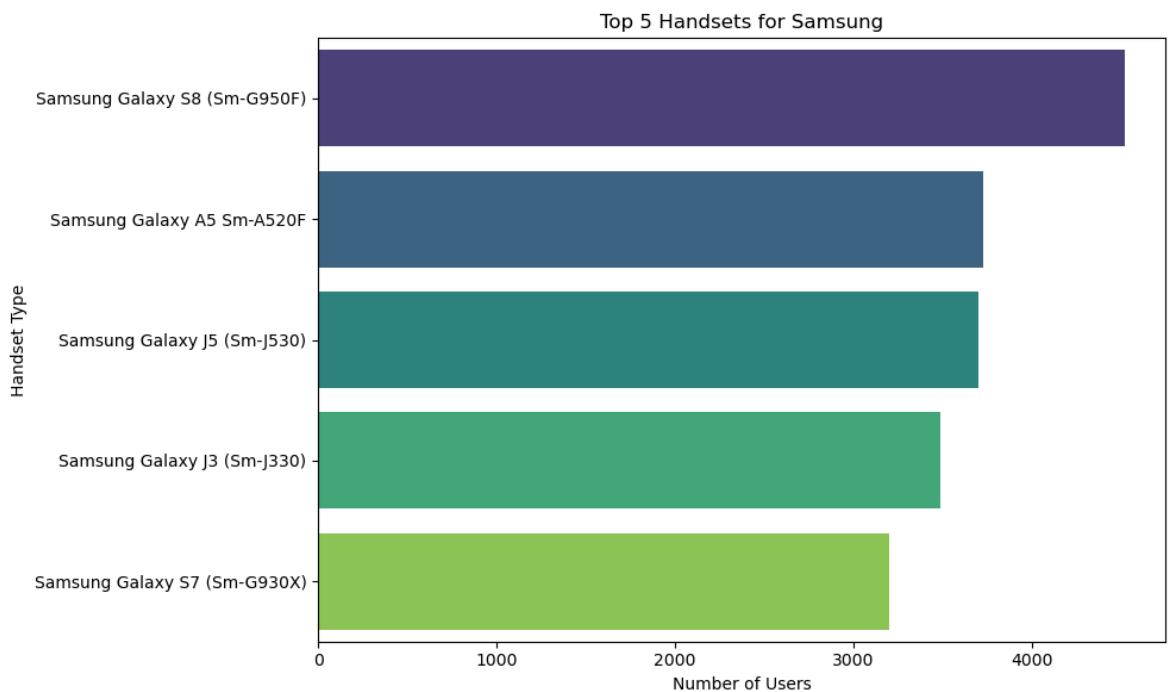
Handset Type

Huawei B528S-23A	19752
Huawei E5180	2079
Huawei P20 Lite Huawei Nova 3E	2021
Huawei P20	1480
Huawei Y6 2018	997

Name: count, dtype: int64

```
In [77]: for manufacturer, handsets in top_5_handsets_per_manufacturer.items():
    plt.figure(figsize=(10, 6))
    sns.barplot(x=handsets.values, y=handsets.index, palette='viridis')
    plt.title(f'Top 5 Handsets for {manufacturer}')
    plt.xlabel('Number of Users')
    plt.ylabel('Handset Type')
    plt.tight_layout()
    plt.show()
```





```
In [81]: application_columns = [
    'Social Media DL (Bytes)', 'Social Media UL (Bytes)',
    'Google DL (Bytes)', 'Google UL (Bytes)',
    'Email DL (Bytes)', 'Email UL (Bytes)',
    'Youtube DL (Bytes)', 'Youtube UL (Bytes)',
    'Netflix DL (Bytes)', 'Netflix UL (Bytes)',
    'Gaming DL (Bytes)', 'Gaming UL (Bytes)',
    'Other DL (Bytes)', 'Other UL (Bytes)'
]

# Summarize data usage for each application
total_usage = dataset[application_columns].sum()
print(total_usage)
```

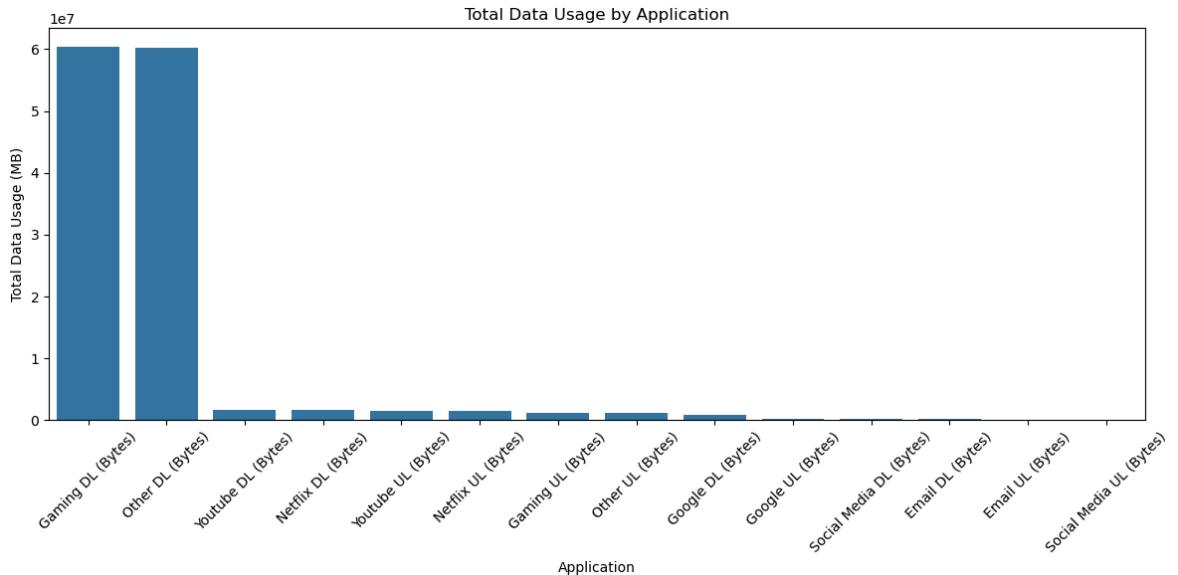
```
Social Media DL (Bytes)      2.693001e+11
Social Media UL (Bytes)     4.939298e+09
Google DL (Bytes)           8.626186e+11
Google UL (Bytes)           3.084833e+11
Email DL (Bytes)            2.687611e+11
Email UL (Bytes)             7.010648e+10
Youtube DL (Bytes)          1.745123e+12
Youtube UL (Bytes)          1.651423e+12
Netflix DL (Bytes)           1.744039e+12
Netflix UL (Bytes)           1.650274e+12
Gaming DL (Bytes)            6.330713e+13
Gaming UL (Bytes)            1.243268e+12
Other DL (Bytes)              6.316550e+13
Other UL (Bytes)              1.239728e+12
dtype: float64
```

In []:

```
In [87]: summary_dataset = dataset[application_columns].sum().reset_index()
summary_dataset.columns = ['Application', 'Total Bytes']
summary_dataset['Total MB'] = summary_dataset['Total Bytes'] / (1024 ** 2) # Co
summary_dataset = summary_dataset.sort_values(by='Total MB', ascending=False)
print(summary_dataset)
```

	Application	Total Bytes	Total MB
10	Gaming DL (Bytes)	6.330713e+13	6.037438e+07
12	Other DL (Bytes)	6.316550e+13	6.023932e+07
6	Youtube DL (Bytes)	1.745123e+12	1.664279e+06
8	Netflix DL (Bytes)	1.744039e+12	1.663246e+06
7	Youtube UL (Bytes)	1.651423e+12	1.574919e+06
9	Netflix UL (Bytes)	1.650274e+12	1.573824e+06
11	Gaming UL (Bytes)	1.243268e+12	1.185673e+06
13	Other UL (Bytes)	1.239728e+12	1.182297e+06
2	Google DL (Bytes)	8.626186e+11	8.226572e+05
3	Google UL (Bytes)	3.084833e+11	2.941926e+05
0	Social Media DL (Bytes)	2.693001e+11	2.568246e+05
4	Email DL (Bytes)	2.687611e+11	2.563106e+05
5	Email UL (Bytes)	7.010648e+10	6.685875e+04
1	Social Media UL (Bytes)	4.939298e+09	4.710482e+03

```
In [91]: plt.figure(figsize=(12, 6))
sns.barplot(x='Application', y='Total MB', data=summary_dataset)
plt.title('Total Data Usage by Application')
plt.xlabel('Application')
plt.ylabel('Total Data Usage (MB)')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



```
In [93]: social_media_usage = dataset[['Social Media DL (Bytes)', 'Social Media UL (Bytes)']]
print(social_media_usage)
```

```
Social Media DL (Bytes)    2.693001e+11
Social Media UL (Bytes)    4.939298e+09
dtype: float64
```

```
In [99]: for app in ['Social Media', 'Google', 'Email', 'Youtube', 'Netflix', 'Gaming', '']:
    dataset[f'{app} Total (Bytes)'] = dataset[f'{app} DL (Bytes)'] + dataset[f'{app} UL (Bytes)']
```

```
In [103...]: user_behavior = dataset.groupby('MSISDN/Number').agg({
    'Bearer_Id': 'count', # Number of xDR sessions
    'Dur. (ms)': 'sum',   # Total session duration
    'Total DL (Bytes)': 'sum', # Total download data
    'Total UL (Bytes)': 'sum', # Total upload data
    **{col: 'sum' for col in application_columns}, # Total data volume for each application
    **{f'{app} Total (Bytes)': 'sum' for app in ['Social Media', 'Google', 'Email', 'Gaming', 'Youtube', 'Netflix']}})
dataset['Total DL (Bytes)'] = dataset['Social Media DL (Bytes)'] + dataset['Google DL (Bytes)'] + dataset['Email DL (Bytes)'] + dataset['Gaming DL (Bytes)'] + dataset['Youtube DL (Bytes)'] + dataset['Netflix DL (Bytes)']
dataset['Total UL (Bytes)'] = dataset['Social Media UL (Bytes)'] + dataset['Google UL (Bytes)'] + dataset['Email UL (Bytes)'] + dataset['Gaming UL (Bytes)'] + dataset['Youtube UL (Bytes)'] + dataset['Netflix UL (Bytes)']
dataset['Total (Bytes)'] = dataset['Total DL (Bytes)'] + dataset['Total UL (Bytes)']
dataset.reset_index()
```

```
In [105...]: user_behavior.rename(columns={
    'Bearer_Id': 'Number of xDR Sessions',
    'Dur. (ms)': 'Total Session Duration',
    'Total DL (Bytes)': 'Total Download Data',
    'Total UL (Bytes)': 'Total Upload Data',
    'Total (Bytes)': 'Total Data Volume'
}, inplace=True)

print(user_behavior.head())
```

	MSISDN/Number	Number of xDR Sessions	Dur. (ms)	Total DL (Bytes)	\
0	3.360100e+10		1	116720.0	8.426375e+08
1	3.360100e+10		1	181230.0	1.207552e+08
2	3.360100e+10		1	134969.0	5.566597e+08
3	3.360101e+10		1	49878.0	4.019932e+08
4	3.360101e+10		2	37104.0	1.363130e+09
	Total UL (Bytes)	Social Media DL (Bytes)	Social Media UL (Bytes)	\	
0	36053108.0	2206504.0		25631.0	
1	36104459.0	2598548.0		62017.0	
2	39306820.0	3148004.0		47619.0	
3	20327526.0	251469.0		28825.0	
4	94280527.0	2861230.0		51312.0	
	Google DL (Bytes)	Google UL (Bytes)	Email DL (Bytes)	...	\
0	3337123.0	1051882.0	837400.0	...	
1	4197697.0	1137166.0	2828821.0	...	
2	3343483.0	99643.0	2436500.0	...	
3	5937765.0	3740728.0	2178618.0	...	
4	13728668.0	4770948.0	2247808.0	...	
	Gaming UL (Bytes)	Other DL (Bytes)	Other UL (Bytes)	\	
0	1367528.0	377096990.0	9473882.0		
1	14714780.0	279557701.0	2152370.0		
2	9759228.0	495086501.0	6607171.0		
3	3051292.0	25248001.0	10031701.0		
4	5816727.0	777643713.0	27160771.0		
	Social Media Total (Bytes)	Google Total (Bytes)	Email Total (Bytes)	\	
0	2232135.0	4389005.0	1331362.0		
1	2660565.0	5334863.0	3307781.0		
2	3195623.0	3443126.0	3205380.0		
3	280294.0	9678493.0	2284670.0		
4	2912542.0	18499616.0	3305469.0		
	Youtube Total (Bytes)	Netflix Total (Bytes)	Gaming Total (Bytes)	\	
0	21624548.0	27180981.0	8.124587e+08		
1	12432223.0	11221763.0	1.197501e+08		
2	21333570.0	19353900.0	5.388277e+08		
3	6977321.0	1942092.0	3.911261e+08		
4	41533002.0	49201724.0	1.314798e+09		
	Other Total (Bytes)				
0	386570872.0				
1	281710071.0				
2	501693672.0				
3	35279702.0				
4	804804484.0				

[5 rows x 26 columns]

```
In [107]: user_behavior.rename(columns={
    'Dur. (ms)': 'Total Session Duration (ms)'
}, inplace=True)

print(user_behavior.head())
```

	MSISDN/Number	Number of xDR Sessions	Total Session Duration (ms)	\	
0	3.360100e+10	1	116720.0		
1	3.360100e+10	1	181230.0		
2	3.360100e+10	1	134969.0		
3	3.360101e+10	1	49878.0		
4	3.360101e+10	2	37104.0		
	Total DL (Bytes)	Total UL (Bytes)	Social Media DL (Bytes)	\	
0	8.426375e+08	36053108.0	2206504.0		
1	1.207552e+08	36104459.0	2598548.0		
2	5.566597e+08	39306820.0	3148004.0		
3	4.019932e+08	20327526.0	251469.0		
4	1.363130e+09	94280527.0	2861230.0		
	Social Media UL (Bytes)	Google DL (Bytes)	Google UL (Bytes)	\	
0	25631.0	3337123.0	1051882.0		
1	62017.0	4197697.0	1137166.0		
2	47619.0	3343483.0	99643.0		
3	28825.0	5937765.0	3740728.0		
4	51312.0	13728668.0	4770948.0		
	Email DL (Bytes)	...	Gaming UL (Bytes)	Other DL (Bytes)	\
0	837400.0	...	1367528.0	377096990.0	
1	2828821.0	...	14714780.0	279557701.0	
2	2436500.0	...	9759228.0	495086501.0	
3	2178618.0	...	3051292.0	25248001.0	
4	2247808.0	...	5816727.0	777643713.0	
	Other UL (Bytes)	Social Media Total (Bytes)	Google Total (Bytes)	\	
0	9473882.0	2232135.0	4389005.0		
1	2152370.0	2660565.0	5334863.0		
2	6607171.0	3195623.0	3443126.0		
3	10031701.0	280294.0	9678493.0		
4	27160771.0	2912542.0	18499616.0		
	Email Total (Bytes)	Youtube Total (Bytes)	Netflix Total (Bytes)	\	
0	1331362.0	21624548.0	27180981.0		
1	3307781.0	12432223.0	11221763.0		
2	3205380.0	21333570.0	19353900.0		
3	2284670.0	6977321.0	1942092.0		
4	3305469.0	41533002.0	49201724.0		
	Gaming Total (Bytes)	Other Total (Bytes)			
0	8.124587e+08	386570872.0			
1	1.197501e+08	281710071.0			
2	5.388277e+08	501693672.0			
3	3.911261e+08	35279702.0			
4	1.314798e+09	804804484.0			

[5 rows x 26 columns]

In [113...]: # Describe the data types of each column
dataset.info()

```

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150001 entries, 0 to 150000
Data columns (total 62 columns):
 #   Column           Non-Null Count Dtype
 ---  -- 
 0   Bearer_Id        150001 non-null float64
 1   Start            150001 non-null object 
 2   Start_ms          150001 non-null float64
 3   End              150001 non-null object 
 4   End_ms            150001 non-null float64
 5   Dur. (ms)         150001 non-null float64
 6   IMSI              150001 non-null float64
 7   MSISDN/Number     150001 non-null float64
 8   IMEI              150001 non-null float64
 9   Last Location Name 150001 non-null object 
 10  Avg RTT DL (ms)  150001 non-null float64
 11  Avg RTT UL (ms)  150001 non-null float64
 12  Avg Bearer TP DL (kbps) 150001 non-null float64
 13  Avg Bearer TP UL (kbps) 150001 non-null float64
 14  TCP DL Retrans. Vol (Bytes) 150001 non-null float64
 15  TCP UL Retrans. Vol (Bytes) 150001 non-null float64
 16  DL TP < 50 Kbps (%) 150001 non-null float64
 17  50 Kbps < DL TP < 250 Kbps (%) 150001 non-null float64
 18  250 Kbps < DL TP < 1 Mbps (%) 150001 non-null float64
 19  DL TP > 1 Mbps (%) 150001 non-null float64
 20  UL TP < 10 Kbps (%) 150001 non-null float64
 21  10 Kbps < UL TP < 50 Kbps (%) 150001 non-null float64
 22  50 Kbps < UL TP < 300 Kbps (%) 150001 non-null float64
 23  UL TP > 300 Kbps (%) 150001 non-null float64
 24  HTTP DL (Bytes)    150001 non-null float64
 25  HTTP UL (Bytes)    150001 non-null float64
 26  Activity Duration DL (ms) 150001 non-null float64
 27  Activity Duration UL (ms) 150001 non-null float64
 28  Dur. (ms).1        150001 non-null float64
 29  Handset Manufacturer 150001 non-null object 
 30  Handset Type       150001 non-null object 
 31  Nb of sec with 125000B < Vol DL 150001 non-null float64
 32  Nb of sec with 1250B < Vol UL < 6250B 150001 non-null float64
 33  Nb of sec with 31250B < Vol DL < 125000B 150001 non-null float64
 34  Nb of sec with 37500B < Vol UL 150001 non-null float64
 35  Nb of sec with 6250B < Vol DL < 31250B 150001 non-null float64
 36  Nb of sec with 6250B < Vol UL < 37500B 150001 non-null float64
 37  Nb of sec with Vol DL < 6250B 150001 non-null float64
 38  Nb of sec with Vol UL < 1250B 150001 non-null float64
 39  Social Media DL (Bytes) 150001 non-null float64
 40  Social Media UL (Bytes) 150001 non-null float64
 41  Google DL (Bytes)    150001 non-null float64
 42  Google UL (Bytes)    150001 non-null float64
 43  Email DL (Bytes)    150001 non-null float64
 44  Email UL (Bytes)    150001 non-null float64
 45  Youtube DL (Bytes)  150001 non-null float64
 46  Youtube UL (Bytes)  150001 non-null float64
 47  Netflix DL (Bytes)  150001 non-null float64
 48  Netflix UL (Bytes)  150001 non-null float64
 49  Gaming DL (Bytes)  150001 non-null float64
 50  Gaming UL (Bytes)  150001 non-null float64
 51  Other DL (Bytes)   150001 non-null float64
 52  Other UL (Bytes)   150001 non-null float64
 53  Total UL (Bytes)   150001 non-null float64
 54  Total DL (Bytes)   150001 non-null float64

```

```

55 Social Media Total (Bytes)           150001 non-null float64
56 Google Total (Bytes)                150001 non-null float64
57 Email Total (Bytes)                 150001 non-null float64
58 Youtube Total (Bytes)               150001 non-null float64
59 Netflix Total (Bytes)                150001 non-null float64
60 Gaming Total (Bytes)                150001 non-null float64
61 Other Total (Bytes)                 150001 non-null float64
dtypes: float64(57), object(5)
memory usage: 71.0+ MB

```

In [115...]

`dataset.describe()`

Out[115...]

	Bearer_Id	Start ms	End ms	Dur. (ms)	IMSI	MSISD
count	1.500010e+05	150001.000000	150001.000000	1.500010e+05	1.500010e+05	1.5
mean	1.012045e+19	499.188199	498.800888	1.046084e+05	2.082016e+14	4.1
std	2.892435e+18	288.610872	288.096693	8.103736e+04	2.144723e+10	2.4
min	6.917540e+18	0.000000	0.000000	7.142000e+03	2.040471e+14	3.3
25%	7.349880e+18	250.000000	251.000000	5.744200e+04	2.082014e+14	3.3
50%	7.349880e+18	499.000000	500.000000	8.639900e+04	2.082015e+14	3.3
75%	1.304240e+19	749.000000	750.000000	1.324300e+05	2.082018e+14	3.3
max	1.318650e+19	999.000000	999.000000	1.859336e+06	2.140743e+14	8.8

8 rows × 57 columns



In [117...]

