Mobile App User Engagement Project

In [8]:
```python
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px

df = pd.read_csv("Mobile App User Engagement.csv")
```

In [9]:
```python
# Display the first few rows to verify
print(df.head())
```

```
     User ID  Gender  Age Country Device Type  App Version  Sessions Per Day  \
0  User_1208    Male   43  Canada         iOS          2.0                 8
1  User_1102  Female   40   India     Android          2.1                 9
2  User_2594  Female   29   India     Android          1.1                14
3  User_1092  Female   27  Canada     Android          1.2                 6
4  User_2735   Other   14  Brazil     Android          2.1                 6

   Avg Session Duration Min  Screens Viewed  Push Notifications Clicked  \
0                     22.22              32                           5
1                     45.20              39                           7
2                     37.68              20                           0
3                     42.25              16                           8
4                     39.01              11                           8

   In App Purchases Subscription Status  Churn Risk Score Last Login Date  \
0                 2                Free              0.73       2/14/2023
1                 2               Trial              0.62        9/2/2024
2                 1               Trial              0.01       9/12/2024
3                 4             Premium              0.61       7/12/2023
4                 2                Free              0.51       2/27/2023

   User Rating
0          4.1
1          2.5
2          2.1
3          2.6
4          3.8
```

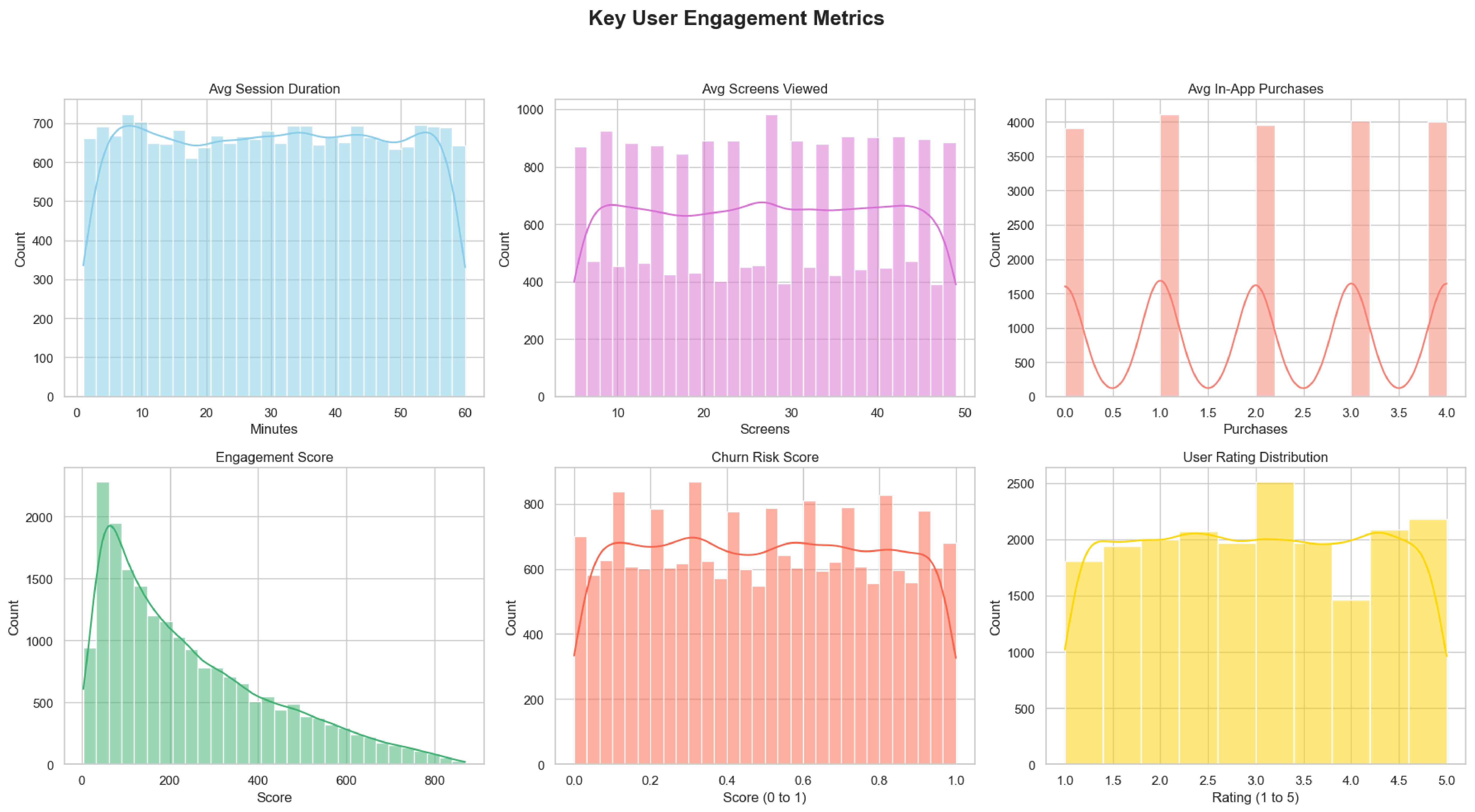
In [11]:
```python
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 20000 entries, 0 to 19999
Data columns (total 15 columns):
 #   Column                     Non-Null Count  Dtype  
---  ------                     --------------  -----  
 0   User ID                    20000 non-null  object 
 1   Gender                     20000 non-null  object 
 2   Age                        20000 non-null  int64  
 3   Country                    20000 non-null  object 
 4   Device Type                20000 non-null  object 
 5   App Version                20000 non-null  float64
 6   Sessions Per Day           20000 non-null  int64  
 7   Avg Session Duration Min   20000 non-null  float64
 8   Screens Viewed             20000 non-null  int64  
 9   Push Notifications Clicked  20000 non-null  int64  
 10  In App Purchases           20000 non-null  int64  
 11  Subscription Status        20000 non-null  object 
 12  Churn Risk Score           20000 non-null  float64
 13  Last Login Date            20000 non-null  object 
 14  User Rating                20000 non-null  float64
dtypes: float64(4), int64(5), object(6)
memory usage: 2.3+ MB
```

