

Report on

**Data Visualization of Mobile Device Usage
and User Behaviour Patterns Across
Demographics**

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Abstract:

This study explores mobile device usage patterns across diverse demographics, providing key insights into how individuals engage with mobile technology. Analysing a dataset of variables such as app usage time, screen-on time, battery consumption, data usage, age, and gender, the findings reveal several important trends. Screen-on time steadily increases with age, with older age groups demonstrating higher engagement than younger users, challenging traditional assumptions about technology adoption. While gender differences in mobile usage were minimal, males typically had a greater number of apps installed across most user behaviour classes, and subtle variations were observed in data usage patterns. User behaviour classes showed a strong correlation with metrics such as screen time, app diversity, and data usage, with higher classes indicating greater engagement. Furthermore, Android remained the dominant operating system across all demographics. These insights offer actionable recommendations for developers and stakeholders aiming to optimize user experiences and adapt to evolving trends in mobile behaviour.

Introduction:

In today's fast-paced digital era, understanding mobile usage patterns has become increasingly important for optimizing user experiences and shaping future innovations. Mobile devices have become integral to daily life, influencing how people communicate, consume information, and engage with digital platforms. Analysing their usage offers valuable insights into user behaviour, preferences, and emerging trends, enabling stakeholders to make data-driven decisions in technology and design.

The dataset used for this analysis was sourced from [Kaggle](#), a reputable platform for publicly available datasets. It provides detailed information on various aspects of mobile device usage and user behaviour, capturing variables such as app usage time, screen-on time, battery consumption, number of installed apps, data usage, age, gender, and operating system. These 11 features together offer a comprehensive perspective on the interplay between user demographics, mobile behaviour, and device performance.

The primary goal of this project is to uncover patterns and relationships in the dataset to address critical questions surrounding mobile device usage. Specifically, the analysis seeks to understand how user behaviour classes are categorized based on other variables using visualizations and statistical techniques. Additionally, it explores whether significant differences in mobile usage patterns exist between male and female users, shedding light on gender-based trends. The analysis further investigates mobile usage patterns across age groups to identify key behaviours associated with different stages of life.

The motivation for this project was inspired by the team's desire to analyse mobile usage patterns, as mobile devices are playing an increasingly vital role in daily life. Recognizing their importance in communication, entertainment, and productivity, the team sought to understand how different demographics and behaviours influence mobile usage. This analysis was seen as an opportunity to highlight the growing significance of mobile technology and its impact on modern lifestyles.

This study aims to engage a wide audience, including individuals curious about user behaviour trends, researchers exploring technology adoption, and students or professionals interested in data visualization. By systematically analysing and visualizing mobile usage data, our goal is to provide a deeper understanding of the ways in which mobile devices shape user experiences and habits.

Data Methodology:

The analysis began by importing the dataset, which was stored as a CSV file. Data preprocessing steps were undertaken to ensure its quality and usability. Duplicate records were identified and removed in relevant columns to avoid redundancy and skewed analysis. Additionally, column names were modified to eliminate special characters and improve readability, making the dataset easier to interpret and work with.

Certain categorical variables, such as "Operating System" and "Gender," were factorized to facilitate analysis and visualization. Factorization of these columns allowed for more straightforward comparisons across different user groups. To ensure the dataset reflected realistic usage patterns, rows with outliers or unrealistic values in key columns—such as "App Usage Time (minutes/day)," "Screen on Time (hours/day)," and "Battery Drain (mAh/day)" were removed. These adjustments were crucial in maintaining the integrity of the data and ensuring that subsequent analysis would yield meaningful and accurate insights.

Once the dataset was cleaned and pre-processed, an initial summary of the data was examined to gain an overall understanding of the variables and their distributions. This step provided an overview of the data's characteristics and helped identify any potential issues that needed further attention. Additionally, the head of the dataset was inspected to confirm the structure, formatting, and correctness of the data.

The data consisted of columns related to various mobile related attributes as below:

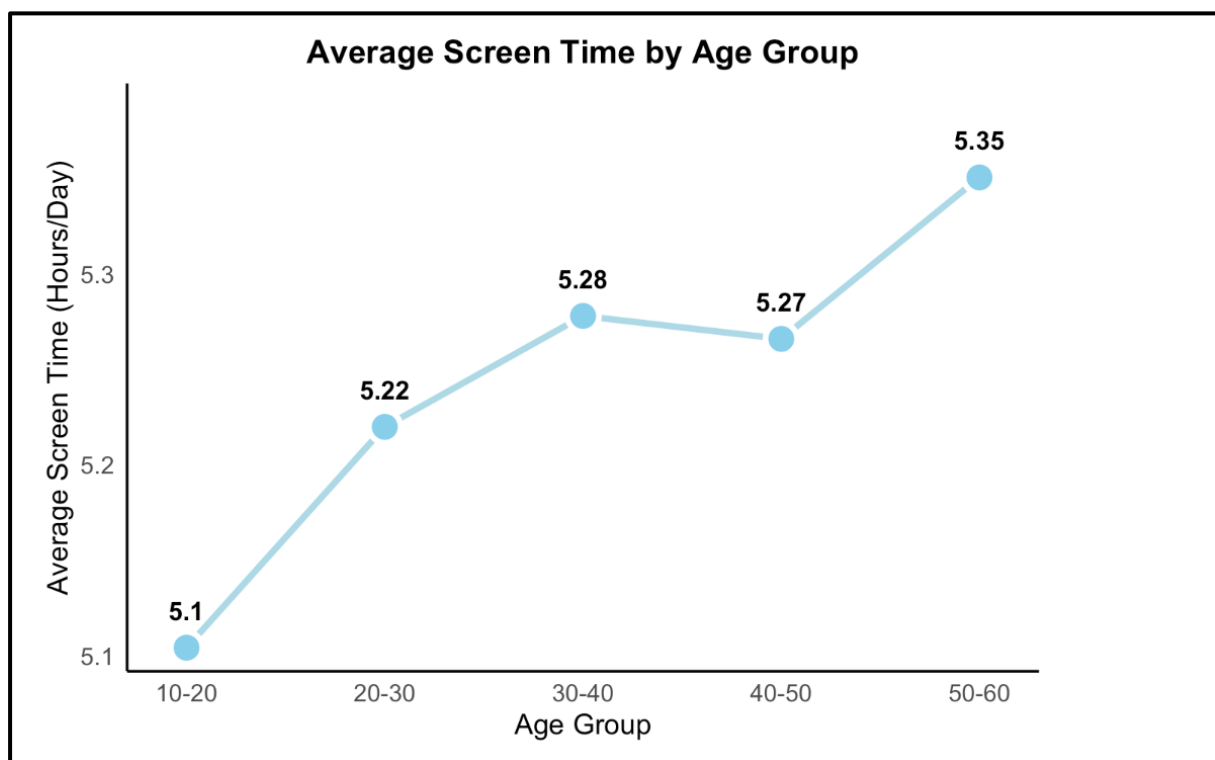
Sr. No.	Column Name	Description
1	User_ID	Unique identifier for each user.
2	Device_Model	The model of the mobile device used by the user.
3	Operating_System	The operating system used by the device (Android or iOS).
4	App_Usage_Time_Mins_Per_Day	Total time spent on apps per day, measured in minutes.
5	Screen_Time_Hours_Per_Day	Total screen time per day, measured in hours.
6	Battery_Consumption_mAh_Per_Day	Battery consumption per day, measured in milliampere-hours (mAh).
7	Number_Of_Apps_Installed	Total number of apps installed on the device.
8	Data_Usage_MB_Per_Day	Total data usage per day, measured in megabytes.
9	Age	Age of the user.
10	Gender	Gender of the user (male or female).
11	User_Behavior_Class	Classification of user behaviour based on usage patterns (Class 1,2,3,4,5) 1 being lowest usage and 5 being highest usage

These initial steps laid a strong foundation for the subsequent analysis and visualization, which aimed to uncover insights into mobile device usage patterns, user behaviour classifications, and the impact of demographics on mobile usage.