```

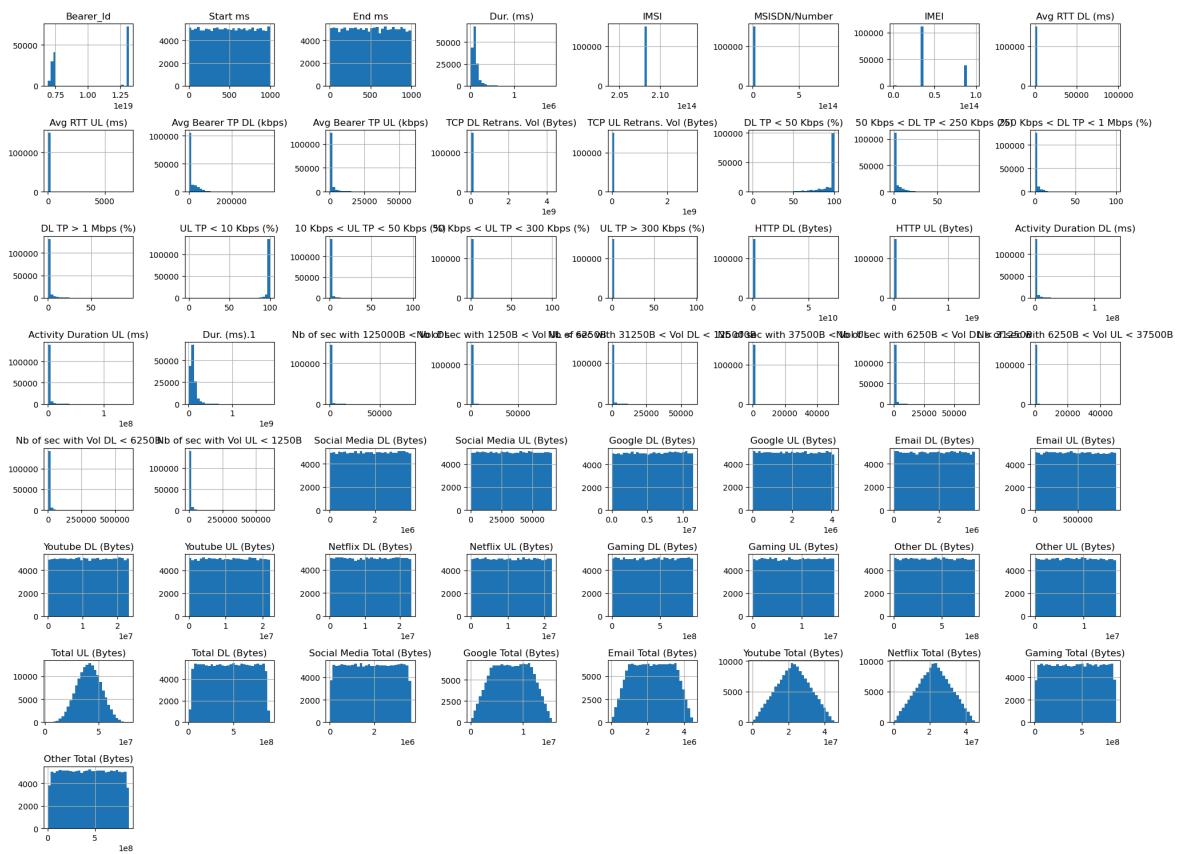
dispersion_params = dataset.select_dtypes(include=['float64', 'int64']).agg(['mean', 'std'])
print(dispersion_params)

```

	Bearer_Id	Start ms	End ms	Dur. (ms)	IMSI	\
mean	1.012045e+19	499.188199	498.800888	1.046084e+05	2.082016e+14	
std	2.892435e+18	288.610872	288.096693	8.103736e+04	2.144723e+10	
var	8.366180e+36	83296.235554	82999.704454	6.567055e+09	4.599835e+20	
min	6.917540e+18	0.000000	0.000000	7.142000e+03	2.040471e+14	
max	1.318650e+19	999.000000	999.000000	1.859336e+06	2.140743e+14	
	MSISDN/Number	IMEI	Avg RTT DL (ms)	Avg RTT UL (ms)		\
mean	4.182441e+10	4.842592e+13	97.774455	15.315031		
std	2.438731e+12	2.238739e+13	559.909444	76.687998		
var	5.947411e+24	5.011953e+26	313498.585409	5881.048988		
min	3.360100e+10	4.400152e+11	0.000000	0.000000		
max	8.823971e+14	9.900120e+13	96923.000000	7120.000000		
	Avg Bearer TP DL (kbps)	...	Other UL (Bytes)	Total UL (Bytes)		\
mean	1.329996e+04	...	8.264799e+06	4.112121e+07		
std	2.397182e+04	...	4.769004e+06	1.127635e+07		
var	5.746483e+08	...	2.274340e+13	1.271560e+14		
min	0.000000e+00	...	1.480000e+02	2.866892e+06		
max	3.781600e+05	...	1.655882e+07	7.833131e+07		
	Total DL (Bytes)	Social Media	Total (Bytes)	Google Total (Bytes)		\
mean	4.546434e+08		1.828250e+06	7.807295e+06		
std	2.441421e+08		1.035646e+06	3.516420e+06		
var	5.960535e+16		1.072563e+12	1.236521e+13		
min	7.114041e+06		1.563000e+03	4.033000e+04		
max	9.029696e+08		3.650861e+06	1.552878e+07		
	Email Total (Bytes)	Youtube Total (Bytes)	Netflix Total (Bytes)	Total (Bytes)		\
mean	2.259102e+06		2.264348e+07	2.262861e+07		
std	1.071109e+06		9.246800e+06	9.260820e+06		
var	1.147275e+12		8.550332e+13	8.576279e+13		
min	8.359000e+03		7.890300e+04	9.843200e+04		
max	4.518036e+06		4.519008e+07	4.519815e+07		
	Gaming Total (Bytes)	Other Total (Bytes)				
mean	4.303331e+08		4.293653e+08			
std	2.440199e+08		2.432681e+08			
var	5.954572e+16		5.917936e+16			
min	3.063580e+05		1.490450e+05			
max	8.592028e+08		8.595209e+08			

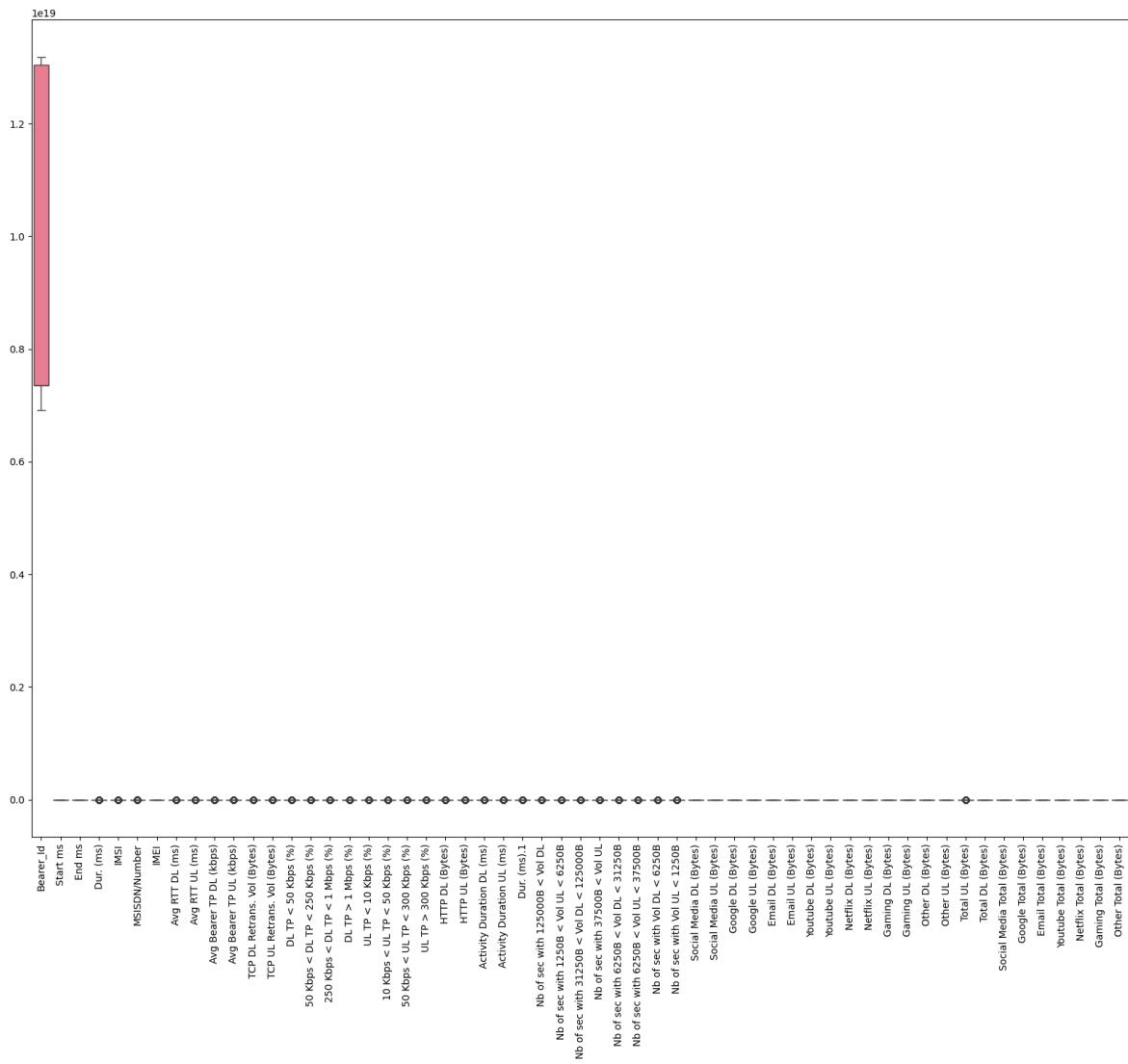
[5 rows x 57 columns]

```
In [119]: dataset.hist(bins=30, figsize=(20, 15))
plt.tight_layout()
plt.show()
```



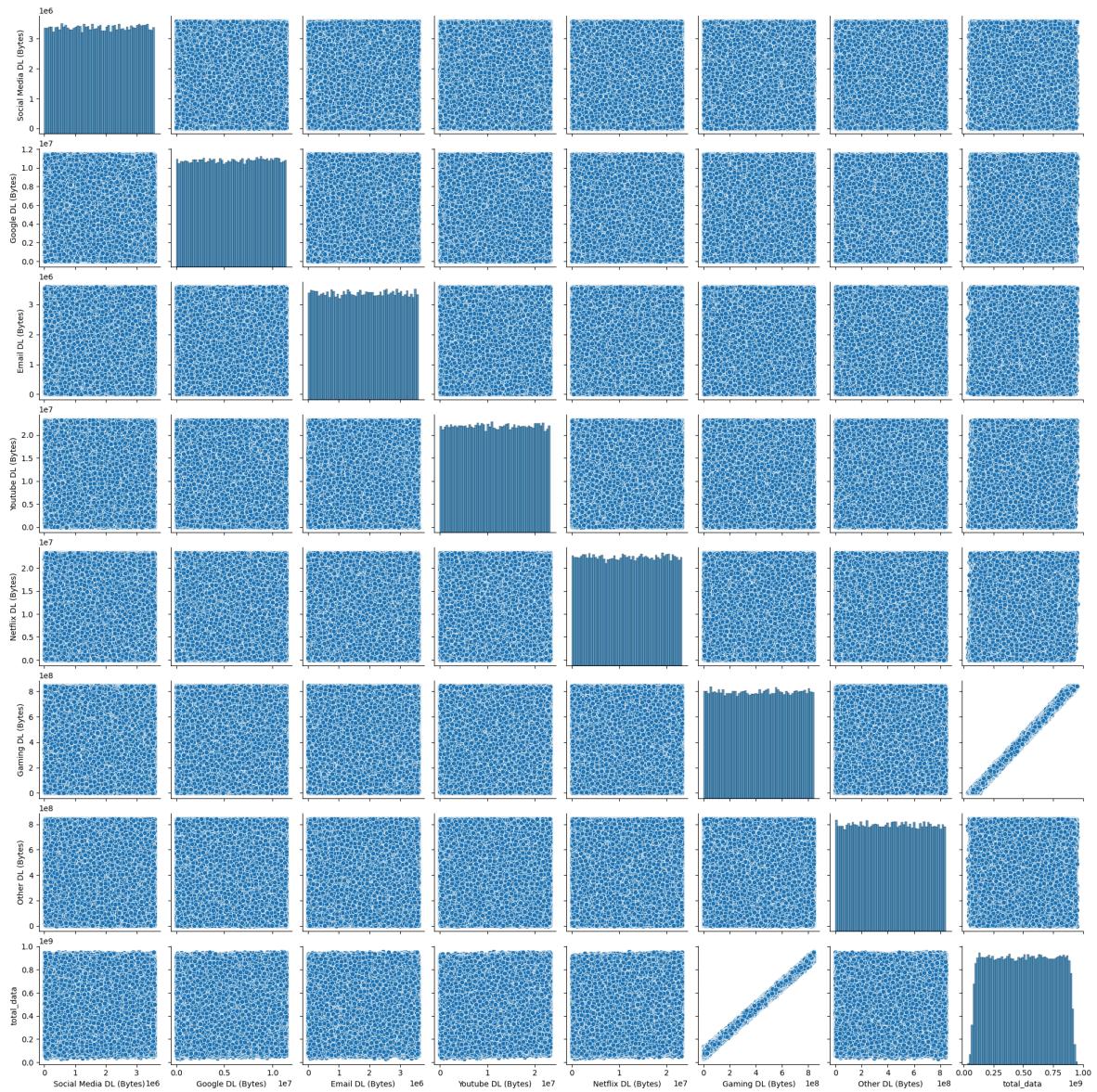
In [123...]

```
# Boxplots for identifying outliers
plt.figure(figsize=(20, 15))
sns.boxplot(data=dataset.select_dtypes(include=['float64', 'int64']))
plt.xticks(rotation=90)
plt.show()
```



```
In [127...]: dataset['total_data'] = dataset[['Total DL (Bytes)', 'Total UL (Bytes)']].sum(axis=1)

# Pairplot for bivariate analysis
sns.pairplot(dataset[['Social Media DL (Bytes)', 'Google DL (Bytes)', 'Email DL (Bytes)', 'Youtube DL (Bytes)', 'Other DL (Bytes)', 'Total DL (Bytes)', 'Social Media Total (Bytes)', 'Google Total (Bytes)', 'Email Total (Bytes)', 'Youtube Total (Bytes)', 'Netflix Total (Bytes)', 'Gaming Total (Bytes)', 'Other Total (Bytes)']])
plt.show()
```

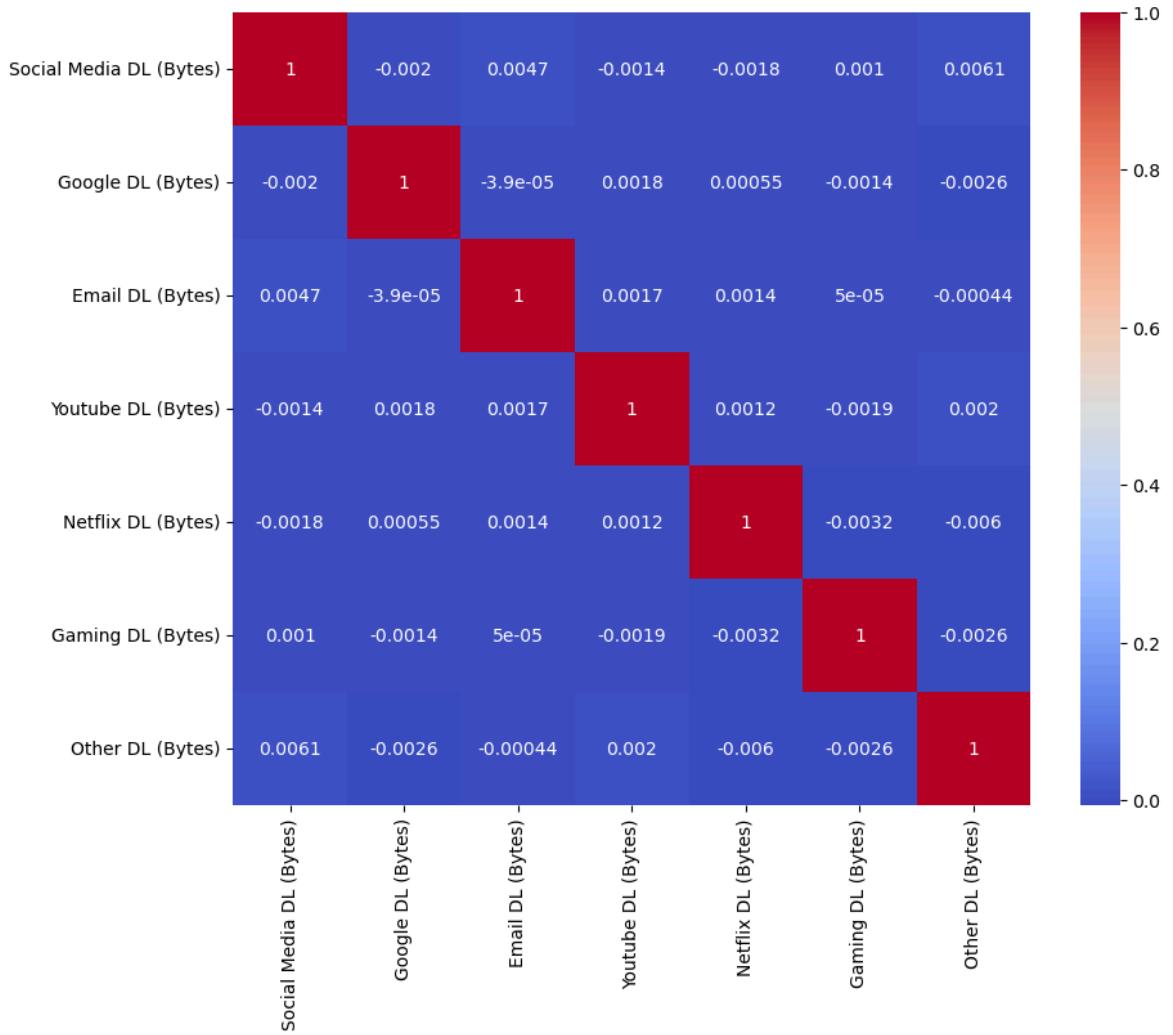


```
In [129... dataset['decile_class'] = pd.qcut(dataset['Dur. (ms)'], 5, labels=False)
decile_totals = dataset.groupby('decile_class')[['Total DL (Bytes)', 'Total UL (Bytes)']]
decile_totals['total_data'] = decile_totals.sum(axis=1)
print(decile_totals)
```

	Total DL (Bytes)	Total UL (Bytes)	total_data
decile_class			
0	1.364976e+13	1.234287e+12	1.488404e+13
1	2.165800e+13	1.962472e+12	2.362047e+13
2	5.580722e+12	5.066822e+11	6.087404e+12
3	1.362235e+13	1.232586e+12	1.485493e+13
4	1.368615e+13	1.232194e+12	1.491834e+13

```
In [133... corr_matrix = dataset[['Social Media DL (Bytes)', 'Google DL (Bytes)', 'Email DL (Bytes)', 'YouTube DL (Bytes)', 'Netflix DL (Bytes)', 'Gaming DL (Bytes)', 'Other DL (Bytes)']].corr()
```

```
In [135... plt.figure(figsize=(10, 8))
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm')
plt.show()
```



In [137...]

```
from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler
```

In [141...]

```
features = ['Social Media DL (Bytes)', 'Google DL (Bytes)', 'Email DL (Bytes)',
            'Youtube DL (Bytes)', 'Netflix DL (Bytes)', 'Gaming DL (Bytes)', 'Other DL (Bytes)']
x = dataset[features].values
x = StandardScaler().fit_transform(x)
```

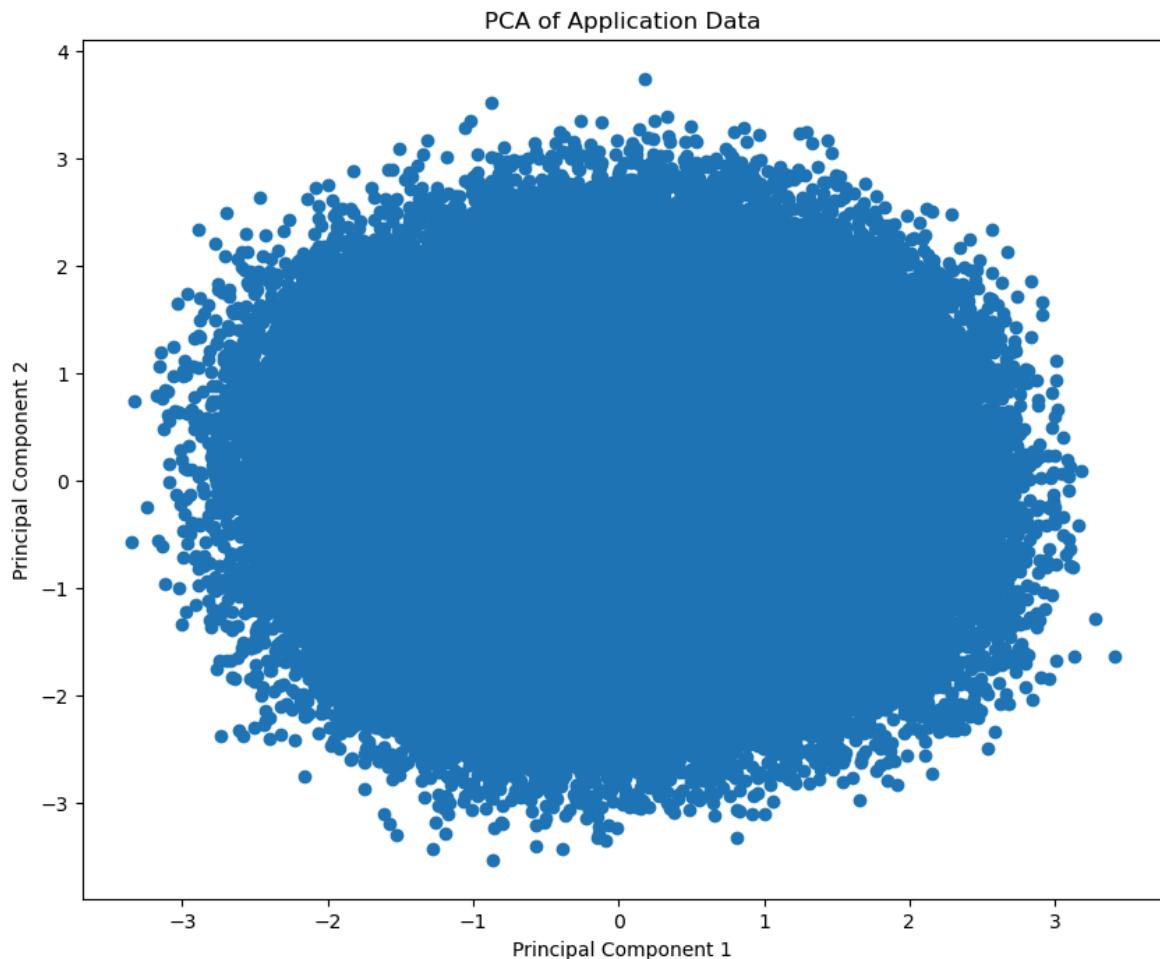
In [143...]