Key Metrics:

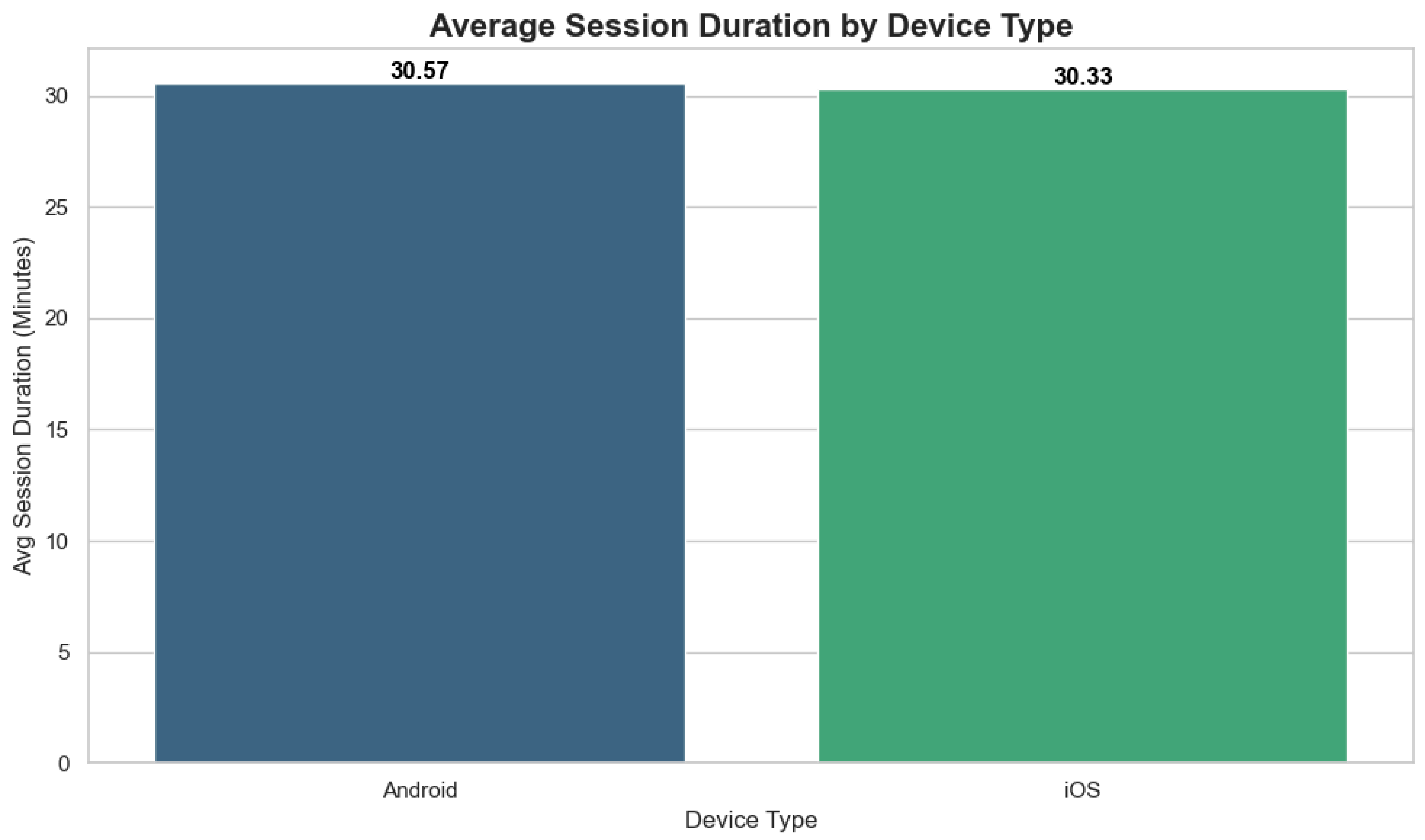
In [40]:
```python
# Visualize Key Metrics: Avg Session Duration, Avg Screens Viewed, Avg In-App Purchases, Engagement Score, Churn Risk Score, User Rating Distribution

# Create Engagement Score
df['Engagement Score'] = (
    df['Sessions Per Day'] * df['Avg Session Duration Min'] +
    df['Screens Viewed'] * 0.5 +
    df['In App Purchases'] * 2
)

# Seaborn style
sns.set(style="whitegrid")

# Set up a 2x3 grid for subplots
fig, axes = plt.subplots(2, 3, figsize=(18, 10))
fig.suptitle('Key User Engagement Metrics', fontsize=18, weight='bold')

# 1. Avg Session Duration
sns.histplot(df['Avg Session Duration Min'], bins=30, ax=axes[0, 0], color='skyblue', kde=True)
axes[0, 0].set_title('Avg Session Duration')
axes[0, 0].set_xlabel('Minutes')

# 2. Screens Viewed
sns.histplot(df['Screens Viewed'], bins=30, ax=axes[0, 1], color='orchid', kde=True)
axes[0, 1].set_title('Avg Screens Viewed')
axes[0, 1].set_xlabel('Screens')

# 3. In-App Purchases
sns.histplot(df['In App Purchases'], bins=20, ax=axes[0, 2], color='salmon', kde=True)
axes[0, 2].set_title('Avg In-App Purchases')
axes[0, 2].set_xlabel('Purchases')

# 4. Engagement Score
sns.histplot(df['Engagement Score'], bins=30, ax=axes[1, 0], color='mediumseagreen', kde=True)
axes[1, 0].set_title('Engagement Score')
```

```python
axes[1, 0].set_xlabel('Score')

# 5. Churn Risk Score
sns.histplot(df['Churn Risk Score'], bins=30, ax=axes[1, 1], color='tomato', kde=True)
axes[1, 1].set_title('Churn Risk Score')
axes[1, 1].set_xlabel('Score (0 to 1)')

# 6. User Rating
sns.histplot(df['User Rating'], bins=10, ax=axes[1, 2], color='gold', kde=True)
axes[1, 2].set_title('User Rating Distribution')
axes[1, 2].set_xlabel('Rating (1 to 5)')

# Tight layout and save
plt.tight_layout(rect=[0, 0, 1, 0.95])
plt.savefig("Key_User_Metrics_Dashboard.png", dpi=300)
plt.show() #Save the Figure
```