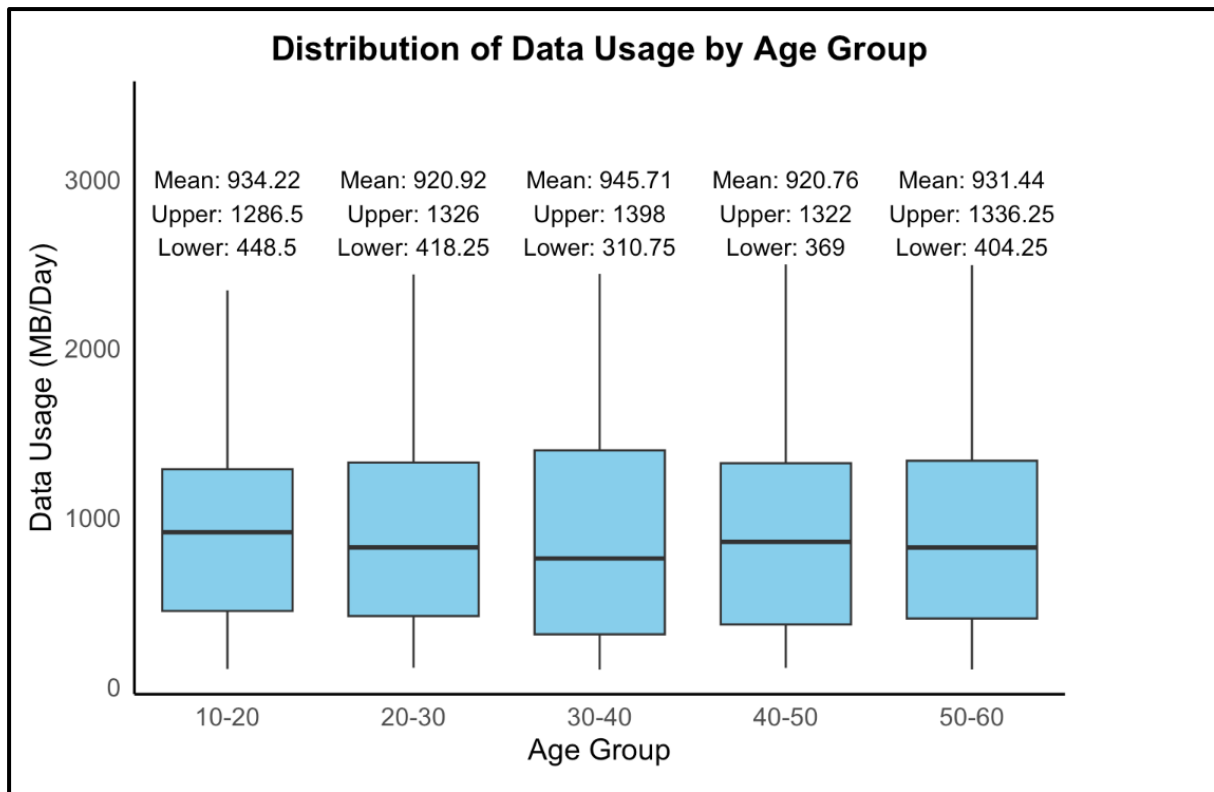
Results:

Mobile Usage by Age Group:

This section examines how mobile usage varies across different age groups, considering key metrics like average screen time, data usage, and preferred operating system (OS). The following graphs illustrate these patterns:

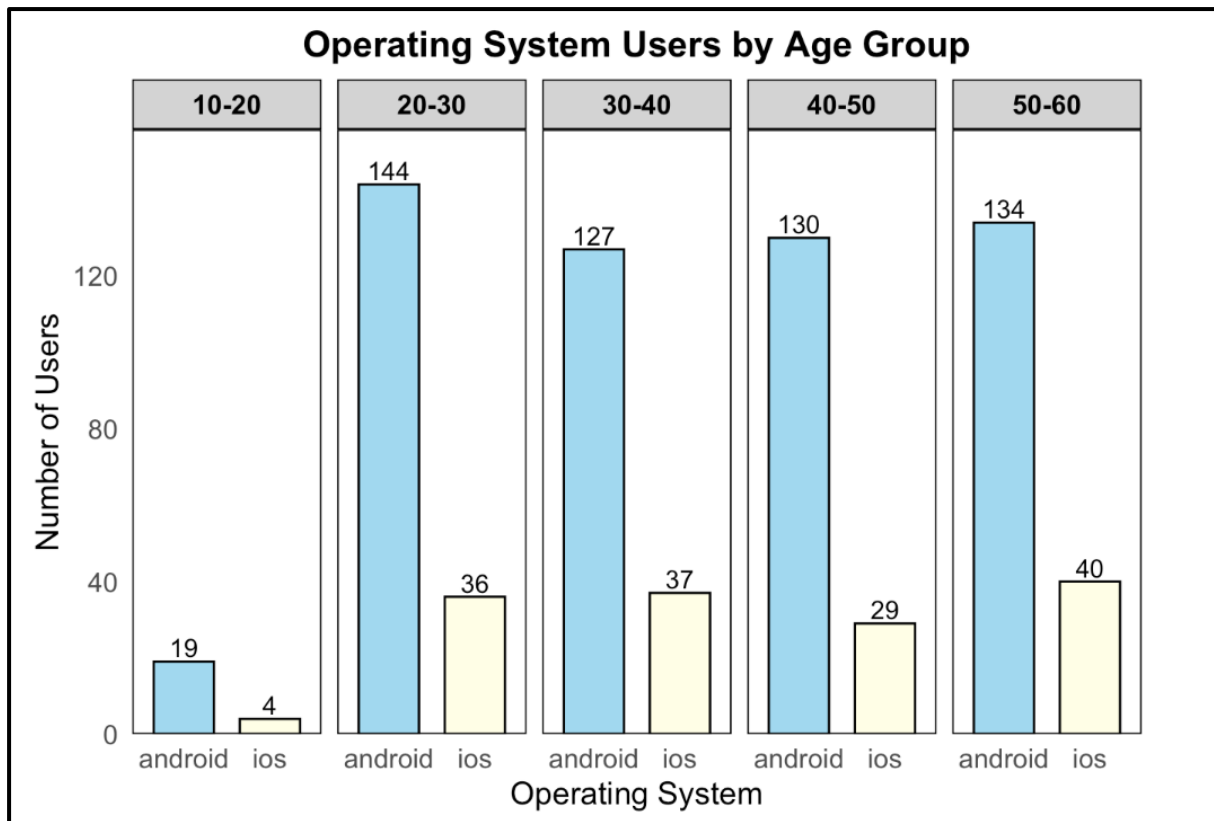


The graph above showing average screen time across different age groups reveals a clear trend: as age increases, so does the average screen time. The youngest group, aged 10-20, spends the least time on their devices, with an average of 5.1 hours per day. This gradually increases through the other age groups, with the 50-60 age group spending the most time on their devices, averaging 5.35 hours per day. There is a steady increase in screen time as the age groups rise, with no significant drop-offs between them. This suggests that older individuals are using mobile devices more than expected, possibly for a variety of reasons such as work, communication, and entertainment. Contrary to popular assumptions, older age groups are not lagging younger ones in terms of mobile usage. Instead, mobile devices appear to be becoming a central part of daily life for people of all ages, with even older users increasing their screen time as their comfort and dependence on technology grow.



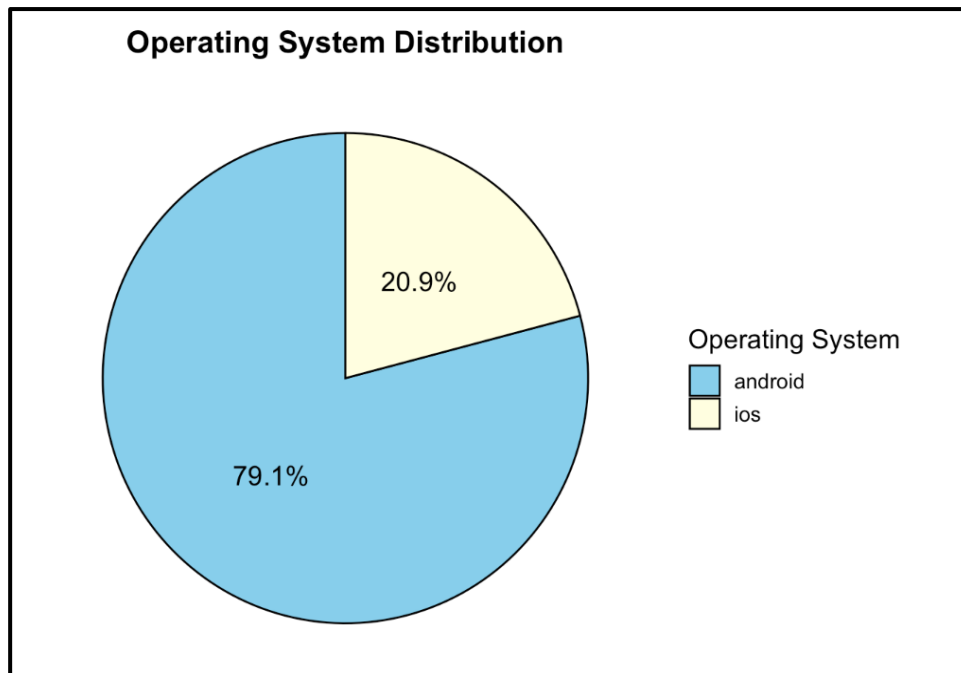
The graph above displaying the distribution of data usage across different age groups shows that data consumption is relatively similar across all age groups, with minor variations. The mean data usage for each age group ranges from approximately 920 MB to 945 MB per day. The 10-20 age group has a mean data usage of 934.22 MB, while the 20-30 group is slightly lower at 920.92 MB. The 30-40 age group has the highest mean at 945.71 MB, followed by a slight decrease in the 40-50 (920.76 MB) and 50-60 (931.44 MB) groups.