```
pca = PCA(n_components=2)
principal_components = pca.fit_transform(x)
pca_df = pd.DataFrame(data=principal_components, columns=['PC1', 'PC2'])
print(pca.explained_variance_ratio_)
```

[0.14439453 0.14355429]

In [145...]

```
plt.figure(figsize=(10, 8))
plt.scatter(pca_df['PC1'], pca_df['PC2'])
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.title('PCA of Application Data')
plt.show()
```



In []:

In []: `# Task-2_User_Engagement_Analysis`In [147...]: `session_frequency_IMSI = dataset.groupby('IMSI')['Bearer_Id'].count().reset_index()
session_frequency_IMSI.columns = ['IMSI', 'Session Frequency']`In [149...]: `session_frequency_IMSI.head()`

Out[149...]

IMSI Session Frequency

0	2.040471e+14	1
1	2.040808e+14	1
2	2.082001e+14	1
3	2.082001e+14	1
4	2.082001e+14	2

In [151...]: `session_duration_IMSI = dataset.groupby('IMSI')['Dur. (ms)'].sum().reset_index()
session_duration_IMSI.columns = ['IMSI', 'Total Session Duration (ms)']`In [153...]: `session_duration_IMSI.head()`

Out[153...]

IMSI Total Session Duration (ms)

	IMSI	Total Session Duration (ms)
0	2.040471e+14	869844.0
1	2.040808e+14	877385.0
2	2.082001e+14	86019.0
3	2.082001e+14	86254.0
4	2.082001e+14	573923.0

In [157...]

```
dataset['Total Traffic (Bytes)'] = dataset['Total DL (Bytes)'] + dataset['Total UL (Bytes)']
```

In [159...]

```
total_traffic_IMSI = dataset.groupby('IMSI')['Total Traffic (Bytes)'].sum().reset_index()
total_traffic_IMSI.columns = ['IMSI', 'Total Traffic (Bytes)']
```

In [161...]

```
total_traffic_IMSI.head()
```

Out[161...]

IMSI Total Traffic (Bytes)

	IMSI	Total Traffic (Bytes)
0	2.040471e+14	1.391536e+08
1	2.040808e+14	2.321240e+08
2	2.082001e+14	8.517164e+07
3	2.082001e+14	4.265016e+08
4	2.082001e+14	1.033092e+09

In [163...]

```
user_engagement_IMSI = session_frequency_IMSI.merge(session_duration_IMSI, on='IMSI')
user_engagement_IMSI = user_engagement_IMSI.merge(total_traffic_IMSI, on='IMSI')
```

In [165...]

```
user_engagement_IMSI.head()
```

Out[165...]

IMSI Session Frequency Total Session Duration (ms) Total Traffic (Bytes)

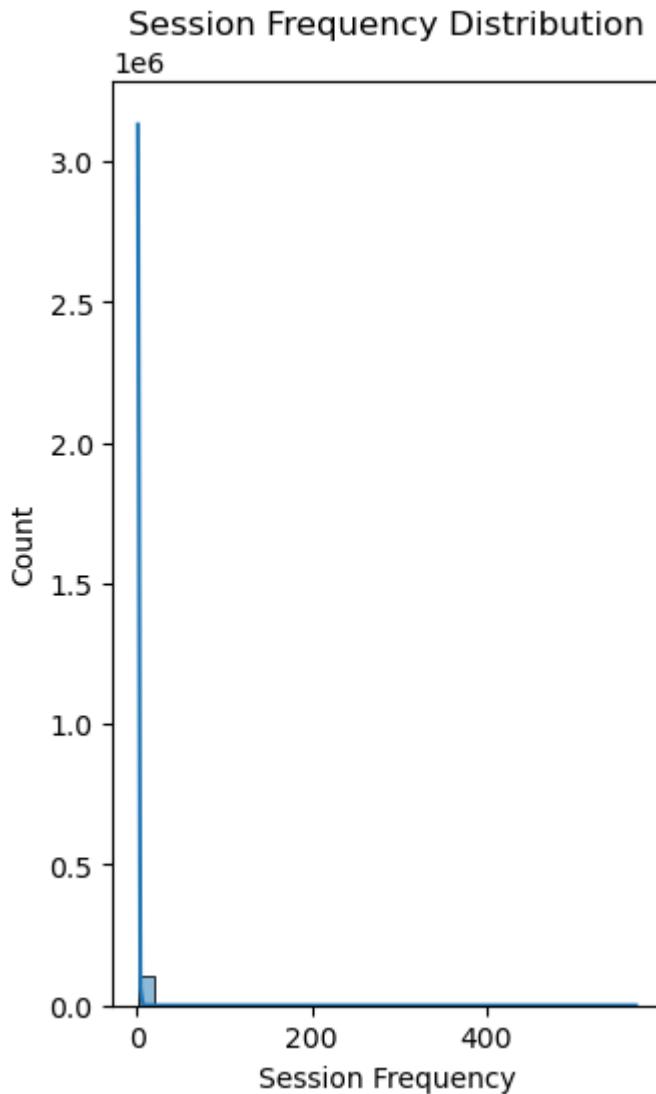
	IMSI	Session Frequency	Total Session Duration (ms)	Total Traffic (Bytes)
0	2.040471e+14	1	869844.0	1.391536e+08
1	2.040808e+14	1	877385.0	2.321240e+08
2	2.082001e+14	1	86019.0	8.517164e+07
3	2.082001e+14	1	86254.0	4.265016e+08
4	2.082001e+14	2	573923.0	1.033092e+09

In [167...]

```
plt.figure(figsize=(12, 6))
plt.subplot(1, 3, 1)
sns.histplot(user_engagement_IMSI['Session Frequency'], bins=30, kde=True)
plt.title('Session Frequency Distribution')
```

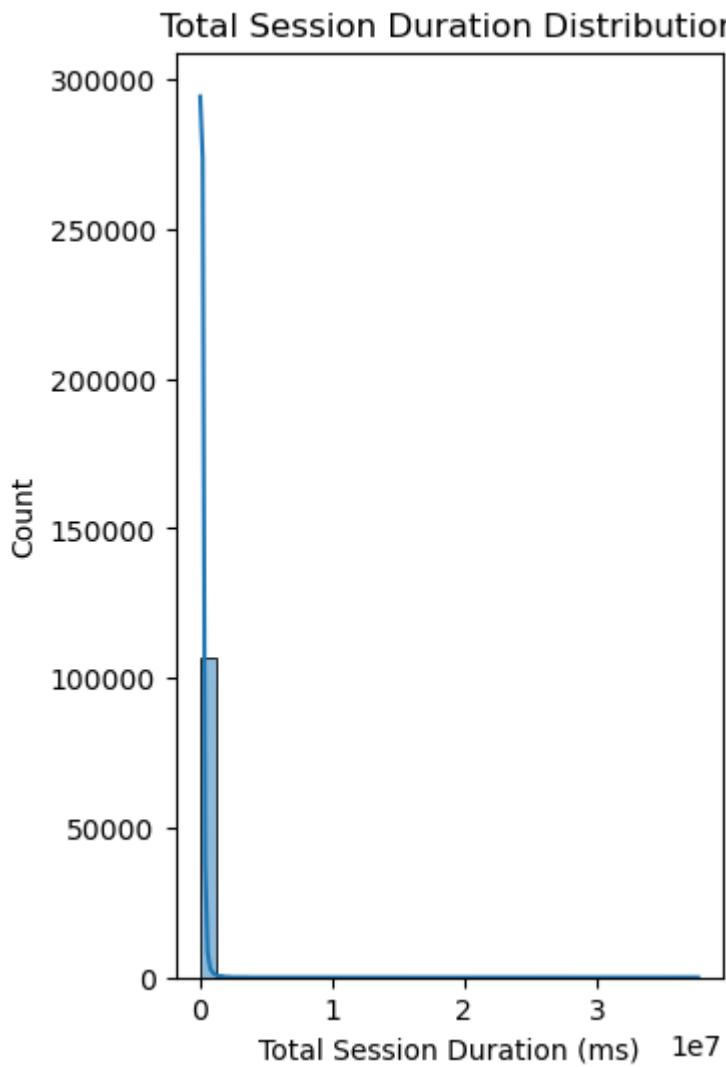
Out[167...]

```
Text(0.5, 1.0, 'Session Frequency Distribution')
```



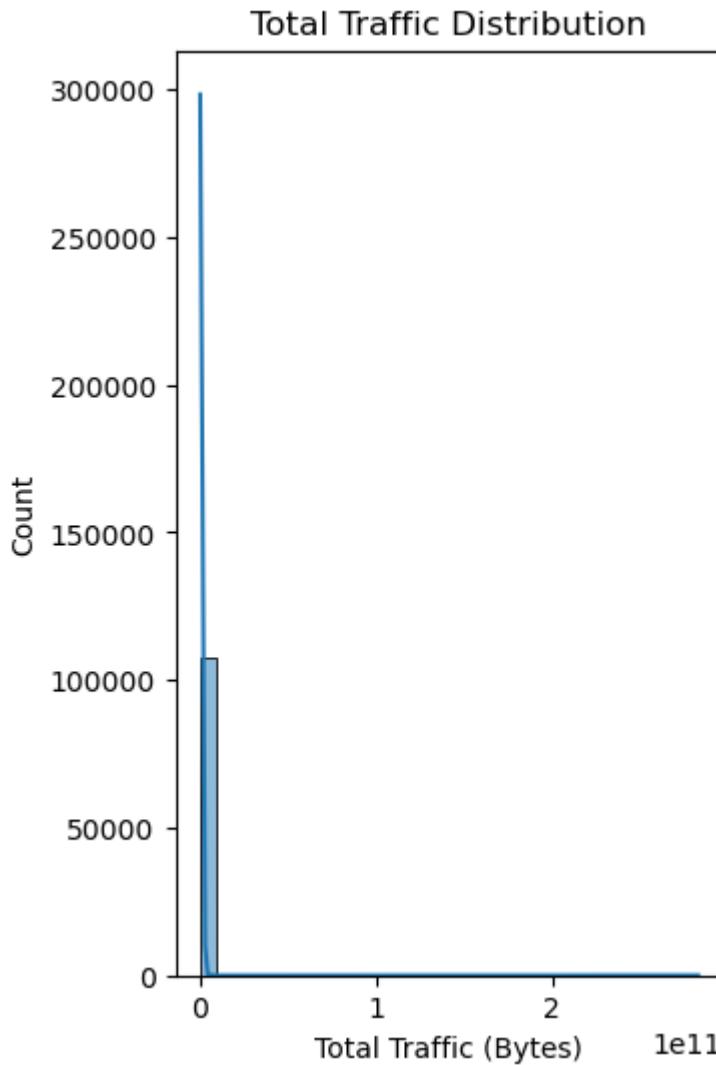
```
In [169...]: plt.figure(figsize=(12, 6))
plt.subplot(1, 3, 2)
sns.histplot(user_engagement_IMSI['Total Session Duration (ms)'], bins=30, kde=True)
plt.title('Total Session Duration Distribution')
```

```
Out[169...]: Text(0.5, 1.0, 'Total Session Duration Distribution')
```



```
In [171]: plt.figure(figsize=(12, 6))
plt.subplot(1, 3, 3)
sns.histplot(user_engagement_IMSI['Total Traffic (Bytes)'], bins=30, kde=True)
plt.title('Total Traffic Distribution')
```

```
Out[171]: Text(0.5, 1.0, 'Total Traffic Distribution')
```



```
In [173...]: #Calculate session frequency per MSISDN
session_frequency_MSISDN = dataset.groupby('MSISDN/Number')[['Bearer_Id']].count()
session_frequency_MSISDN.columns = ['MSISDN/Number', 'Session Frequency']
```

```
In [175...]: session_frequency_MSISDN.head()
```

```
Out[175...]:
```

	MSISDN/Number	Session Frequency
0	3.360100e+10	1
1	3.360100e+10	1
2	3.360100e+10	1
3	3.360101e+10	1
4	3.360101e+10	2

```
In [181...]: # Calculate total session duration per MSISDN
session_duration_MSISDN = dataset.groupby('MSISDN/Number')[['Dur. (ms)']].sum().reset_index()
session_duration_MSISDN.columns = ['MSISDN/Number', 'Total Session Duration (ms)']
```

```
In [183...]: session_duration_MSISDN.head()
```

Out[183...]

	MSISDN/Number	Total Session Duration (ms)
0	3.360100e+10	116720.0
1	3.360100e+10	181230.0
2	3.360100e+10	134969.0
3	3.360101e+10	49878.0
4	3.360101e+10	37104.0

In [187...]

```
#Calculate total session duration per MSISDN
session_duration_MSISDN = dataset.groupby('MSISDN/Number')['Dur. (ms)'].sum().reset_index()
session_duration_MSISDN.columns = ['MSISDN/Number', 'Total Session Duration (ms)']
```

In [189...]

```
session_duration_MSISDN.head()
```

Out[189...]

	MSISDN/Number	Total Session Duration (ms)
0	3.360100e+10	116720.0
1	3.360100e+10	181230.0
2	3.360100e+10	134969.0
3	3.360101e+10	49878.0
4	3.360101e+10	37104.0

In [191...]

```
# Calculate total traffic per MSISDN
total_traffic_MSISDN = dataset.groupby('MSISDN/Number')['Total Traffic (Bytes)'].sum().reset_index()
total_traffic_MSISDN.columns = ['MSISDN/Number', 'Total Traffic (Bytes)']
```

In [193...]

```
total_traffic_MSISDN.head()
```

Out[193...]

	MSISDN/Number	Total Traffic (Bytes)
0	3.360100e+10	8.786906e+08
1	3.360100e+10	1.568596e+08
2	3.360100e+10	5.959665e+08
3	3.360101e+10	4.223207e+08
4	3.360101e+10	1.457411e+09

In [199...]

```
user_engagement_MSISDN = session_frequency_MSISDN.merge(session_duration_MSISDN,
user_engagement_MSISDN = user_engagement_MSISDN.merge(total_traffic_MSISDN, on='
```

In [201...]

```
top_10_session_frequency = user_engagement_MSISDN.nlargest(10, 'Session Frequency')
```

In [203...]

```
top_10_session_frequency
```

Out[203...]

	MSISDN/Number	Session Frequency	Total Session Duration (ms)	Total Traffic (Bytes)
53644	3.366371e+10	1067	72655568.0	5.319636e+11
13526	3.362632e+10	18	8791927.0	7.971167e+09
6437	3.361489e+10	17	9966898.0	8.846226e+09
13180	3.362578e+10	17	18553754.0	8.499621e+09
37052	3.365973e+10	16	4035428.0	7.705863e+09
76363	3.367588e+10	15	4865947.0	7.891111e+09
92923	3.376054e+10	15	9279434.0	8.514774e+09
65118	3.366716e+10	13	8744914.0	5.618394e+09
666	3.360313e+10	12	6287761.0	4.976195e+09
1279	3.360452e+10	12	5207990.0	5.487855e+09

In [207...]

```
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
import matplotlib.pyplot as plt
```

In [209...]

```
scaler = StandardScaler()
normalized_metrics = scaler.fit_transform(user_engagement_MSISDN[['Session Frequency',
'Total Session Duration (ms)', 'Total Traffic (Bytes)']])
```

In [211...]

```
kmeans = KMeans(n_clusters=3, random_state=0).fit(normalized_metrics)
user_engagement_MSISDN['Cluster'] = kmeans.labels_
```

In [213...]

```
#Compute statistics for each cluster
cluster_stats = user_engagement_MSISDN.groupby('Cluster').agg({
    'Session Frequency': ['min', 'max', 'mean', 'sum'],
    'Total Session Duration (ms)': ['min', 'max', 'mean', 'sum'],
    'Total Traffic (Bytes)': ['min', 'max', 'mean', 'sum']
})
```

In [215...]

```
cluster_stats
```

Out[215...]

Cluster	Session Frequency				Total Session Duration (ms)			
	min	max	mean	sum	min	max	mean	
0	1	18	3.226192	28626	89973.0	18553754.0	5.047891e+05	4.4789
1	1067	1067	1067.000000	1067	72655568.0	72655568.0	7.265557e+07	7.2655
2	1	4	1.227858	120308	7142.0	433962.0	1.136915e+05	1.1139

In [217...]

```
application_columns = ['Social Media DL (Bytes)', 'Social Media UL (Bytes)', 'Google DL (Bytes)', 'Google UL (Bytes)', 'Email DL (Bytes)', 'Email UL (Bytes)']
```

```
'Youtube DL (Bytes)', 'Youtube UL (Bytes)', 'Netflix DL (B  
'Netflix UL (Bytes)', 'Gaming DL (Bytes)', 'Gaming UL (Byt  
'Other DL (Bytes)', 'Other UL (Bytes)']
```

```
In [223...]: # Calculate total traffic per application  
for app in application_columns:  
    dataset[app + ' Total'] = dataset[app]
```

```
In [227...]: # Sum the total traffic per application per user  
application_traffic = dataset.groupby('MSISDN/Number')[['Social Media DL (Bytes)  
'Social Media UL (Bytes) Tota  
'Google DL (Bytes) Total',  
'Google UL (Bytes) Total',  
'Email DL (Bytes) Total',  
'Email UL (Bytes) Total',  
'Youtube DL (Bytes) Total',  
'Youtube UL (Bytes) Total',  
'Netflix DL (Bytes) Total',  
'Netflix UL (Bytes) Total',  
'Gaming DL (Bytes) Total',  
'Gaming UL (Bytes) Total',  
'Other DL (Bytes) Total',  
'Other UL (Bytes) Total']] .su
```

```
In [229...]: top_10_per_app = {}  
for app in application_columns:  
    app_col = app + ' Total'  
    top_10_per_app[app] = application_traffic.nlargest(10, app_col)
```

```
In [231...]: top_10_per_app
```

```
Out[231]: {'Social Media DL (Bytes)': MSISDN/Number Social Media DL (Bytes) Total \
1 \
53644 3.366371e+10 1.938043e+09
13526 3.362632e+10 4.274384e+07
92923 3.376054e+10 3.929765e+07
37052 3.365973e+10 3.490044e+07
6437 3.361489e+10 2.774974e+07
13180 3.362578e+10 2.656412e+07
65118 3.366716e+10 2.375375e+07
106137 3.378632e+10 2.356866e+07
70960 3.366907e+10 2.347705e+07
666 3.360313e+10 2.277668e+07

Social Media UL (Bytes) Total Google DL (Bytes) Total \
53644 3.615635e+07 6.009292e+09
13526 6.309420e+05 1.161065e+08
92923 4.855430e+05 8.862653e+07
37052 5.119140e+05 9.095855e+07
6437 5.448000e+05 9.394171e+07
13180 5.713790e+05 1.079047e+08
65118 4.940970e+05 7.170783e+07
106137 4.062640e+05 7.881981e+07
70960 3.237870e+05 5.491522e+07
666 3.011460e+05 7.394206e+07

Google UL (Bytes) Total Email DL (Bytes) Total \
53644 2.241409e+09 1.906935e+09
13526 3.608540e+07 3.340478e+07
92923 3.459657e+07 2.643790e+07
37052 2.555780e+07 2.990765e+07
6437 3.403208e+07 3.360721e+07
13180 3.440318e+07 3.189541e+07
65118 3.332487e+07 2.327675e+07
106137 3.143467e+07 3.087691e+07
70960 2.290947e+07 1.781358e+07
666 1.298696e+07 2.034373e+07

Email UL (Bytes) Total Youtube DL (Bytes) Total \
53644 4.966873e+08 1.249731e+10
13526 9.013997e+06 1.640487e+08
92923 7.255872e+06 1.940683e+08
37052 6.092145e+06 1.196581e+08
6437 7.181423e+06 1.998234e+08
13180 8.738554e+06 2.378830e+08
65118 7.059044e+06 1.419727e+08
106137 5.433215e+06 1.181299e+08
70960 5.109829e+06 1.362953e+08
666 5.855167e+06 1.589767e+08