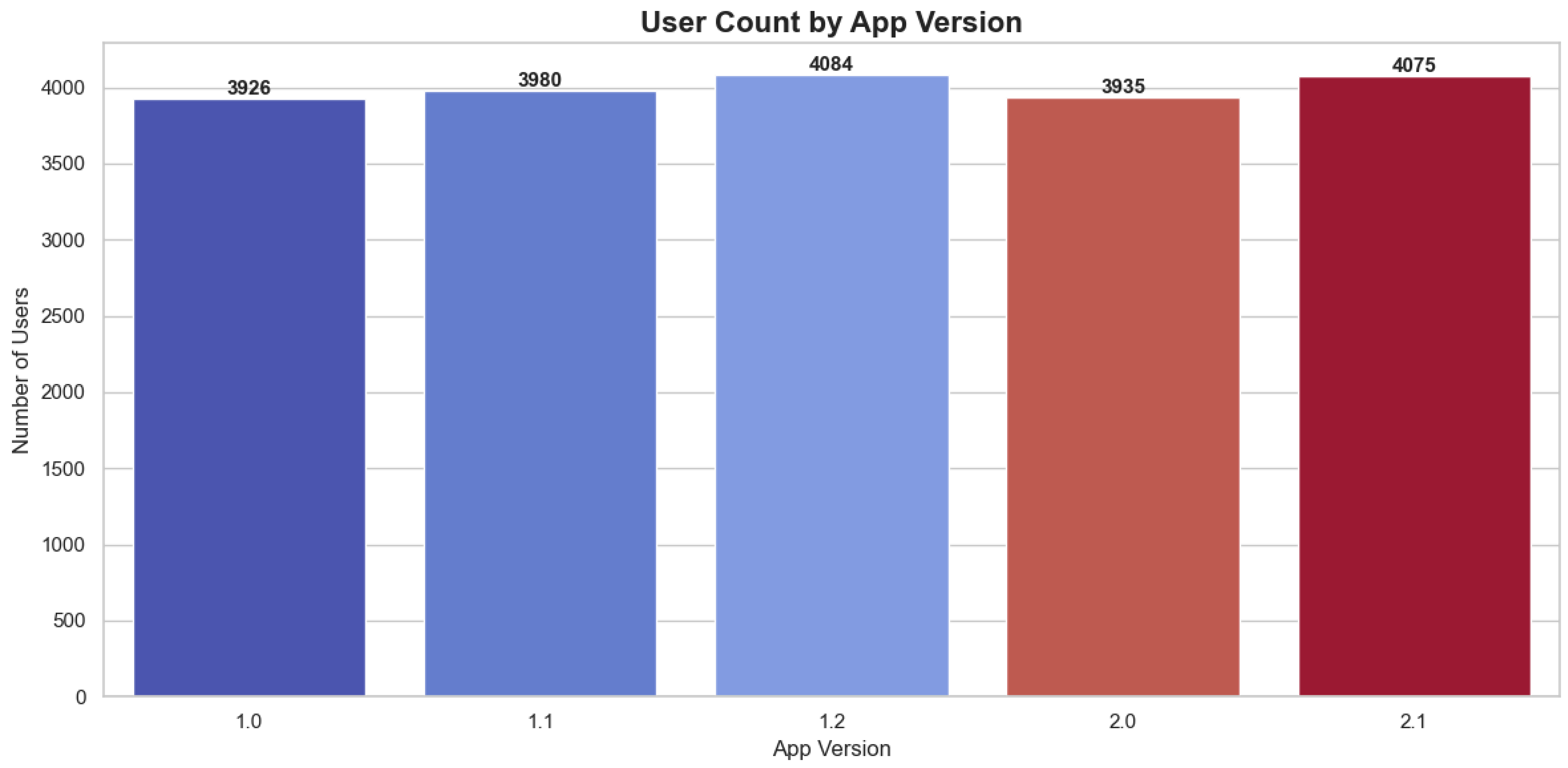
Average Session Duration by Device Type

In [20]:
```
# 1. What is the average session duration by device type?

# Group and calculate average session duration
avg_duration_by_device = df.groupby('Device Type')['Avg Session Duration Min'].mean().reset_index()

# Seaborn style
sns.set(style="whitegrid")

# Plotting with updated hue usage
plt.figure(figsize=(10, 6))
barplot = sns.barplot(
    data=avg_duration_by_device,
    x='Device Type',
    y='Avg Session Duration Min',
    hue='Device Type',  # Added to comply with future version
    palette='viridis',
    legend=False         # Prevents duplicate legend
)

# Add value annotations
for p in barplot.patches:
    barplot.annotate(f"{p.get_height():.2f}",
                     (p.get_x() + p.get_width() / 2., p.get_height()),
                     ha='center', va='bottom', fontsize=12, color='black', weight='bold')

# Titles and axis labels
plt.title('Average Session Duration by Device Type', fontsize=16, weight='bold')
plt.xlabel('Device Type', fontsize=12)
plt.ylabel('Avg Session Duration (Minutes)', fontsize=12)
plt.tight_layout()

# Save to a valid path
plt.savefig("Avg_Session_Duration_by_Device_Type.png", dpi=300)
plt.show() # Show the Figure
```



User Distribution Across App Versions: Who’s Using What?