The boxplots indicate that the spread (the range between the lower and upper quartiles) of data usage is also fairly consistent across the groups, with no extreme outliers. The variation in data usage across all groups is relatively narrow, suggesting that mobile data usage is common among users of all ages, regardless of age group. The data suggests that there is no drastic increase or decrease in data usage with age, meaning that mobile data consumption remains fairly stable across the population.

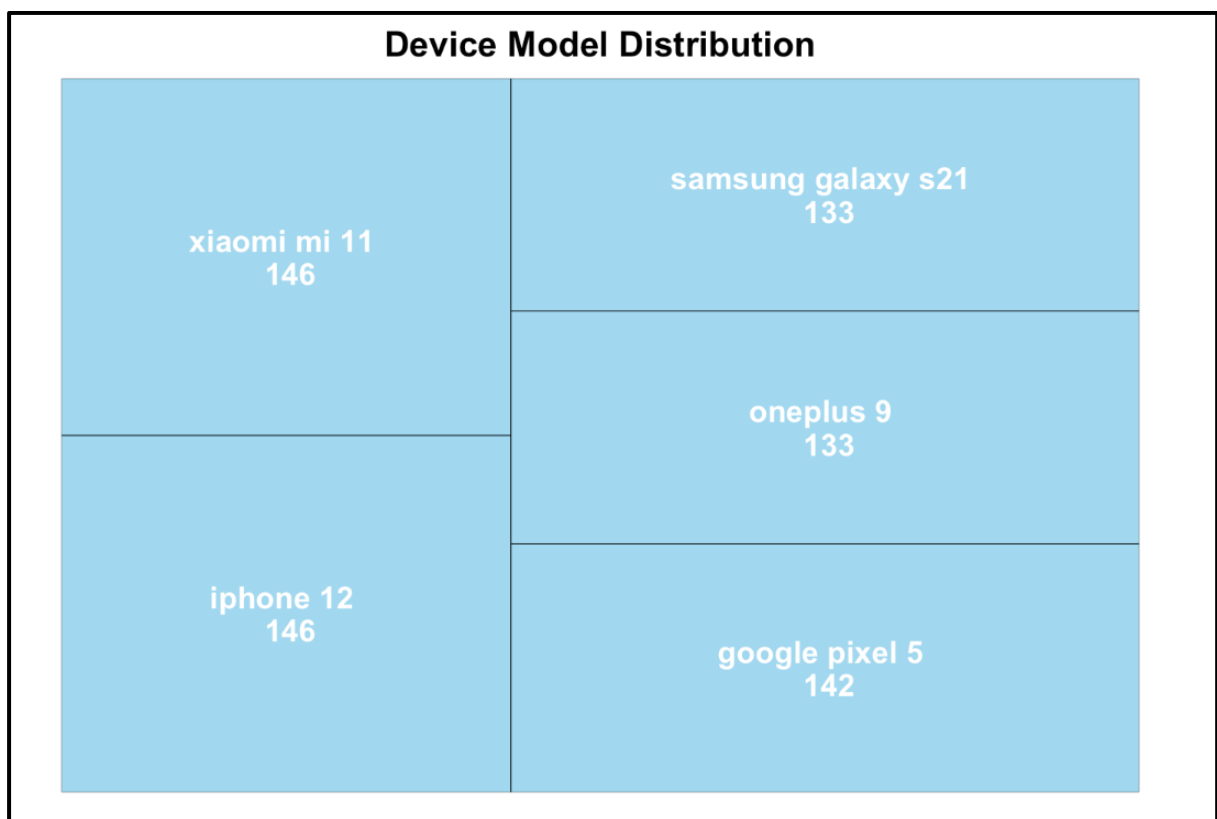


The provided graph offers a clear picture of operating system preferences across different age groups. A dominant trend emerges: Android consistently outperforms iOS in every age category. While the gap between the two systems narrows slightly as we move to older age groups, Android maintains its lead. This suggests a strong preference for Android, particularly among younger demographics.

But the distribution of OS should also be considered, as shown in the below pie chart.



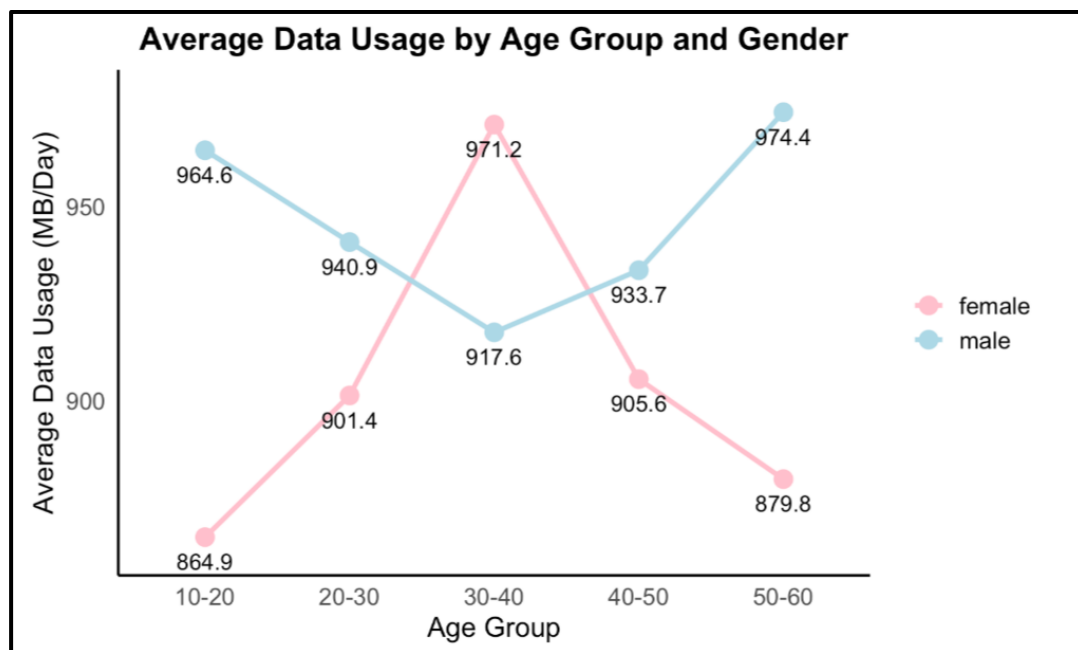
Approximately 79.1% of users opt for Android, while only 20.9% choose iOS. This significant disparity highlights the widespread adoption of Android across various demographics. This dominance of Android likely influences the observed trends in the age group analysis. The higher prevalence of Android across all age groups, particularly among younger demographics, reflects its broader market appeal and accessibility. There were 5 device models considered in the dataset as below.



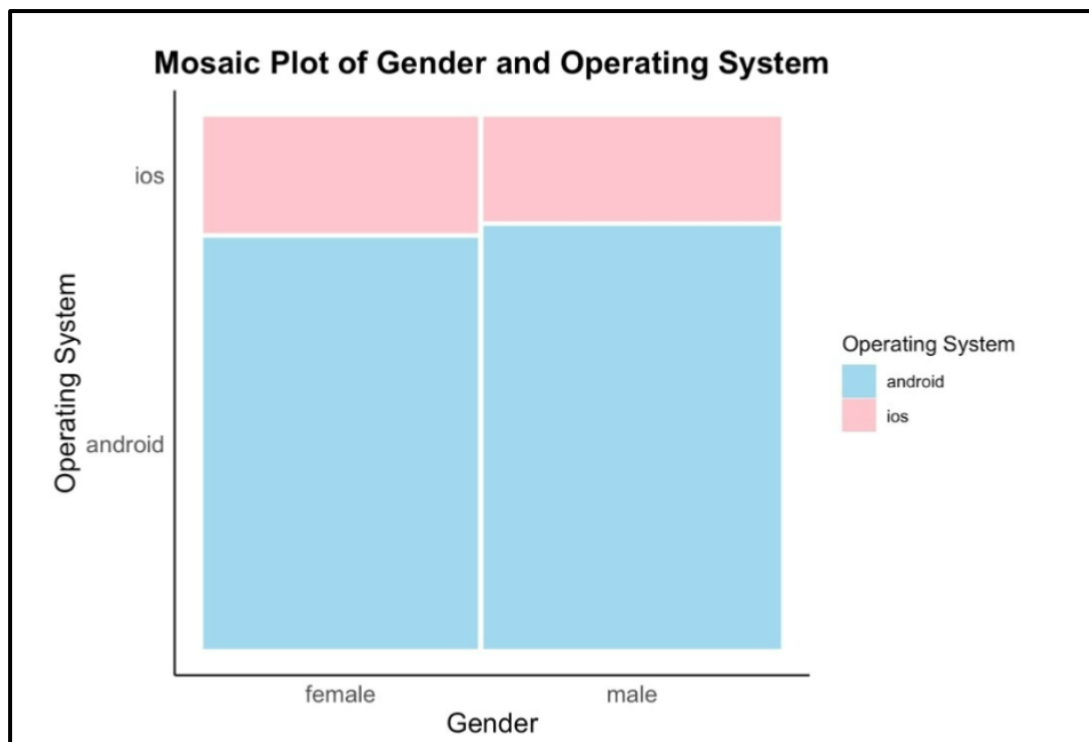
Factors such as cost-effectiveness, a wider range of devices, and a more open ecosystem contribute to Android's popularity.