Youtube UL (Bytes) Total Netflix DL (Bytes) Total \
53644 1.185341e+10 1.230177e+10
13526 2.104343e+08 1.994792e+08
92923 2.022209e+08 1.465008e+08
37052 1.383329e+08 1.962772e+08
6437 1.945468e+08 1.795860e+08
13180 2.150757e+08 1.939122e+08
65118 1.732586e+08 1.679324e+08
106137 9.663405e+07 1.636027e+08
70960 1.001075e+08 7.892370e+07
666 1.251134e+08 1.560865e+08
```

	Netflix UL (Bytes)	Total	Gaming DL (Bytes)	Total	\
53644	1.198034e+10		4.528908e+11		
13526	1.292465e+08		6.745734e+09		
92923	1.881424e+08		7.316364e+09		
37052	2.032419e+08		6.609900e+09		
6437	1.818151e+08		7.622035e+09		
13180	1.630684e+08		7.171884e+09		
65118	1.460071e+08		4.623424e+09		
106137	1.423371e+08		4.740903e+09		
70960	1.330853e+08		3.166462e+09		
666	1.044019e+08		4.108482e+09		
	Gaming UL (Bytes)	Total	Other DL (Bytes)	Total	\
53644	8.743856e+09		4.425858e+11		
13526	1.418386e+08		8.025477e+09		
92923	1.446811e+08		4.590038e+09		
37052	1.156587e+08		6.182551e+09		
6437	1.273968e+08		7.495298e+09		
13180	1.547897e+08		6.201653e+09		
65118	1.021977e+08		4.837534e+09		
106137	1.101923e+08		4.172594e+09		
70960	1.026901e+08		4.540939e+09		
666	8.296289e+07		6.222705e+09		
	Other UL (Bytes)	Total			
53644	9.066371e+09				
13526	1.424009e+08				
92923	1.260962e+08				
37052	1.348649e+08				
6437	1.439660e+08				
13180	1.529305e+08				
65118	1.039850e+08				
106137	7.989267e+07				
70960	6.442987e+07				
666	1.039662e+08	,			
'Social Media UL (Bytes)': MSISDN/Number Social Media DL (Bytes) Total					
\					
53644	3.366371e+10		1.938043e+09		
13526	3.362632e+10		4.274384e+07		
13180	3.362578e+10		2.656412e+07		
76363	3.367588e+10		1.865536e+07		
6437	3.361489e+10		2.774974e+07		
37052	3.365973e+10		3.490044e+07		
65118	3.366716e+10		2.375375e+07		
92923	3.376054e+10		3.929765e+07		
30715	3.365836e+10		1.686561e+07		
35436	3.365936e+10		2.091208e+07		
	Social Media UL (Bytes)	Total	Google DL (Bytes)	Total	\
53644	3.615635e+07		6.009292e+09		
13526	6.309420e+05		1.161065e+08		
13180	5.713790e+05		1.079047e+08		
76363	5.675570e+05		8.300299e+07		
6437	5.448000e+05		9.394171e+07		
37052	5.119140e+05		9.095855e+07		
65118	4.940970e+05		7.170783e+07		
92923	4.855430e+05		8.862653e+07		
30715	4.201460e+05		5.867198e+07		
35436	4.095640e+05		6.507065e+07		

	Google UL (Bytes)	Total	Email DL (Bytes)	Total	\
53644	2.241409e+09		1.906935e+09		
13526	3.608540e+07		3.340478e+07		
13180	3.440318e+07		3.189541e+07		
76363	2.685751e+07		2.428472e+07		
6437	3.403208e+07		3.360721e+07		
37052	2.555780e+07		2.990765e+07		
65118	3.332487e+07		2.327675e+07		
92923	3.459657e+07		2.643790e+07		
30715	1.783515e+07		1.755392e+07		
35436	2.597037e+07		2.046246e+07		

	Email UL (Bytes)	Total	Youtube DL (Bytes)	Total	\
53644	4.966873e+08		1.249731e+10		
13526	9.013997e+06		1.640487e+08		
13180	8.738554e+06		2.378830e+08		
76363	7.229698e+06		1.586652e+08		
6437	7.181423e+06		1.998234e+08		
37052	6.092145e+06		1.196581e+08		
65118	7.059044e+06		1.419727e+08		
92923	7.255872e+06		1.940683e+08		
30715	2.128126e+06		1.193796e+08		
35436	5.154458e+06		9.959090e+07		

	Youtube UL (Bytes)	Total	Netflix DL (Bytes)	Total	\
53644	1.185341e+10		1.230177e+10		
13526	2.104343e+08		1.994792e+08		
13180	2.150757e+08		1.939122e+08		
76363	1.587453e+08		1.616265e+08		
6437	1.945468e+08		1.795860e+08		
37052	1.383329e+08		1.962772e+08		
65118	1.732586e+08		1.679324e+08		
92923	2.022209e+08		1.465008e+08		
30715	1.416103e+08		1.313589e+08		
35436	1.209011e+08		1.298099e+08		

	Netflix UL (Bytes)	Total	Gaming DL (Bytes)	Total	\
53644	1.198034e+10		4.528908e+11		
13526	1.292465e+08		6.745734e+09		
13180	1.630684e+08		7.171884e+09		
76363	1.474667e+08		6.863307e+09		
6437	1.818151e+08		7.622035e+09		
37052	2.032419e+08		6.609900e+09		
65118	1.460071e+08		4.623424e+09		
92923	1.881424e+08		7.316364e+09		
30715	1.327831e+08		5.628473e+09		
35436	1.008069e+08		3.919882e+09		

	Gaming UL (Bytes)	Total	Other DL (Bytes)	Total	Other UL (Bytes)	Total
53644	8.743856e+09		4.425858e+11		9.066371e+09	
13526	1.418386e+08		8.025477e+09		1.424009e+08	
13180	1.547897e+08		6.201653e+09		1.529305e+08	
76363	1.072606e+08		6.665074e+09		1.334414e+08	
6437	1.273968e+08		7.495298e+09		1.439660e+08	
37052	1.156587e+08		6.182551e+09		1.348649e+08	
65118	1.021977e+08		4.837534e+09		1.039850e+08	
92923	1.446811e+08		4.590038e+09		1.260962e+08	
30715	7.744628e+07		4.905779e+09		1.078713e+08	
35436	9.668884e+07		4.518964e+09		5.277823e+07	

'Google DL (Bytes)':	MSISDN/Number	Social Media DL (Bytes)	Total	\
53644	3.366371e+10	1.938043e+09		
13526	3.362632e+10	4.274384e+07		
13180	3.362578e+10	2.656412e+07		
6437	3.361489e+10	2.774974e+07		
37052	3.365973e+10	3.490044e+07		
92923	3.376054e+10	3.929765e+07		
76363	3.367588e+10	1.865536e+07		
106137	3.378632e+10	2.356866e+07		
666	3.360313e+10	2.277668e+07		
94654	3.376127e+10	1.420143e+07		
Social Media UL (Bytes)	Total	Google DL (Bytes)	Total	\
53644	3.615635e+07	6.009292e+09		
13526	6.309420e+05	1.161065e+08		
13180	5.713790e+05	1.079047e+08		
6437	5.448000e+05	9.394171e+07		
37052	5.119140e+05	9.095855e+07		
92923	4.855430e+05	8.862653e+07		
76363	5.675570e+05	8.300299e+07		
106137	4.062640e+05	7.881981e+07		
666	3.011460e+05	7.394206e+07		
94654	2.946530e+05	7.294980e+07		
Google UL (Bytes)	Total	Email DL (Bytes)	Total	\
53644	2.241409e+09	1.906935e+09		
13526	3.608540e+07	3.340478e+07		
13180	3.440318e+07	3.189541e+07		
6437	3.403208e+07	3.360721e+07		
37052	2.555780e+07	2.990765e+07		
92923	3.459657e+07	2.643790e+07		
76363	2.685751e+07	2.428472e+07		
106137	3.143467e+07	3.087691e+07		
666	1.298696e+07	2.034373e+07		
94654	2.414018e+07	1.576884e+07		
Email UL (Bytes)	Total	Youtube DL (Bytes)	Total	\
53644	4.966873e+08	1.249731e+10		
13526	9.013997e+06	1.640487e+08		
13180	8.738554e+06	2.378830e+08		
6437	7.181423e+06	1.998234e+08		
37052	6.092145e+06	1.196581e+08		
92923	7.255872e+06	1.940683e+08		
76363	7.229698e+06	1.586652e+08		
106137	5.433215e+06	1.181299e+08		
666	5.855167e+06	1.589767e+08		
94654	4.984880e+06	1.190565e+08		
Youtube UL (Bytes)	Total	Netflix DL (Bytes)	Total	\
53644	1.185341e+10	1.230177e+10		
13526	2.104343e+08	1.994792e+08		
13180	2.150757e+08	1.939122e+08		
6437	1.945468e+08	1.795860e+08		
37052	1.383329e+08	1.962772e+08		
92923	2.022209e+08	1.465008e+08		
76363	1.587453e+08	1.616265e+08		
106137	9.663405e+07	1.636027e+08		
666	1.251134e+08	1.560865e+08		
94654	1.537331e+08	1.672611e+08		

	Netflix UL (Bytes)	Total	Gaming DL (Bytes)	Total	\
53644	1.198034e+10		4.528908e+11		
13526	1.292465e+08		6.745734e+09		
13180	1.630684e+08		7.171884e+09		
6437	1.818151e+08		7.622035e+09		
37052	2.032419e+08		6.609900e+09		
92923	1.881424e+08		7.316364e+09		
76363	1.474667e+08		6.863307e+09		
106137	1.423371e+08		4.740903e+09		
666	1.044019e+08		4.108482e+09		
94654	1.248302e+08		4.165410e+09		
	Gaming UL (Bytes)	Total	Other DL (Bytes)	Total	\
53644	8.743856e+09		4.425858e+11		
13526	1.418386e+08		8.025477e+09		
13180	1.547897e+08		6.201653e+09		
6437	1.273968e+08		7.495298e+09		
37052	1.156587e+08		6.182551e+09		
92923	1.446811e+08		4.590038e+09		
76363	1.072606e+08		6.665074e+09		
106137	1.101923e+08		4.172594e+09		
666	8.296289e+07		6.222705e+09		
94654	1.086893e+08		4.997985e+09		
	Other UL (Bytes)	Total			
53644	9.066371e+09				
13526	1.424009e+08				
13180	1.529305e+08				
6437	1.439660e+08				
37052	1.348649e+08				
92923	1.260962e+08				
76363	1.334414e+08				
106137	7.989267e+07				
666	1.039662e+08				
94654	7.979475e+07	,			
'Google UL (Bytes)': MSISDN/Number Social Media DL (Bytes)					
53644	3.366371e+10		1.938043e+09		
13526	3.362632e+10		4.274384e+07		
92923	3.376054e+10		3.929765e+07		
13180	3.362578e+10		2.656412e+07		
6437	3.361489e+10		2.774974e+07		
65118	3.366716e+10		2.375375e+07		
106137	3.378632e+10		2.356866e+07		
76363	3.367588e+10		1.865536e+07		
63028	3.366646e+10		1.823492e+07		
92577	3.376041e+10		2.051577e+07		
	Social Media UL (Bytes)	Total	Google DL (Bytes)	Total	\
53644	3.615635e+07		6.009292e+09		
13526	6.309420e+05		1.161065e+08		
92923	4.855430e+05		8.862653e+07		
13180	5.713790e+05		1.079047e+08		
6437	5.448000e+05		9.394171e+07		
65118	4.940970e+05		7.170783e+07		
106137	4.062640e+05		7.881981e+07		
76363	5.675570e+05		8.300299e+07		
63028	3.950620e+05		6.259921e+07		
92577	2.614310e+05		5.633185e+07		

	Google UL (Bytes)	Total	Email DL (Bytes)	Total	\
53644	2.241409e+09		1.906935e+09		
13526	3.608540e+07		3.340478e+07		
92923	3.459657e+07		2.643790e+07		
13180	3.440318e+07		3.189541e+07		
6437	3.403208e+07		3.360721e+07		
65118	3.332487e+07		2.327675e+07		
106137	3.143467e+07		3.087691e+07		
76363	2.685751e+07		2.428472e+07		
63028	2.672152e+07		1.966718e+07		
92577	2.640687e+07		2.179130e+07		

	Email UL (Bytes)	Total	Youtube DL (Bytes)	Total	\
53644	4.966873e+08		1.249731e+10		
13526	9.013997e+06		1.640487e+08		
92923	7.255872e+06		1.940683e+08		
13180	8.738554e+06		2.378830e+08		
6437	7.181423e+06		1.998234e+08		
65118	7.059044e+06		1.419727e+08		
106137	5.433215e+06		1.181299e+08		
76363	7.229698e+06		1.586652e+08		
63028	5.889958e+06		1.406639e+08		
92577	3.785669e+06		1.742460e+08		

	Youtube UL (Bytes)	Total	Netflix DL (Bytes)	Total	\
53644	1.185341e+10		1.230177e+10		
13526	2.104343e+08		1.994792e+08		
92923	2.022209e+08		1.465008e+08		
13180	2.150757e+08		1.939122e+08		
6437	1.945468e+08		1.795860e+08		
65118	1.732586e+08		1.679324e+08		
106137	9.663405e+07		1.636027e+08		
76363	1.587453e+08		1.616265e+08		
63028	8.667215e+07		1.159470e+08		
92577	1.289231e+08		1.670238e+08		

	Netflix UL (Bytes)	Total	Gaming DL (Bytes)	Total	\
53644	1.198034e+10		4.528908e+11		
13526	1.292465e+08		6.745734e+09		
92923	1.881424e+08		7.316364e+09		
13180	1.630684e+08		7.171884e+09		
6437	1.818151e+08		7.622035e+09		
65118	1.460071e+08		4.623424e+09		
106137	1.423371e+08		4.740903e+09		
76363	1.474667e+08		6.863307e+09		
63028	9.846994e+07		6.546328e+09		
92577	1.513237e+08		6.170943e+09		

	Gaming UL (Bytes)	Total	Other DL (Bytes)	Total	\
53644	8.743856e+09		4.425858e+11		
13526	1.418386e+08		8.025477e+09		
92923	1.446811e+08		4.590038e+09		
13180	1.547897e+08		6.201653e+09		
6437	1.273968e+08		7.495298e+09		
65118	1.021977e+08		4.837534e+09		
106137	1.101923e+08		4.172594e+09		
76363	1.072606e+08		6.665074e+09		
63028	9.997554e+07		4.262205e+09		
92577	9.767668e+07		3.988504e+09		

	Other UL (Bytes)	Total
53644	9.066371e+09	
13526	1.424009e+08	
92923	1.260962e+08	
13180	1.529305e+08	
6437	1.439660e+08	
65118	1.039850e+08	
106137	7.989267e+07	
76363	1.334414e+08	
63028	8.693680e+07	
92577	1.131414e+08	,
'Email DL (Bytes)'	MSISDN/Number	Social Media DL (Bytes)
53644	3.366371e+10	1.938043e+09
6437	3.361489e+10	2.774974e+07
13526	3.362632e+10	4.274384e+07
13180	3.362578e+10	2.656412e+07
106137	3.378632e+10	2.356866e+07
37052	3.365973e+10	3.490044e+07
92923	3.376054e+10	3.929765e+07
60087	3.366546e+10	1.033136e+07
76363	3.367588e+10	1.865536e+07
86455	3.369879e+10	1.539078e+07
Social Media UL (Bytes)	Total	Google DL (Bytes)
53644	3.615635e+07	6.009292e+09
6437	5.448000e+05	9.394171e+07
13526	6.309420e+05	1.161065e+08
13180	5.713790e+05	1.079047e+08
106137	4.062640e+05	7.881981e+07
37052	5.119140e+05	9.095855e+07
92923	4.855430e+05	8.862653e+07
60087	2.234800e+05	4.398405e+07
76363	5.675570e+05	8.300299e+07
86455	3.373770e+05	5.994399e+07
Google UL (Bytes)	Total	Email DL (Bytes)
53644	2.241409e+09	1.906935e+09
6437	3.403208e+07	3.360721e+07
13526	3.608540e+07	3.340478e+07
13180	3.440318e+07	3.189541e+07
106137	3.143467e+07	3.087691e+07
37052	2.555780e+07	2.990765e+07
92923	3.459657e+07	2.643790e+07
60087	1.961338e+07	2.594287e+07
76363	2.685751e+07	2.428472e+07
86455	1.979213e+07	2.416560e+07
Email UL (Bytes)	Total	Youtube DL (Bytes)
53644	4.966873e+08	1.249731e+10
6437	7.181423e+06	1.998234e+08
13526	9.013997e+06	1.640487e+08
13180	8.738554e+06	2.378830e+08
106137	5.433215e+06	1.181299e+08
37052	6.092145e+06	1.196581e+08
92923	7.255872e+06	1.940683e+08
60087	4.475014e+06	1.439943e+08
76363	7.229698e+06	1.586652e+08
86455	4.893443e+06	1.669003e+08
Youtube UL (Bytes)	Total	Netflix DL (Bytes)

53644	1.185341e+10	1.230177e+10
6437	1.945468e+08	1.795860e+08
13526	2.104343e+08	1.994792e+08
13180	2.150757e+08	1.939122e+08
106137	9.663405e+07	1.636027e+08
37052	1.383329e+08	1.962772e+08
92923	2.022209e+08	1.465008e+08
60087	8.829824e+07	8.349906e+07
76363	1.587453e+08	1.616265e+08
86455	1.357616e+08	1.030272e+08

	Netflix UL (Bytes)	Total	Gaming DL (Bytes)	Total	\
53644	1.198034e+10		4.528908e+11		
6437	1.818151e+08		7.622035e+09		
13526	1.292465e+08		6.745734e+09		
13180	1.630684e+08		7.171884e+09		
106137	1.423371e+08		4.740903e+09		
37052	2.032419e+08		6.609900e+09		
92923	1.881424e+08		7.316364e+09		
60087	1.140189e+08		4.734492e+09		
76363	1.474667e+08		6.863307e+09		
86455	1.652202e+08		5.641128e+09		

	Gaming UL (Bytes)	Total	Other DL (Bytes)	Total	\
53644	8.743856e+09		4.425858e+11		
6437	1.273968e+08		7.495298e+09		
13526	1.418386e+08		8.025477e+09		
13180	1.547897e+08		6.201653e+09		
106137	1.101923e+08		4.172594e+09		
37052	1.156587e+08		6.182551e+09		
92923	1.446811e+08		4.590038e+09		
60087	4.651067e+07		2.900205e+09		
76363	1.072606e+08		6.665074e+09		
86455	1.126150e+08		4.598153e+09		

	Other UL (Bytes)	Total
53644	9.066371e+09	
6437	1.439660e+08	
13526	1.424009e+08	
13180	1.529305e+08	
106137	7.989267e+07	
37052	1.348649e+08	
92923	1.260962e+08	
60087	7.324759e+07	
76363	1.334414e+08	
86455	9.172329e+07	,

	Email UL (Bytes)	MSISDN/Number	Social Media DL (Bytes)	Total	\
53644	3.366371e+10		1.938043e+09		
13526	3.362632e+10		4.274384e+07		
13180	3.362578e+10		2.656412e+07		
92923	3.376054e+10		3.929765e+07		
76363	3.367588e+10		1.865536e+07		
6437	3.361489e+10		2.774974e+07		
65118	3.366716e+10		2.375375e+07		
37470	3.365982e+10		1.925379e+07		
13994	3.362708e+10		1.743867e+07		
57241	3.366471e+10		1.903573e+07		

	Social Media UL (Bytes)	Total	Google DL (Bytes)	Total	\
53644		3.615635e+07		6.009292e+09	

13526	6.309420e+05	1.161065e+08
13180	5.713790e+05	1.079047e+08
92923	4.855430e+05	8.862653e+07
76363	5.675570e+05	8.300299e+07
6437	5.448000e+05	9.394171e+07
65118	4.940970e+05	7.170783e+07
37470	3.364890e+05	6.317154e+07
13994	3.702400e+05	6.272240e+07
57241	3.548700e+05	6.494602e+07

	Google UL (Bytes)	Total	Email DL (Bytes)	Total	\
53644	2.241409e+09		1.906935e+09		
13526	3.608540e+07		3.340478e+07		
13180	3.440318e+07		3.189541e+07		
92923	3.459657e+07		2.643790e+07		
76363	2.685751e+07		2.428472e+07		
6437	3.403208e+07		3.360721e+07		
65118	3.332487e+07		2.327675e+07		
37470	2.218394e+07		1.589613e+07		
13994	2.440352e+07		1.735396e+07		
57241	2.544336e+07		1.521356e+07		

	Email UL (Bytes)	Total	Youtube DL (Bytes)	Total	\
53644	4.966873e+08		1.249731e+10		
13526	9.013997e+06		1.640487e+08		
13180	8.738554e+06		2.378830e+08		
92923	7.255872e+06		1.940683e+08		
76363	7.229698e+06		1.586652e+08		
6437	7.181423e+06		1.998234e+08		
65118	7.059044e+06		1.419727e+08		
37470	6.937942e+06		1.440488e+08		
13994	6.213264e+06		1.873233e+08		
57241	6.212447e+06		1.530745e+08		

	Youtube UL (Bytes)	Total	Netflix DL (Bytes)	Total	\
53644	1.185341e+10		1.230177e+10		
13526	2.104343e+08		1.994792e+08		
13180	2.150757e+08		1.939122e+08		
92923	2.022209e+08		1.465008e+08		
76363	1.587453e+08		1.616265e+08		
6437	1.945468e+08		1.795860e+08		
65118	1.732586e+08		1.679324e+08		
37470	8.099426e+07		1.070452e+08		
13994	1.214675e+08		1.446232e+08		
57241	1.237595e+08		1.349416e+08		

	Netflix UL (Bytes)	Total	Gaming DL (Bytes)	Total	\
53644	1.198034e+10		4.528908e+11		
13526	1.292465e+08		6.745734e+09		
13180	1.630684e+08		7.171884e+09		
92923	1.881424e+08		7.316364e+09		
76363	1.474667e+08		6.863307e+09		
6437	1.818151e+08		7.622035e+09		
65118	1.460071e+08		4.623424e+09		
37470	9.891979e+07		2.601082e+09		
13994	1.224177e+08		4.880017e+09		
57241	1.168572e+08		6.013562e+09		

	Gaming UL (Bytes)	Total	Other DL (Bytes)	Total	Other UL (Bytes)	Total
53644	8.743856e+09		4.425858e+11		9.066371e+09	

13526	1.418386e+08	8.025477e+09	1.424009e+08
13180	1.547897e+08	6.201653e+09	1.529305e+08
92923	1.446811e+08	4.590038e+09	1.260962e+08
76363	1.072606e+08	6.665074e+09	1.334414e+08
6437	1.273968e+08	7.495298e+09	1.439660e+08
65118	1.021977e+08	4.837534e+09	1.039850e+08
37470	8.969852e+07	3.346528e+09	4.980758e+07
13994	9.233558e+07	5.039747e+09	7.804420e+07
57241	9.029361e+07	3.868637e+09	1.083234e+08

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'Youtube DL (Bytes)': MSISDN/Number Social Media DL (Bytes) Total \

53644	3.366371e+10	1.938043e+09
13180	3.362578e+10	2.656412e+07
6437	3.361489e+10	2.774974e+07
92923	3.376054e+10	3.929765e+07
13994	3.362708e+10	1.743867e+07
92577	3.376041e+10	2.051577e+07
86455	3.369879e+10	1.539078e+07
13526	3.362632e+10	4.274384e+07
666	3.360313e+10	2.277668e+07
76363	3.367588e+10	1.865536e+07

Social Media UL (Bytes) Total Google DL (Bytes) Total \

53644	3.615635e+07	6.009292e+09
13180	5.713790e+05	1.079047e+08
6437	5.448000e+05	9.394171e+07
92923	4.855430e+05	8.862653e+07
13994	3.702400e+05	6.272240e+07
92577	2.614310e+05	5.633185e+07
86455	3.373770e+05	5.994399e+07
13526	6.309420e+05	1.161065e+08
666	3.011460e+05	7.394206e+07
76363	5.675570e+05	8.300299e+07

Google UL (Bytes) Total Email DL (Bytes) Total \

53644	2.241409e+09	1.906935e+09
13180	3.440318e+07	3.189541e+07
6437	3.403208e+07	3.360721e+07
92923	3.459657e+07	2.643790e+07
13994	2.440352e+07	1.735396e+07
92577	2.640687e+07	2.179130e+07
86455	1.979213e+07	2.416560e+07
13526	3.608540e+07	3.340478e+07
666	1.298696e+07	2.034373e+07
76363	2.685751e+07	2.428472e+07

Email UL (Bytes) Total Youtube DL (Bytes) Total \

53644	4.966873e+08	1.249731e+10
13180	8.738554e+06	2.378830e+08
6437	7.181423e+06	1.998234e+08
92923	7.255872e+06	1.940683e+08
13994	6.213264e+06	1.873233e+08
92577	3.785669e+06	1.742460e+08
86455	4.893443e+06	1.669003e+08
13526	9.013997e+06	1.640487e+08
666	5.855167e+06	1.589767e+08
76363	7.229698e+06	1.586652e+08

Youtube UL (Bytes) Total Netflix DL (Bytes) Total \

53644	1.185341e+10	1.230177e+10
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13180	2.150757e+08	1.939122e+08
6437	1.945468e+08	1.795860e+08
92923	2.022209e+08	1.465008e+08
13994	1.214675e+08	1.446232e+08
92577	1.289231e+08	1.670238e+08
86455	1.357616e+08	1.030272e+08
13526	2.104343e+08	1.994792e+08
666	1.251134e+08	1.560865e+08
76363	1.587453e+08	1.616265e+08

	Netflix UL (Bytes)	Total	Gaming DL (Bytes)	Total	\
53644	1.198034e+10		4.528908e+11		
13180	1.630684e+08		7.171884e+09		
6437	1.818151e+08		7.622035e+09		
92923	1.881424e+08		7.316364e+09		
13994	1.224177e+08		4.880017e+09		
92577	1.513237e+08		6.170943e+09		
86455	1.652202e+08		5.641128e+09		
13526	1.292465e+08		6.745734e+09		
666	1.044019e+08		4.108482e+09		
76363	1.474667e+08		6.863307e+09		

	Gaming UL (Bytes)	Total	Other DL (Bytes)	Total	Other UL (Bytes)	Total
53644	8.743856e+09		4.425858e+11		9.066371e+09	
13180	1.547897e+08		6.201653e+09		1.529305e+08	
6437	1.273968e+08		7.495298e+09		1.439660e+08	