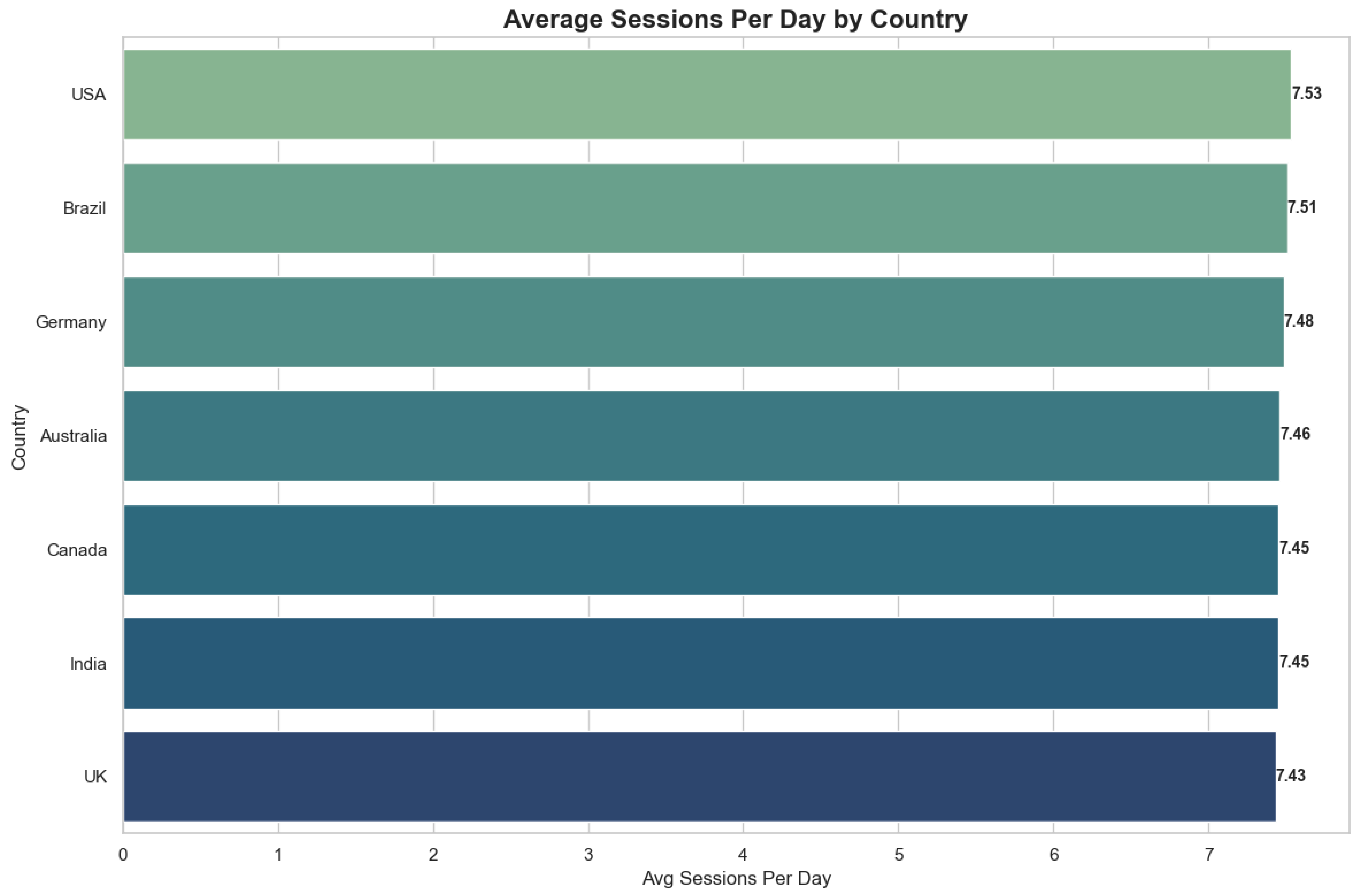
In [21]:
```python
# 2. How many users use each app version?

# Count number of users for each app version
app_version_counts = df['App Version'].value_counts().reset_index()
app_version_counts.columns = ['App Version', 'User Count']
app_version_counts = app_version_counts.sort_values('App Version')

# Seaborn style
sns.set(style="whitegrid")

# Plotting
plt.figure(figsize=(12, 6))
barplot = sns.barplot(
    data=app_version_counts,
    x='App Version',
    y='User Count',
    hue='App Version',          # Added to prevent warning
    palette='coolwarm',
    legend=False
)

# Add value labels
for p in barplot.patches:
    barplot.annotate(f"{int(p.get_height())}",
                     (p.get_x() + p.get_width() / 2., p.get_height()),
                     ha='center', va='bottom', fontsize=11, weight='bold')

# Titles and labels
plt.title('User Count by App Version', fontsize=16, weight='bold')
plt.xlabel('App Version', fontsize=12)
plt.ylabel('Number of Users', fontsize=12)
plt.tight_layout()

# Save the chart
plt.savefig("User_Count_by_App_Version.png", dpi=300)
plt.show() # Show the Chart
```



Country-wise User Engagement: Who’s Most Active Per Day?