Gender-based Mobile Usage Patterns

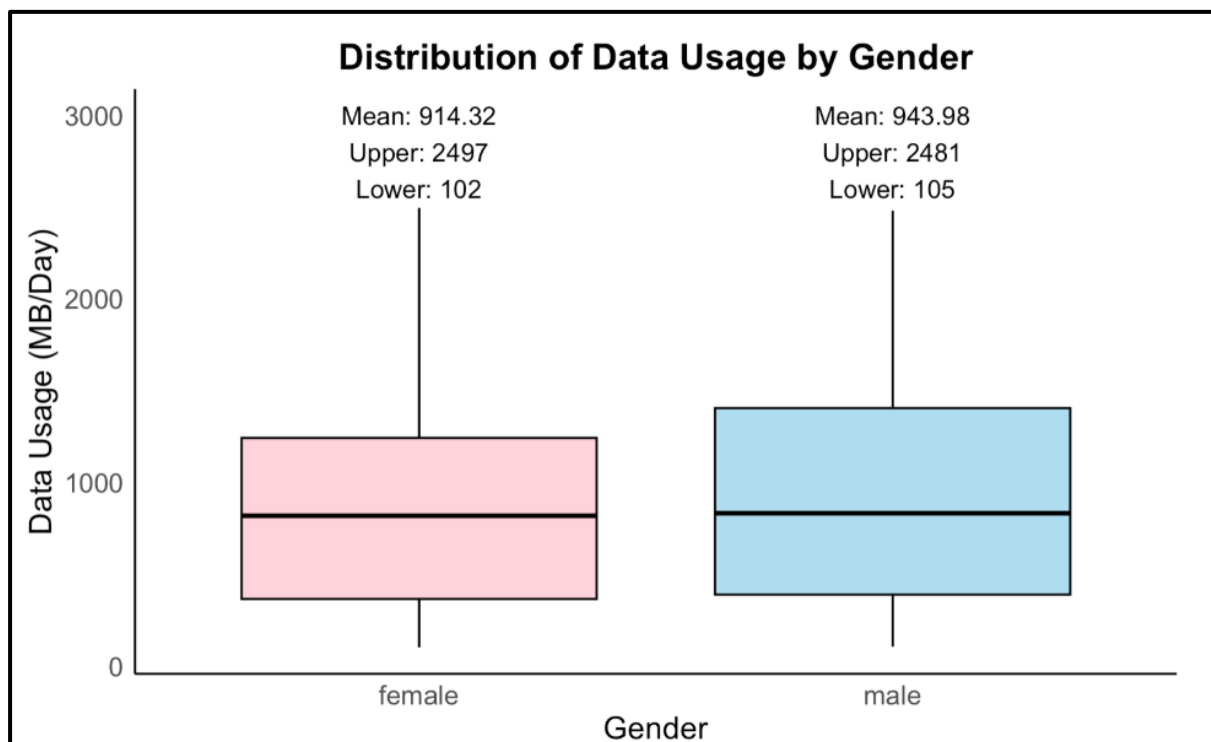
The graph below illustrates key gender-based trends in mobile data usage across different age groups, revealing noticeable but relatively modest differences between male and female users. Male users consistently demonstrate higher average data usage compared to females in most age groups, with the exception of the 30-40 age range, where female users peak at 971.2 MB/day, slightly surpassing males at 917.6 MB/day. Male data usage follows a more fluctuating trend, starting high at 964.6 MB/day in the 10-20 age group, dipping to 940.9 MB/day in the 20-30 group, and reaching a low of 917.6 MB/day in the 30-40 group before rising again to 933.7 MB/day and 974.4 MB/day in the 40-50 and 50-60 groups, respectively. The differences between genders in MB/day usage are modest, typically ranging between 30 MB and 70 MB/day, highlighting a relatively balanced overall reliance on mobile data.



The fluctuating trend for males and the peak in female data usage during the 30-40 age group suggest that gendered behavioural patterns and life-stage priorities influence mobile usage. Male data consumption may reflect a steady engagement with data-intensive activities, such as entertainment and online services, with a rebound in older age groups potentially due to increased leisure time or greater reliance on mobile connectivity. On the other hand, females' peak usage in the 30-40 group could be tied to active engagement with productivity, social, and lifestyle apps during a particularly dynamic life stage. These trends, combined with the relatively small differences in data usage, underscore the nuanced nature of mobile engagement across genders, influenced by a combination of age, lifestyle, and individual preferences.

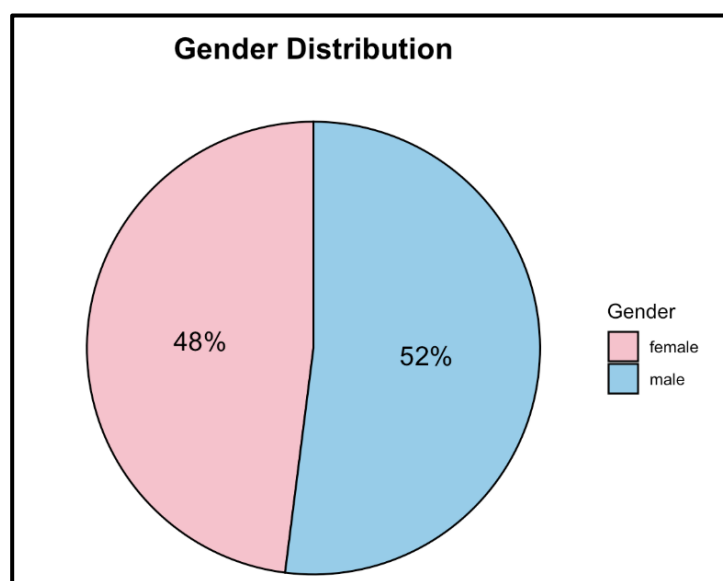


The above mosaic plot highlights the dominance of Android as the preferred mobile operating system across both genders, with a larger proportion of users opting for Android over iOS. This aligns with trends observed in age group analysis, where Android maintained its lead across all demographics, likely due to its affordability and device diversity. The balanced proportions in the plot indicate that gender does not significantly influence operating system preference, as both males and females exhibit similar patterns in their choices.



The box plot visualizes the distribution of daily mobile data usage (in MB/day) by gender, offering insights into how data consumption varies between male and female users. Both genders show a similar spread of data usage, with the interquartile ranges (IQRs) for males and females overlapping significantly. This suggests that typical data usage patterns for most users are consistent across genders. The median data usage is slightly higher for males than for females, indicating a modest tendency for males to consume more data on average. However, the difference is not substantial, pointing to relatively balanced usage between genders.

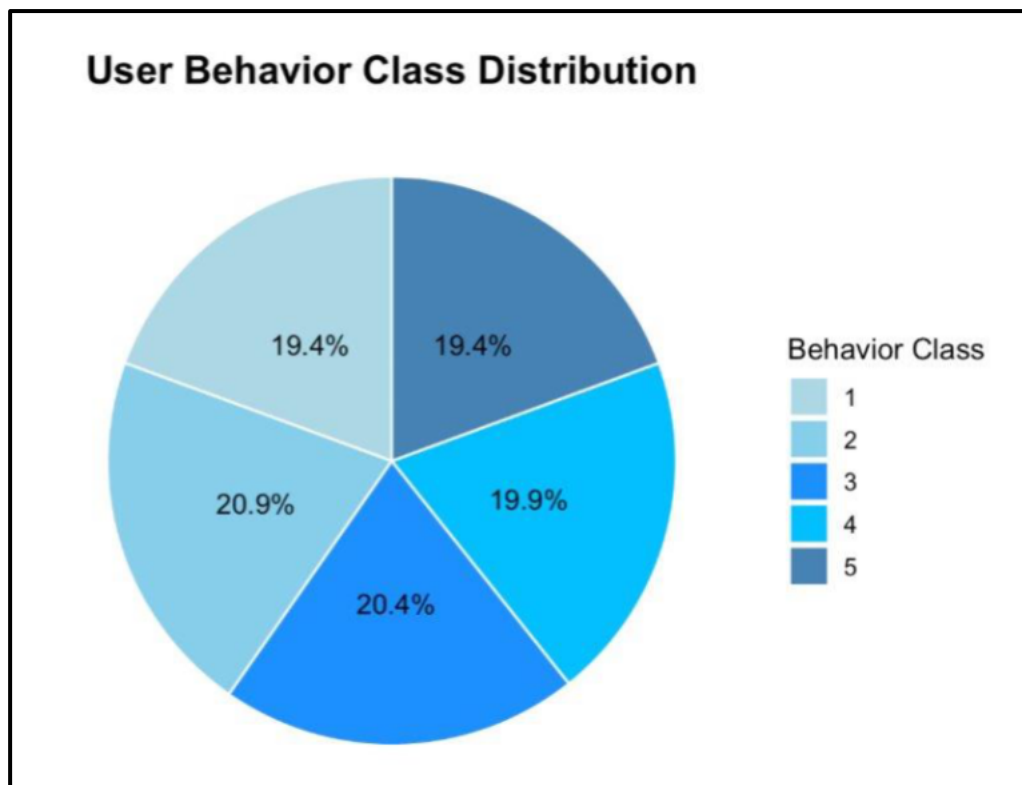
The range of data usage is also comparable, as reflected in the lengths of the whiskers extending to the minimum and maximum values. This indicates that extreme high or low data consumption levels occur at a similar frequency for both genders. The lack of significant disparity between male and female data usage suggests that gender is not a dominant factor in determining daily mobile data consumption.