92923	1.446811e+08		4.590038e+09		1.260962e+08	
13994	9.233558e+07		5.039747e+09		7.804420e+07	
92577	9.767668e+07		3.988504e+09		1.131414e+08	
86455	1.126150e+08		4.598153e+09		9.172329e+07	
13526	1.418386e+08		8.025477e+09		1.424009e+08	
666	8.296289e+07		6.222705e+09		1.039662e+08	
76363	1.072606e+08		6.665074e+09		1.334414e+08	

,

	'Youtube UL (Bytes)'	MSISDN/Number	Social Media DL (Bytes)	Total	\
53644	3.366371e+10		1.938043e+09		
13180	3.362578e+10		2.656412e+07		
13526	3.362632e+10		4.274384e+07		
92923	3.376054e+10		3.929765e+07		
6437	3.361489e+10		2.774974e+07		
65118	3.366716e+10		2.375375e+07		
76363	3.367588e+10		1.865536e+07		
30225	3.365826e+10		2.141476e+07		
94654	3.376127e+10		1.420143e+07		
15664	3.363004e+10		1.445861e+07		

	Social Media UL (Bytes)	Total	Google DL (Bytes)	Total	\
53644	3.615635e+07		6.009292e+09		
13180	5.713790e+05		1.079047e+08		
13526	6.309420e+05		1.161065e+08		
92923	4.855430e+05		8.862653e+07		
6437	5.448000e+05		9.394171e+07		
65118	4.940970e+05		7.170783e+07		
76363	5.675570e+05		8.300299e+07		
30225	2.809830e+05		6.271370e+07		
94654	2.946530e+05		7.294980e+07		
15664	3.525890e+05		5.287280e+07		

	Google UL (Bytes)	Total	Email DL (Bytes)	Total	\
53644	2.241409e+09		1.906935e+09		

13180	3.440318e+07	3.189541e+07
13526	3.608540e+07	3.340478e+07
92923	3.459657e+07	2.643790e+07
6437	3.403208e+07	3.360721e+07
65118	3.332487e+07	2.327675e+07
76363	2.685751e+07	2.428472e+07
30225	2.465949e+07	2.225209e+07
94654	2.414018e+07	1.576884e+07
15664	2.384475e+07	2.132616e+07

	Email UL (Bytes)	Total	Youtube DL (Bytes)	Total	\
53644	4.966873e+08		1.249731e+10		
13180	8.738554e+06		2.378830e+08		
13526	9.013997e+06		1.640487e+08		
92923	7.255872e+06		1.940683e+08		
6437	7.181423e+06		1.998234e+08		
65118	7.059044e+06		1.419727e+08		
76363	7.229698e+06		1.586652e+08		
30225	4.403125e+06		1.082978e+08		
94654	4.984880e+06		1.190565e+08		
15664	5.572088e+06		1.262141e+08		

	Youtube UL (Bytes)	Total	Netflix DL (Bytes)	Total	\
53644	1.185341e+10		1.230177e+10		
13180	2.150757e+08		1.939122e+08		
13526	2.104343e+08		1.994792e+08		
92923	2.022209e+08		1.465008e+08		
6437	1.945468e+08		1.795860e+08		
65118	1.732586e+08		1.679324e+08		
76363	1.587453e+08		1.616265e+08		
30225	1.565403e+08		9.045478e+07		
94654	1.537331e+08		1.672611e+08		
15664	1.492479e+08		1.444323e+08		

	Netflix UL (Bytes)	Total	Gaming DL (Bytes)	Total	\
53644	1.198034e+10		4.528908e+11		
13180	1.630684e+08		7.171884e+09		
13526	1.292465e+08		6.745734e+09		
92923	1.881424e+08		7.316364e+09		
6437	1.818151e+08		7.622035e+09		
65118	1.460071e+08		4.623424e+09		
76363	1.474667e+08		6.863307e+09		
30225	1.067097e+08		4.900201e+09		
94654	1.248302e+08		4.165410e+09		
15664	8.894622e+07		4.702908e+09		

	Gaming UL (Bytes)	Total	Other DL (Bytes)	Total	Other UL (Bytes)	Total
53644	8.743856e+09		4.425858e+11		9.066371e+09	
13180	1.547897e+08		6.201653e+09		1.529305e+08	
13526	1.418386e+08		8.025477e+09		1.424009e+08	
92923	1.446811e+08		4.590038e+09		1.260962e+08	
6437	1.273968e+08		7.495298e+09		1.439660e+08	
65118	1.021977e+08		4.837534e+09		1.039850e+08	
76363	1.072606e+08		6.665074e+09		1.334414e+08	
30225	1.026892e+08		4.031098e+09		7.459015e+07	
94654	1.086893e+08		4.997985e+09		7.979475e+07	
15664	9.172232e+07		4.906609e+09		7.224368e+07	

	'Netflix DL (Bytes)'	MSISDN/Number	Social Media DL (Bytes)	Total	\
53644	3.366371e+10		1.938043e+09		

13526	3.362632e+10	4.274384e+07
37052	3.365973e+10	3.490044e+07
13180	3.362578e+10	2.656412e+07
6437	3.361489e+10	2.774974e+07
65118	3.366716e+10	2.375375e+07
94654	3.376127e+10	1.420143e+07
92577	3.376041e+10	2.051577e+07
106137	3.378632e+10	2.356866e+07
76363	3.367588e+10	1.865536e+07

	Social Media UL (Bytes) Total	Google DL (Bytes) Total	\
53644	3.615635e+07	6.009292e+09	
13526	6.309420e+05	1.161065e+08	
37052	5.119140e+05	9.095855e+07	
13180	5.713790e+05	1.079047e+08	
6437	5.448000e+05	9.394171e+07	
65118	4.940970e+05	7.170783e+07	
94654	2.946530e+05	7.294980e+07	
92577	2.614310e+05	5.633185e+07	
106137	4.062640e+05	7.881981e+07	
76363	5.675570e+05	8.300299e+07	

	Google UL (Bytes) Total	Email DL (Bytes) Total	\
53644	2.241409e+09	1.906935e+09	
13526	3.608540e+07	3.340478e+07	
37052	2.555780e+07	2.990765e+07	
13180	3.440318e+07	3.189541e+07	
6437	3.403208e+07	3.360721e+07	
65118	3.332487e+07	2.327675e+07	
94654	2.414018e+07	1.576884e+07	
92577	2.640687e+07	2.179130e+07	
106137	3.143467e+07	3.087691e+07	
76363	2.685751e+07	2.428472e+07	

	Email UL (Bytes) Total	Youtube DL (Bytes) Total	\
53644	4.966873e+08	1.249731e+10	
13526	9.013997e+06	1.640487e+08	
37052	6.092145e+06	1.196581e+08	
13180	8.738554e+06	2.378830e+08	
6437	7.181423e+06	1.998234e+08	
65118	7.059044e+06	1.419727e+08	
94654	4.984880e+06	1.190565e+08	
92577	3.785669e+06	1.742460e+08	
106137	5.433215e+06	1.181299e+08	
76363	7.229698e+06	1.586652e+08	

	Youtube UL (Bytes) Total	Netflix DL (Bytes) Total	\
53644	1.185341e+10	1.230177e+10	
13526	2.104343e+08	1.994792e+08	
37052	1.383329e+08	1.962772e+08	
13180	2.150757e+08	1.939122e+08	
6437	1.945468e+08	1.795860e+08	
65118	1.732586e+08	1.679324e+08	
94654	1.537331e+08	1.672611e+08	
92577	1.289231e+08	1.670238e+08	
106137	9.663405e+07	1.636027e+08	
76363	1.587453e+08	1.616265e+08	

	Netflix UL (Bytes) Total	Gaming DL (Bytes) Total	\
53644	1.198034e+10	4.528908e+11	

13526	1.292465e+08	6.745734e+09
37052	2.032419e+08	6.609900e+09
13180	1.630684e+08	7.171884e+09
6437	1.818151e+08	7.622035e+09
65118	1.460071e+08	4.623424e+09
94654	1.248302e+08	4.165410e+09
92577	1.513237e+08	6.170943e+09
106137	1.423371e+08	4.740903e+09
76363	1.474667e+08	6.863307e+09

	Gaming UL (Bytes)	Total	Other DL (Bytes)	Total	\
53644	8.743856e+09		4.425858e+11		
13526	1.418386e+08		8.025477e+09		
37052	1.156587e+08		6.182551e+09		
13180	1.547897e+08		6.201653e+09		
6437	1.273968e+08		7.495298e+09		
65118	1.021977e+08		4.837534e+09		
94654	1.086893e+08		4.997985e+09		
92577	9.767668e+07		3.988504e+09		
106137	1.101923e+08		4.172594e+09		
76363	1.072606e+08		6.665074e+09		

	Other UL (Bytes)	Total
53644	9.066371e+09	
13526	1.424009e+08	
37052	1.348649e+08	
13180	1.529305e+08	
6437	1.439660e+08	
65118	1.039850e+08	
94654	7.979475e+07	
92577	1.131414e+08	
106137	7.989267e+07	
76363	1.334414e+08	,

	'Netflix UL (Bytes)'	MSISDN/Number	Social Media DL (Bytes)	Total	\
53644	3.366371e+10		1.938043e+09		
37052	3.365973e+10		3.490044e+07		
92923	3.376054e+10		3.929765e+07		
6437	3.361489e+10		2.774974e+07		
86455	3.369879e+10		1.539078e+07		
13180	3.362578e+10		2.656412e+07		
92577	3.376041e+10		2.051577e+07		
97584	3.376233e+10		1.719581e+07		
76363	3.367588e+10		1.865536e+07		
86313	3.369876e+10		1.512112e+07		

	Social Media UL (Bytes)	Total	Google DL (Bytes)	Total	\
53644		3.615635e+07		6.009292e+09	
37052		5.119140e+05		9.095855e+07	
92923		4.855430e+05		8.862653e+07	
6437		5.448000e+05		9.394171e+07	
86455		3.373770e+05		5.994399e+07	
13180		5.713790e+05		1.079047e+08	
92577		2.614310e+05		5.633185e+07	
97584		3.062180e+05		4.188636e+07	
76363		5.675570e+05		8.300299e+07	
86313		3.751230e+05		6.945934e+07	

	Google UL (Bytes)	Total	Email DL (Bytes)	Total	\
53644		2.241409e+09		1.906935e+09	
37052		2.555780e+07		2.990765e+07	

92923	3.459657e+07	2.643790e+07
6437	3.403208e+07	3.360721e+07
86455	1.979213e+07	2.416560e+07
13180	3.440318e+07	3.189541e+07
92577	2.640687e+07	2.179130e+07
97584	1.888704e+07	2.215948e+07
76363	2.685751e+07	2.428472e+07
86313	2.247581e+07	2.294808e+07

	Email UL (Bytes)	Total	Youtube DL (Bytes)	Total	\
53644	4.966873e+08		1.249731e+10		
37052	6.092145e+06		1.196581e+08		
92923	7.255872e+06		1.940683e+08		
6437	7.181423e+06		1.998234e+08		
86455	4.893443e+06		1.669003e+08		
13180	8.738554e+06		2.378830e+08		
92577	3.785669e+06		1.742460e+08		
97584	3.481642e+06		1.344773e+08		
76363	7.229698e+06		1.586652e+08		
86313	5.491624e+06		1.280375e+08		

	Youtube UL (Bytes)	Total	Netflix DL (Bytes)	Total	\
53644	1.185341e+10		1.230177e+10		
37052	1.383329e+08		1.962772e+08		
92923	2.022209e+08		1.465008e+08		
6437	1.945468e+08		1.795860e+08		
86455	1.357616e+08		1.030272e+08		
13180	2.150757e+08		1.939122e+08		
92577	1.289231e+08		1.670238e+08		
97584	7.810463e+07		1.098673e+08		
76363	1.587453e+08		1.616265e+08		
86313	1.233846e+08		1.335827e+08		

	Netflix UL (Bytes)	Total	Gaming DL (Bytes)	Total	\
53644	1.198034e+10		4.528908e+11		
37052	2.032419e+08		6.609900e+09		
92923	1.881424e+08		7.316364e+09		
6437	1.818151e+08		7.622035e+09		
86455	1.652202e+08		5.641128e+09		
13180	1.630684e+08		7.171884e+09		
92577	1.513237e+08		6.170943e+09		
97584	1.500268e+08		4.160650e+09		
76363	1.474667e+08		6.863307e+09		
86313	1.472298e+08		5.022608e+09		

	Gaming UL (Bytes)	Total	Other DL (Bytes)	Total	Other UL (Bytes)	Total
53644	8.743856e+09		4.425858e+11		9.066371e+09	
37052	1.156587e+08		6.182551e+09		1.348649e+08	
92923	1.446811e+08		4.590038e+09		1.260962e+08	
6437	1.273968e+08		7.495298e+09		1.439660e+08	
86455	1.126150e+08		4.598153e+09		9.172329e+07	
13180	1.547897e+08		6.201653e+09		1.529305e+08	
92577	9.767668e+07		3.988504e+09		1.131414e+08	
97584	6.764851e+07		4.204194e+09		9.033022e+07	
76363	1.072606e+08		6.665074e+09		1.334414e+08	
86313	9.577267e+07		4.446847e+09		8.577640e+07	

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'Gaming DL (Bytes)'	MSISDN/Number	Social Media DL (Bytes)	Total	\
53644	3.366371e+10	1.938043e+09		
6437	3.361489e+10	2.774974e+07		

92923	3.376054e+10	3.929765e+07
13180	3.362578e+10	2.656412e+07
76363	3.367588e+10	1.865536e+07
13526	3.362632e+10	4.274384e+07
37052	3.365973e+10	3.490044e+07
63028	3.366646e+10	1.823492e+07
92577	3.376041e+10	2.051577e+07
57241	3.366471e+10	1.903573e+07

	Social Media UL (Bytes) Total	Google DL (Bytes) Total	\
53644	3.615635e+07	6.009292e+09	
6437	5.448000e+05	9.394171e+07	
92923	4.855430e+05	8.862653e+07	
13180	5.713790e+05	1.079047e+08	
76363	5.675570e+05	8.300299e+07	
13526	6.309420e+05	1.161065e+08	
37052	5.119140e+05	9.095855e+07	
63028	3.950620e+05	6.259921e+07	
92577	2.614310e+05	5.633185e+07	
57241	3.548700e+05	6.494602e+07	

	Google UL (Bytes) Total	Email DL (Bytes) Total	\
53644	2.241409e+09	1.906935e+09	
6437	3.403208e+07	3.360721e+07	
92923	3.459657e+07	2.643790e+07	
13180	3.440318e+07	3.189541e+07	
76363	2.685751e+07	2.428472e+07	
13526	3.608540e+07	3.340478e+07	
37052	2.555780e+07	2.990765e+07	
63028	2.672152e+07	1.966718e+07	
92577	2.640687e+07	2.179130e+07	
57241	2.544336e+07	1.521356e+07	

	Email UL (Bytes) Total	Youtube DL (Bytes) Total	\
53644	4.966873e+08	1.249731e+10	
6437	7.181423e+06	1.998234e+08	
92923	7.255872e+06	1.940683e+08	
13180	8.738554e+06	2.378830e+08	
76363	7.229698e+06	1.586652e+08	
13526	9.013997e+06	1.640487e+08	
37052	6.092145e+06	1.196581e+08	
63028	5.889958e+06	1.406639e+08	
92577	3.785669e+06	1.742460e+08	
57241	6.212447e+06	1.530745e+08	

	Youtube UL (Bytes) Total	Netflix DL (Bytes) Total	\
53644	1.185341e+10	1.230177e+10	
6437	1.945468e+08	1.795860e+08	
92923	2.022209e+08	1.465008e+08	
13180	2.150757e+08	1.939122e+08	
76363	1.587453e+08	1.616265e+08	
13526	2.104343e+08	1.994792e+08	
37052	1.383329e+08	1.962772e+08	
63028	8.667215e+07	1.159470e+08	
92577	1.289231e+08	1.670238e+08	
57241	1.237595e+08	1.349416e+08	

	Netflix UL (Bytes) Total	Gaming DL (Bytes) Total	\
53644	1.198034e+10	4.528908e+11	
6437	1.818151e+08	7.622035e+09	

92923	1.881424e+08	7.316364e+09
13180	1.630684e+08	7.171884e+09
76363	1.474667e+08	6.863307e+09
13526	1.292465e+08	6.745734e+09
37052	2.032419e+08	6.609900e+09
63028	9.846994e+07	6.546328e+09
92577	1.513237e+08	6.170943e+09
57241	1.168572e+08	6.013562e+09
Gaming	UL (Bytes)	Total
53644	8.743856e+09	4.425858e+11
6437	1.273968e+08	7.495298e+09
92923	1.446811e+08	4.590038e+09
13180	1.547897e+08	6.201653e+09
76363	1.072606e+08	6.665074e+09
13526	1.418386e+08	8.025477e+09
37052	1.156587e+08	6.182551e+09
63028	9.997554e+07	4.262205e+09
92577	9.767668e+07	3.988504e+09
57241	9.029361e+07	3.868637e+09
'Gaming	UL (Bytes)'	MSISDN/Number
53644	3.366371e+10	1.938043e+09
13180	3.362578e+10	2.656412e+07
92923	3.376054e+10	3.929765e+07
13526	3.362632e+10	4.274384e+07
6437	3.361489e+10	2.774974e+07
37052	3.365973e+10	3.490044e+07
86455	3.369879e+10	1.539078e+07
106137	3.378632e+10	2.356866e+07
94654	3.376127e+10	1.420143e+07
76363	3.367588e+10	1.865536e+07
Social Media	UL (Bytes)	Total
53644	3.615635e+07	6.009292e+09
13180	5.713790e+05	1.079047e+08
92923	4.855430e+05	8.862653e+07
13526	6.309420e+05	1.161065e+08
6437	5.448000e+05	9.394171e+07
37052	5.119140e+05	9.095855e+07
86455	3.373770e+05	5.994399e+07
106137	4.062640e+05	7.881981e+07
94654	2.946530e+05	7.294980e+07
76363	5.675570e+05	8.300299e+07
Google	UL (Bytes)	Total
53644	2.241409e+09	1.906935e+09
13180	3.440318e+07	3.189541e+07
92923	3.459657e+07	2.643790e+07
13526	3.608540e+07	3.340478e+07
6437	3.403208e+07	3.360721e+07
37052	2.555780e+07	2.990765e+07
86455	1.979213e+07	2.416560e+07
106137	3.143467e+07	3.087691e+07
94654	2.414018e+07	1.576884e+07
76363	2.685751e+07	2.428472e+07
Email	UL (Bytes)	Total
53644	4.966873e+08	1.249731e+10
13180	8.738554e+06	2.378830e+08

92923	7.255872e+06	1.940683e+08
13526	9.013997e+06	1.640487e+08
6437	7.181423e+06	1.998234e+08
37052	6.092145e+06	1.196581e+08
86455	4.893443e+06	1.669003e+08
106137	5.433215e+06	1.181299e+08
94654	4.984880e+06	1.190565e+08
76363	7.229698e+06	1.586652e+08
 Youtube UL (Bytes) Total Netflix DL (Bytes) Total \		
53644	1.185341e+10	1.230177e+10
13180	2.150757e+08	1.939122e+08
92923	2.022209e+08	1.465008e+08
13526	2.104343e+08	1.994792e+08
6437	1.945468e+08	1.795860e+08
37052	1.383329e+08	1.962772e+08
86455	1.357616e+08	1.030272e+08
106137	9.663405e+07	1.636027e+08
94654	1.537331e+08	1.672611e+08
76363	1.587453e+08	1.616265e+08
 Netflix UL (Bytes) Total Gaming DL (Bytes) Total \		
53644	1.198034e+10	4.528908e+11
13180	1.630684e+08	7.171884e+09
92923	1.881424e+08	7.316364e+09
13526	1.292465e+08	6.745734e+09
6437	1.818151e+08	7.622035e+09
37052	2.032419e+08	6.609900e+09
86455	1.652202e+08	5.641128e+09
106137	1.423371e+08	4.740903e+09
94654	1.248302e+08	4.165410e+09
76363	1.474667e+08	6.863307e+09
 Gaming UL (Bytes) Total Other DL (Bytes) Total \		
53644	8.743856e+09	4.425858e+11
13180	1.547897e+08	6.201653e+09
92923	1.446811e+08	4.590038e+09
13526	1.418386e+08	8.025477e+09
6437	1.273968e+08	7.495298e+09
37052	1.156587e+08	6.182551e+09
86455	1.126150e+08	4.598153e+09
106137	1.101923e+08	4.172594e+09
94654	1.086893e+08	4.997985e+09
76363	1.072606e+08	6.665074e+09
 Other UL (Bytes) Total		
53644	9.066371e+09	
13180	1.529305e+08	
92923	1.260962e+08	
13526	1.424009e+08	
6437	1.439660e+08	
37052	1.348649e+08	
86455	9.172329e+07	
106137	7.989267e+07	
94654	7.979475e+07	
76363	1.334414e+08	,
'Other DL (Bytes)': MSISDN/Number Social Media DL (Bytes) Total \		
53644	3.366371e+10	1.938043e+09
13526	3.362632e+10	4.274384e+07
6437	3.361489e+10	2.774974e+07

76363	3.367588e+10	1.865536e+07
666	3.360313e+10	2.277668e+07
13180	3.362578e+10	2.656412e+07
37052	3.365973e+10	3.490044e+07
13936	3.362695e+10	1.658993e+07
13994	3.362708e+10	1.743867e+07
94654	3.376127e+10	1.420143e+07

	Social Media UL (Bytes)	Total	Google DL (Bytes)	Total	\
53644	3.615635e+07		6.009292e+09		
13526	6.309420e+05		1.161065e+08		
6437	5.448000e+05		9.394171e+07		
76363	5.675570e+05		8.300299e+07		
666	3.011460e+05		7.394206e+07		
13180	5.713790e+05		1.079047e+08		
37052	5.119140e+05		9.095855e+07		
13936	3.320680e+05		5.762776e+07		
13994	3.702400e+05		6.272240e+07		
94654	2.946530e+05		7.294980e+07		

	Google UL (Bytes)	Total	Email DL (Bytes)	Total	\
53644	2.241409e+09		1.906935e+09		
13526	3.608540e+07		3.340478e+07		
6437	3.403208e+07		3.360721e+07		
76363	2.685751e+07		2.428472e+07		
666	1.298696e+07		2.034373e+07		
13180	3.440318e+07		3.189541e+07		
37052	2.555780e+07		2.990765e+07		
13936	1.236019e+07		1.297899e+07		
13994	2.440352e+07		1.735396e+07		
94654	2.414018e+07		1.576884e+07		

	Email UL (Bytes)	Total	Youtube DL (Bytes)	Total	\
53644	4.966873e+08		1.249731e+10		
13526	9.013997e+06		1.640487e+08		
6437	7.181423e+06		1.998234e+08		
76363	7.229698e+06		1.586652e+08		
666	5.855167e+06		1.589767e+08		
13180	8.738554e+06		2.378830e+08		
37052	6.092145e+06		1.196581e+08		
13936	4.503799e+06		8.547465e+07		
13994	6.213264e+06		1.873233e+08		
94654	4.984880e+06		1.190565e+08		

	Youtube UL (Bytes)	Total	Netflix DL (Bytes)	Total	\
53644	1.185341e+10		1.230177e+10		
13526	2.104343e+08		1.994792e+08		
6437	1.945468e+08		1.795860e+08		
76363	1.587453e+08		1.616265e+08		
666	1.251134e+08		1.560865e+08		
13180	2.150757e+08		1.939122e+08		
37052	1.383329e+08		1.962772e+08		
13936	1.146106e+08		1.179109e+08		
13994	1.214675e+08		1.446232e+08		
94654	1.537331e+08		1.672611e+08		

	Netflix UL (Bytes)	Total	Gaming DL (Bytes)	Total	\
53644	1.198034e+10		4.528908e+11		
13526	1.292465e+08		6.745734e+09		
6437	1.818151e+08		7.622035e+09		

76363	1.474667e+08	6.863307e+09
666	1.044019e+08	4.108482e+09
13180	1.630684e+08	7.171884e+09
37052	2.032419e+08	6.609900e+09
13936	1.448111e+08	4.099560e+09
13994	1.224177e+08	4.880017e+09
94654	1.248302e+08	4.165410e+09

	Gaming	UL (Bytes)	Total	Other	DL (Bytes)	Total	Other	UL (Bytes)	Total
53644		8.743856e+09			4.425858e+11			9.066371e+09	
13526		1.418386e+08			8.025477e+09			1.424009e+08	
6437		1.273968e+08			7.495298e+09			1.439660e+08	
76363		1.072606e+08			6.665074e+09			1.334414e+08	
666		8.296289e+07			6.222705e+09			1.039662e+08	
13180		1.547897e+08			6.201653e+09			1.529305e+08	
37052		1.156587e+08			6.182551e+09			1.348649e+08	
13936		8.220240e+07			5.228772e+09			7.667580e+07	
13994		9.233558e+07			5.039747e+09			7.804420e+07	
94654		1.086893e+08			4.997985e+09			7.979475e+07	

,

'Other UL (Bytes)': MSISDN/Number Social Media DL (Bytes) Total \

53644	3.366371e+10	1.938043e+09
13180	3.362578e+10	2.656412e+07
6437	3.361489e+10	2.774974e+07
13526	3.362632e+10	4.274384e+07
37052	3.365973e+10	3.490044e+07
76363	3.367588e+10	1.865536e+07
92923	3.376054e+10	3.929765e+07
92577	3.376041e+10	2.051577e+07
57241	3.366471e+10	1.903573e+07
30715	3.365836e+10	1.686561e+07

Social Media UL (Bytes) Total Google DL (Bytes) Total \

53644	3.615635e+07	6.009292e+09
13180	5.713790e+05	1.079047e+08
6437	5.448000e+05	9.394171e+07
13526	6.309420e+05	1.161065e+08
37052	5.119140e+05	9.095855e+07
76363	5.675570e+05	8.300299e+07
92923	4.855430e+05	8.862653e+07
92577	2.614310e+05	5.633185e+07
57241	3.548700e+05	6.494602e+07
30715	4.201460e+05	5.867198e+07

Google UL (Bytes) Total Email DL (Bytes) Total \

53644	2.241409e+09	1.906935e+09
13180	3.440318e+07	3.189541e+07
6437	3.403208e+07	3.360721e+07
13526	3.608540e+07	3.340478e+07
37052	2.555780e+07	2.990765e+07
76363	2.685751e+07	2.428472e+07
92923	3.459657e+07	2.643790e+07
92577	2.640687e+07	2.179130e+07
57241	2.544336e+07	1.521356e+07
30715	1.783515e+07	1.755392e+07

Email UL (Bytes) Total Youtube DL (Bytes) Total \

53644	4.966873e+08	1.249731e+10
13180	8.738554e+06	2.378830e+08
6437	7.181423e+06	1.998234e+08