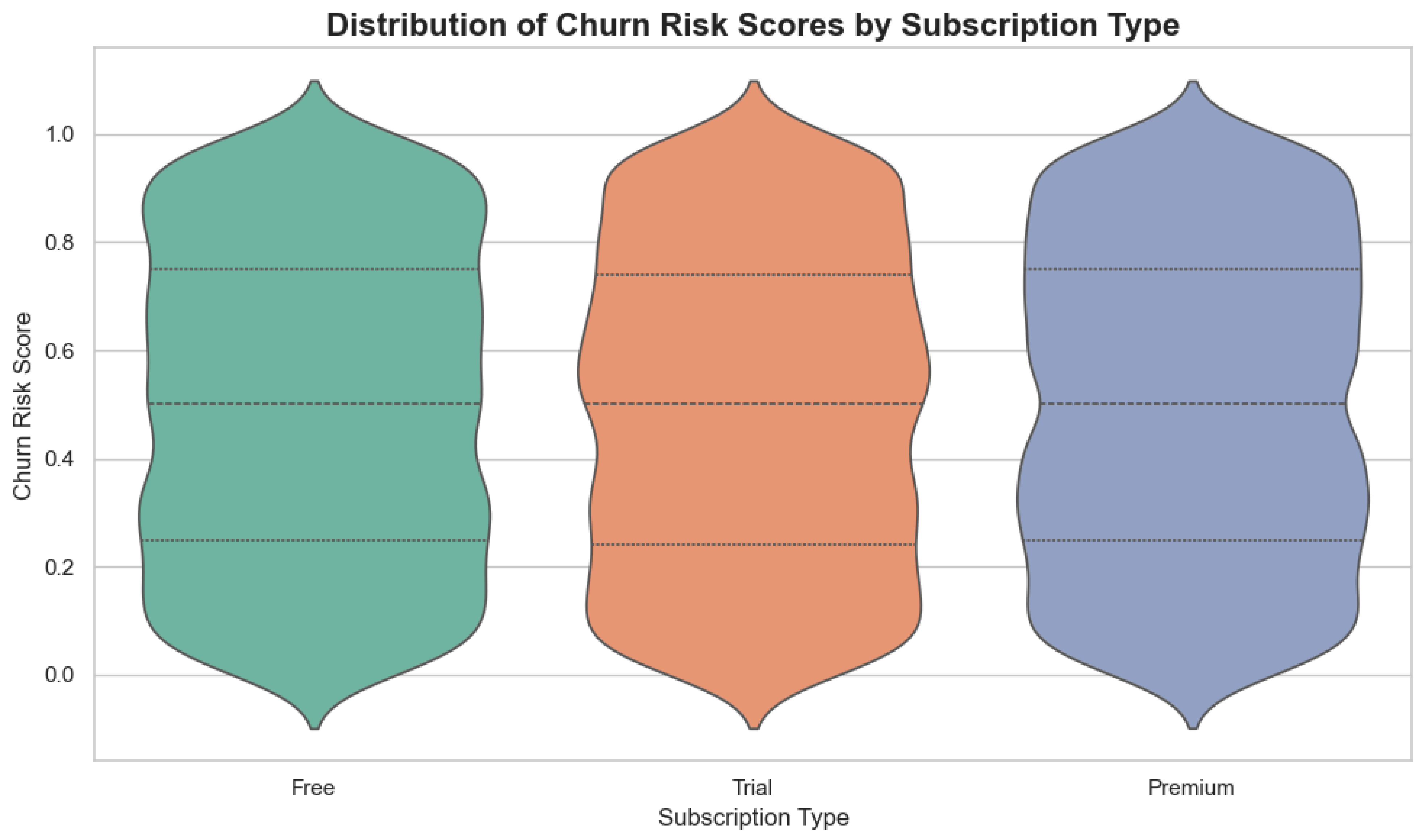
In [22]:
```python
# 3. Which countries have the highest and lowest user engagement (in terms of sessions per day)?

# Group by country and calculate average sessions per day
country_engagement = df.groupby('Country')['Sessions Per Day'].mean().reset_index()
country_engagement = country_engagement.sort_values('Sessions Per Day', ascending=False)

# Seaborn style
sns.set(style="whitegrid")

# Plotting horizontal bar chart
plt.figure(figsize=(12, 8))
barplot = sns.barplot(
    data=country_engagement,
    y='Country',
    x='Sessions Per Day',
    palette='crest',
    hue='Country',     # Avoid deprecation warning
    legend=False
)

# Annotate values
```

```python
for p in barplot.patches:
    barplot.annotate(f"{p.get_width():.2f}",
                     (p.get_width(), p.get_y() + p.get_height() / 2.0),
                     ha='left', va='center', fontsize=10, weight='bold')

# Titles and labels
plt.title('Average Sessions Per Day by Country', fontsize=16, weight='bold')
plt.xlabel('Avg Sessions Per Day', fontsize=12)
plt.ylabel('Country', fontsize=12)
plt.tight_layout()

# Save the plot
plt.savefig("Country_User_Engagement_Sessions_Per_Day.png", dpi=300)
plt.show() # Show the Figure
```



Churn Risk Distribution by Subscription Type: Who's at Risk?

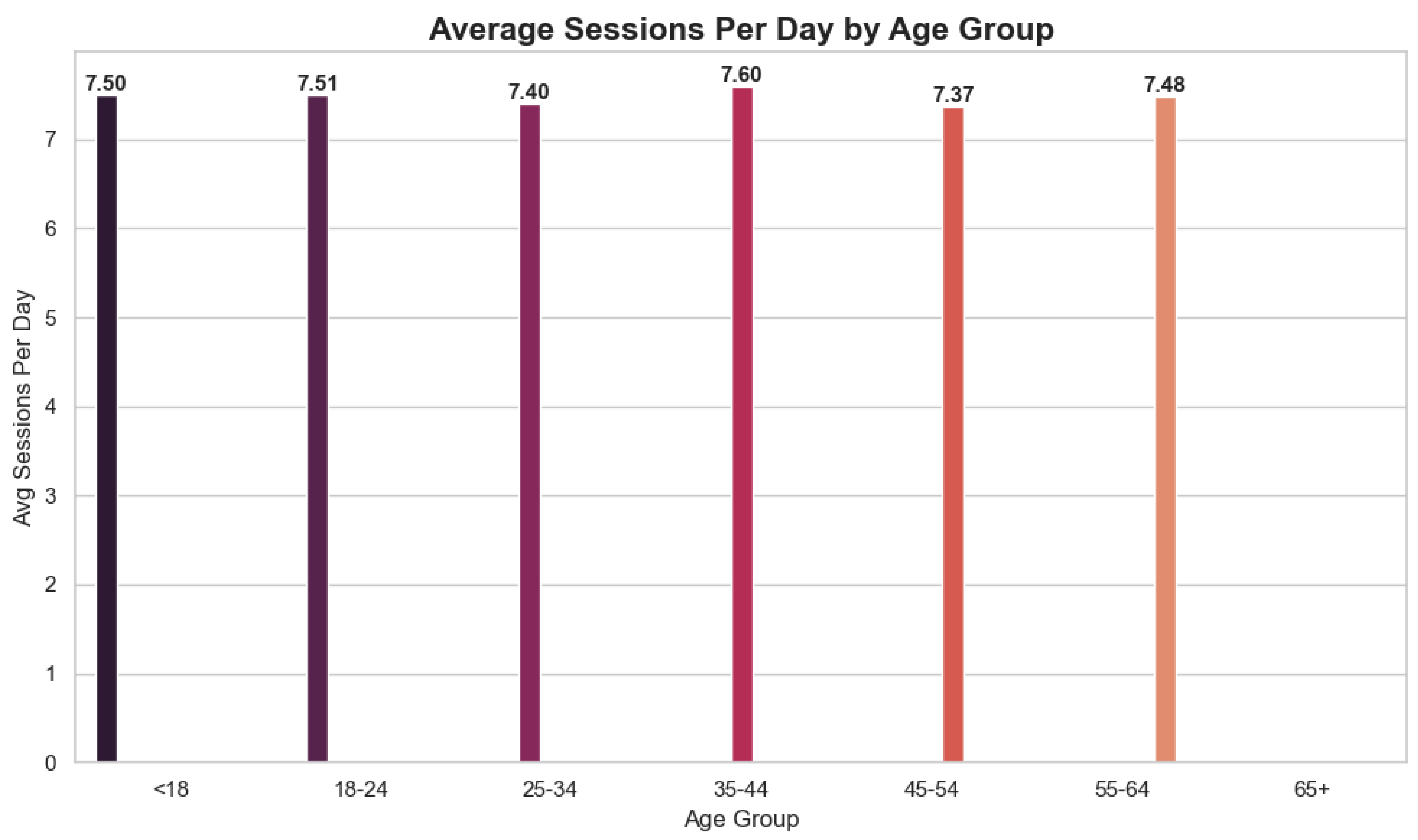
In [27]:
```
# 4. Distribution of churn risk scores across subscription types:

# Seaborn style
sns.set(style="whitegrid")

# Plotting violin plot with explicit hue to avoid future warnings
plt.figure(figsize=(10, 6))
violin = sns.violinplot(
    data=df,
    x='Subscription Status',
    y='Churn Risk Score',
    hue='Subscription Status',   # Explicitly assigning hue
    palette='Set2',
    inner='quartile',
    legend=False                 # Disabling duplicate legend
)

# Titles and labels
plt.title('Distribution of Churn Risk Scores by Subscription Type', fontsize=16, weight='bold')
plt.xlabel('Subscription Type', fontsize=12)
plt.ylabel('Churn Risk Score', fontsize=12)
plt.tight_layout()

# Save the chart
plt.savefig("Churn_Risk_Distribution_by_Subscription_Type.png", dpi=300)
plt.show() # Show the Figure
```