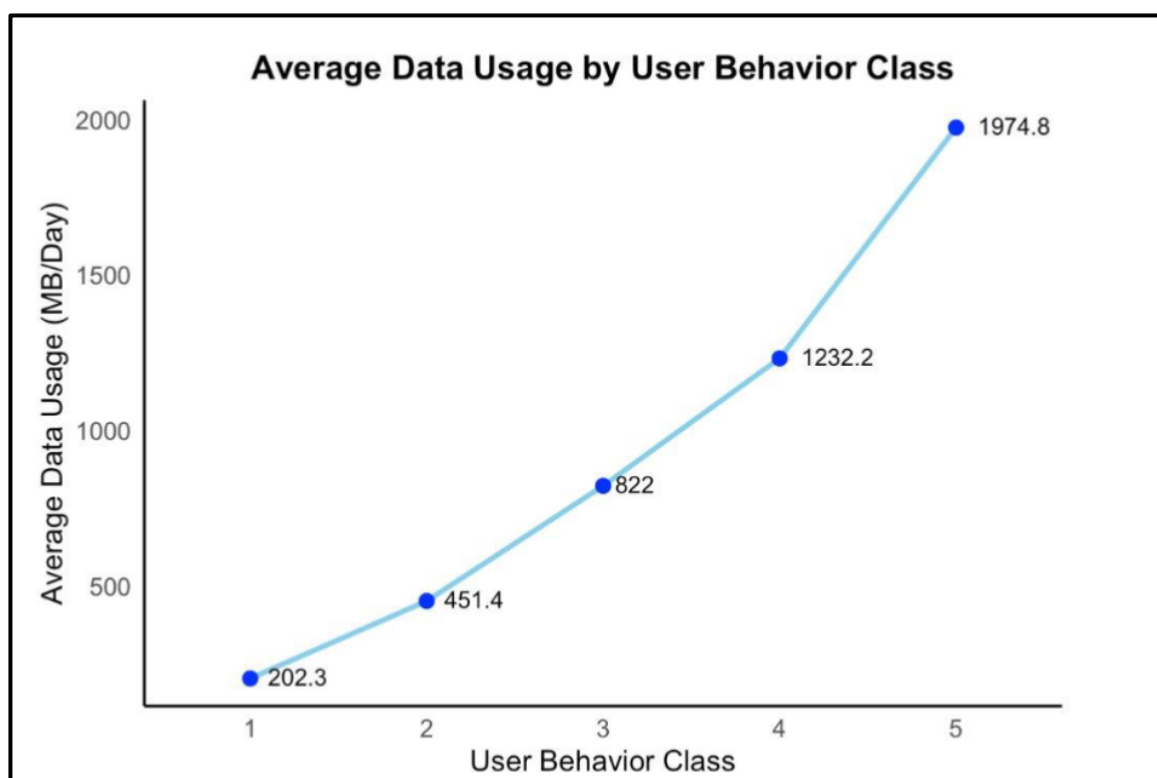
The pie chart illustrates the gender distribution within the dataset, revealing a relatively balanced split between male and female users. Males make up 52% of the dataset, while females account for 48%, indicating near parity. This balanced representation ensures that insights and conclusions derived from the analysis are not significantly skewed by gender proportions.

Exploring User Behaviour Patterns

The pie chart below reveals a relatively even distribution of users across the five behaviour classes. No single class has a significantly higher percentage of users, indicating a diverse range of user behaviours and engagement levels within the dataset.

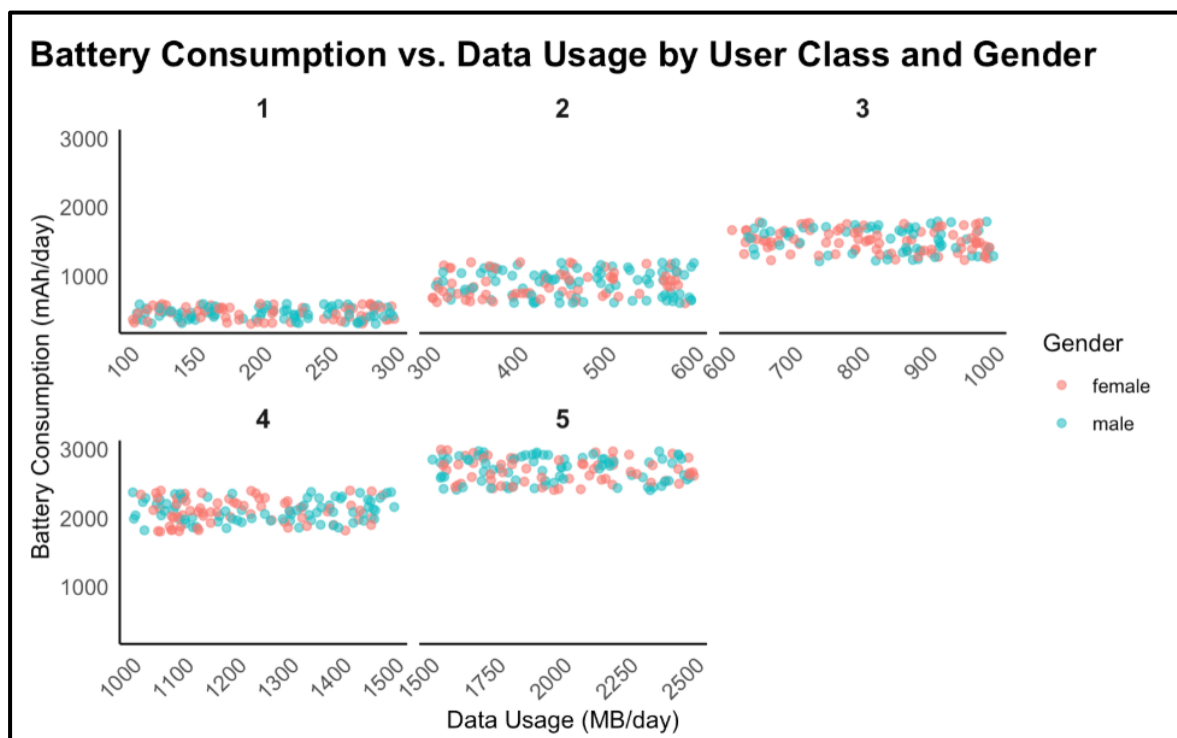


To understand the basis of user behaviour classification, we must examine patterns across key variables. This analysis aims to identify the factors that differentiate users across different behaviour classes. By exploring relationships between variables such as screen time, app usage, and data consumption, we can gain insights into the characteristics that define each user behaviour class.

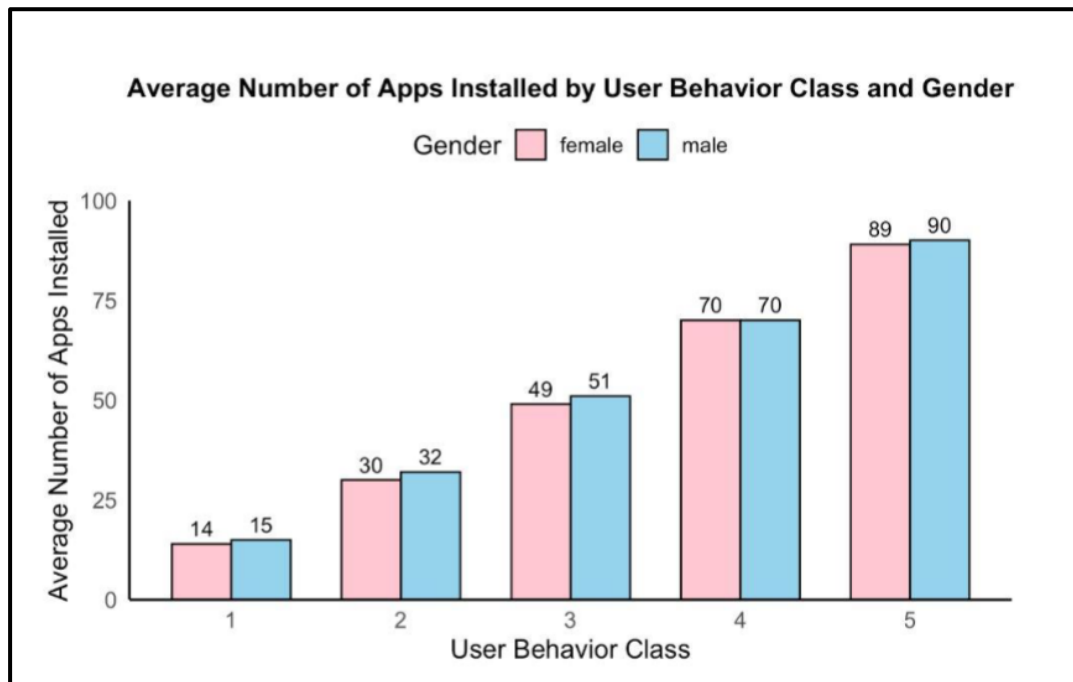


The above graph reveals a clear trend. Average data usage increases significantly with the user behaviour class. Users in Class 1 have the lowest average data usage, while those in Class 5 exhibit the highest, suggesting a strong correlation between user engagement and data consumption. This pattern suggests that users in higher behaviour classes are more likely to engage in data-intensive activities such as streaming, downloading, and online gaming, leading to increased data usage.

The scatterplot below matrix illustrates a clear positive relationship between data usage and battery consumption across all user behaviour classes, with both metrics increasing significantly as user engagement levels rise. Users in lower behaviour classes (e.g., Class 1) show minimal resource consumption, with data usage concentrated between 100–250 MB/day and battery consumption below 1000 mAh/day. In contrast, Class 5 users, representing the highest engagement levels, exhibit data usage exceeding 2000 MB/day and battery consumption ranging from 2000–3000 mAh/day. This scaling trend reflects the energy-intensive nature of activities associated with higher engagement, such as streaming, gaming, and extended app usage. The progression across classes highlights how increased reliance on mobile devices translates into greater resource demands, reinforcing the correlation between engagement and device performance.

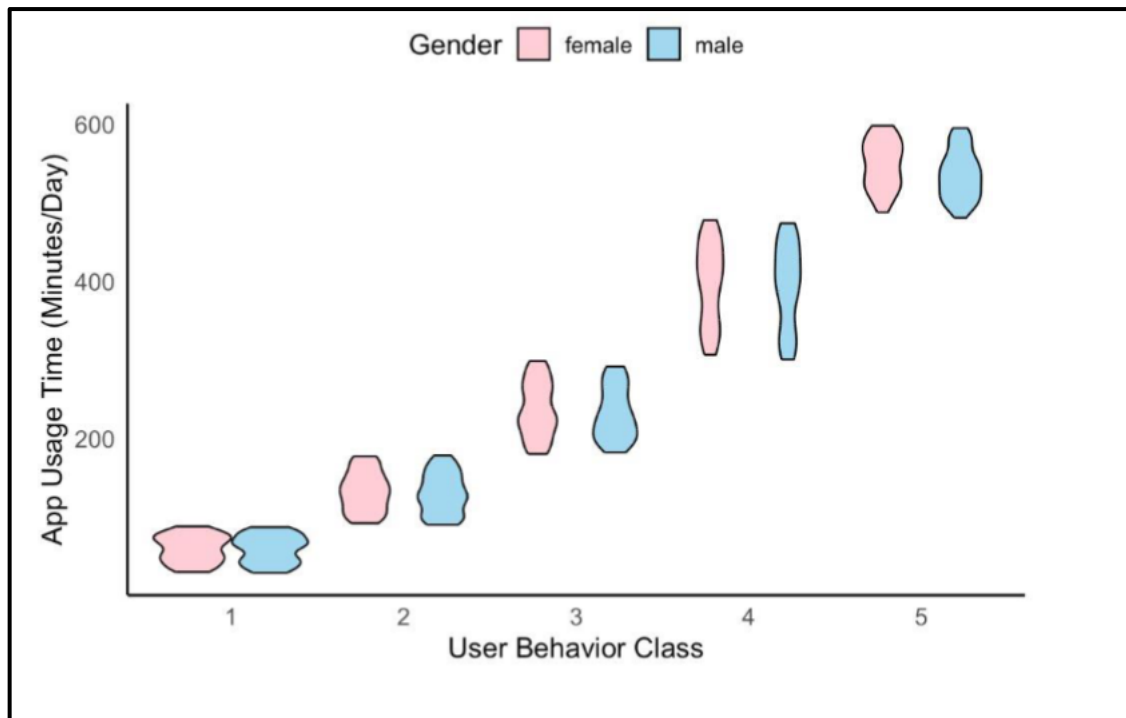


Gender-based trends remain consistent across all classes, with male and female data points closely clustered, indicating similar patterns in how resource consumption scales with engagement. Subtle variations, such as a denser clustering of female users in the lower ranges of battery consumption within Classes 1 and 2, suggest that females may engage in slightly less battery-intensive activities in lower behaviour classes. However, these differences diminish as engagement levels increase. This suggests that behaviour class, rather than gender, is the primary driver of resource consumption patterns. These insights underscore the importance of optimizing device performance and energy efficiency for users in higher engagement classes while accounting for their diverse and intensive usage patterns.

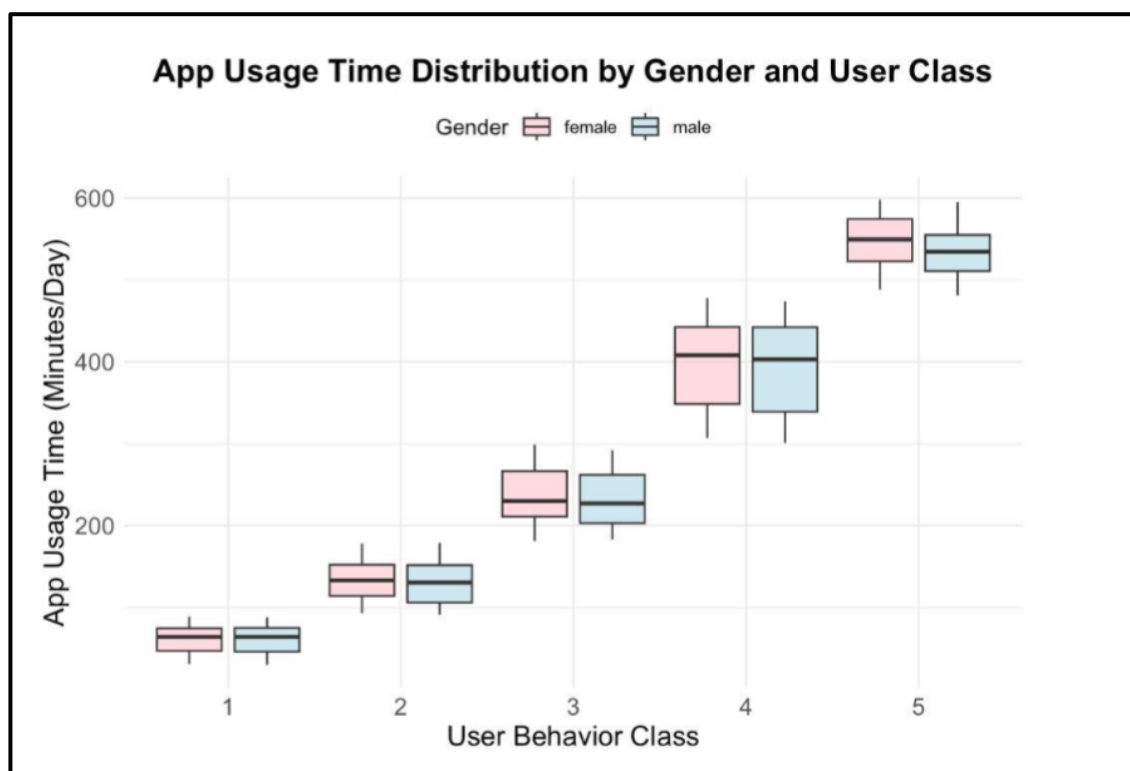


The graph above illustrates a clear relationship between user behaviour class and the number of apps installed. As the user behaviour class increases, indicating higher user engagement, the average number of apps installed also significantly increases. This suggests that users with higher engagement levels tend to have a more diverse range of applications on their devices. Furthermore, the analysis reveals a consistent trend across all user classes: male users consistently have a higher average number of apps installed compared to female users. This suggests that gender may play a role in app usage preferences, with male users generally exhibiting a wider range of app interests.

Several factors could contribute to this gender-based difference in app installations. Men may be more inclined to explore and experiment with a wider variety of apps, driven by interests in gaming, technology, and productivity tools. Additionally, social and cultural factors might influence app preferences and downloading behaviour. Further research into specific app categories and usage patterns could provide valuable insights into the underlying reasons for this gender-based disparity.