```

13526      9.013997e+06      1.640487e+08
37052      6.092145e+06      1.196581e+08
76363      7.229698e+06      1.586652e+08
92923      7.255872e+06      1.940683e+08
92577      3.785669e+06      1.742460e+08
57241      6.212447e+06      1.530745e+08
30715      2.128126e+06      1.193796e+08

    Youtube UL (Bytes) Total  Netflix DL (Bytes) Total  \
53644          1.185341e+10      1.230177e+10
13180          2.150757e+08      1.939122e+08
6437           1.945468e+08      1.795860e+08
13526          2.104343e+08      1.994792e+08
37052          1.383329e+08      1.962772e+08
76363          1.587453e+08      1.616265e+08
92923          2.022209e+08      1.465008e+08
92577          1.289231e+08      1.670238e+08
57241          1.237595e+08      1.349416e+08
30715          1.416103e+08      1.313589e+08

    Netflix UL (Bytes) Total  Gaming DL (Bytes) Total  \
53644          1.198034e+10      4.528908e+11
13180          1.630684e+08      7.171884e+09
6437           1.818151e+08      7.622035e+09
13526          1.292465e+08      6.745734e+09
37052          2.032419e+08      6.609900e+09
76363          1.474667e+08      6.863307e+09
92923          1.881424e+08      7.316364e+09
92577          1.513237e+08      6.170943e+09
57241          1.168572e+08      6.013562e+09
30715          1.327831e+08      5.628473e+09

    Gaming UL (Bytes) Total  Other DL (Bytes) Total  Other UL (Bytes) Total
53644          8.743856e+09      4.425858e+11      9.066371e+09
13180          1.547897e+08      6.201653e+09      1.529305e+08
6437           1.273968e+08      7.495298e+09      1.439660e+08
13526          1.418386e+08      8.025477e+09      1.424009e+08
37052          1.156587e+08      6.182551e+09      1.348649e+08
76363          1.072606e+08      6.665074e+09      1.334414e+08
92923          1.446811e+08      4.590038e+09      1.260962e+08
92577          9.767668e+07      3.988504e+09      1.131414e+08
57241          9.029361e+07      3.868637e+09      1.083234e+08
30715          7.744628e+07      4.905779e+09      1.078713e+08
}

```

```
In [233...]: application_totals = application_traffic.sum().reset_index()
application_totals.columns = ['Application', 'Total Traffic (Bytes)']
```

```
In [235...]: application_totals
```

Out[235...]

	Application	Total Traffic (Bytes)
0	MSISDN/Number	4.820780e+15
1	Social Media DL (Bytes) Total	2.693001e+11
2	Social Media UL (Bytes) Total	4.939298e+09
3	Google DL (Bytes) Total	8.626186e+11
4	Google UL (Bytes) Total	3.084833e+11
5	Email DL (Bytes) Total	2.687611e+11
6	Email UL (Bytes) Total	7.010648e+10
7	Youtube DL (Bytes) Total	1.745123e+12
8	Youtube UL (Bytes) Total	1.651423e+12
9	Netflix DL (Bytes) Total	1.744039e+12
10	Netflix UL (Bytes) Total	1.650274e+12
11	Gaming DL (Bytes) Total	6.330713e+13
12	Gaming UL (Bytes) Total	1.243268e+12
13	Other DL (Bytes) Total	6.316550e+13
14	Other UL (Bytes) Total	1.239728e+12

In [237...]

```
# Filter out the MSISDN column
application_totals = application_totals[application_totals['Application'] != 'MSISDN']
```

In [239...]

```
top_3_apps = application_totals.nlargest(3, 'Total Traffic (Bytes)')
```

In [241...]

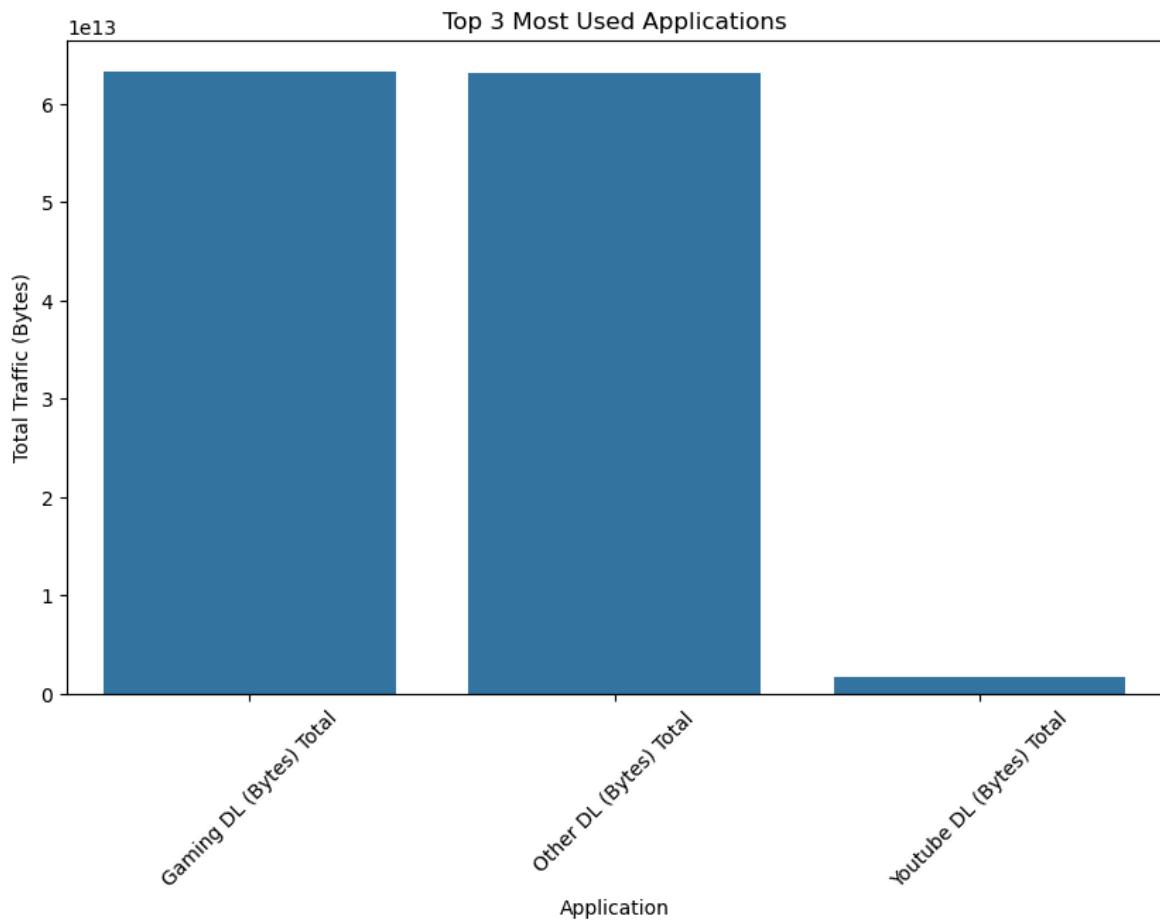
```
top_3_apps
```

Out[241...]

	Application	Total Traffic (Bytes)
11	Gaming DL (Bytes) Total	6.330713e+13
13	Other DL (Bytes) Total	6.316550e+13
7	Youtube DL (Bytes) Total	1.745123e+12

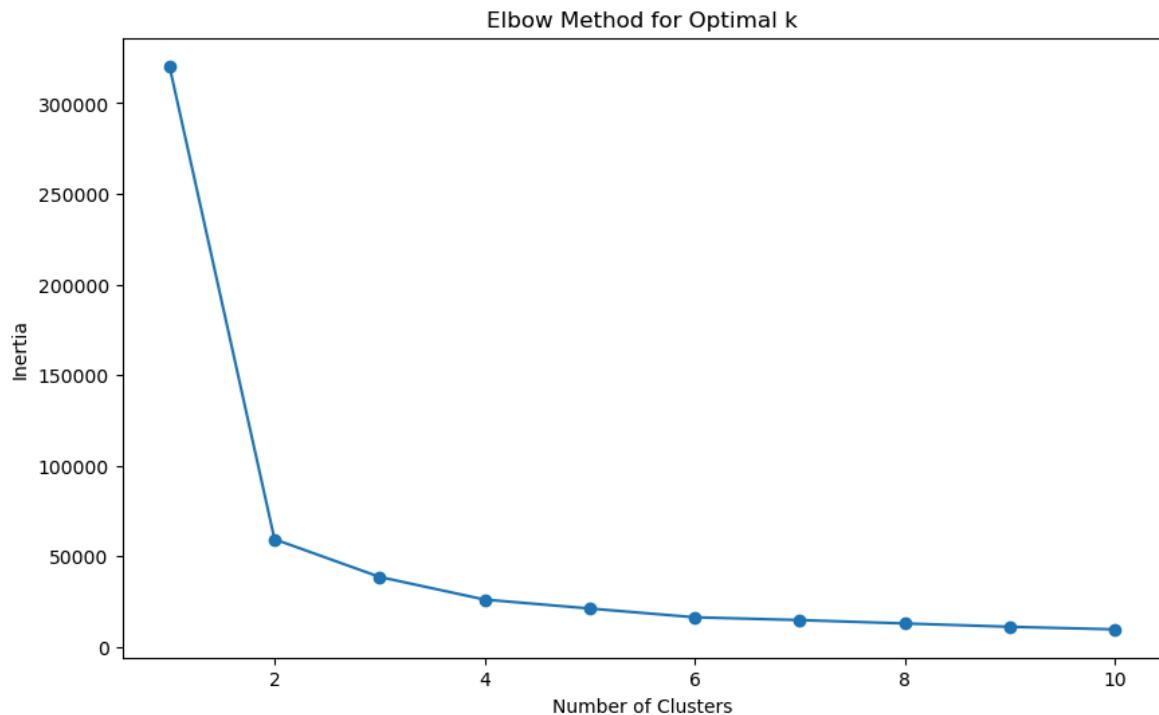
In [243...]