User Engagement by Age Group: Who's Most Active?

In [30]:
```
# 5. How does user activity vary with age group?

# Create Age Groups
```

```
age_bins = [0, 17, 24, 34, 44, 54, 64, 100]
age_labels = ['<18', '18-24', '25-34', '35-44', '45-54', '55-64', '65+']
df['Age Group'] = pd.cut(df['Age'], bins=age_bins, labels=age_labels)

# Group by Age Group and calculate average sessions per day
activity_by_age = df.groupby('Age Group', observed=True)['Sessions Per Day'].mean().reset_index()

# Plotting
sns.set(style="whitegrid")
plt.figure(figsize=(10, 6))
barplot = sns.barplot(
    data=activity_by_age,
    x='Age Group',
    y='Sessions Per Day',
    hue='Age Group',
    palette='rocket',
    legend=False
)

# Add value labels
for p in barplot.patches:
    barplot.annotate(f"{p.get_height():.2f}",
                     (p.get_x() + p.get_width() / 2., p.get_height()),
                     ha='center', va='bottom', fontsize=11, weight='bold')

# Titles and labels
plt.title('Average Sessions Per Day by Age Group', fontsize=16, weight='bold')
plt.xlabel('Age Group', fontsize=12)
plt.ylabel('Avg Sessions Per Day', fontsize=12)
plt.tight_layout()

# Save plot
plt.savefig("User_Activity_by_Age_Group.png", dpi=300)
plt.show() #Show the Figure
```

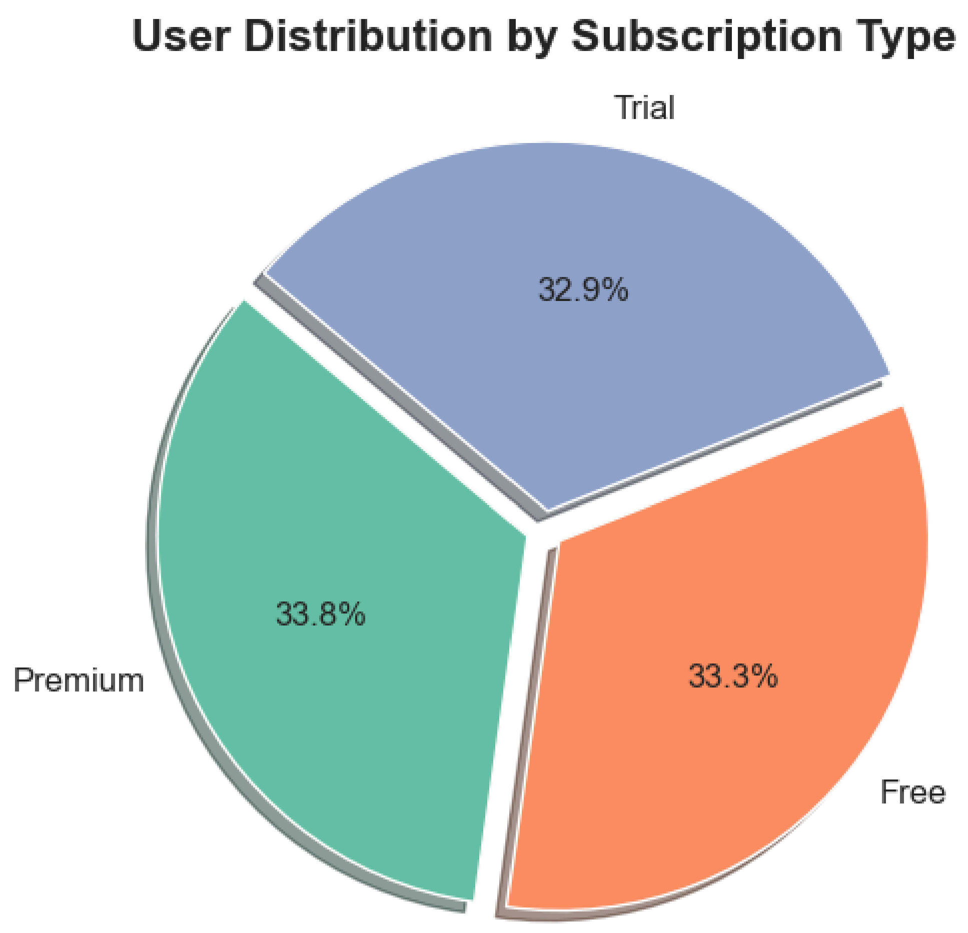


User Subscription Breakdown: Free vs Trial vs Premium

In [32]:

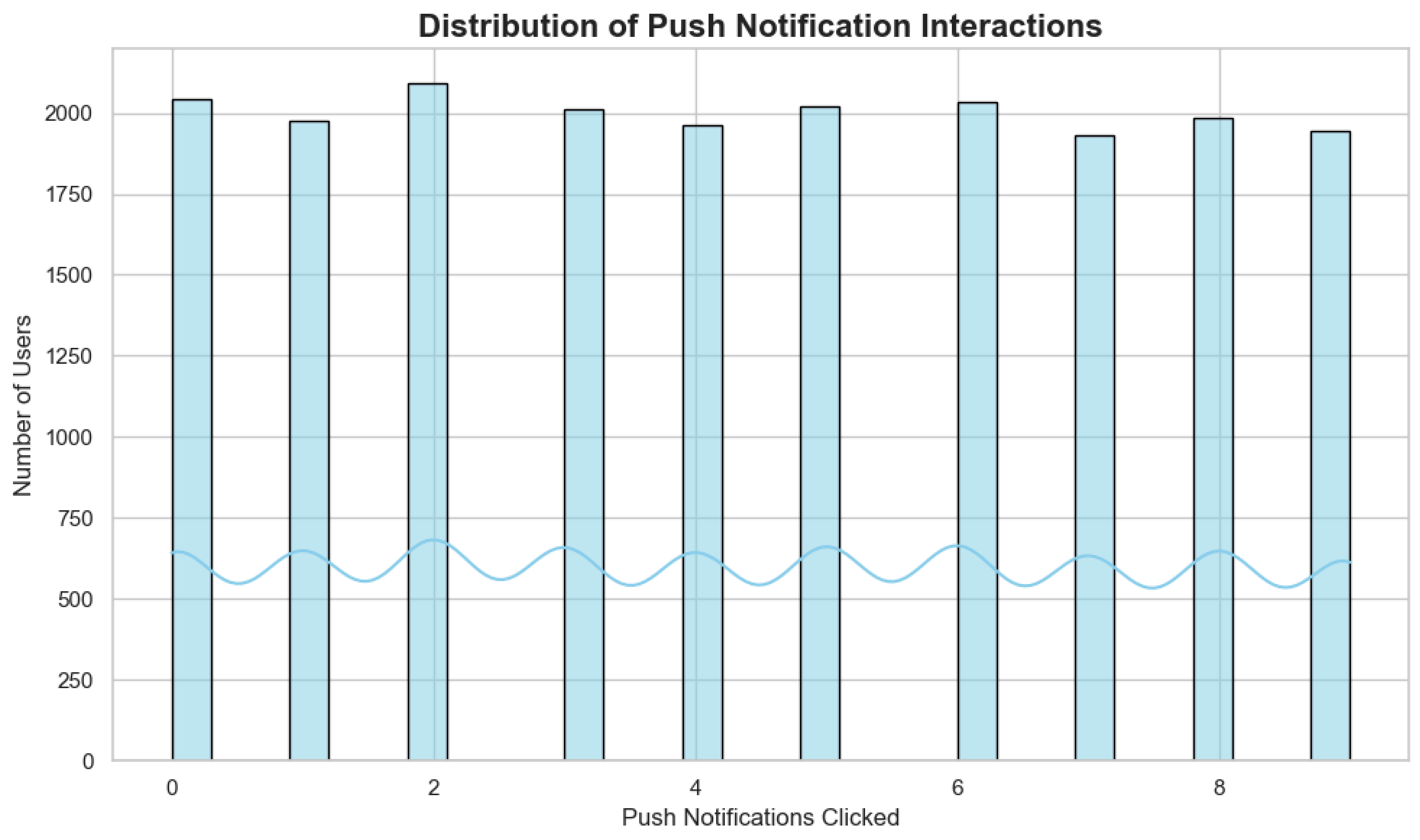
```
# 6. What percentage of users are on Free, Trial, and Premium?

# Count users by Subscription Status
subscription_counts = df['Subscription Status'].value_counts(normalize=True) * 100
subscription_counts = subscription_counts.round(2)

# Plotting
plt.figure(figsize=(8, 6))
colors = ['#66c2a5', '#fc8d62', '#8da0cb']
explode = (0.05, 0.05, 0.05)  # Slightly explode all slices

plt.pie(subscription_counts,
        labels=subscription_counts.index,
        autopct='%1.1f%%',
        startangle=140,
        colors=colors,
        explode=explode,
        shadow=True,
        textprops={'fontsize': 12})

# Title
```

```python
plt.title('User Distribution by Subscription Type', fontsize=16, weight='bold')

# Save the plot
plt.savefig("Subscription_Distribution_Percentage.png", dpi=300)
plt.show() #Show the Figure
```



Push Notification Engagement: How Often Do Users Click?

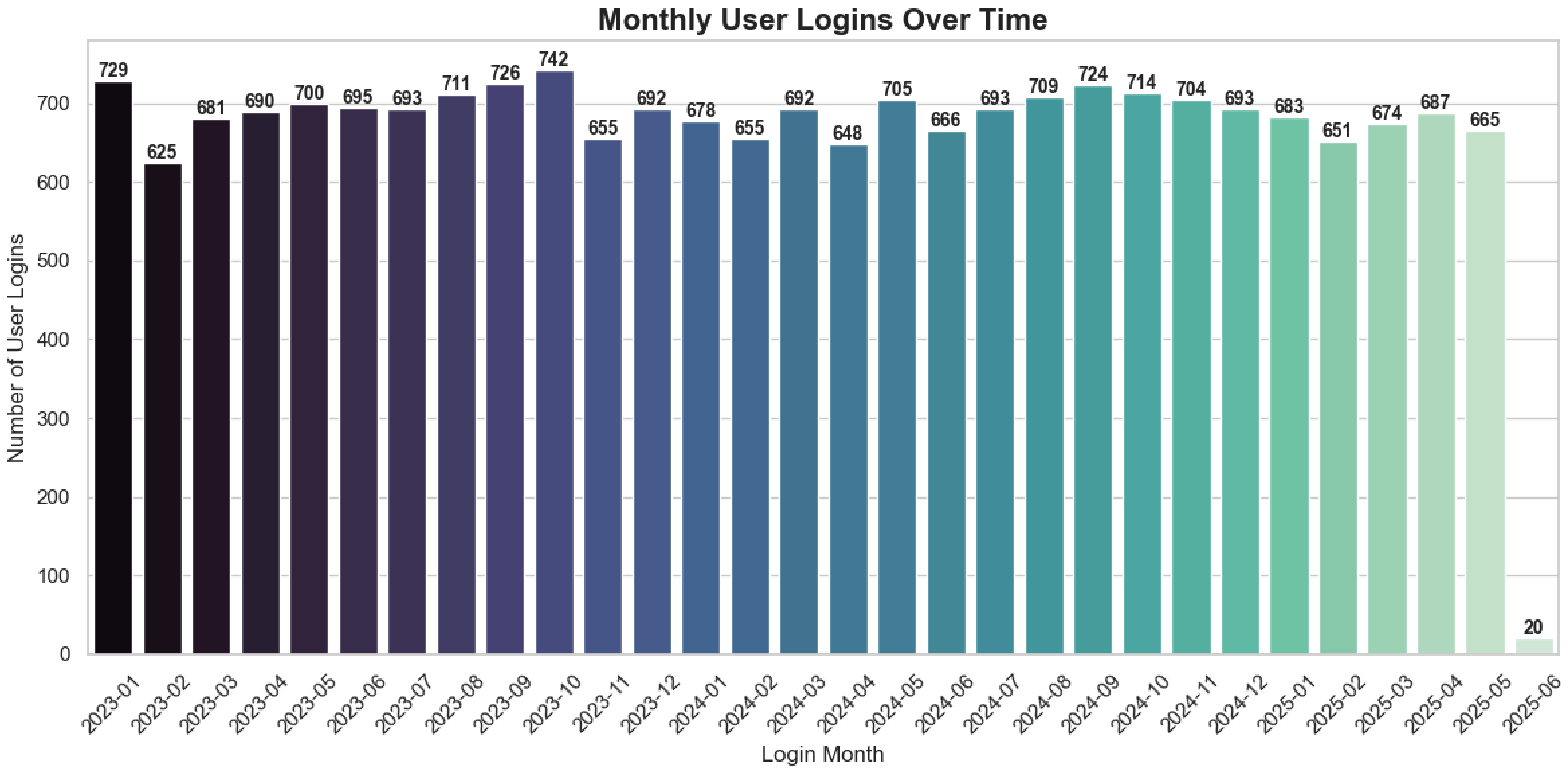
In [33]:
```python
# 7. What’s the distribution of push notification interaction?

# Seaborn style
sns.set(style="whitegrid")

# Plot histogram
plt.figure(figsize=(10, 6))
hist = sns.histplot(
    data=df,
    x='Push Notifications Clicked',
    bins=30,
    kde=True,
    color='skyblue',
    edgecolor='black'
)

# Titles and labels
plt.title('Distribution of Push Notification Interactions', fontsize=16, weight='bold')
plt.xlabel('Push Notifications Clicked', fontsize=12)
plt.ylabel('Number of Users', fontsize=12)
plt.tight_layout()

# Save the plot
plt.savefig("Push_Notification_Interaction_Distribution.png", dpi=300)
plt.show() # Show the Figure
```



User Login Activity by Month: Tracking Engagement Over Time

In [37]:
```
# 8. Time-based Analysis: User logins by month:

# Convert 'Last Login Date' to datetime
df['Last Login Date'] = pd.to_datetime(df['Last Login Date'], errors='coerce')

# Extract login month in "YYYY-MM" format
df['Login Month'] = df['Last Login Date'].dt.to_period('M').astype(str)

# Count users per login month
logins_by_month = df['Login Month'].value_counts().reset_index()
logins_by_month.columns = ['Login Month', 'User Count']
logins_by_month = logins_by_month.sort_values('Login Month')

# Seaborn style
sns.set(style="whitegrid")
```

```python
# Plotting with hue to silence future warning
plt.figure(figsize=(12, 6))
barplot = sns.barplot(
    data=logins_by_month,
    x='Login Month',
    y='User Count',
    hue='Login Month',     # Fix: add hue
    palette='mako',
    legend=False           # Hide extra legend
)

# Rotate x-axis labels for better readability
plt.xticks(rotation=45)

# Add value labels on bars
for p in barplot.patches:
    barplot.annotate(f"{int(p.get_height())}",
                     (p.get_x() + p.get_width() / 2., p.get_height()),
                     ha='center', va='bottom', fontsize=10, weight='bold')

# Titles and axis labels
plt.title('Monthly User Logins Over Time', fontsize=16, weight='bold')
plt.xlabel('Login Month', fontsize=12)
plt.ylabel('Number of User Logins', fontsize=12)
plt.tight_layout()

# Save the plot
plt.savefig("Monthly_User_Logins.png", dpi=300)
plt.show() #Show the Figure
```


Monthly User Logins Over Time
Number of User Logins
Login Month
729
625
681
690
700
695
693
711
726
742
655
692
678
655
692
648
705
666
693
709
724
714
704
693
683
651
674
687
665
20
2023-01
2023-02
2023-03
2023-04
2023-05
2023-06
2023-07
2023-08
2023-09
2023-10
2023-11
2023-12
2024-01
2024-02
2024-03
2024-04
2024-05
2024-06
2024-07
2024-08
2024-09
2024-10
2024-11
2024-12
2025-01
2025-02
2025-03
2025-04
2025-05
2025-06

```
In [ ]:
```