

Analysis of the Influence of Quality of Services and Experiences on Average Revenue per User (ARPU) on Cellular Operators in Indonesia

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ABSTRACT

This study analyzes the effect of Quality of Service (QoS) and Quality of Experience (QoE) on Average Revenue per User (ARPU) for three major mobile operators in Indonesia: Telkomsel, XL Axiata, and Indosat. This research uses semiannual observations (Q2 and Q4) from 2020 to 2024 and Spearman correlation analysis to measure relationships among the variables. The results show a strong, significant positive correlation between improvements in quality of service (QoS/QoE) and increases in ARPU for XL Axiata and Indosat. In contrast, Telkomsel, despite excellent technical service quality, shows no significant correlation between service quality improvements and ARPU, suggesting that other factors, such as brand image, may be more influential for established operators in the market. The study also found that user preferences change over time, with gaming experiences becoming dominant in 2020-2021, shifting to upload speeds and voice applications in 2022, and download speeds becoming the primary focus in 2023-2024. These findings emphasize that mobile operators in Indonesia must continue adapting their service quality and user experience strategies to increase monetization and remain competitive in the dynamic telecommunications market.

1. Introduction

Indonesia's rapidly developing digital ecosystem has driven national internet penetration to 79.5% by 2024, with over 221 million users (Asosiasi Penyelenggara Jasa Internet Indonesia [APJII], 2024). Mobile devices dominate this trend, with 74.27% of connections coming from mobile data (APJII, 2024). The shift from 1G to 4G has moved communication from voice- and SMS-based to data-based, driven by the popularity of Over-The-Top (OTT) services such as WhatsApp and YouTube (Cholik, 2021). This transformation has fundamentally changed mobile operators' business models, which now focus on data services as their primary revenue source. Consequently, data traffic has surged, putting significant pressure on operators' network capacity and quality. In this competitive landscape, maintaining Quality of Service (QoS) and Quality of Experience (QoE) is critical to customer satisfaction and loyalty (Goyal & Kar, 2019; Rahmadi & Elsandra, 2025; Ribeiro et al., 2024). A positive user experience is associated with customer loyalty, whereas a poor service experience can encourage switching behavior (Arianto & Sari, 2023; Ribeiro et al., 2024). Despite Indonesia's high data consumption volume, the industry faces a major challenge in monetizing high-value users and improving Average Revenue Per User (ARPU) in a highly competitive market (Opensignal, 2021a). This situation requires operators to evaluate strategies that optimize network quality and user experience to support revenue growth.

2. Literature review

This study covers three main models: Quality of Service (QoS), Quality of Experience (QoE), and Average Revenue Per User (ARPU). Each model is defined in depth, along with relevant parameters and the rationale for its selection within the context of the Indonesian mobile telecommunications industry.

2.1 Quality of Service (QoS)

Quality of Service (QoS) refers to the overall characteristics of a telecommunications service that determine its ability to meet users' explicit and implicit needs (International Telecommunication Union [ITU], 2023). QoS is measured by user satisfaction from both technical and non-technical perspectives. This concept is divided into two main components:

1. **Network Performance:** Involves objectively measurable technical parameters to ensure optimal network performance. These parameters include latency (data transmission delay), jitter (fluctuation in packet arrival times), and packet loss (lost data packets) (ITU, 2023).
2. **Non-Network Performance:** Includes non-technical parameters such as time and repair service provision, rates, and speed of customer complaint resolution (ITU, 2022).

In this research, QoS is measured through the two most direct parameters felt by the user end: download and upload speed, both measured in megabits per second (Mbps) (Opensignal, 2022c).

1. **Download Speed:** Measuring how fast data is transferred from the internet to the user's device. Speed matters for activities like watching high-quality streaming videos without buffering or downloading large files efficiently (Opensignal, 2022c).
2. **Upload Speed:** Measuring how fast data is sent from the user's device to the internet. This is crucial for activities like clear video calls, uploading content to social media, or collaborative work using cloud platforms (Opensignal, 2022c).

2.2 Quality of Experience (QoE)

Different from QoS, which is Technical, Quality of Experience (QoE) is defined as the level of satisfaction or annoyance a user has with an application or service. QoE is a holistic, subjective view of the quality of services received. This concept is influenced not only by network technical parameters but also by user expectations, usage context, and psychological factors. This research adopts three QoE parameters, with data sourced from the OpenSignal report. Each parameter is assessed on a 0-100 scale (ITU, 2023; Opensignal, 2022c).

1. **Video Experience:** Measures the video quality received by a mobile device, based on the International Telecommunication Union (ITU) approach that examines the relationship between technical parameters (image quality, loading time, traffic congestion level) and the perceived user experience. A score above 78 is considered "Very Good," while a score below 48 is considered "Poor" (Opensignal, 2022c).
2. **Game Experience:** Measures the user experience when playing real-time multiplayer mobile games. This metric is highly sensitive to latency, jitter, and packet loss. A score above 85 is categorized as "Very Good," while a score below 40 is categorized as "Very Poor" (Opensignal, 2022c).
3. **Voice App Experience:** Measures the quality of over-the-top (OTT) voice services on apps like WhatsApp or Telegram, using an ITU standards-based data model. A score above 95 indicates "Very Good," while a score below 45 indicates "Impossible to Communicate" (Opensignal, 2022c).

The selection of these three QoE parameters is based on the service's popularity and sensitivity to network quality. Video streaming is a major entertainment and educational service that is highly affected by buffering. Online gaming is a "stress test" for networks because it is highly sensitive to lag. However, voice applications remain a crucial communication function, where clarity and continuity are crucial for users (Opensignal, 2022c).

2.3 Average Revenue Per User (ARPU)

Average Revenue Per User (ARPU) is a key financial indicator in the telecommunications industry that measures the average revenue generated per subscriber over a specific period (Rahman et al., 2023). ARPU is calculated by dividing total revenue by the number of active subscribers. Operators often differentiate between prepaid ARPU, postpaid ARPU, and Combined ARPU. This study specifically uses Combined ARPU to gain a holistic view. ARPU plays a crucial role in the telecommunications industry:

1. Measuring Performance and Efficiency: ARPU serves as a metric for measuring the effectiveness of customer base monetization and the efficiency of product strategies (Rahman et al., 2023).
2. Reflecting Service Quality: ARPU generally does not directly reflect QoS and QoE, as users are generally willing to pay more for faster, more stable, and smoother service (Goyal & Kar, 2019; Opensignal, 2021a; Rahmadi & Elsandra, 2025).
3. Basis for Strategic Decision-Making: ARPU serves as a basis for investment decisions, such as network expansion or the launch of new technologies, and for market segmentation and pricing strategy determination (Rahman et al., 2023).
4. Competitiveness Indicator: In financial reports, a high ARPU is often seen as a reflection of attractive products and good customer loyalty, indicating a strong market position (Arianto & Sari, 2023; Ribeiro et al., 2024).

3. Method

By following the systematic framework and methods used in this research, the objectives were achieved, and the research questions were answered scientifically. This methodology encompasses the research channels, approaches, objects, data sources, variables, and data analysis techniques used.

3.1 Flow, Types, and Approaches

This study follows a structured workflow as shown in Figure 1, starting with data collection, followed by Spearman's correlation test, then interpretation of the results, and concluding with conclusions and recommendations. The approach was quantitative because the research objective was to measure relationships between variables using numerical data and statistical analysis. Specifically, this study used descriptive and correlational methods.

The primary objective is to evaluate the relationship between quality of service (QoS) and quality of experience (QoE) metrics and Average Revenue Per User (ARPU) across operators. This study also analyzes differences in correlation patterns across operators to provide strategic implications and identify annual correlation trends from 2020 to 2024 to understand shifts in customer preferences over time.

3.2 Objects, Data Sources, and Time

The research focuses on three major mobile operators in Indonesia: Telkomsel, XL Axiata, and Indosat Ooredoo Hutchison. These three operators were chosen because they are dominant players in the Indonesian telecommunications market, allowing their analysis to provide a representative picture of industry dynamics (Naeruz, 2020). This study uses secondary data at semiannual observation points (Q2 and Q4) from Q2 2020 to Q4 2024. The data source for the QoS and QoE variables is OpenSignal, using the Indonesia Mobile Network Experience reports published during 2020-2024 (Opensignal, 2020a, 2020b, 2021b, 2021c, 2022a, 2022b, 2023a, 2023b, 2024a, 2024b). OpenSignal collects data from users' devices to reflect real-world mobile network experience (OpenSignal, 2024b). Meanwhile, ARPU data are obtained from the published financial and performance reports of XL Axiata (PT XL Axiata Tbk, 2020a, 2020b, 2021a, 2021b, 2022a, 2022b, 2023a, 2023b, 2024a, 2024b), Indosat (PT Indosat Tbk, 2020a, 2020b, 2021a, 2021b, 2022a, 2022b, 2023a, 2023b, 2024a,

2024b), and Telkom/Telkomsel (PT Telkom Indonesia (Persero) Tbk, 2020a, 2020b, 2021a, 2021b, 2022a, 2022b, 2023a, 2023b, 2024a, 2024b). The data collection technique used is a documentary study.

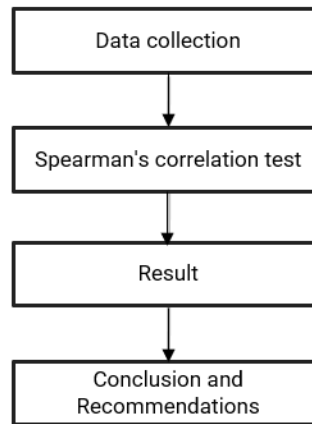


Figure 1. Research Flow

3.3 Variables Research and Operational Definition

This study divides the variables into independent variables (QoS and QoE) and a dependent variable (ARPU).

1. Independent Variables

- a) Quality of Service (QoS) is measured through two main metrics (Opensignal, 2022c):
 - 1) Download Speed: The speed of data transfer from the server to the user's device, measured in megabits per second (Mb/s).
 - 2) Upload Speed: The speed of data transfer from the user's device to the server, measured in Megabits per second (Mb/s).
- b) Quality of Experience (QoE) is measured through three dimensions of user perception (Opensignal, 2022c):
 - 1) Video Experience: User perception of quality when streaming video, including clarity, stability, and buffering, measured in points.
 - 2) Gaming Experience: Perception of quality when playing online games, including responsiveness and graphics quality, measured in points.
 - 3) Voice App Experience: Perception of quality when using voice-based communication services in apps, including voice clarity and connection stability, measured in points.

2. Dependent Variables

Average Revenue Per User (ARPU): The average revenue generated per user. This study uses combined ARPU (postpaid and prepaid ARPU) to obtain a holistic view of a company's monetization performance. ARPU is expressed in thousands of Rupiah for each Q2/Q4 observation (Rahman et al., 2023).

3.4 Data Processing and Analysis Methods

Data analysis was carried out using three main techniques:

1. Descriptive Analysis: Used to provide a comprehensive description of the trends and developments of each studied variable for each operator during the 2020-2024 period. Data are presented through graphs and tables for visualization.

2. **Spearman Rank Correlation Analysis:** This method was chosen as the primary analytical tool to measure the strength and direction of the relationship between QoS/QoE variables and ARPU (Nelvidawati & Kasman, 2023). The Spearman correlation was chosen for three main reasons:
 - Capability to Capture Non-Linear Relationships:** The relationship between network quality and ARPU is not always linear. Speed improvements at low rates can potentially have a greater impact than improvements at high rates. Spearman can capture this monotonic relationship.
 - Does Not Require Normal Distribution Assumptions:** As a non-parametric test, Spearman does not require normally distributed data, making it suitable for real-world financial performance data.
 - Suitability with Ordinal Data:** This method suits QoE variables measured on a point scale, where rank or ordinal scores matter more than absolute values.

Spearman's rank correlation coefficient (ρ) is calculated using the following formula (Nelvidawati & Kasman, 2023).

$$\rho = 1 - [6 \sum(d_i^2)] / [n(n^2 - 1)] \quad 1)$$

Where:

ρ = Spearman rank correlation coefficient

d_i = Difference between the paired ranks for observation i

n = Number of paired observations

Table 1. Interpretation of rho Values

rho Positive	rho Negative	Category
$0.90 \leq \rho \leq 1.00$	$-1.00 \leq \rho \leq -0.90$	Very strong
$0.70 \leq \rho < 0.90$	$-0.90 < \rho \leq -0.70$	Strong
$0.50 \leq \rho < 0.70$	$-0.70 < \rho \leq -0.50$	Moderate
$0.30 \leq \rho < 0.50$	$-0.50 < \rho \leq -0.30$	Weak
$0.00 \leq \rho < 0.30$	$-0.30 < \rho < 0.00$	Very weak

Spearman's correlation coefficient value is always between -1 and +1, indicating that the resulting correlation is always within clear limits. The direction of the relationship between variables is indicated by a positive (+) or negative (-) sign in the correlation coefficient figures in Table 1. A positive (+) sign indicates a unidirectional (positive) relationship, meaning that when the first variable increases, the second also tends to increase. Conversely, a negative (-) sign indicates the opposite (negative) relationship: when the first variable increases, the second tends to decrease (Nelvidawati & Kasman, 2023).

3. **Comparative Analysis:** This analysis was conducted by comparing the correlation results between the three operators. The goal was to draw meaningful conclusions about differences in the impact of QoS and QoE on ARPU for each operator, providing additional insight into the factors influencing monetization performance in the Indonesian telecommunications market.

4. Results and Discussion

The analysis used two main approaches: visual trend analysis to identify general patterns and Spearman's correlation test to measure the strength and statistical significance of relationships between variables.

4.1 Speed Trend Download against ARPU

Analysis of data trends from the second quarter (Q2) of 2020 to the fourth quarter (Q4) of 2024 shows that the relationship between download speed and Average Revenue Per User (ARPU) varies across mobile operators. In general, increases in download speed are not always accompanied by increases in ARPU, and this pattern is consistent across operators. Telkomsel consistently recorded the highest download speeds throughout the observation period, but ARPU values tended to remain relatively stable and even declined slightly in some periods. This suggests that superior download speed is not yet the primary driver of Telkomsel's ARPU increase. In contrast, XL Axiata and Indosat show a more consistent pattern, where ARPU increases accompany year-over-year increases in download speed. Download speeds for both operators nearly doubled over the study period, with relatively stable ARPU increases, indicating a positive relationship between the two variables.

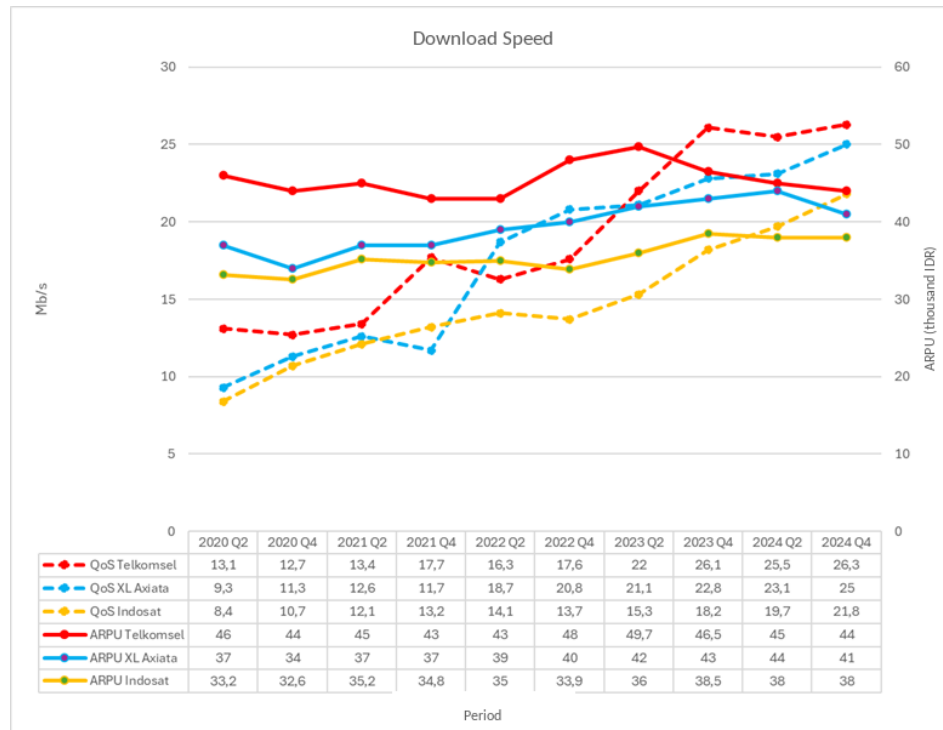


Figure 2. Speed Trend Download against ARPU

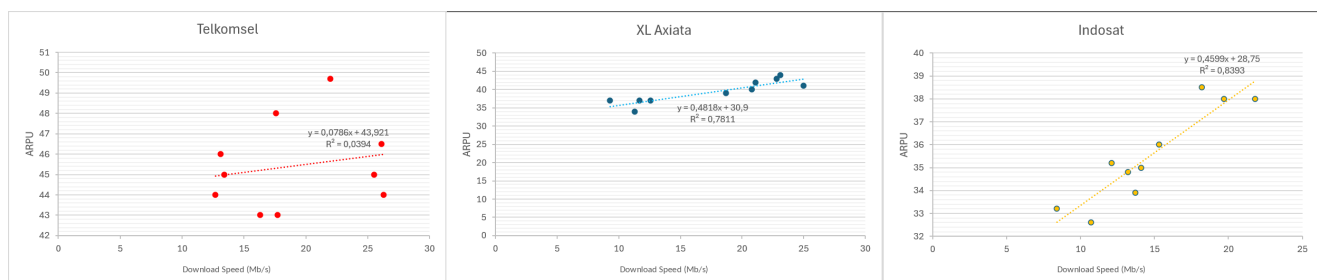


Figure 3. Scatter Plot Download against ARPU

This finding is reinforced by the scatterplot visualization in Figure 3, which depicts the relationship between download speed and ARPU for each operator. Visually, Telkomsel shows a relatively random distribution of data points with a very weak positive correlation, so ARPU does not consistently increase with download speed. In contrast, the scatterplots for XL Axiata and Indosat show a more regular distribution and an upward trend,

indicating that higher download speed tends to be followed by higher ARPU. Compared with XL Axiata, Indosat's relationship pattern appears more consistent, as the data points cluster more tightly around the trend.

4.2 Speed Trend Upload against ARPU

Based on the data trend analysis in Figure 4 from 2020 to 2024, the relationship between upload speed and Average Revenue Per User (ARPU) shows a distinct pattern across Indonesian mobile operators. The upload-speed pattern mirrors the download-speed trend, with a clear distinction between market leader Telkomsel and competitors XL Axiata and Indosat.

Telkomsel consistently recorded the highest upload speeds throughout the study period. However, this technical superiority was not accompanied by a comparable increase in ARPU. Instead, Telkomsel's ARPU tended to stagnate and even decline in several periods, particularly towards the end of the observation period. This indicates that improvements in network quality, particularly upload speed, have not consistently driven increases in average revenue per user. This suggests Telkomsel has entered a more mature market phase, where service-quality improvements are no longer a primary driver of ARPU.

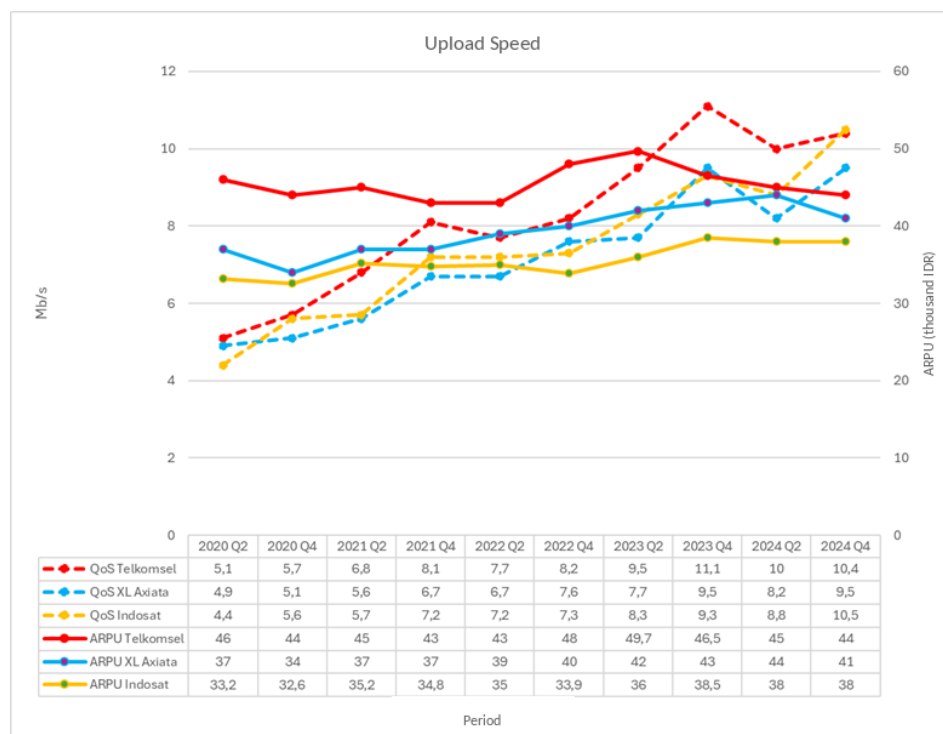


Figure 4. Speed Trend Upload against ARPU

In contrast, XL Axiata and Indosat exhibited a different pattern. Both operators gradually increased upload speeds throughout the study period, followed by a relatively consistent rise in ARPU. ARPU growth for XL Axiata and Indosat began to emerge along with increases in upload speeds from 2021 to 2022. This indicates that improvements in network quality, particularly for upload activities such as social media content sharing, video conferencing, and other digital services, have the potential to increase customer-perceived value, thus encouraging the use of higher-value service packages (Allana et al., 2022; Musikasari et al., 2021; Rahmadi & Elsandra, 2025).

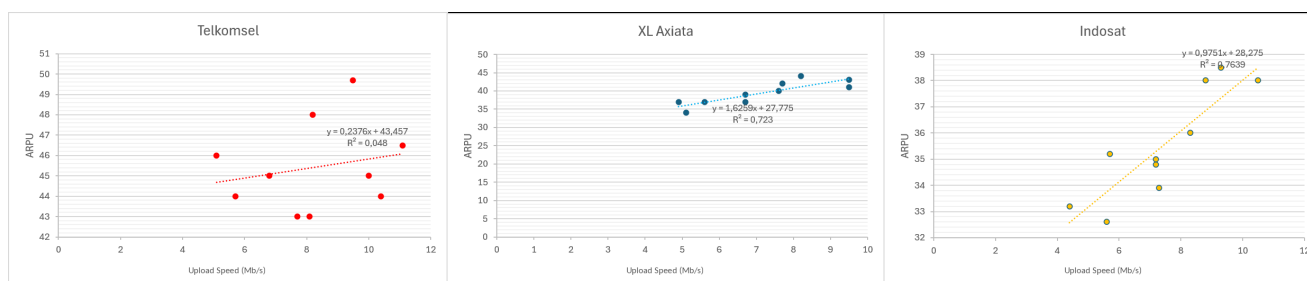


Figure 5. Scatter Plot: Upload against ARPU

Figure 5 scatterplot supports this finding by showing the relationship between upload speed and ARPU for each operator. For Telkomsel, the data points appear relatively random, indicating no consistent relationship between increases in upload speed and ARPU. Conversely, for XL Axiata and Indosat, the data points tend to form an upward trend, indicating that ARPU generally increases with upload speed. Indosat's pattern appears slightly more consistent than XL Axiata's, while Telkomsel shows greater variation, making the relationship between the two variables less visually clear.

4.3 Video Experience Trends against ARPU

An analysis of video experience trends on Average Revenue Per User (ARPU) from 2020 to 2024 (Figure 6) shows that the impact of video experience quality on ARPU varies across operators. From the beginning of the observation period through 2022, Telkomsel consistently had the highest video experience score, consistent with its relatively higher ARPU compared to other operators. However, in 2022, video experience scores fell across all operators, indicating a decline in video service quality during that period.

Each operator responded differently to changes in video quality. For XL Axiata, ARPU continued to trend upward despite a decline in the video experience score in 2022. This indicates that changes in video experience quality did not directly translate into changes in ARPU. Therefore, it is possible that other factors, such as pricing strategy, service packages, or improvements in the quality of other digital services, had a greater impact on average revenue per user than video experience itself (Musikasari et al., 2021; Subkhan & Barrygian, 2024).

In contrast, Indosat showed a more consistent pattern between video experience and ARPU. ARPU declined in 2022, following the decline in video experience scores. Then, when video experience quality improved again in 2023, ARPU also increased. This pattern suggests that improvements in video experience quality can help increase average revenue per user at Indosat.

Meanwhile, at Telkomsel, the relationship between video experience and ARPU did not show a consistent pattern. Although ARPU declined in early 2022 in line with the decline in video experience scores, ARPU increased again at the end of the year, even though changes in video quality did not follow the same pattern. This condition indicates that changes in video experience cannot consistently explain changes in ARPU at Telkomsel.

This finding is reinforced by the scatterplot visualization in Figure 7, which illustrates the relationship between video experience and ARPU for each operator. At Telkomsel, the data points do not form a clear pattern, indicating that increases in video experience quality do not always lead to higher ARPU. A similar pattern also appears at XL Axiata, where data points are spread out without a consistent relationship between the two variables. In contrast, at Indosat, the data points show an upward trend, visually indicating that increases in ARPU generally accompany improvements in video experience quality. This pattern aligns with the trend analysis results, which show that changes in video experience at Indosat tend to move in the same direction as changes in ARPU during the observation period.

Overall, the trend analysis and scatterplot visualization provide a mutually supportive picture, indicating that the relationship between video experience and ARPU is clearer at Indosat than at Telkomsel and XL Axiata. At Telkomsel and XL Axiata, changes in video experience quality have not shown a consistent relationship with changes in ARPU, suggesting that other factors likely dominate in influencing average revenue per user.

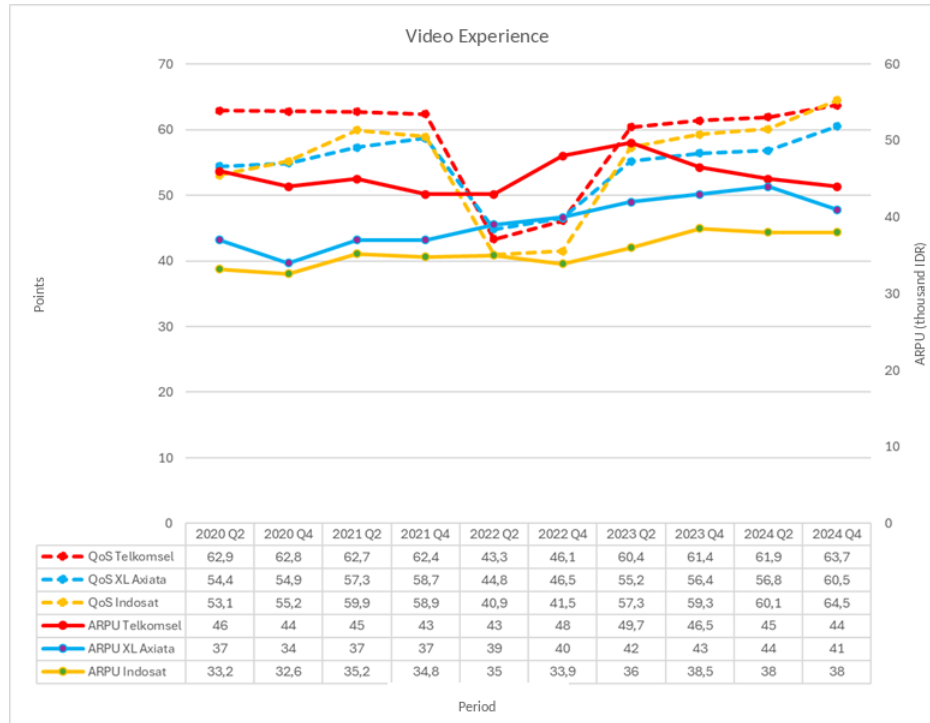


Figure 6. Video Experience Trends against ARPU

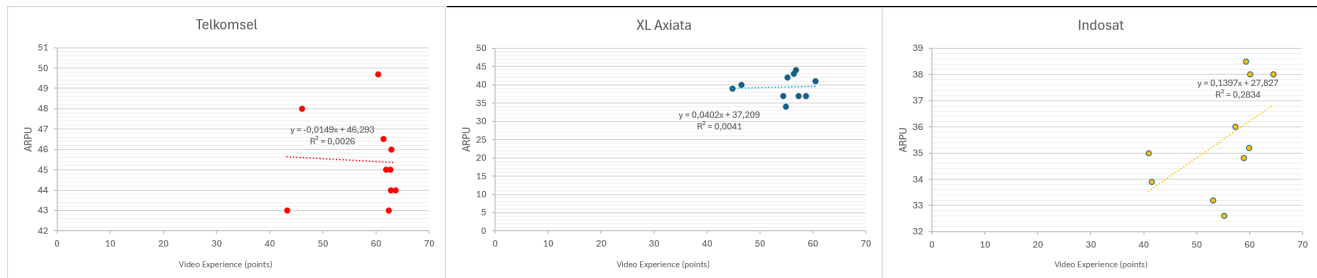


Figure 7. Scatter Plot Video Experience against ARPU

4.4 Experience Trends Gaming vs ARPU

Figure 8 clearly presents the historical trend analysis of gaming experience for 2020–2024, highlighting differences in growth strategies and their impact on Average Revenue Per User (ARPU) for each mobile operator. For XL Axiata and Indosat, this trend tells a success story: gaming experience scores rose sharply, especially in 2023, followed by corresponding ARPU growth. This suggests that improving gaming experience quality is an effective strategy for driving revenue growth for both operators.

In contrast, Telkomsel exhibits the opposite dynamic. While Telkomsel has consistently maintained relatively high gaming experience scores, peaking in 2024, its ARPU has not increased. In fact, Telkomsel's ARPU tends to decline in 2023–2024, precisely when gaming experience is at its optimal level. This time-series finding suggests that, for Telkomsel, the gaming segment no longer contributes significantly to per-user revenue growth.

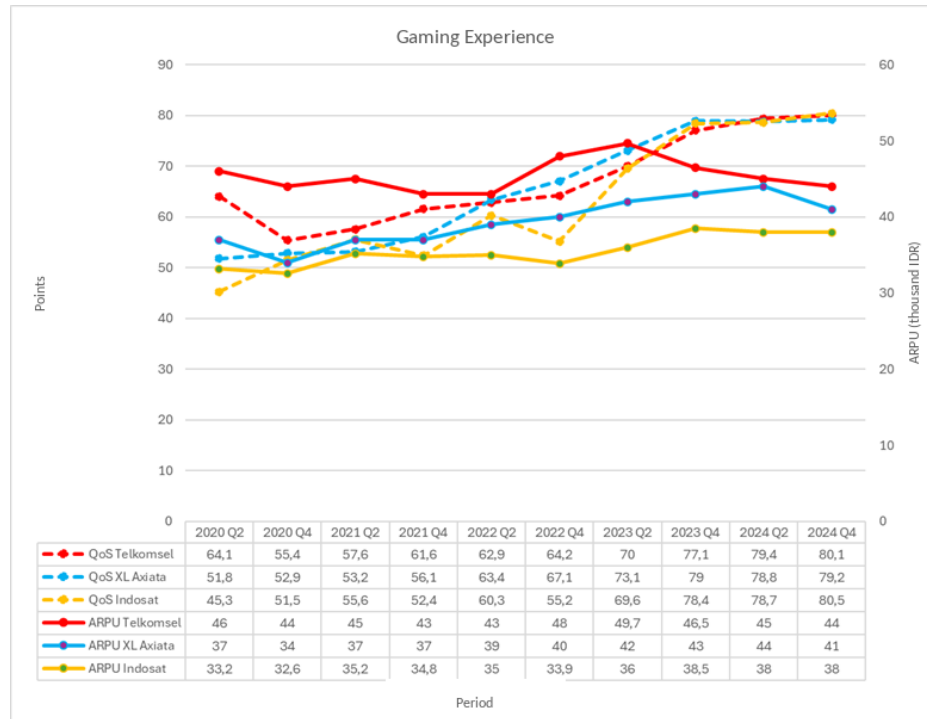


Figure 8. Trend of Depreciation Playing Games against ARPU

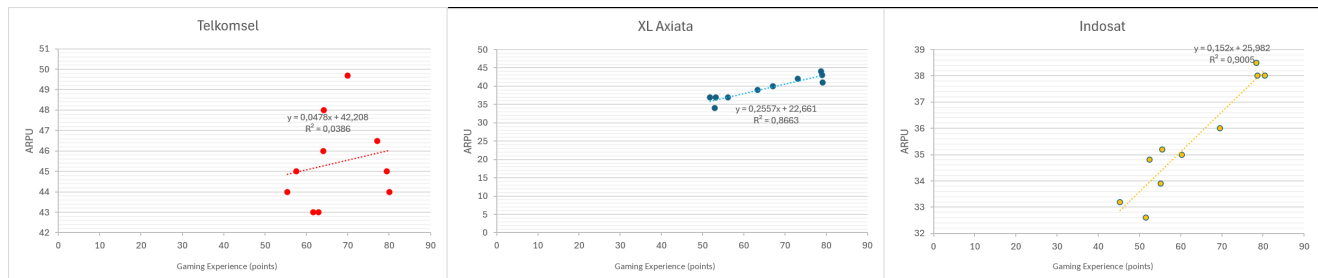


Figure 9. Scatter Plot Playing Games against ARPU

Based on Figure 9 for XL Axiata and Indosat, the data point distribution shows a very strong, regular positive relationship. This pattern shows that increases in gaming variables are consistently proportional to increases in ARPU, with XL Axiata showing the strongest revenue-growth response. Indosat also shows the most stable and predictable correlation. In contrast, the data point distribution for Telkomsel appears random and shows no clear pattern, strongly confirming that gaming variables have no significant correlation with ARPU movements.

Thus, the scatterplot confirms that improving the quality of the gaming experience is a key driver of strong ARPU growth for XL Axiata and Indosat. For Telkomsel, the lack of correlation underscores the need for strategic reorientation and monetization diversification into other segments or services outside the gaming ecosystem (Opensignal, 2021a; Ribeiro et al., 2024).

4.5 Experience Trends: Voice Applications and ARPU

The analysis of voice app experience trends from 2020 to 2024, presented in Figure 10, shows varying impacts on Average Revenue Per User (ARPU) for each mobile operator. However, all operators recorded positive trends in quality scores. For Indosat and XL Axiata, the relationship is close, with improvements in voice

quality scores consistently accompanied by ARPU growth. This correlation is most striking for Indosat, suggesting that improvements in call data quality have increased the service's value in users' eyes, driving loyalty and usage frequency. XL Axiata exhibits a similar pattern, with ARPU growth coinciding with the rapid increase in its voice score after 2021. Overall, both operators have successfully translated improvements in voice app experience into revenue growth per user (Lailiyah & Chrismardani, 2021; Rahmadi & Elsandra, 2025).

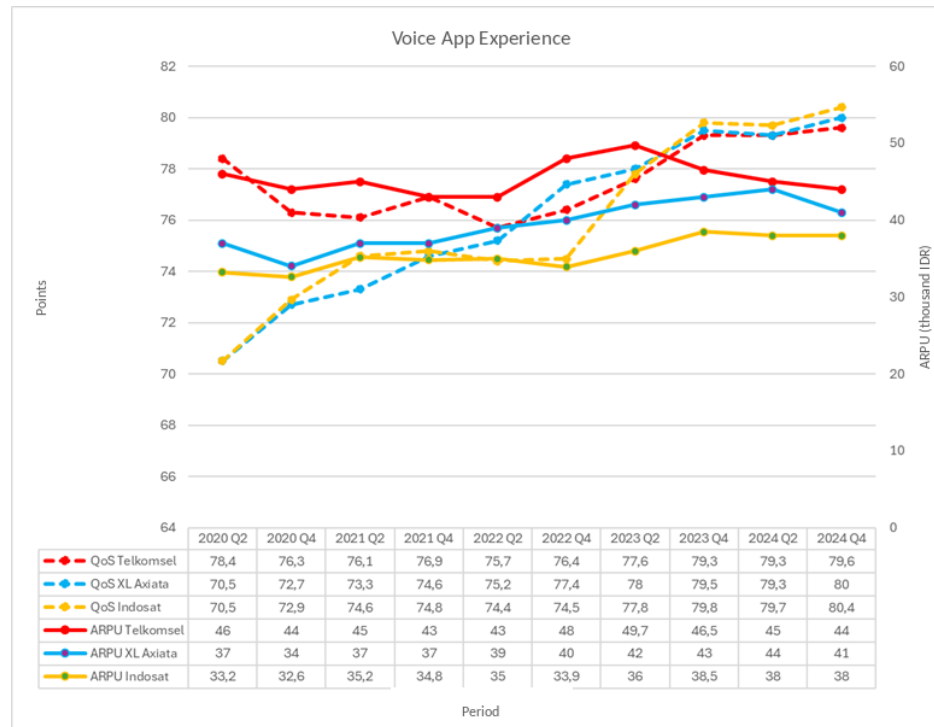


Figure 10. Experience Trends of Voice Applications to ARPU

On the other hand, Telkomsel exhibits a paradoxical phenomenon. Despite a relatively high voice app experience score at the start of the period, Telkomsel's ARPU declined over the same period. This suggests Telkomsel has long provided high-quality voice service standards, so further quality improvements no longer incentivize users to pay more. The decline in ARPU likely reflects escalating market competition and user migration to high-quality OTT app-based calling services, facilitated by Telkomsel's superior network quality (Arianto & Sari, 2023; Kusumahadi, 2021; Opensignal, 2021a).

In Figure 11, for Indosat and XL Axiata, the data distribution pattern shows a strong, regular positive relationship. This pattern empirically confirms that increases in voice variables are consistently proportional to ARPU growth. XL Axiata showed the highest sensitivity in revenue growth to improvements in voice services, while Indosat showed the most stable and predictable relationship. In contrast, the data points for Telkomsel appear random. It shows no clear pattern, strongly confirming that voice variables have no significant correlation with ARPU movements.

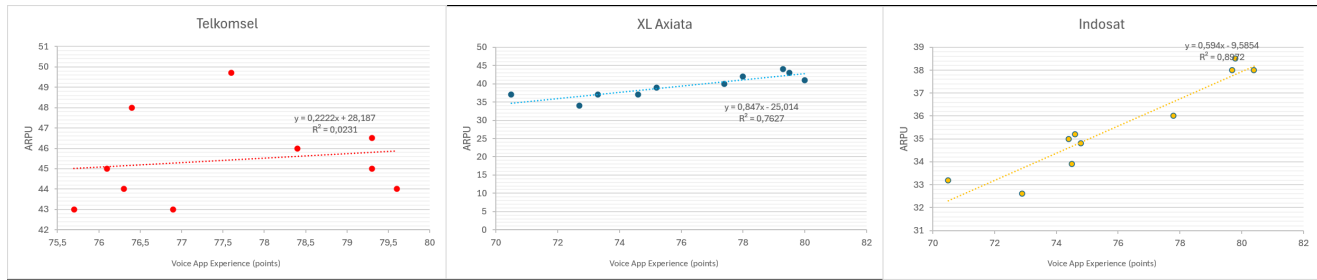


Figure 11. Scatter plot Voice Applications to ARPU

4.6 Spearman Correlation Test per Operator

This section presents the results of a quantitative statistical analysis evaluating the relationship between each QoS/QoE (Quality of Service/Quality of Experience) indicator variable and ARPU (Average Revenue per User). Using the Spearman rank correlation test, this study measures the strength and significance of the relationship for each operator: Telkomsel, XL Axiata, and Indosat. The significance test is conducted by comparing the resulting p-value with a significance level (α) set at 0.05. Figure 12 and Table 2 show the Spearman correlation and P-value of QoS/QoE against ARPU for each operator.

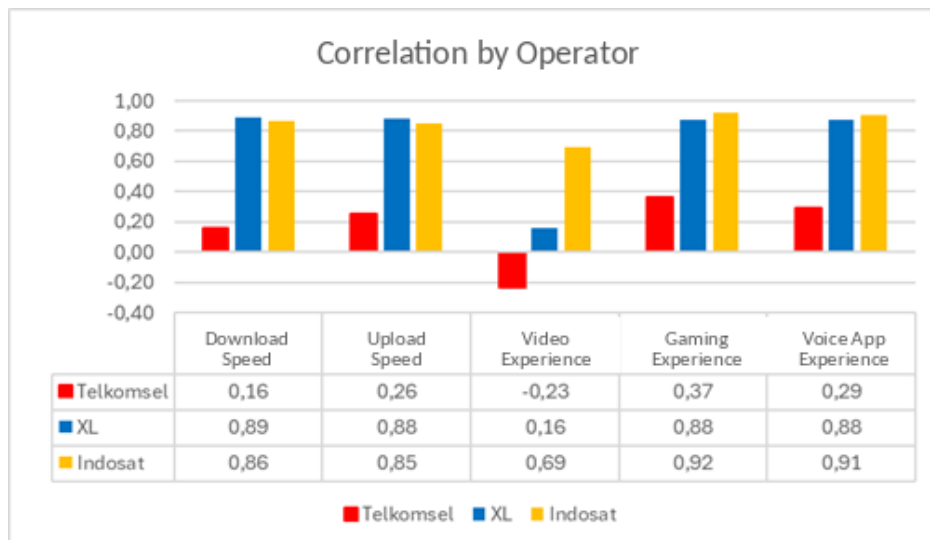


Figure 12. Correlation Test Results Per Operator

Telkomsel confirmed that the correlation between QoS/QoE metrics and ARPU tends to be lower compared to other operators. The strongest relationship was found in the Gaming Experience metric, with a correlation coefficient (ρ) of 0.37, which is classified as weak. However, this relationship is not statistically significant ($p = 0.20$). Another interesting finding is the negative correlation between Video Experience and ARPU. Overall, improving the quality of service provided by Telkomsel does not have a strong, significant relationship with increasing ARPU. This suggests that factors beyond technical quality, such as strong brand image and existing customer loyalty, likely play a larger role in determining Telkomsel's ARPU (Arianto & Sari, 2023; Kusumahadi, 2021; Ribeiro et al., 2024).

Table 2. Results of p-values between operators

Operator	Download Speed	Upload Speed	Video Experience	Gaming Experience	Voice App Experience
Telkomsel	0.34	0.28	0.30	0.20	0.26
XL	0.00	0.00	0.34	0.00	0.00
Indosat	0.00	0.00	0.02	0.00	0.00

At XL Axiata, we observed a strong, statistically significant correlation across nearly all tested metrics. The highest correlation coefficient was recorded for Download Speed ($\rho=0.89$), followed by Upload Speed, Gaming Experience, and Voice Application Experience, all with a $\rho=0.88$. All these strong correlations are supported by p-values well below 0.05, confirming statistical significance. These findings indicate a clear, direct relationship: improvements in network quality and user experience significantly increase ARPU. XL customers who receive the best quality service tend to have higher ARPU, underscoring the importance of investing in infrastructure and technology to meet customer demand and drive revenue (Allana et al., 2022; Musikasari et al., 2021; Rahmadi & Elsandra, 2025).

Like XL, Indosat also showed a very strong correlation between most QoS/QoE metrics and ARPU, indicating that customers are highly responsive to service quality improvements. However, Indosat's unique characteristic lies in its strong correlation in real-time applications. The highest correlation coefficients were found for Gaming Experience ($\rho=0.92$) and Voice Application Experience ($\rho=0.91$). Download ($\rho=0.86$) and upload ($\rho=0.85$) speed metrics also show a very strong correlation. All of these connections are statistically significant. This implies that, for Indosat, the dominant ARPU driver is user satisfaction from smooth app interactions, which is key to increasing potential revenue (Lailiyah & Chrismardani, 2021; Rahmadi & Elsandra, 2025).

4.7 Correlation Test per Year

Figure 13 and Table 3 show the Spearman correlation results per year and the P-values. The annual Spearman correlation analysis reveals how the Quality of Service (QoS) and Quality of Experience (QoE) metrics that most influence Average Revenue per User (ARPU) change from year to year, reflecting shifts in consumer preferences and behaviors across the Indonesian telecommunications industry.

In 2020, gaming experience showed the strongest and most statistically significant correlation with ARPU. With a correlation coefficient (ρ) of 0.89 and a p-value of 0.01, this finding indicates that operators with better gaming experience scores tend to have higher ARPU. This trend is supported by a data.ai report showing that Indonesia rose to third place in the world in terms of mobile game downloads on the Google Play Store in 2020 (data.ai, 2023).

The trend continued into 2021, with gaming experience remaining the dominant metric and strongly correlated with ARPU ($\rho=0.84$). This relationship remains statistically significant ($p=0.02$). The public's strong interest in mobile games remains persistent, driving high data consumption and a tendency to choose larger or dedicated gaming service packages, which directly contributes to higher ARPU (data.ai, 2023).

In 2022, a significant shift will occur. The metrics most strongly and significantly correlated with ARPU are upload speed ($\rho=0.77$) and app voice experience ($\rho=0.77$). Both metrics are statistically significant ($p=0.04$). This shift is closely related to the surge in social media users in Indonesia, which has reached 191.4 million. Increasingly active user behavior in uploading content, conducting live broadcasts, and interacting through voice calls or messages demands good upload quality and low latency, which ultimately has a positive impact on ARPU (Kemp, 2022).

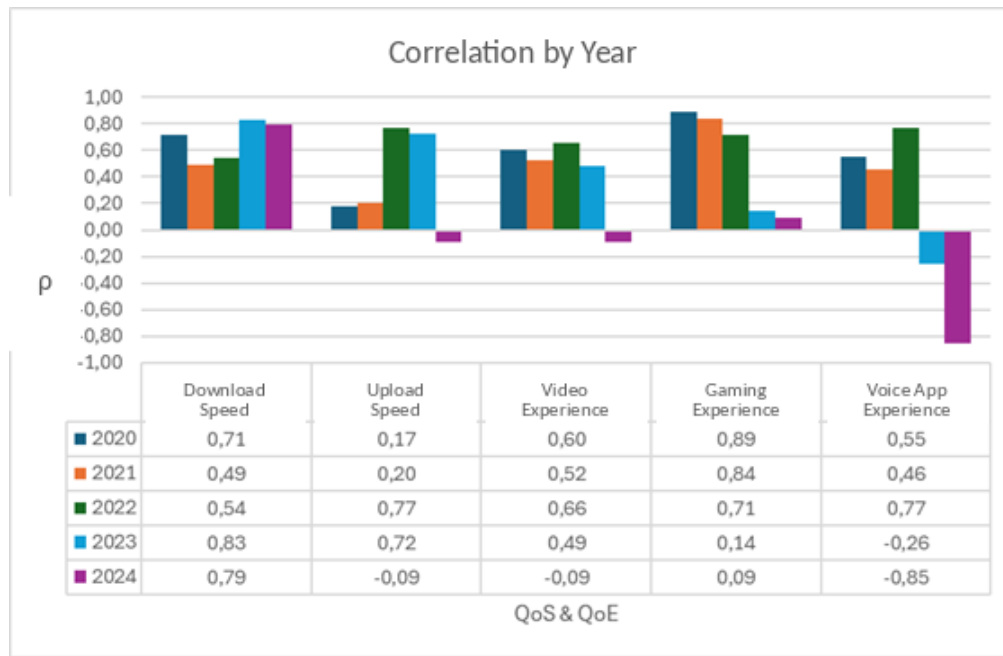


Figure 13. Correlation Results per Year

Table 3. P-Value of correlation every year

Year	Download Speed	Upload Speed	Video Experience	Gaming Experience	Voice App Experience
2020	0.06	0.35	0.12	0.01	0.15
2021	0.19	0.34	0.17	0.02	0.21
2022	0.16	0.04	0.09	0.06	0.04
2023	0.02	0.06	0.19	0.36	0.32
2024	0.03	0.37	0.37	0.37	0.02

This trend reversed in 2023, with download speed becoming the metric most strongly correlated with ARPU ($\rho=0.83$) and statistically significant ($p\text{-value}=0.02$). This trend aligns with the increasing use of data-intensive applications, such as high-quality video services (HD/4K), large-format mobile games, and cloud applications. This increased application intensity encouraged consumers to choose larger data packages, contributing to higher mobile operators' ARPU (Kemp, 2024; Subkhan & Barrygian, 2024).

The trend from 2023 continued into 2024, with download speed remaining a key factor and showing a strong, significant correlation ($\rho=0.79$; $p\text{-value}=0.03$). This trend was driven by the increasing adoption of high-resolution video content and the growth of the digital creator economy. Active user behavior in downloading content, live streaming, and updating large-format apps and games reinforces the role of download speed as a key determinant in ARPU growth strategies. Operators that provide high download speeds tend to be more competitive in attracting customers from high-data-consumption segments (Kemp, 2024).

5. Conclusion

The relationship between Quality of Service (QoS), Quality of Experience (QoE), and Average Revenue per User (ARPU) in the Indonesian telecommunications industry shows varying and inconsistent trends across major players. This study's main finding is that network quality improvements affect ARPU differently for each

operator. For XL Axiata and Indosat, we found a clear and significant relationship: improvements in network quality, speed (QoS), and user experience in applications (QoE) were positively correlated with ARPU increases. This indicates that customers of both operators are highly responsive to service improvements and willing to increase spending as their digital experience improves. In contrast, Telkomsel shows a different dynamic. Although Telkomsel consistently has superior network quality and the highest ARPU among the three, this study did not find a significant increase in ARPU despite continued network quality improvements. Telkomsel's ARPU growth tends to be slower than its competitors'. This suggests that for operators that have reached a mature level of quality and market penetration, technical quality improvements alone are no longer the primary driver of revenue growth. Therefore, Telkomsel needs a more creative strategic approach to drive future ARPU growth. Further research also concluded that while network quality generally correlates with ARPU, its impact is not static. Internet users' preferences and focus shift from year to year, causing the QoS/QoE metrics that most influence ARPU to change. As content and applications become more demanding and require greater data consumption, internet users' behaviors and priorities also evolve, ultimately impacting ARPU correlation. Therefore, telecommunications operators need a deep understanding of how user behavior and preferences change to design effective, relevant ARPU-boosting strategies.

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