```
plt.figure(figsize=(10, 6))
sns.barplot(x='Application', y='Total Traffic (Bytes)', data=top_3_apps)
plt.title('Top 3 Most Used Applications')
plt.xlabel('Application')
plt.ylabel('Total Traffic (Bytes)')
plt.xticks(rotation=45)
plt.show()
```



```
In [245...]:  
    inertia = []  
    k_range = range(1, 11)  
    for k in k_range:  
        kmeans = KMeans(n_clusters=k, random_state=0).fit(normalized_metrics)  
        inertia.append(kmeans.inertia_)
```

```
In [247...]:  
    # Plot the elbow curve  
    plt.figure(figsize=(10, 6))  
    plt.plot(k_range, inertia, marker='o')  
    plt.title('Elbow Method for Optimal k')  
    plt.xlabel('Number of Clusters')  
    plt.ylabel('Inertia')  
    plt.show()
```



```
In [249...]: dataset.shape
Out[249...]: (150001, 79)

In [423...]: dataset.to_csv(r"D:\Next hike 5-project-March-25\featured_telcom_data.csv", index=False)
In [255...]: # Task-3_Experience_Analytics
In [425...]: dataset = pd.read_csv(r"D:\Next hike 5-project-March-25\featured_telcom_data.csv")
In [427...]: dataset.head(5)
Out[427...]:
```

	Avg TCP Retrans. Vol (Bytes)	Avg RTT (ms)	Avg Throughput (kbps)	Cluster
0	2.217323e+06	52.396962	6553.878919	0
1	1.073967e+09	71.431476	35644.455143	1
2	9.485174e+05	5142.496732	1248.575163	2

```
In [272...]: dataset.shape
Out[272...]: (150001, 80)

In [274...]: dataset.columns
```

```
Out[274...]: Index(['Unnamed: 0', 'Bearer_Id', 'Start', 'Start ms', 'End', 'End ms',  
'Dur. (ms)', 'IMSI', 'MSISDN/Number', 'IMEI', 'Last Location Name',  
'Avg RTT DL (ms)', 'Avg RTT UL (ms)', 'Avg Bearer TP DL (kbps)',  
'Avg Bearer TP UL (kbps)', 'TCP DL Retrans. Vol (Bytes)',  
'TCP UL Retrans. Vol (Bytes)', 'DL TP < 50 Kbps (%)',  
'50 Kbps < DL TP < 250 Kbps (%)', '250 Kbps < DL TP < 1 Mbps (%)',  
'DL TP > 1 Mbps (%)', 'UL TP < 10 Kbps (%)',  
'10 Kbps < UL TP < 50 Kbps (%)', '50 Kbps < UL TP < 300 Kbps (%)',  
'UL TP > 300 Kbps (%)', 'HTTP DL (Bytes)', 'HTTP UL (Bytes)',  
'Activity Duration DL (ms)', 'Activity Duration UL (ms)', 'Dur. (ms).1',  
'Handset Manufacturer', 'Handset Type',  
'Nb of sec with 125000B < Vol DL',  
'Nb of sec with 1250B < Vol UL < 6250B',  
'Nb of sec with 31250B < Vol DL < 125000B',  
'Nb of sec with 37500B < Vol UL',  
'Nb of sec with 6250B < Vol DL < 31250B',  
'Nb of sec with 6250B < Vol UL < 37500B',  
'Nb of sec with Vol DL < 6250B', 'Nb of sec with Vol UL < 1250B',  
'Social Media DL (Bytes)', 'Social Media UL (Bytes)',  
'Google DL (Bytes)', 'Google UL (Bytes)', 'Email DL (Bytes)',  
'Email UL (Bytes)', 'Youtube DL (Bytes)', 'Youtube UL (Bytes)',  
'Netflix DL (Bytes)', 'Netflix UL (Bytes)', 'Gaming DL (Bytes)',  
'Gaming UL (Bytes)', 'Other DL (Bytes)', 'Other UL (Bytes)',  
'Total UL (Bytes)', 'Total DL (Bytes)', 'Social Media Total (Bytes)',  
'Google Total (Bytes)', 'Email Total (Bytes)', 'Youtube Total (Bytes)',  
'Netflix Total (Bytes)', 'Gaming Total (Bytes)', 'Other Total (Bytes)',  
'total_data', 'decile_class', 'Total Traffic (Bytes)',  
'Social Media DL (Bytes) Total', 'Social Media UL (Bytes) Total',  
'Google DL (Bytes) Total', 'Google UL (Bytes) Total',  
'Email DL (Bytes) Total', 'Email UL (Bytes) Total',  
'Youtube DL (Bytes) Total', 'Youtube UL (Bytes) Total',  
'Netflix DL (Bytes) Total', 'Netflix UL (Bytes) Total',  
'Gaming DL (Bytes) Total', 'Gaming UL (Bytes) Total',  
'Other DL (Bytes) Total', 'Other UL (Bytes) Total'],  
dtype='object')
```

```
In [276...]: dataset.isnull().sum().iloc[30:70]
```

```
Out[276... Handset Manufacturer          0
      Handset Type                 0
      Nb of sec with 125000B < Vol DL    0
      Nb of sec with 1250B < Vol UL < 6250B   0
      Nb of sec with 31250B < Vol DL < 125000B   0
      Nb of sec with 37500B < Vol UL          0
      Nb of sec with 6250B < Vol DL < 31250B    0
      Nb of sec with 6250B < Vol UL < 37500B    0
      Nb of sec with Vol DL < 6250B          0
      Nb of sec with Vol UL < 1250B          0
      Social Media DL (Bytes)                0
      Social Media UL (Bytes)                0
      Google DL (Bytes)                     0
      Google UL (Bytes)                     0
      Email DL (Bytes)                     0
      Email UL (Bytes)                     0
      Youtube DL (Bytes)                   0
      Youtube UL (Bytes)                   0
      Netflix DL (Bytes)                   0
      Netflix UL (Bytes)                   0
      Gaming DL (Bytes)                    0
      Gaming UL (Bytes)                    0
      Other DL (Bytes)                     0
      Other UL (Bytes)                     0
      Total UL (Bytes)                     0
      Total DL (Bytes)                     0
      Social Media Total (Bytes)           0
      Google Total (Bytes)                 0
      Email Total (Bytes)                 0
      Youtube Total (Bytes)                0
      Netflix Total (Bytes)                0
      Gaming Total (Bytes)                 0
      Other Total (Bytes)                  0
      total_data                          0
      decile_class                        0
      Total Traffic (Bytes)                0
      Social Media DL (Bytes) Total        0
      Social Media UL (Bytes) Total        0
      Google DL (Bytes) Total              0
      Google UL (Bytes) Total              0
      dtype: int64
```

```
In [278... aggregated_dataset = dataset.groupby('IMSI').agg({
    'TCP DL Retrans. Vol (Bytes)': 'mean',
    'TCP UL Retrans. Vol (Bytes)': 'mean',
    'Avg RTT DL (ms)': 'mean',
    'Avg RTT UL (ms)': 'mean',
    'Handset Type': lambda x: x.mode()[0], # most common handset type per customer
    'Avg Bearer TP DL (kbps)': 'mean',
    'Avg Bearer TP UL (kbps)': 'mean'
}).reset_index()
```

```
In [282... aggregated_dataset['Avg TCP Retrans. Vol (Bytes)'] = (aggregated_dataset['TCP DL Retrans. Vol (Bytes)'] + aggregated_dataset['TCP UL Retrans. Vol (Bytes)']) / 2
```

```
In [284... aggregated_dataset['Avg TCP Retrans. Vol (Bytes)']
```

```
Out[284... 0      294839.75
           1      294839.75
           2      11823.25
           3      13989.50
           4      294839.75
           ...
           107260 294839.75
           107261 294839.75
           107262 28997.75
           107263 294839.75
           107264 294839.75
Name: Avg TCP Retrans. Vol (Bytes), Length: 107265, dtype: float64
```

```
In [288... aggregated_dataset['Avg RTT (ms)'] = (aggregated_dataset['Avg RTT DL (ms)'] +
                                             aggregated_dataset['Avg RTT UL (ms)']) / 2
```

```
In [290... aggregated_dataset['Avg RTT (ms)']
```

```
Out[290... 0      25.0
           1      25.0
           2      151.5
           3      42.0
           4      46.0
           ...
           107260 25.0
           107261 25.0
           107262 23.5
           107263 25.0
           107264 29.0
Name: Avg RTT (ms), Length: 107265, dtype: float64
```

```
In [294... aggregated_dataset['Avg Throughput (kbps)'] = (aggregated_dataset['Avg Bearer TP (kbps)'] +
                                             aggregated_dataset['Avg Bearer TP UL (kbps)']) / 2
```

```
In [296... aggregated_dataset['Avg Throughput (kbps)']
```

```
Out[296... 0      1.00
           1      0.50
           2      54.50
           3      377.00
           4      40.25
           ...
           107260 7.50
           107261 7.50
           107262 439.00
           107263 1.00
           107264 3.50
Name: Avg Throughput (kbps), Length: 107265, dtype: float64
```

```
In [298... aggregated_dataset.drop(columns=['TCP DL Retrans. Vol (Bytes)', 'TCP UL Retrans. Vol (Bytes)', 'Avg RTT DL (ms)', 'Avg RTT UL (ms)', 'Avg Bearer TP (kbps)', 'Avg Bearer TP UL (kbps)'], inplace=True)
```

```
In [300... aggregated_dataset.rename(columns={'Handset Type': 'Most Common Handset Type'}, inplace=True)
```

```
In [302... print(aggregated_dataset.head())
```

```
IMSI          Most Common Handset Type \
0  2.040471e+14 Quectel Wireless. Quectel Ec21-E
1  2.040808e+14 Quectel Wireless. Quectel Ec25-E
2  2.082001e+14 Dn Electronics Danew Konnect 350
3  2.082001e+14 Samsung Galaxy Grand (Gt-I9060X)
4  2.082001e+14           Apple iPhone 6S (A1688)
```

	Avg TCP Retrans. Vol (Bytes)	Avg RTT (ms)	Avg Throughput (kbps)
0	294839.75	25.0	1.00
1	294839.75	25.0	0.50
2	11823.25	151.5	54.50
3	13989.50	42.0	377.00
4	294839.75	46.0	40.25

```
In [306... aggregated_dataset.to_csv(r"D:\Next hike 5-project-March-25\aggregated_customer_
```

```
In [308... def get_top_bottom_most_frequent(aggregated_dataset, col, top_n=10):
    top_values = aggregated_dataset[col].nlargest(top_n)
    bottom_values = aggregated_dataset[col].nsmallest(top_n)
    most_frequent_values = aggregated_dataset[col].value_counts().nlargest(top_n)
    return top_values, bottom_values, most_frequent_values
```

```
In [312... top_tcp, bottom_tcp, most_freq_tcp = get_top_bottom_most_frequent(aggregated_dat
```

```
In [314... top_tcp, bottom_tcp, most_freq_tcp
```

```
Out[314... (76093 2.150739e+09
    70098 2.144060e+09
    25608 2.134324e+09
    27762 2.127330e+09
    82401 2.105629e+09
    66329 2.083297e+09
    31005 2.068969e+09
    81324 2.058902e+09
    76790 1.984060e+09
    97867 1.893435e+09
Name: Avg TCP Retrans. Vol (Bytes), dtype: float64,
29703    48.5
6407     64.0
107028   64.5
56004    67.0
60466    71.5
5962     88.0
12644    88.0
52330    88.5
14282    89.5
102610   91.0
Name: Avg TCP Retrans. Vol (Bytes), dtype: float64,
Avg TCP Retrans. Vol (Bytes)
294839.750 56055
285012.000 368
285030.000 168
11139.750 146
289925.875 82
285024.000 81
11804.750 80
10520.750 79
10493.750 70
285695.000 65
Name: count, dtype: int64)
```

```
In [318... top_rtt, bottom_rtt, most_freq_rtt = get_top_bottom_most_frequent(aggregated_dat
```

```
In [320... top_rtt, bottom_rtt, most_freq_rtt
```

```
Out[320... (60036 48462.00
97639 27424.00
59324 16167.50
40882 13639.00
26711 13150.00
7172 12857.50
6342 12694.00
11680 12369.00
66138 11505.25
91831 10490.00
Name: Avg RTT (ms), dtype: float64,
4705 0.0
75243 0.0
73880 1.0
36675 2.0
13477 2.5
70976 3.0
90082 4.0
1368 4.5
48343 4.5
12935 5.0
Name: Avg RTT (ms), dtype: float64,
Avg RTT (ms)
25.0 19576
14.5 2952
19.5 2414
19.0 1658
20.0 1649
15.0 1576
14.0 1456
24.5 1403
20.5 1268
15.5 1191
Name: count, dtype: int64)
```

```
In [324... top_throughput, bottom_throughput, most_freq_throughput = get_top_bottom_most_fr
```

```
In [326... top_throughput, bottom_throughput, most_freq_throughput
```

```
Out[326... (99472    141965.50
78733    132862.00
82270    132588.25
30923    127475.00
100792    119491.00
97566    117682.50
81129    115491.00
44664    114151.50
82533    113667.00
50621    113252.50
Name: Avg Throughput (kbps), dtype: float64,
759      0.0
1256     0.0
2184     0.0
2437     0.0
3155     0.0
4918     0.0
5943     0.0
5973     0.0
7596     0.0
7948     0.0
Name: Avg Throughput (kbps), dtype: float64,
Avg Throughput (kbps)
7.5      2882
31.5     2138
48.5     1094
45.0     1062
49.0     1026
48.0      939
49.5      918
44.5      882
45.5      868
47.5      856
Name: count, dtype: int64)
```

```
In [328... throughput_per_handset = aggregated_dataset.groupby('Most Common Handset Type')[
```

```
In [330... throughput_per_handset
```

Out[330...]

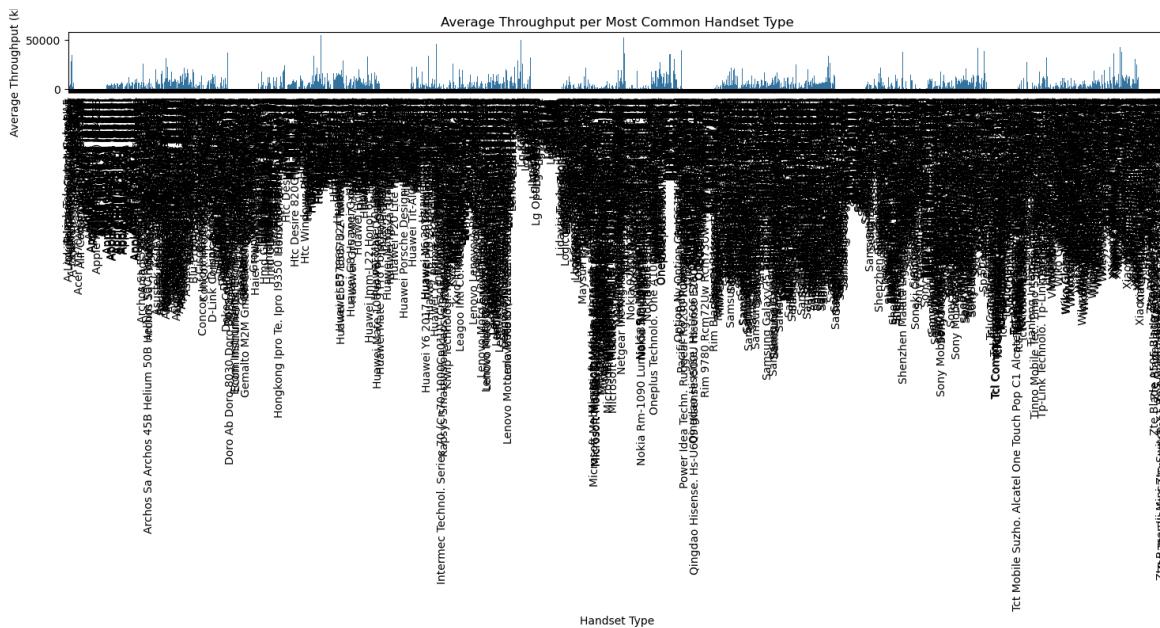
Most Common Handset Type Avg Throughput (kbps)

0	A-Link Telecom I. Cubot A5	11755.000000
1	A-Link Telecom I. Cubot Note Plus	3349.500000
2	A-Link Telecom I. Cubot Note S	4468.500000
3	A-Link Telecom I. Cubot Nova	28108.500000
4	A-Link Telecom I. Cubot Power	34734.000000
...
1392	Zte Zte Blade C2 Smartphone Android By Sfr Sta...	29.000000
1393	Zyxel Communicat. Lte7460	30978.000000
1394	Zyxel Communicat. Sbg3600	48675.500000
1395	Zyxel Communicat. Zyxel Wah7706	1086.500000
1396	undefined	4327.433644

1397 rows × 2 columns

In [332...]

```
plt.figure(figsize=(15, 8))
sns.barplot(data=throughput_per_handset, x='Most Common Handset Type', y='Avg Th
plt.xticks(rotation=90)
plt.title('Average Throughput per Most Common Handset Type')
plt.xlabel('Handset Type')
plt.ylabel('Average Throughput (kbps)')
plt.tight_layout()
plt.show()
```



In [336...]

```
tcp_retrans_per_handset = aggregated_dataset.groupby('Most Common Handset Type')
```

In [338...]

```
tcp_retrans_per_handset
```

Out[338...]

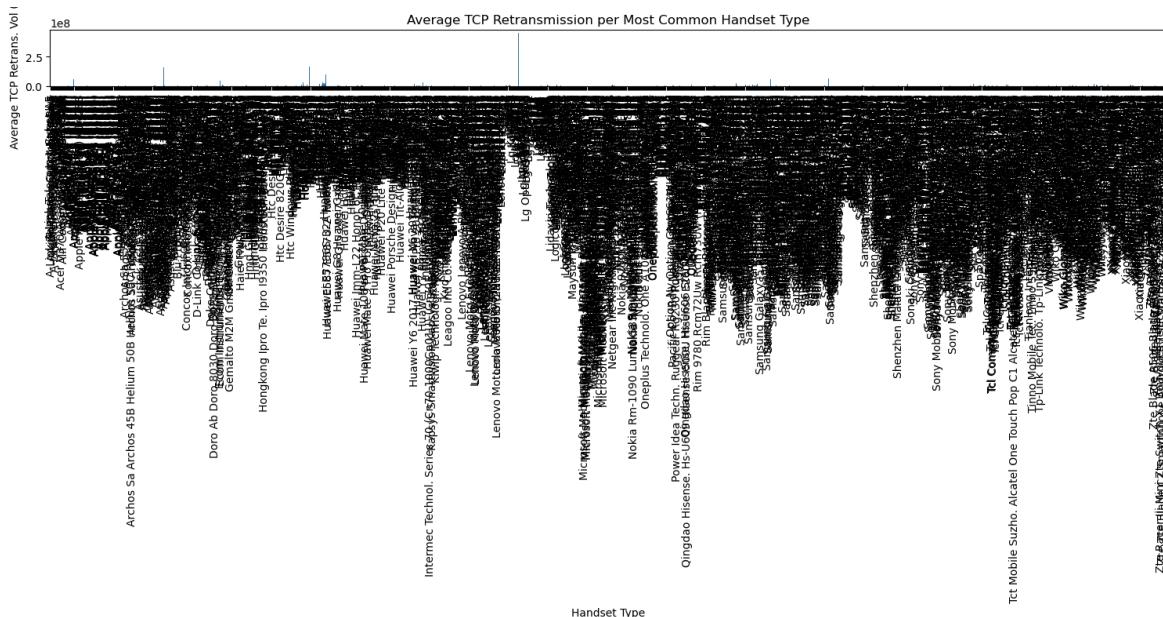
Most Common Handset Type Avg TCP Retrans. Vol (Bytes)

0	A-Link Telecom I. Cubot A5	2.948398e+05
1	A-Link Telecom I. Cubot Note Plus	3.081065e+05
2	A-Link Telecom I. Cubot Note S	2.070587e+07
3	A-Link Telecom I. Cubot Nova	6.858500e+04
4	A-Link Telecom I. Cubot Power	4.020500e+03
...
1392	Zte Zte Blade C2 Smartphone Android By Sfr Sta...	1.533222e+05
1393	Zyxel Communicat. Lte7460	2.063827e+07
1394	Zyxel Communicat. Sbg3600	2.674347e+07
1395	Zyxel Communicat. Zyxel Wah7706	1.053275e+04
1396	undefined	6.761174e+05

1397 rows × 2 columns

In [340...]

```
plt.figure(figsize=(15, 8))
sns.barplot(data=tcp_retrans_per_handset, x='Most Common Handset Type', y='Avg T
plt.xticks(rotation=90)
plt.title('Average TCP Retransmission per Most Common Handset Type')
plt.xlabel('Handset Type')
plt.ylabel('Average TCP Retrans. Vol (Bytes)')
plt.tight_layout()
plt.show()
```



In [342...]

```
throughput_per_handset_sorted = throughput_per_handset.sort_values(by='Avg Throu
```

In [344...]

```
throughput_per_handset_sorted
```

Out[344...]

	Most Common Handset Type	Avg Throughput (kbps)
321	Huawei B715S-23C	54933.4
706	New-Bund Technol. Mix 2	52605.5
575	Lg G6+	50067.5
1394	Zyxel Communicat. Sbg3600	48675.5
468	Huawei Y9 2019	45869.5
...
1006	Samsung Gt-S6310N	1.0
172	Concox Informati. Concox Gt06 Gt06N Tr06	1.0
804	Quectel Wireless. Quectel Ec25-E	0.5
1254	Wct Uno	0.0
589	Lg Lg-T385	0.0

321	Huawei B715S-23C	54933.4
706	New-Bund Technol. Mix 2	52605.5
575	Lg G6+	50067.5
1394	Zyxel Communicat. Sbg3600	48675.5
468	Huawei Y9 2019	45869.5
...
1006	Samsung Gt-S6310N	1.0
172	Concox Informati. Concox Gt06 Gt06N Tr06	1.0
804	Quectel Wireless. Quectel Ec25-E	0.5
1254	Wct Uno	0.0
589	Lg Lg-T385	0.0

1397 rows × 2 columns

In [346...]

tcp_retrans_per_handset_sorted = tcp_retrans_per_handset.sort_values(by='Avg TCP Retrans. Vol (Bytes)', ascending=False)

In [348...]

tcp_retrans_per_handset_sorted

Out[348...]

	Most Common Handset Type	Avg TCP Retrans. Vol (Bytes)
586	Lg Lg-H635	4.525316e+08
324	Huawei Bln-AI10	1.645873e+08
142	Asustek Asus Zenfone Selfie Zd551Kl	1.608292e+08
345	Huawei E5776S-32	9.939708e+07
974	Samsung Galaxy Tab S3 (Sm-T825)	6.341046e+07
...
761	Oppo A37F	1.188500e+03
551	Lenovo Moto X Play	9.085000e+02
233	Gotron (Hk) Elec. Armor X	7.500000e+02
917	Samsung Galaxy Note 8 (Sm-N9500)	2.090000e+02
166	Casper Bilgisaya. Via M1	1.800000e+02

586	Lg Lg-H635	4.525316e+08
324	Huawei Bln-AI10	1.645873e+08
142	Asustek Asus Zenfone Selfie Zd551Kl	1.608292e+08
345	Huawei E5776S-32	9.939708e+07
974	Samsung Galaxy Tab S3 (Sm-T825)	6.341046e+07
...
761	Oppo A37F	1.188500e+03
551	Lenovo Moto X Play	9.085000e+02
233	Gotron (Hk) Elec. Armor X	7.500000e+02
917	Samsung Galaxy Note 8 (Sm-N9500)	2.090000e+02
166	Casper Bilgisaya. Via M1	1.800000e+02

1397 rows × 2 columns

In [350...]

features = aggregated_dataset[['Avg TCP Retrans. Vol (Bytes)', 'Avg RTT (ms)', 'Avg Throughput (kbps)']]

In [352...]

features

Out[352...]

	Avg TCP Retrans. Vol (Bytes)	Avg RTT (ms)	Avg Throughput (kbps)
0	294839.75	25.0	1.00
1	294839.75	25.0	0.50
2	11823.25	151.5	54.50
3	13989.50	42.0	377.00
4	294839.75	46.0	40.25
...
107260	294839.75	25.0	7.50
107261	294839.75	25.0	7.50
107262	28997.75	23.5	439.00
107263	294839.75	25.0	1.00
107264	294839.75	29.0	3.50

107265 rows × 3 columns

In [354...]

```
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
```

In [356...]

```
scaler = StandardScaler()
features_scaled = scaler.fit_transform(features)
```

In [360...]

```
kmeans = KMeans(n_clusters=3, random_state=42)
aggregated_dataset['Cluster'] = kmeans.fit_predict(features_scaled)
```

In [362...]