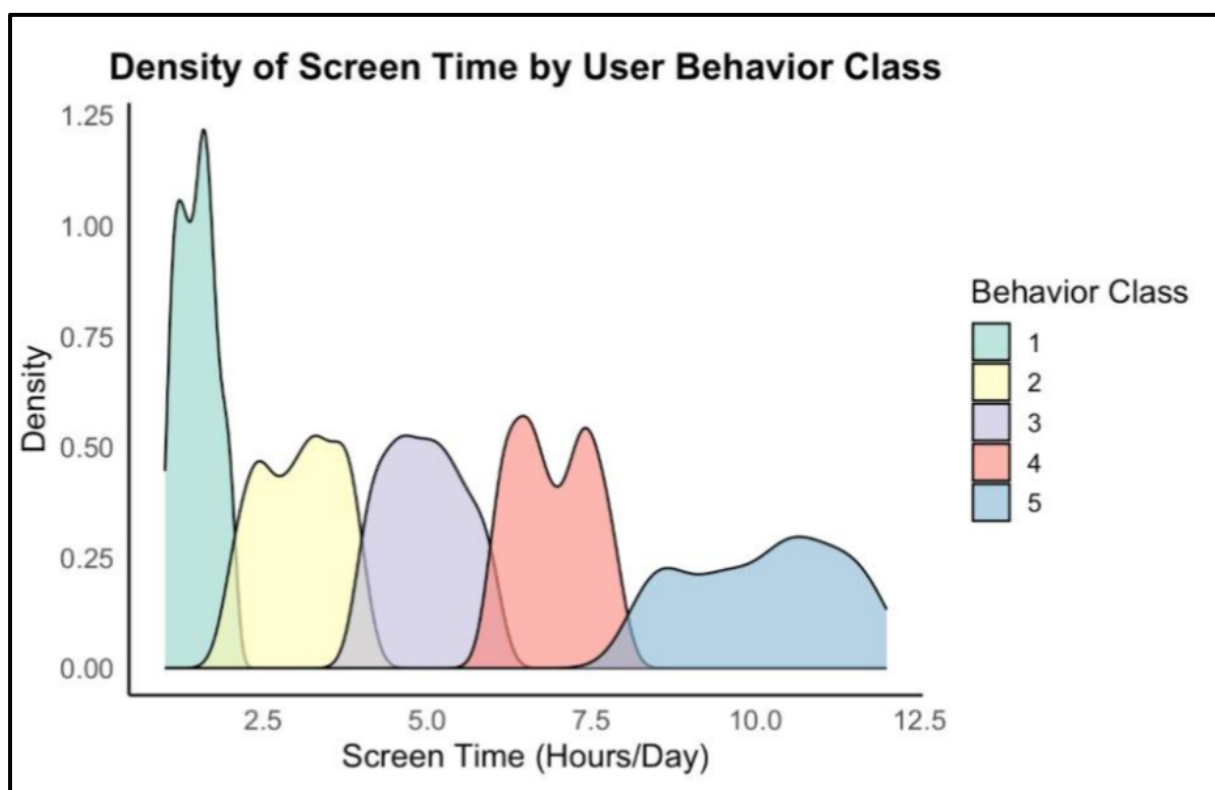


This violin plot illustrates the distribution of app usage time (in minutes per day) across different user behaviour classes, with a breakdown by gender. A clear trend is evident: as the user behaviour class increases, the overall app usage time also increases. This suggests that users in higher behaviour classes tend to spend more time engaged with mobile applications. However, we do not clearly see a distinct gender-based trend in app usage time from this violin plot. The distributions for both genders within each class appear to overlap considerably. To further investigate potential gender differences, we analysed the same data using box plots, which can provide a more granular view of the data distribution and potential outliers.



Examining the box plot for Class 5 reveals an interesting finding: the median app usage time for female users is slightly higher than that of male users. This suggests that, on average, female users in the highest engagement class (Class 5) spend slightly more time on their devices. This observation adds a layer of nuance to the overall trend, indicating that while the general pattern shows increasing app usage with higher behaviour classes, there might be subtle gender-specific variations within certain classes.

The combination of violin and box plots reveals a clear trend of increasing app usage time with higher user behaviour classes. While both genders exhibit this trend, the box plots highlight subtle gender differences. In most classes, the median app usage time is similar for both genders. However, in Class 5, female users demonstrate slightly higher median app usage times, suggesting nuanced variations in usage patterns within the highest engagement group.



The density plot reveals a clear trend of increasing screen time as the user behaviour class increases. Class 1 exhibits a sharp peak at around 1.5 hours/day, indicating minimal screen usage. As the class number rises, the distribution shifts towards higher screen time values. Class 2 shows a broader distribution centred around 3.5 hours/day, followed by Class 3 with a narrower distribution around 5 hours/day. Class 4 demonstrates screen time centred around 7 hours/day with some variability. Finally, Class 5 exhibits the highest screen engagement with a flatter curve extending to 8-12 hours/day. These distinct patterns across classes suggest that user behaviour significantly influences screen time usage, likely driven by factors such as lifestyle, occupation, and individual preferences.



The heatmap provides a visual representation of how average data usage varies across different user behaviour classes and age groups. A clear trend emerges average data usage consistently increases as the user behaviour class increases, regardless of the age group. This indicates that users in higher engagement classes, irrespective of their age, tend to consume more data.

While this overall trend holds true, the heatmap also reveals nuanced variations within each age group. In younger age groups (10-20 and 20-30), data usage increases steadily from lower to higher behaviour classes. However, in the middle age group (30-40), the increase in data usage across behaviour classes is less pronounced. Interestingly, in the older age groups (40-50 and 50-60), data usage increases sharply from lower to higher behaviour classes, with the highest average data usage observed in the combination of Class 5 and these older age groups.

These observations suggest a complex interplay between user behaviour class and age in shaping data usage patterns. While higher engagement consistently leads to increased data consumption, the rate of increase and the overall data usage levels vary across different age groups. This highlights the influence of factors such as lifestyle, occupational needs, and access to technology on data usage patterns within each age group.

Discussion:

The analysis reveals that mobile usage is prevalent across all age groups, contrary to common perceptions. While screen time increases slightly with age, data usage remains relatively consistent. Android's dominance in the market is evident, influencing usage patterns across all age groups. However, the data suggests that mobile usage is becoming increasingly omnipresent, with older adults demonstrating higher engagement than previously assumed. Further research could delve into specific app usage patterns, the impact of device type (e.g., smartphones vs. tablets), and regional variations to gain a deeper understanding of mobile behaviour across different age groups.

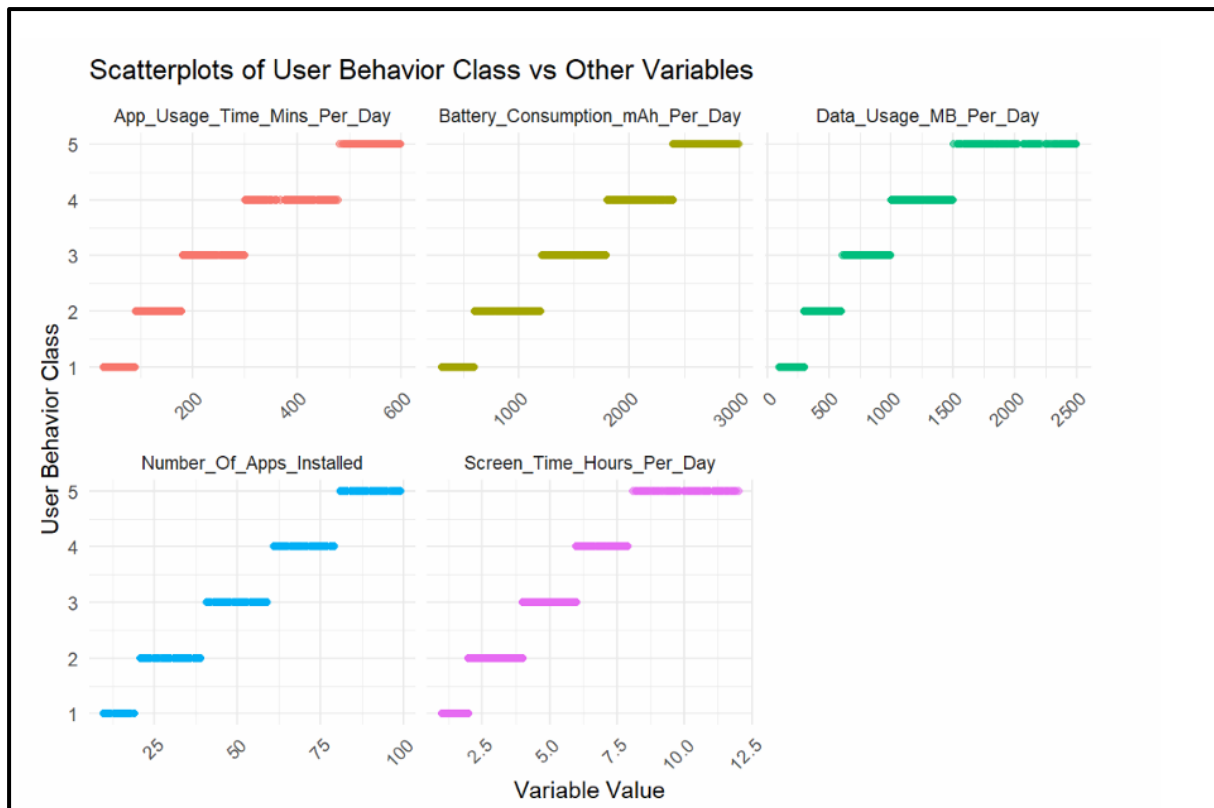
It is important to note that the data presented here may not capture the full complexity of mobile usage. Factors such as socioeconomic status, cultural differences, and specific device features could also influence usage patterns. Additionally, while Android's dominance is clear, a more nuanced analysis of user preferences within each age group could provide valuable insights. By considering these factors, future research can provide a more comprehensive understanding of mobile usage and its implications for various age groups.

The gender-based analysis reveals nuanced yet balanced trends in mobile usage patterns, shedding light on how males and females engage with technology. Across the datasets, males consistently demonstrated slightly higher levels of mobile data consumption compared to females, as seen in both average and distribution-based visualizations. This difference, though modest, suggests that males may engage more with data-intensive activities like streaming, gaming, or other digital services. On the other hand, females exhibited peaks in certain age groups, particularly the 30-40 range, reflecting life-stage-specific engagement driven by productivity, communication, or social apps. However, the overall similarity in data usage across genders indicates that mobile technology plays an equally vital role in the lives of both groups.

The analysis of operating system preferences and gender distribution further reinforces the balanced nature of mobile usage trends. Both genders showed a clear preference for Android over iOS, which aligns with its affordability and versatility across diverse user needs. The near-equal gender distribution in the dataset enhances the reliability of these findings, as it avoids biases stemming from unequal representation. Collectively, these patterns suggest that while minor differences exist, gender alone is not a dominant factor in shaping mobile behaviour. Instead, broader influences like age, lifestyle, and device accessibility appear to play a more pivotal role in driving these trends, pointing to the complex interplay of demographic and behavioural factors in mobile usage.

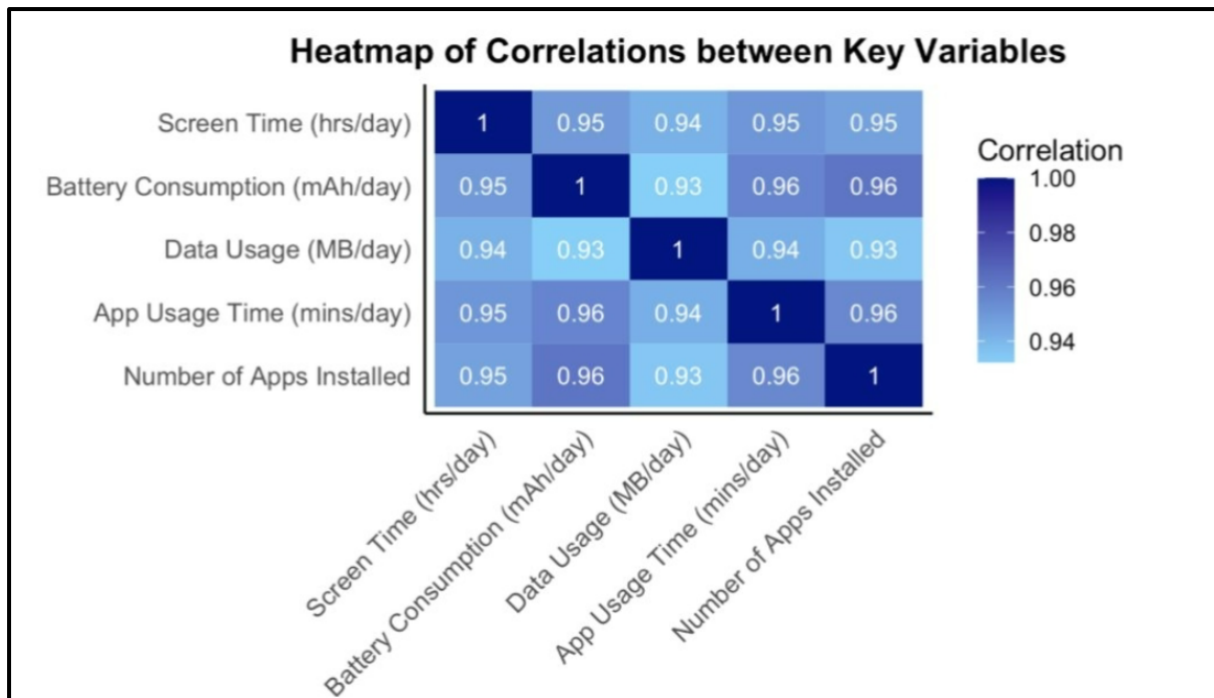
From a general perspective, this equitable gender distribution adds strength to the analysis, as it allows for a fair comparison of patterns, behaviours, and preferences between males and females. It ensures that neither gender disproportionately influences overall trends in mobile usage, operating system preferences, or data consumption.

The analysis reveals a strong positive correlation between user behaviours class and key mobile usage metrics, including screen time, data usage, app usage time, and the number of apps installed.



The composite scatterplot provides a comprehensive summary of the relationships between user behaviour class and key variables. Across all panels, a consistent positive trend is evident, with higher user behaviour classes corresponding to increased values for all variables. As the user behaviour class increases, these metrics consistently rise, indicating that users in higher classes are more active and engaged with their mobile devices. These individuals tend to spend more time on apps, consume more data, and install a greater variety of applications, reflecting the growing reliance on mobile technology for daily tasks such as communication, entertainment, and productivity.

The heatmap of correlations between key variables further supports these findings, demonstrating a consistent and strong interrelationship among metrics. Correlation values range from 0.93 to 0.96, indicating that as one variable increases, others tend to rise proportionally. For instance, app usage time exhibits a strong correlation (0.95) with screen time, while battery consumption is intricately linked to both app usage time (0.96) and the number of installed apps (0.96). This highlights the interconnected nature of mobile activities—users who spend more time using apps and screens also experience higher battery consumption and engage in more data-intensive behaviours. These trends suggest that users in higher behaviour classes not only exhibit higher overall engagement but also demand more from their devices in terms of energy and performance.



While these trends are consistent across genders, subtle variations emerge within the highest behaviour class. Male users consistently show a higher number of installed apps across all behaviour classes, reflecting a broader interest in exploring diverse tools and platforms. Conversely, female users in Class 5 demonstrate slightly higher median app usage times, pointing to deeper engagement with specific applications. These nuances highlight the influence of individual preferences and behavioural tendencies on mobile usage patterns, with male users potentially emphasizing breadth and variety in app usage, while females may focus on depth of engagement.

The observed trends reflect broader lifestyle and demographic influences, including individual preferences, work demands, and access to technology. Users in higher behaviour classes may rely more heavily on their devices for multitasking, entertainment, and communication, making mobile technology an integral part of their routines. The strong correlations between key variables and behaviour class reinforce the conclusion that user engagement increases with reliance on mobile devices for a range of activities. These findings provide valuable insights for developers and designers aiming to optimize user experiences for different behaviour classes and demographics.

Conclusion:

This report provides a comprehensive analysis of mobile device usage patterns and user behaviour across various demographics, offering valuable insights into the role of mobile technology in modern life. The findings challenge common perceptions about age-based mobile engagement, revealing that older age groups demonstrate significant levels of device usage, with screen time steadily increasing with age. This highlights the growing integration of technology into the daily lives of older individuals, driven by communication, productivity, and entertainment needs. Gender-based trends, while present, were modest. Males exhibited a

greater number of installed apps across most user behaviour classes, while subtle differences in data usage patterns. These patterns suggest that gender plays a nuanced but not dominant role in shaping mobile behaviour. Operating system preferences showed a clear dominance of Android across all demographics, reflecting its affordability and versatility, which appeal to a broad audience. The classification of users into distinct behaviour classes revealed a strong correlation between engagement levels and key metrics such as screen time, data usage, app usage, and battery consumption. Higher behaviour classes consistently exhibited more intensive usage, underscoring the importance of optimizing device performance for these highly engaged users. Furthermore, the interconnected nature of mobile activities was evident, with strong relationships among key variables such as app usage time, screen time, and battery consumption. These patterns reflect the multifaceted ways in which mobile devices are integrated into daily routines. Overall, the study underscores the significant influence of demographic and lifestyle factors on mobile behaviour, demonstrating how individual preferences and life stages shape technology engagement. By understanding these trends, stakeholders across technology, design, and research domains can better tailor innovations to meet the needs of diverse user groups. Future research could expand on these findings by examining regional variations, socioeconomic factors, and specific app or device preferences to further enhance the understanding of mobile usage patterns in a rapidly evolving digital landscape.

Reference:

1. Data Source: <https://www.kaggle.com/datasets/valakhorasani/mobile-device-usage-and-user-behavior-dataset>
2. User Behaviour Classification: <https://www.kaggle.com/code/samanyuk/user-behavior-class-100-accuracy>