Assessment and Evaluation of Mobile Internet Speed in Cabanatuan City: Basis for Proposed Upgrades in Cellular Data Networks among Different Cellular Network Operators

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***Abstract*—This study examines the mobile internet speed of three major cellular network providers in Cabanatuan City, Philippines: Globe Telecom, Smart Communication, and Dito Telecom. The research aims to evaluate mobile network performance, specifically in terms of download speed, upload speed, and latency, using two speed test applications (Ookla and Meteor) across 296 sampling points over 59.2 kilometers of major roads and highways. A quantitative, descriptive-experimental approach was used, with statistical analysis employing One-way ANOVA to determine significant differences between network operators and measurement applications. Findings indicate that Dito Telecom demonstrated the highest average download speed (26.35 Mbps), followed by Smart (16.94 Mbps) and Globe (11.85 Mbps). Average upload speeds varied, with Smart leading (11.95 Mbps), followed by Dito (9.34 Mbps) and Globe (6.78 Mbps). Latency and upload differences were not significant between operators, but network download speed varied significantly between the measurement applications. Recommendations include enhancing network speed and coverage in identified weak areas, ensuring uniformity in speed performance, and expanding research sampling areas in future studies. This research provides a foundation for targeted network improvements and is intended to support reliable mobile connectivity in Cabanatuan City.**

***Index Terms*— Cabanatuan City, Cellular Network Performance, Download and Upload Speeds, Mobile Internet Speed, Latency**

I. INTRODUCTION

In today's interconnected society, electronic communication is central to social, economic, and educational activities, providing a foundation for rapid and efficient information exchange (Chang et al., 2022). This capability allows individuals to participate in a range of activities, from online commerce to virtual education, with unprecedented immediacy and access. Cellular communication, as a subset of electronic communication, has transformed access to digital resources by enabling users to connect to the internet from virtually any location via mobile networks (Božanić & Sinha, 2021).

The Philippines, where cellular communication is a primary mode of internet access, is served by three major providers—Globe Telecom, Smart Communications, and Dito Telecom—which together offer mobile internet to millions of users nationwide (Serafica & Oren, 2022). These providers enable digital access to services that underpin social interactions and business transactions, making network performance a matter of public interest and relevance. Mobile internet speed, in particular, is a critical component of user experience, as it directly affects the quality of online services and activities such as streaming, virtual learning, and remote work (Kim & Park, 2021).

Globally, mobile internet speed varies widely based on infrastructure, investment, and technological advances. The average global mobile internet download speed as of early 2024 was 50 Mbps, with an average upload speed of 11.3 Mbps, although these averages are subject to significant regional variation. For instance, in Asia, download speeds typically range around 35 Mbps, with upload speeds closer to 8 Mbps, reflecting differences in network coverage and technology across countries (Speedtest Global Index, 2024; Taylor, 2024). In the Philippines, which ranks below the global average, the national mobile internet speed averages 34.52 Mbps for download and 8.3 Mbps for upload (Speedtest Global Index, 2024). This discrepancy is influenced by challenges in infrastructure expansion, geographic barriers, and high

subscriber density in urban areas (Hambly & Rajabiun, 2021).

The impact of mobile internet speed is substantial, affecting users' ability to participate in essential activities. For instance, faster download speeds support high-quality video streaming and efficient file transfers, while lower latency facilitates responsive online interactions such as video conferencing and online gaming (Yaqoob et al., 2020). As more users rely on mobile networks for work and leisure, network quality has become increasingly vital, making it essential to regularly assess and address performance differences among service providers.

This study seeks to evaluate the mobile internet connectivity speeds offered by Globe, Smart, and Dito within Cabanatuan City, Philippines. Cabanatuan City, a rapidly growing urban center, experiences high demand for reliable mobile network connectivity due to its growing population and thriving local economy. By analyzing download speed, upload speed, and latency across different locations, this study provides a detailed performance evaluation of each network provider, aiming to identify areas for improvement. The findings are expected to contribute valuable insights for network providers, policymakers, and local authorities seeking to enhance digital infrastructure and bridge the connectivity gap in regional areas.

Enhanced connectivity can support broader objectives, such as economic growth and social inclusion, by allowing residents to access reliable online services and participate fully in the digital economy. This research, therefore, aligns with broader goals of promoting equitable access to digital resources and improving the quality of life for the residents of Cabanatuan City and similar urban centers in the Philippines.

II. RESEARCH PROBLEM AND HYPOTHESIS

The general objective of this study is to assess and evaluate the mobile internet speed of the three cellular network operators in Cabanatuan City as a basis of proposed upgrades in cellular network and increase in capacity among their mobile internet and specifically sought to answer the following questions:

1. How may the mobile internet speed among the three-network operator be described in terms of:
   a. Download speed
   b. Upload speed
   c. Latency
2. How may the mobile internet speed among the three-network operator be compared in terms of:
   a. Download speed
   b. Upload speed
   c. Latency
3. Is there is significant difference between the mobile data download, upload speed and latency reading among the two measurement applications used?
4. What are the implications of the study's findings for future improvements in mobile network connectivity and infrastructure in Cabanatuan City?

The following statement are the hypothesis of the study.

1. Ho: There is no significant different between mobile data download, upload speed and latency among the three cellular network providers.
2. Ho: There is no significant different between the measurement results of upload, download mobile speed and latency among the two measurements application.

III. METHODOLOGY

A. Research Design

This study used a quantitative type of research specifically the descriptive- experimental form. To describe the characteristics of different mobile network parameters the researchers get the weighted mean, the minimum and maximum values. The standard deviation is also defined to show the variability of the parameters in different network operators. One-way ANOVA was used by the researcher to test the significant difference between the network parameters of different network operators.

B. Locale of the Study

The research local of the study where the sample point of the experiment was carried out is in Cabanatuan City. A total of 296 sample test points or equivalent to 59.20 kilometers linear distance were taken along the main highways and main roads of Cabanatuan City as shown in Figure 1.

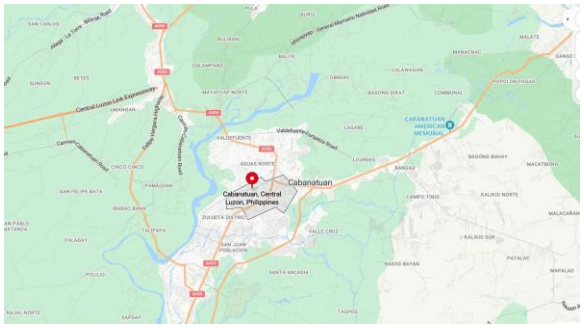

Figure 1. *Map of Cabanatuan City*

C Data Gathering Instrument

This study utilized an experimental data gathering techniques using mobile data speed applications. Sample mobile data speed was taken on both mobile speed application such as Ookla and Meteor. These applications were pre- installed in the three identical mobile cellular phones. The researchers used Oppo A5S model along with three mobile data sim cards. The individual mobile data sim card inserted in each mobile phone includes Smart, Globe and Dito network sim card.

D. Data Gathering Procedures

On the map, the researcher plotted the sample point spots along the main roads and highways of Cabanatuan City where the samples readings of different mobile data parameters were recorded. These sample point spots were equally spaced every 200-meter marked, the spacing is approximated between 3 electrical posts. The readings of the mobile data networks parameters such as download speed, upload speed and latency were recorded and tabulated at each sample point spot per segment area.

There are 6 segments area where the data were taken. Segment 1 is from NE Crossing to Cabu Cabanatuan City where a total of 63 sample points were taken. Segment 2 is from Jollibee Sumacab to Caalibangbangan via Felipe Vergara Highway where a total of 58 sample points were taken. Segment 3 is from NE Crossing to Sumacab where a total of 40 sample points were taken. Segment 4 is from NE Crossing to Caalibangbangan via Maharlika Highway where 43 sample points were taken. Segment 5 is from Bantog Cabanatuan to Santa Rosa Boundary via Emilio Vergara Highway where a total of 49 sample points were taken. Lastly, Segment 6 is from AGL to Aliaga Boundary via Pamaldan where a total of 43 sample points were taken.

E. Data Analysis Techniques

Data that has been generated from the experiment using the mobile speed test application on different sample points with different application software was treated using SPSS version 21. To describe the different mobile data speed parameters the researcher utilized the weighted mean, minimum, maximum values and the standard deviation. To compare the mean difference between different mobile data speed parameters the researchers used One- way ANOVA statistical treatment with 95% level of confidence. Lastly, the researcher also uses One- way ANOVA to compare the mean difference between the mobile speed parameters among the two-application tool used in the study.

IV. RESULTS AND DISCUSSION

Based on the data gathered and analyzed, the following results were obtained.

Table 1 displays the mobile network parameters (download speed, upload speed, and latency) for the three major network operators—Globe, Smart, and Dito Telecom—along major roads and highways in Cabanatuan City, covering 592 sample points. The findings indicate that, on average, Dito Telecom demonstrated the highest download speed at 26.35 Mbps, followed by Smart at 16.94 Mbps, and Globe at 11.85 Mbps. For upload speeds, Smart led with an average of 11.95 Mbps, followed by Dito at 9.34

Table 1. Mobile network parameters in major roads and highways of Cabanatuan City

Network Parameters	Network Operator	No. of sample points	Minimum	Maximum	Mean	SD
Network Download Speed (in Mbps)	Globe Telecom	592	0.00	50.70	11.85	9.43
	Smart Communication		0.00	114.00	16.94	17.31
	Dito Telecom		0.00	126.00	26.35	23.37
Network Upload Speed (in Mbps)	Globe Telecom	592	0.00	29.30	6.78	7.61
	Smart Communication		0.00	62.00	11.95	12.92
	Dito Telecom		0.00	48.50	9.34	9.60
	Globe Telecom	592	0.00	3944.00	41.21	167.21

Network Latency (in ms)	Smart Communication		20.00	5351.00	55.39	273.11
	Dito Telecom		0.00	249.00	52.94	19.26

Mbps and Globe at 6.78 Mbps. With regard to latency, Globe had the lowest latency at 41.21 ms, indicating potentially faster response times, while Dito and Smart had latencies of 52.94 ms and 55.39 ms, respectively.

These findings align with prior research indicating that download and upload speeds are key indicators of network performance, impacting users' ability to access data-intensive applications smoothly (Chau et al., 2020). High latency can lead to slower page loads, buffering, and lower responsiveness in applications, which is particularly critical for real-time services like online gaming and video conferencing (Santos et al., 2021). Thus, the lower latency observed with Globe's network may translate into a more responsive browsing experience for users, although there is the cost of slightly slower data transfer speeds.

Table 2 compares the network parameters of the three operators using one-way ANOVA to determine if there are statistically significant differences in their download speed, upload speed, and latency. For both download and upload speeds, the p-value is 0.000 ($p < 0.05$), indicating significant differences among the three operators. This suggests that network operators in Cabanatuan City vary meaningfully in their capabilities to provide data speeds, corroborating studies that highlight the disparities in mobile network performance across operators, often influenced by infrastructure investments and coverage limitations (Borralho et al., 2021).

However, the latency comparison yielded a p-value of 0.232, indicating no significant difference among the operators. This lack of variance in latency could imply a baseline level of infrastructure that ensures moderate responsiveness across all providers in the area. Prior studies have shown that latency is often less variable than download and upload speeds, as it can be affected by both internal network factors and external traffic conditions (Blessing, 2024).

Table 2. Comparison of mobile network parameters in major roads and highways of Cabanatuan City

Network Parameters	Network Operator	p-value	Interpretation
Network Download Speed (in Mbps)	Globe Telecom	0.000	significant
	Smart Communication		
	Dito Telecom		
Network Upload Speed (in Mbps)	Globe Telecom	0.000	significant
	Smart Communication		
	Dito Telecom		
Network Latency (in ms)	Globe Telecom	0.232	not significant
	Smart Communication		
	Dito Telecom		

Table 3. Comparison of speed test application in mobile network parameters test in major roads and highways of Cabanatuan City

Network Parameters	Speed Test Application	p-value	Interpretation
Network Download Speed (in Mbps)	Ookla	0.023	significant
	Meteor		
Network Upload Speed (in Mbps)	Ookla	0.650	not significant
	Meteor		
Network Latency (in ms)	Ookla	0.082	not significant
	Meteor		

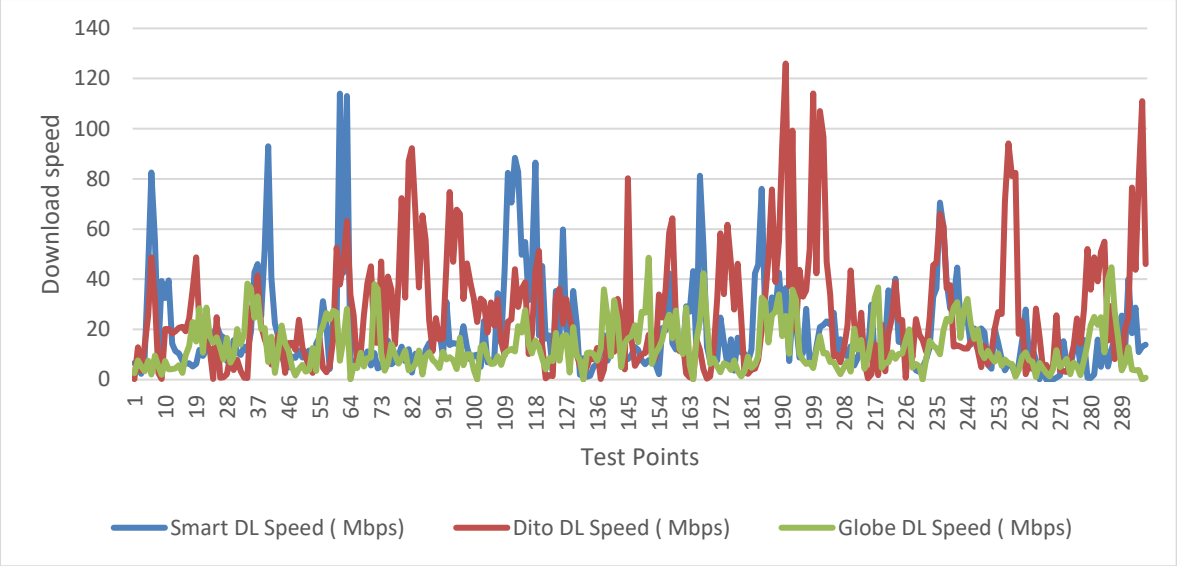

Figure 2. Download speed test results of all cellular network operators

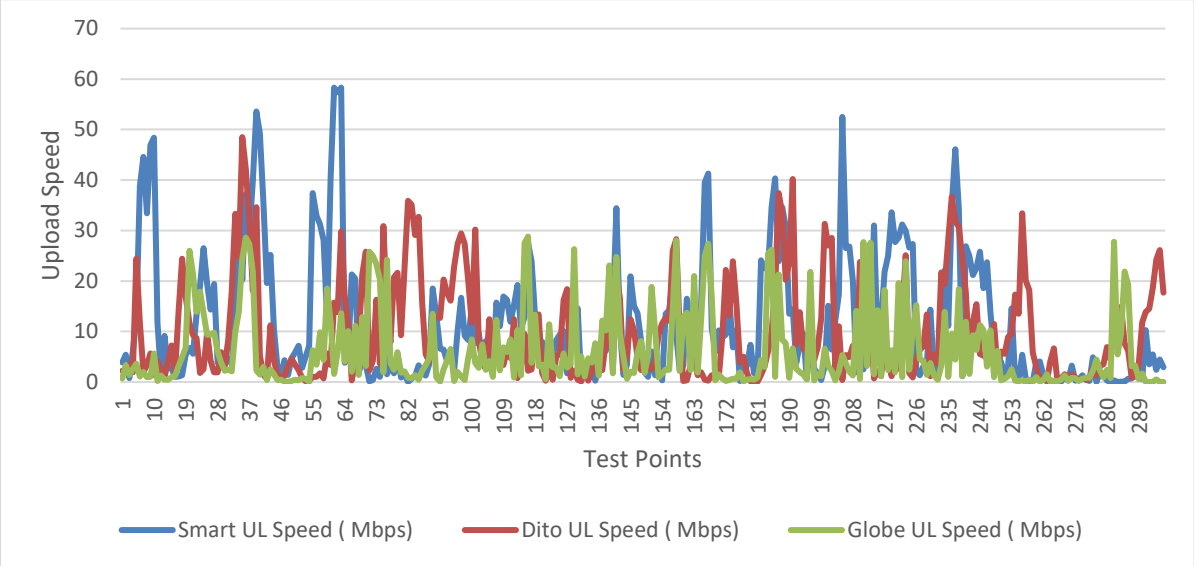

Figure 3. Upload speed test results of all cellular network operators

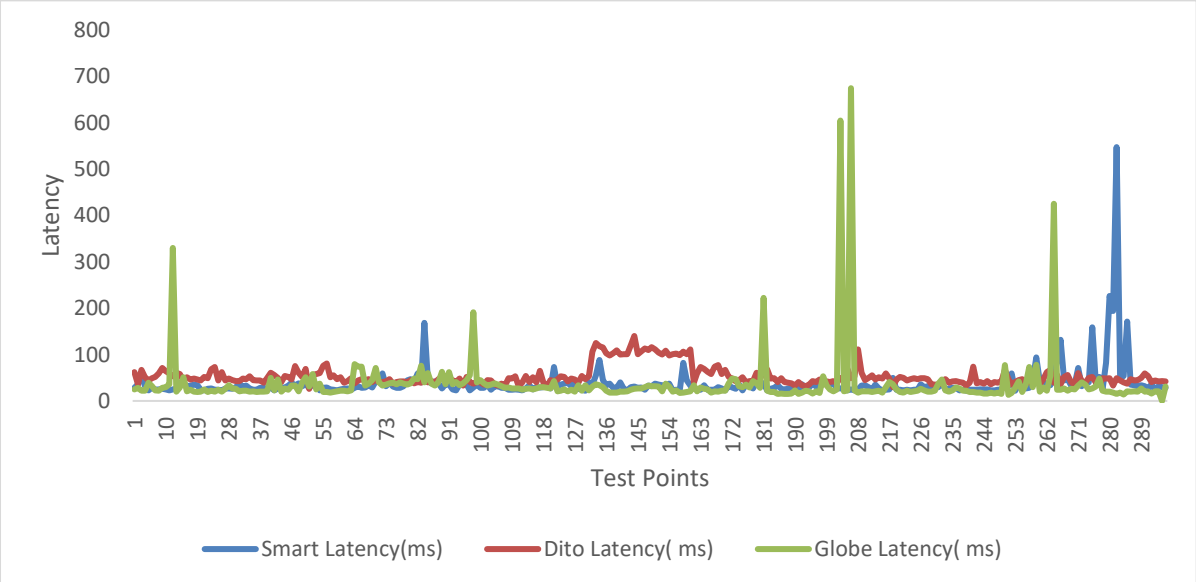

Figure 4. Network latency test results of all cellular network operators

Table 3 presents the results of comparing two speed test applications—Ookla and Meteor—used to measure network parameters. The p-value for download speed was 0.023 ($p < 0.05$), indicating a significant difference between the two applications for this parameter, while upload speed and latency had p-values of 0.650 and 0.082, respectively, indicating no significant differences. This finding suggests that while both applications are generally reliable, they may produce differing results for download speeds due to variations in testing protocols, server locations, and the methodology used to calculate final speeds (Feamster & Livingood, 2020).

Figures 2 through 4 illustrate the performance of each network operator across different segments of major roads and highways in Cabanatuan City. These visual representations allow for an easy comparison of network reliability across locations. Dito's consistently high download speed across the 296 sample points (spanning 59.2 kilometers) highlights its current advantage in providing faster data services in the area. However, Globe's lower latency remains beneficial for applications that prioritize quick response times over high data transfer rates.

V. SUMMARY OF FINDINGS

This study evaluated the mobile network parameters of Globe, Smart, and Dito Telecom in Cabanatuan City. Analysis was based on download and upload speeds, along with network latency, measured across major roads and highways. The key findings are as follows:

1. The highest average download speed observed in different locations of Cabanatuan City is 26.35 Mbps for Dito Telecom network. This is followed by 16.94 Mbps for Smart Communication network and 11.85 Mbps for Globe Telecom network.
2. The highest average upload speed observed in different locations of Cabanatuan City is 11.95 Mbps for Smart Communications, followed by 9.34 Mbps for Dito Telecom network and 6.78 Mbps for Globe Telecom network.
3. For network latency parameters, the fastest average latency period is 41.21 ms for Globe Telecom network followed by 52.94 ms for Dito Telecom network and 55.39 ms for Smart Communication network.
4. The maximum download speed of 114 Mbps was measured under Smart Communication network in segment 1 location, NE Crossing to Cabu Cabanatuan City. Globe Telecom maximum download speed of 48.6 Mbps was observed in segment 3, NE Crossing to Sumacab Cabanatuan City. For Dito Telecom network, the maximum download speed of 126 Mbps was measured in segment 4, NE crossing to Calibangbangan via Maharlika Highway location.
5. There are some portions of the main roads and highway of Cabanatuan City where the download and upload speed measured a 0 Mbps data speed in different cellular network provider.
6. Dito Telecom has the highest average download and upload speed which is possibly due to a smaller number of subscribers compared to Smart and Globe Telecom subscriber.

VI. CONCLUSIONS

Based from the findings of the study, the following conclusions were drawn:

1. For Globe, Smart, and Dito networks, the respective average download speeds were 11.85 Mbps, 16.94 Mbps, and 26.35 Mbps; average upload speeds were 6.78 Mbps, 11.95 Mbps, and 9.34 Mbps; and latency periods averaged 41.21 ms, 55.39 ms, and 52.94 ms, respectively.
2. Significant differences in download and upload speeds were observed among the three network providers, though latency differences were not statistically significant.
3. A significant discrepancy was noted in download speed measurements between the two-speed test applications, suggesting a potential influence of the testing platform on results. However, upload speed and latency measurements remained consistent across applications.
4. The findings suggest that network providers can use this data to identify specific areas for improvement within Cabanatuan City. This data may help them to enhance user experience by increasing network coverage and performance in underserved areas, benefiting subscribers and the broader public.

VII. RECOMMENDATIONS

1. For Network Providers: Based on the study's conclusions, network providers should aim to minimize differences in download and upload speeds across locations. Establishing consistent performance standards can enhance user satisfaction.
2. Standardize Testing: Future assessments should work towards eliminating inconsistencies in network speed measurement across different applications, perhaps by adopting standardized testing protocols to ensure more reliable data comparisons.
3. Network Improvement Initiatives: It is recommended that mobile providers enhance network parameters (such as coverage and speed) in areas identified as having weak or non-existent mobile data connections. Upgrading or establishing new cellular infrastructure in these areas could mitigate these issues.
4. Future Research: Future studies should consider expanding data collection beyond the primary roads and highways of Cabanatuan City, incorporating more diverse geographical areas to gain a comprehensive understanding of network performance across the city.

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