```
cluster_centers = kmeans.cluster_centers_
cluster_centers = scaler.inverse_transform(cluster_centers)
```

In [364...]

```
cluster_summary = pd.DataFrame(cluster_centers, columns=['Avg TCP Retrans. Vol (Bytes)'])
cluster_summary['Cluster'] = range(3)
```

In [366...]

```
cluster_summary
```

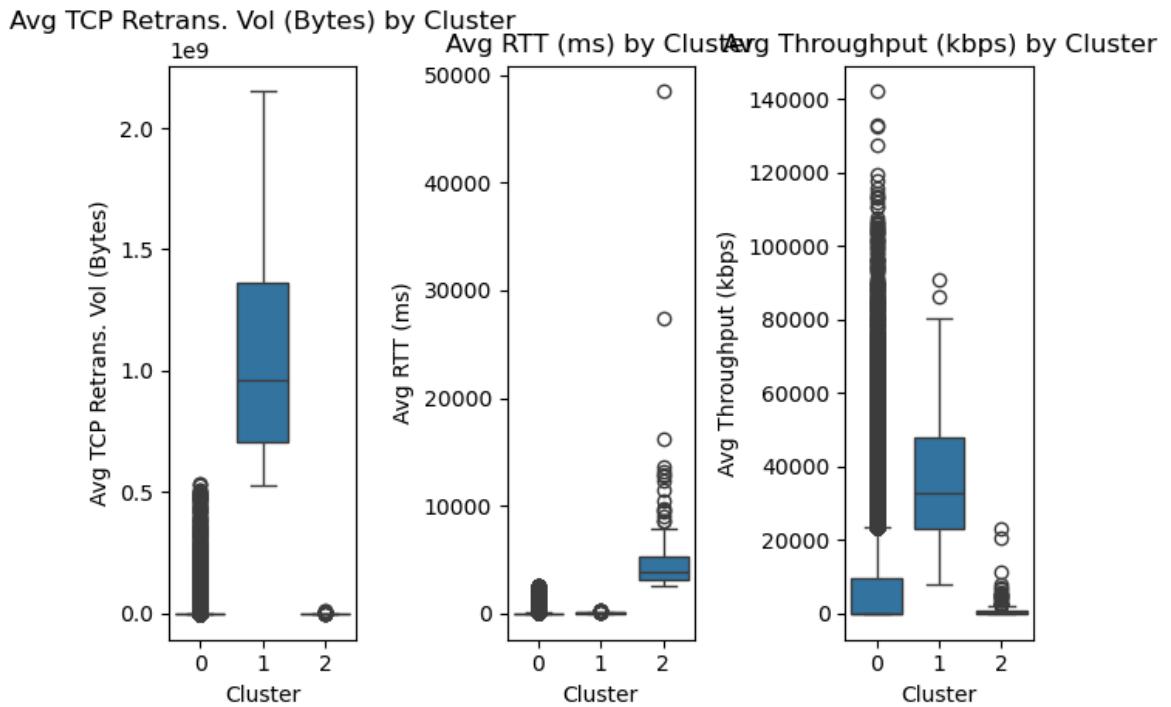
Out[366...]

	Avg TCP Retrans. Vol (Bytes)	Avg RTT (ms)	Avg Throughput (kbps)	Cluster
0	2.217323e+06	52.396962	6553.878919	0
1	1.073967e+09	71.431476	35644.455143	1
2	9.485174e+05	5142.496732	1248.575163	2

In [370...]

```
for i, col in enumerate(['Avg TCP Retrans. Vol (Bytes)', 'Avg RTT (ms)', 'Avg Throughput (kbps)']):
    plt.subplot(1, 3, i+1)
    sns.boxplot(x='Cluster', y=col, data=aggregated_dataset)
    plt.title(f'{col} by Cluster')

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



```
In [372...]: print(cluster_summary)
```

	Avg TCP Retrans. Vol (Bytes)	Avg RTT (ms)	Avg Throughput (kbps)	Cluster
0	2.217323e+06	52.396962	6553.878919	0
1	1.073967e+09	71.431476	35644.455143	1
2	9.485174e+05	5142.496732	1248.575163	2

```
In [374...]: for cluster in range(3):
    cluster_data = aggregated_dataset[aggregated_dataset['Cluster'] == cluster]
```

```
In [376...]: cluster_data
```

Out[376...]

		IMSI	Most Common Handset Type	Avg TCP Retrans. Vol (Bytes)	Avg RTT (ms)	Avg Throughput (kbps)	Cluster
389	2.082003e+14	Google Inc Pixel 3		7378306.50	8547.5	348.5	2
938	2.082003e+14	Samsung Galaxy Note 4 (Sm-N910X)		208948.00	3337.5	5095.0	2
2006	2.082003e+14	Apple iPhone 7 Plus (A1784)		1593178.50	4805.0	1059.5	2
2596	2.082003e+14	Apple iPhone 8 (A1905)		377900.50	6418.0	192.5	2
2663	2.082003e+14	Apple iPhone 6 (A1586)		36129.50	5440.5	99.5	2
...
100991	2.082021e+14	Huawei P20 Pro		294839.75	4215.5	54.0	2
101185	2.082021e+14	Samsung Galaxy A3 (Sm-A310X)		294839.75	3579.0	509.0	2
104600	2.082022e+14	Samsung Galaxy A3 (Sm-A310X)		289686.25	9409.0	128.0	2
105573	2.082099e+14	Samsung Galaxy A6 (Sm-A605Fn)		3439329.00	2979.5	446.0	2
107229	2.082099e+14	Apple iPhone X (A1901)		114856.50	2989.5	192.0	2

153 rows × 6 columns

In [394...]

cluster_summary.to_csv(r"D:\Next hike 5-project-March-25\cluster_summary.csv", index=False)

In [380...]

Task-4_Satisfaction Analysis

In [451...]

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
from scipy.spatial.distance import cdist
warnings.filterwarnings("ignore")
```

In []:

In [443... dataset

Out[443...]

		Bearer_Id	Start	Start_ms	End	End_ms	Dur. (ms)	IMSI	MSISDN/I
0	1.311450e+19		2019-04-04 12:01:18	770	2019-04-25 14:35:31	662	1823652	2.082010e+14	3.3664
1	1.311450e+19		2019-04-09 13:04:04	235	2019-04-25 08:15:48	606	1365104	2.082020e+14	3.3681
2	1.311450e+19		2019-04-09 17:42:11	1	2019-04-25 11:58:13	652	1361762	2.082000e+14	3.3760
3	1.311450e+19		2019-04-10 00:31:25	486	2019-04-25 07:36:35	171	1321509	2.082010e+14	3.3750
4	1.311450e+19		2019-04-12 20:10:23	565	2019-04-25 10:40:32	954	1089009	2.082010e+14	3.3699
...
149996	7.277830e+18		2019-04-29 07:28:42	451	2019-04-30 06:02:33	214	81230	2.082020e+14	3.3650
149997	7.349880e+18		2019-04-29 07:28:42	483	2019-04-30 10:41:33	187	97970	2.082020e+14	3.3663
149998	1.311450e+19		2019-04-29 07:28:43	283	2019-04-30 10:46:12	810	98249	2.082020e+14	3.3621
149999	1.311450e+19		2019-04-29 07:28:43	696	2019-04-30 10:40:34	327	97910	2.082020e+14	3.3619
150000		Nan	2019-04-29 07:08:38	499	2019-04-25 00:01:32	500	86399	2.082020e+14	3.3663

150001 rows × 70 columns



In [445... dataset.shape

Out[445... (150001, 70)

In [454... dataset['Avg TCP Retrans. Vol (Bytes)'] = (dataset['TCP DL Retrans. Vol (Bytes)'
dataset['TCP UL Retrans. Vol (Bytes)']) /

In [458... dataset['Avg TCP Retrans. Vol (Bytes)']

```

Out[458...]: 0    294839.75
              1    294839.75
              2    294839.75
              3    294839.75
              4    294839.75
              ...
              149996 294839.75
              149997 294839.75
              149998 294839.75
              149999 294839.75
              150000 294839.75
Name: Avg TCP Retrans. Vol (Bytes), Length: 150001, dtype: float64

In [460...]: dataset['Avg RTT (ms)'] = (dataset['Avg RTT DL (ms)'] + dataset['Avg RTT UL (ms)'])

In [462...]: dataset['Avg RTT (ms)']

Out[462...]: 0    23.5
              1    35.0
              2    25.0
              3    25.0
              4    25.0
              ...
              149996 16.0
              149997 14.5
              149998 24.5
              149999 21.0
              150000 25.0
Name: Avg RTT (ms), Length: 150001, dtype: float64

In [464...]: dataset['Avg Throughput (kbps)'] = (dataset['Avg Bearer TP DL (kbps)'] + dataset['Avg Bearer TP UL (kbps)'])

In [466...]: dataset['Avg Throughput (kbps)']

Out[466...]: 0    33.5
              1    21.0
              2    7.5
              3    44.0
              4    7.5
              ...
              149996 58.5
              149997 38.5
              149998 45.0
              149999 35.5
              150000 63.0
Name: Avg Throughput (kbps), Length: 150001, dtype: float64

In [468...]: features = dataset[['Avg TCP Retrans. Vol (Bytes)', 'Avg RTT (ms)', 'Avg Throughput (kbps)']]

In [470...]: # Standardize the data
            scaler = StandardScaler()
            features_scaled = scaler.fit_transform(features)

In [472...]: kmeans_engagement = KMeans(n_clusters=3, random_state=42)
            engagement_clusters = kmeans_engagement.fit_predict(features_scaled)
            dataset['Engagement Cluster'] = engagement_clusters

```

```
In [474...]: kmeans_experience = KMeans(n_clusters=3, random_state=42)
experience_clusters = kmeans_experience.fit_predict(features_scaled)
dataset['Experience Cluster'] = experience_clusters
```

```
In [476...]: less_engaged_centroid = kmeans_engagement.cluster_centers_[0]
dataset['Engagement Score'] = cdist(features_scaled, [less_engaged_centroid], metric='euclidean')[..., 0]
```

```
In [478...]: dataset['Engagement Score']
```

```
Out[478...]: 0      0.195454
1      0.174413
2      0.193815
3      0.191628
4      0.193815
...
149996 0.211362
149997 0.216120
149998 0.192628
149999 0.200868
150000 0.190495
Name: Engagement Score, Length: 150001, dtype: float64
```

```
In [480...]: worst_experience_centroid = kmeans_experience.cluster_centers_[2]
dataset['Experience Score'] = cdist(features_scaled, [worst_experience_centroid], metric='euclidean')[..., 0]
```

```
In [482...]: dataset['Experience Score']
```

```
Out[482...]: 0      2.318006
1      2.317472
2      2.319707
3      2.316994
4      2.319707
...
149996 2.317487
149997 2.319277
149998 2.316996
149999 2.318270
150000 2.315582
Name: Experience Score, Length: 150001, dtype: float64
```

```
In [486...]: dataset['Satisfaction Score'] = (dataset['Engagement Score'] + dataset['Experience Score']) / 2
```

```
In [488...]: dataset['Satisfaction Score']
```

```
Out[488...]: 0      1.256730
1      1.245942
2      1.256761
3      1.254311
4      1.256761
...
149996 1.264425
149997 1.267698
149998 1.254812
149999 1.259569
150000 1.253039
Name: Satisfaction Score, Length: 150001, dtype: float64
```

```
In [490...]: top_10_satisfied_customers = dataset.nsmallest(10, 'Satisfaction Score')
```

```
In [492...]: print(top_10_satisfied_customers[['Engagement Score', 'Experience Score', 'Satisfaction Score']])

Engagement Score  Experience Score  Satisfaction Score
3803              0.645366          1.515799          1.080582
117910             0.619941          1.541225          1.080583
137193             1.447365          0.713802          1.080583
77992              0.730120          1.431047          1.080583
76783              0.769380          1.391790          1.080585
24001              0.430901          1.730271          1.080586
1172               0.695187          1.465986          1.080587
2379               0.428509          1.732667          1.080588
77526              0.654626          1.506552          1.080589
112497             0.626012          1.535168          1.080590
```

```
In [494...]: from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score
```

```
In [498...]: # Prepare the features and target
X = np.asarray(dataset[['Avg TCP Retrans. Vol (Bytes)', 'Avg RTT (ms)', 'Avg Jitter (ms)']])
y = np.asarray(dataset['Satisfaction Score'])
```

```
In [500...]: X.shape, y.shape
```

```
Out[500...]: ((150001, 3), (150001,))
```

```
In [502...]: # Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

```
In [504...]: model = LinearRegression()
model.fit(X_train, y_train)
y_pred = model.predict(X_test)
```

```
In [506...]: r2_score_ = r2_score(y_test, y_pred)
```

```
In [508...]: r2_score_
```

```
Out[508...]: 0.9268559732925541
```

```
In [510...]: mae = mean_absolute_error(y_test, y_pred)
mse = mean_squared_error(y_test, y_pred)
rmse = np.sqrt(mse)
```

```
In [512...]: mae, mse, rmse
```

```
Out[512...]: (0.24507451149179818, 0.13479988403755677, 0.3671510370917625)
```

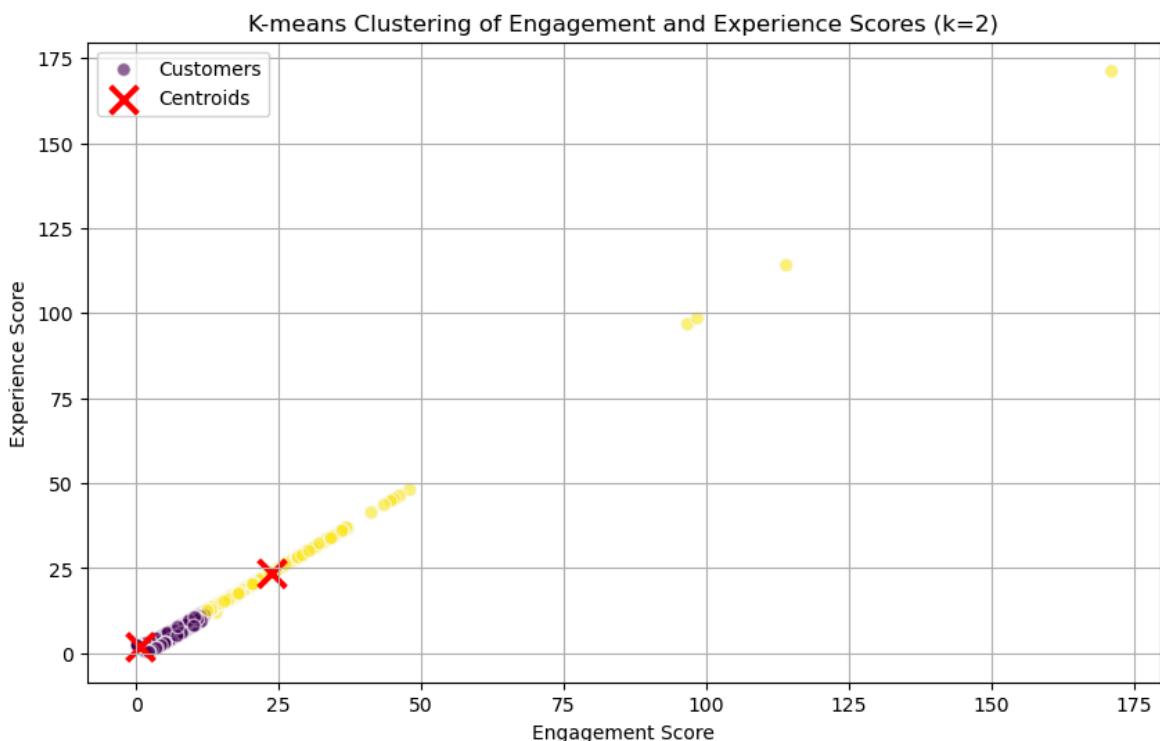
```
In [514...]: import pickle
pickle.dump(model, open('regression_model.pkl', 'wb'))
print(type(model))

<class 'sklearn.linear_model._base.LinearRegression'>
```

```
In [518...]: scores = dataset[['Engagement Score', 'Experience Score']]
```

```
In [520...]: kmeans = KMeans(n_clusters=2, random_state=42)
dataset['Score Cluster'] = kmeans.fit_predict(scores)
```

```
In [522...]: centroids = kmeans.cluster_centers_
In [524...]: centroids
Out[524...]: array([[ 0.68909856,  1.95593978],
   [23.70481548, 23.53889333]])
In [526...]: plt.figure(figsize=(10, 6))
plt.scatter(dataset['Engagement Score'], dataset['Experience Score'], c=dataset['Score Cluster'])
plt.scatter(centroids[:, 0], centroids[:, 1], c='red', marker='x', s=200, linewidths=2)
plt.title('K-means Clustering of Engagement and Experience Scores (k=2)')
plt.xlabel('Engagement Score')
plt.ylabel('Experience Score')
plt.legend()
plt.grid(True)
plt.show()
```



```
In [528...]: print(pd.DataFrame(centroids, columns=['Engagement Score', 'Experience Score']))
Engagement Score    Experience Score
0                 0.689099           1.955940
1                23.704815          23.538893
In [530...]: dataset['Satisfaction Score'] = (dataset['Engagement Score'] + dataset['Experience Score']) / 2
In [532...]: cluster_aggregation = dataset.groupby('Score Cluster').agg({
    'Satisfaction Score': 'mean',
    'Experience Score': 'mean'
}).reset_index()
In [534...]: cluster_aggregation
```

Out[534...]

	Score Cluster	Satisfaction Score	Experience Score
0	0	1.322519	1.955940
1	1	23.621854	23.538893

In [536...]

```
Mysql_Data=pd.DataFrame(dataset,columns=['Bearer_Id','Engagement Score', 'Experience Score', 'Satisfaction Score'])
```

In [538...]

```
Mysql_Data.sample(5)
```

Out[538...]

	Bearer_Id	Engagement Score	Experience Score	Satisfaction Score
67125	7.349880e+18	0.216782	2.318564	1.267673
60441	1.311450e+19	0.219476	2.319036	1.269256
64360	7.349880e+18	0.214273	2.318320	1.266296
82824	7.277830e+18	1.666827	0.509413	1.088120
14806	7.277830e+18	0.351925	1.844090	1.098007

In [540...]

```
Mysql_Data.isnull().sum()
```

Out[540...]

Bearer_Id	991
Engagement Score	0
Experience Score	0
Satisfaction Score	0
dtype: int64	

In [550...]

```
pip install mysql-connector-python
```

Collecting mysql-connector-python

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----- 11.7/16.1 MB 337.9 kB/s eta 0:00:13
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```

```
----- 11.8/16.1 MB 338.9 kB/s eta 0:00:13
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```



```
-- 15.6/16.1 MB 494.9 kB/s eta 0:00:02
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-- 15.6/16.1 MB 518.0 kB/s eta 0:00:01
-- 15.7/16.1 MB 516.7 kB/s eta 0:00:01
-- 15.7/16.1 MB 515.5 kB/s eta 0:00:01
-- 15.8/16.1 MB 515.1 kB/s eta 0:00:01
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-- 16.1/16.1 MB 546.5 kB/s eta 0:00:01
-- 16.1/16.1 MB 548.3 kB/s eta 0:00:00
```

Installing collected packages: mysql-connector-python

Successfully installed mysql-connector-python-9.2.0

Note: you may need to restart the kernel to use updated packages.

In [552...]

```
import mysql.connector
print("MySQL Connector is installed and working!")
```

MySQL Connector is installed and working!

In [559...]

```
pip install pymysql
```

Collecting pymysql
Note: you may need to restart the kernel to use updated package s.

```
Downloading PyMySQL-1.1.1-py3-none-any.whl.metadata (4.4 kB)
Downloading PyMySQL-1.1.1-py3-none-any.whl (44 kB)
```

```
-- 0/45.0 kB ? eta -:::-:
-- 10.2/45.0 kB ? eta -:::-:
-- 30.7/45.0 kB 330.3 kB/s eta 0:00:01
-- 45.0/45.0 kB 373.5 kB/s eta 0:00:00
```

Installing collected packages: pymysql

Successfully installed pymysql-1.1.1

In [561...]

```
import pymysql
print("PyMySQL is installed and working!")
```

PyMySQL is installed and working!

In [565...]

```
from pandas.io import sql
import mysql.connector
import pymysql
from sqlalchemy import create_engine
```

In [569...]

```
# Database credentials and connection
db_username = 'root'
db_password = 'root'
db_host = 'localhost'
db_port = 3306
db_name = 'telecome_project'
```

In [571...]

```
engine = create_engine(f"mysql+mysqlconnector://{{db_username}}:{{db_password}}@{{db_}}
```

In []: Mysql_Data.to_sql(name='final_telecomm_table', con=engine, if_exists='replace',

In []: 150001

In []:

```
query = "SELECT * FROM final_telecomm_table LIMIT 10;"  
data_from_db = pd.read_sql(query, con=engine)  
print(data_from_db)
```

In []:

	Bearer_Id	Engagement Score	Experience Score	\
0	13114483460844900352	0.196168	22.346687	
1	13114483482878900224	0.175220	22.346503	
2	13114483484080500736	0.194544	22.346875	
3	13114483485442799616	0.192352	22.346551	
4	13114483499480700928	0.194544	22.346875	
5	13114483499779198976	0.191277	22.346391	
6	13114483501243799552	0.156342	22.346103	
7	13042425910865399808	0.102993	22.333657	
8	13114483506432499712	0.192143	22.346520	
9	13042425914669299712	0.083317	22.297112	

	Satisfaction Score
0	11.271427
1	11.260862
2	11.270709
3	11.269452
4	11.270709
5	11.268834
6	11.251222
7	11.218325
8	11.269331
9	11.190215

In [7]: `Mysql_Data.to_csv(r"D:\Next hike 5-project-March-25\Final_Data.csv", index=False)`

In []: