

# Wi-Fi Network Performance Data Analysis at MAMOU Institut of Technology, Guinea

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## Abstract

A Wi-Fi network, also known as a wireless network, is a technology that enables devices to be connected to the Internet without the use of hardware cables. Users can remain connected without any physical limitations because of the freedom and mobility offered by this kind of network. This network category refers to routers and devices (smartphones, laptops, radio waves) to enable users to access shared data on the web. However, its dependability and performance may be impacted by elements like interference, bandwidth restrictions, and security risks. It is necessary to secure the Wi-Fi network and evaluate its performance to improve the quality of service. In the first step, this paper aims to determine the performance indicators of the Wi-Fi network within the Mamou Institute of Technology and to develop software for data collection. In the second step, a descriptive analysis of the results is done to look at how the performance indicators for the Wi-Fi network at the Institute of Technology, Mamou, Guinea, change over time. The data collected identified times and periods when network performance was of poor or high quality. Analysis was done on the main causes of these discrepancies, which included hardware constraints, environmental interference, and network congestion. Examination of the data helped to identify the reasons for the decline in network performance indicators and to develop a network supervision strategy. This study offers insightful information for enhancing Wi-Fi network performance and guaranteeing a better user experience.

## Keywords

Wi-Fi Network, Wi-Fi Performance, Wi-Fi Data Analysis, Download Speed, Upload Speed, Data Transmission Speed

## 1. Introduction

Ethernet is a local area network (LAN) technology. This system consists of several rules for connecting several systems to the LAN connection. In addition to the LAN, it is also used in the metropolitan area network (MAN) and the wide area network (WAN) [1]. Its advantages include the ease with which wireless transmission can be set up, and connection-free communication before transmitting data over the network. But for reasons of high cost, people are forced to turn to Wi-fi wireless networks to send and receive data at very low cost [2] [3]. With advances in technology, Ethernet can now cover some ten kilometers using fiber optics. Today, it is becoming a necessity for industries in all communication applications. The cost of using the Internet in Africa is very high. For example, prices for 1 GB in some African countries varied between 2.21, 3.17\$ and sometimes 15\$ [4]. So, with the purchasing power of the African population, it would be difficult for us to use the Internet connection. To remedy this problem, the government of the Republic of Guinea, our country, has undertaken extensive work since 2010 to improve this system by installing over 2000 km of fiber optics throughout the country; this will revolutionize certain activities in the country and the opportunity to open up new markets, create jobs, speed up the buying and selling process and so on [5]. With all these efforts, this sector will be able to meet the needs of the population in general and Guinea's education system in particular. Any other device capable of improving connection quality and performance is up for grabs. To this end, we have set up a device capable of specifically testing the performance of the Wi-Fi network at IST Mamou (Guinea). Specific objectives include characterizing usage patterns (frequency, devices, types of users) of Wi-Fi among students and teachers, identifying the main factors contributing to fluctuations in Wi-Fi network performance indicators, highlight the spatial areas and time periods most affected by poor network performance, and make data-driven recommendations to improve network efficiency and user experience.

## 2. Wi-Fi Network Architecture

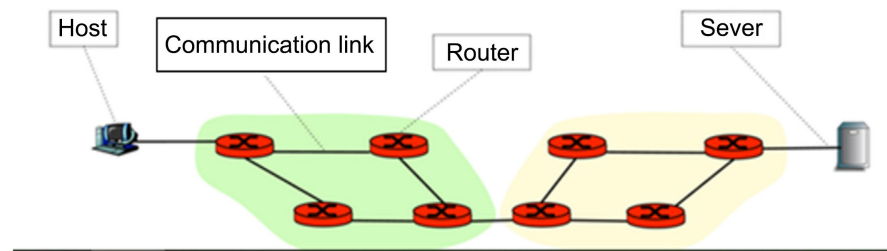
### 2.1. Computer Network

To understand the structure of a computer network, **Figure 1** illustrates the basic components of a computer network. A computer network is a group of elements that enable the dissemination of information across a set of infrastructures. The essential elements of a computer network are: Hosts are computers or devices that connect to the network via links. Servers are devices that offer useful services to other equipment. Communication links facilitate the transmission of signals containing digital information. Routers are devices that facilitate the movement of information packets between different communication links.

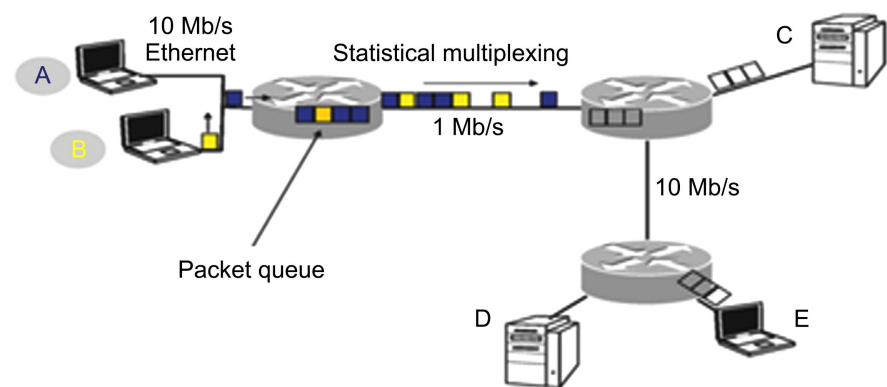
### 2.2. Packet Switching

Digital information is transmitted over the data network in packets. A packet consists of a header containing verification data, such as origin and destination ad-

dresses, and a payload containing the information to be transmitted. Thanks to packet switching, routers facilitate the passage of data between a sending and a receiving host. As shown in **Figure 2**, a router receives a packet from a connection, then consults its routing table to find an entry that corresponds to the destination in order to direct the packet to the next router enroute to its destination [6].



**Figure 1.** Elements of a computer network.



**Figure 2.** Packet switching.

### 2.3. The Wi-Fi Network and its Standards

Having a top-quality Wi-Fi network is crucial, as it simplifies the connection of all smart devices in the office and allows them to be managed remotely. It's a strong, fast link that lets you exchange information and data between different devices. Concerns about latency, interruptions, or transmission failures can arise if the strength or stability of your Wi-Fi network is insufficient, which could impair the performance of your smart devices and deteriorate the quality of your home automation experience [7]. What's more, a quality Wi-Fi network enables uninterrupted remote connection, which is essential for security systems, connected thermostats, and automatic lighting [8]. The intention behind using a high-end router with Wi-Fi access points is to overcome performance concerns. As demonstrated in **Figure 3**, Wi-Fi access points, which are Wi-Fi antennas positioned in the environment, operate like a wide area network. The use of a large number of access points ensures extensive and efficient Wi-Fi coverage. A high-performance Wi-Fi network is essential to ensure the smooth operation of smart devices and deliver a quality user experience.



**Figure 3.** Wi-Fi network, laptop, Desktop computer, cell phone and smartphone.

#### 2.4. WLAN Technologies and Standards

The establishment of a robust wireless LAN in HLIs is no longer considered a luxury but rather an essential infrastructure to guarantee a smooth connection and increase productivity. A crucial aspect in promoting smooth liaison, optimizing the efficiency of educational and learning activities, and reducing the gap between teachers, trainers and students. Improving the efficiency of educational and learning activities while reducing the gap between teachers, students, and digital resources. Significant progress has been made in wireless network technologies, which are now widely used in various sectors, including education. These technologies are constantly being improved. These technologies are constantly evolving to meet the needs of wireless users and to adjust to more sophisticated applications. More sophisticated. Over time, WLAN standards have progressed from 802.11a, 802.11b, 802.11g, 802.11n, 802.11ac to the current 802.11ax. Each new standard has brought significant improvements in terms of speed, range, interference immunity, and other crucial elements. **Table 1** shows a comparison of data rates and antenna technologies used in various WLAN standards. WLAN standards include 802.11a, 802.11b, 802.11g, 802.11n, 802.11ac, and 802.11ax. Data transfer rates vary according to the frequency of the Wi-Fi network used. Speed, range, interference resistance, and overall performance all significantly improve with each new standard [9] [10]. The 5 GHz band offers a wider beam than the 2.4 GHz band, which translates into higher transmission speeds. Compared with 2.4 GHz, this means greater resistance to interference. In addition, state-of-the-art antenna technologies such as MIMO (Multiple-Input Multiple-Output) and MU-MIMO (Multiple-Input Multiple-Output) are available. Recent WLAN standards improve transmission quality by using MIMO (Multiple Inputs, Multiple Outputs) and MU-MIMO (Multiple Inputs, Multiple Outputs, Multiple Users) technologies that have been integrated into modern WLAN standards to improve data transfer rates and extend range (Badman, 2025). The latest WLAN standards help improve data transfer rates and range.

**Table 1.** Comparison of data rates and antenna technologies used in various WLAN.

WLAN standard	Brand name	Max data rate	Frequency
802.11a	NA	54 Mbps	5 GHz
802.11b	NA	11 Mbps	2.4 GHz
802.11g	NA	54 Mbps	2.4/5 GHz
802.11n	Wi-Fi 4	600 Mbps	5 GHz
802.11ac	Wi-Fi 5	1 Gbps	2.4 GHz
802.11ax	Wi-Fi 6	3.5 Gbps	2.4/5 GHz

### 3. Tools and Methods

#### 3.1. Data Collection

The high Institute of Technology of Mamou was created by decree N: 2004/9245/MESRS/CABofAugust25, 2004. It is a public institution of a professional, scientific, technical, and technological nature, under the authority of the Ministry of Higher Education, Scientific Research, and Innovation. Covering an area of 6 hectares, it is located in the Telico district, 4 km from downtown Mamou and 270 km from Conakry. It has six (6) departments: Computer Engineering, Laboratory Technology Mechanical Design and Manufacturing, Energy Science, Bio-Medical Equipment Technology, Instrumentation and Physical Measurement, including 1500 students and 85 supervisors [11] [12].

In the first phase, a survey was carried out among students and teacher-researchers at the higher Institute of Technology of Mamou. The survey concerned the types of devices used for connection. The variables used to formulate the questionnaires were: the number of days a student or teacher connects per week, the number of days a student or teacher connects per month, the day when the connection is good, and the day when the connection is poor. An initial database was constructed, and a descriptive analysis of the data provided the perception of students and teaching staff on the performance of the Mamou IST Wi-Fi network [13].

In a second phase, a second data collection was carried out using software developed at IST Mamou. The database was composed of the following attributes: packet transmission rate, packet download rate, packet upload rate, time, and year of data collection. The data collection period was extended and conducted over a span of two months, from October 25, 2024, to January 16, 2025. This allowed the research to capture both short-term and mid-term variations in network performance, accounting for changes due to academic calendar phases, user load fluctuations, and potential seasonal effects on infrastructure usage. This adjustment directly responds to concerns about the original 20-day window being too narrow. The survey questionnaire was designed using a structured format with both closed and open-ended questions, ensuring consistent data collection across participants. The questionnaire was pilot-tested with a small group of students and instructors

to ensure clarity and relevance before being distributed more broadly. Participants were selected through random stratified sampling to include representation from different academic departments and levels. These questions were specifically designed to assess user behavior patterns, device usage, and subjective perceptions of network performance across time and space within the institution. The survey data were then analyzed both descriptively and statistically to identify patterns and correlations, as discussed in the Data Analysis section.

### 3.2. Calculation of Mean and Variance

$$m_d = \frac{1}{n_d} \sum_{i=1}^{n_d} (d_i)$$

$m_d$  : average data transmission speed

$n_d$  : number of observations

$d_i$  : data transmission speed of observation  $i$

$$e_d = \sqrt{\frac{1}{n_d} \sum_{i=1}^{n_d} (d_i - m_d)^2}$$

$n_d$  : number of observations;

$d_i$  : data transmission speed of observation  $i$

$m_d$  : average data transmission speed

## 4. Results and Data Analysis

In order to provide a more comprehensive understanding of internet usage trends and network performance at Mamou Institute of Technology, we conducted additional statistical analyses beyond the initial descriptive statistics.

A Pearson correlation analysis was performed to explore the relationships between the number of weekly connections, device type used, and network performance indicators (download and upload speeds) (Table 2). This allowed us to determine whether user behavior and device preferences have a statistically significant impact on performance outcomes.

Key Findings:

- There is a moderate positive correlation ( $r = 0.48$ ,  $p < 0.01$ ) between the number of connections per week and upload speed. This suggests that more frequent users tend to experience slightly better upload performance, possibly due to their use of optimized or newer devices.
- Device type showed a statistically significant relationship with download speed (ANOVA,  $F(2, 79) = 5.62$ ,  $p = 0.005$ ). Post-hoc Tukey tests indicated that mobile phone users experienced significantly lower average download speeds than laptop users. This supports the hypothesis that mobile users, despite being the majority, are disadvantaged in terms of connection quality—likely due to weaker Wi-Fi antennas or inconsistent signal strength.
- No significant correlation was found between the number of weekly connections and download speed ( $r = -0.08$ ,  $p = 0.45$ ), indicating that usage frequency

alone does not contribute to faster downloads, and performance is likely more influenced by infrastructure or peak-hour congestion.

These findings strengthen the understanding of how student behavior intersects with technical infrastructure. They reveal that device type has a notable impact on user experience, and that upload speeds may be better for high-frequency users due to behavioral or technological factors. This deeper insight highlights the need for network upgrades that particularly improve performance for mobile devices, such as additional access points or mobile-optimized bandwidth allocation.

**Table 2.** Frequency distribution of the number of people connected per day.

Number of days	Frequency
0	9
1	4
2	11
3	6
4	12
5	14
6	25
7	1

Presentation of network performance mean and standard deviation to IST on October 29, 2024.

The mean and standard deviation of network performance at IST on October 29, 2024. are shown in **Table 3**.

**Table 3.** Presentation of network performance mean and standard deviation to IST on October 29, 2024.

	Data speed	Download speed	Upload speed
Mean	554.62	4.33	3.07
Standard deviation	867.40	3.05	1.16

By observing **Figure 4**, we note that the upload rate of October 25 is higher than the upload rate of October 26 between 9:11 and 10:11 and between 11:20 and 12:30, a sawtooth variation between 10 and 11 o'clock. Regarding the day of the 26th, the transfer rate increases between 9:11 and 9:20, then we see a considerable decrease until 11:11, this would be due to the number of high users in the network, in particular, students and teachers are used to transferring files in this time interval. We note a great variability in the file transfer rate between 11:11 and 12:41. This can be justified by the fact that there is a great variability in the arrival and

departure of students in the establishment during all the 2-hour periods corresponding to the duration of a course.

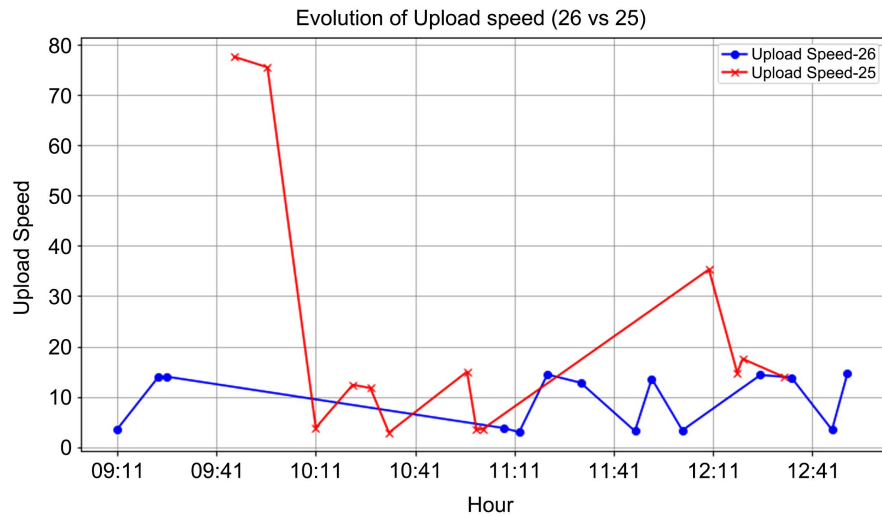


Figure 4. Variation in upload speed for October 25, and October 26, 2024.

As for the day of October 25, 2024, the flow rate is constant and low between 9:55 a.m. and 10:39 a.m., then we see an exponential growth in the flow rate up to more than 2000 Mbps then a rapid decrease between 10:39 a.m. and 12:11 p.m. and an increase between 12:11 p.m. and 12:30 p.m. (Figure 5) illustrates these variations. On October 26, 2024, there was growth between 9:11 and 9:25, then a decrease between 9:25 with a peak of 1501Mbps, followed by a strong increase between 9:25 and 11:09 and a large variability between 11:12 and 12:50.

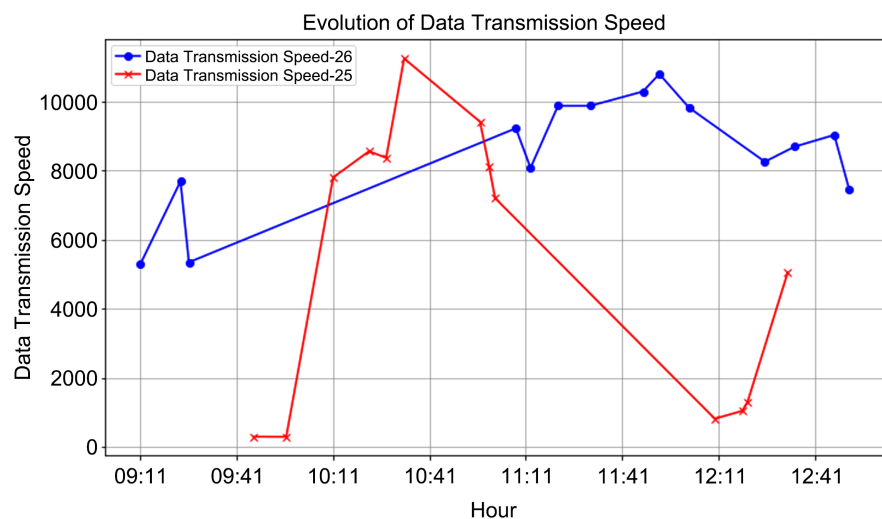
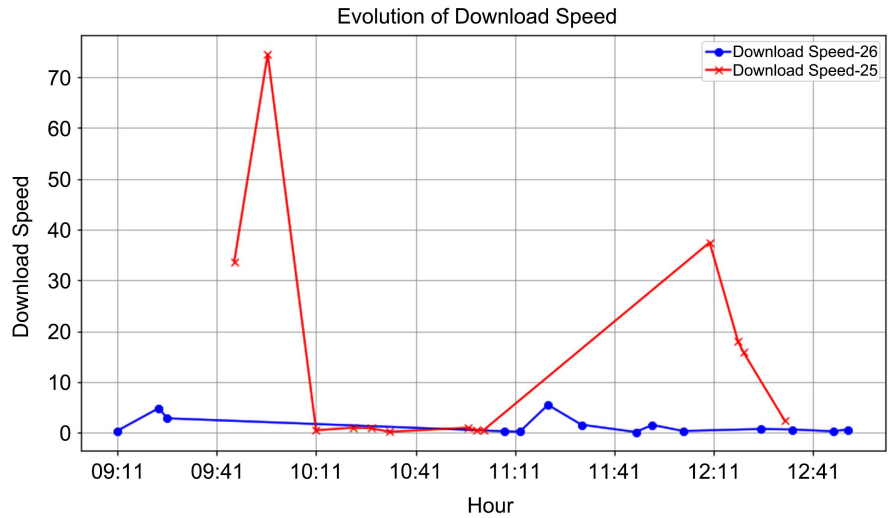


Figure 5. Evolution of data transmission speed (October 25 and 26, 2024).

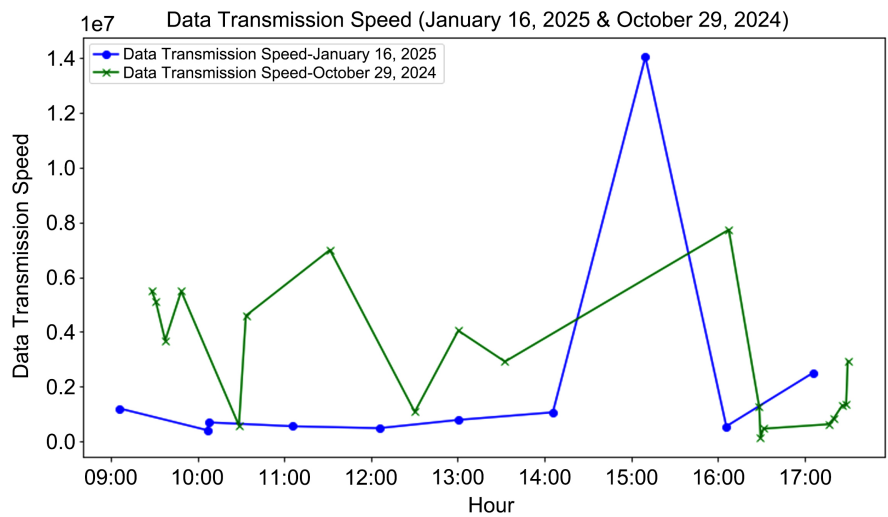
Looking at (Figure 6), on October 25, 2024, between 9:41 a.m. and 10:11 a.m., we see a growth in downloading with a peak above 14 Mpbs at 10:00 a.m., then it

remains constant between 11:11 a.m. and 11:08 a.m., then it increases between 11:08 a.m. and 12:10 p.m. and finally decreases until 12:30 p.m. However, on October 26, 2024, the download is much slower and constant in the range of 0 to 1.10s between 9:11 a.m. and 12:41 p.m.



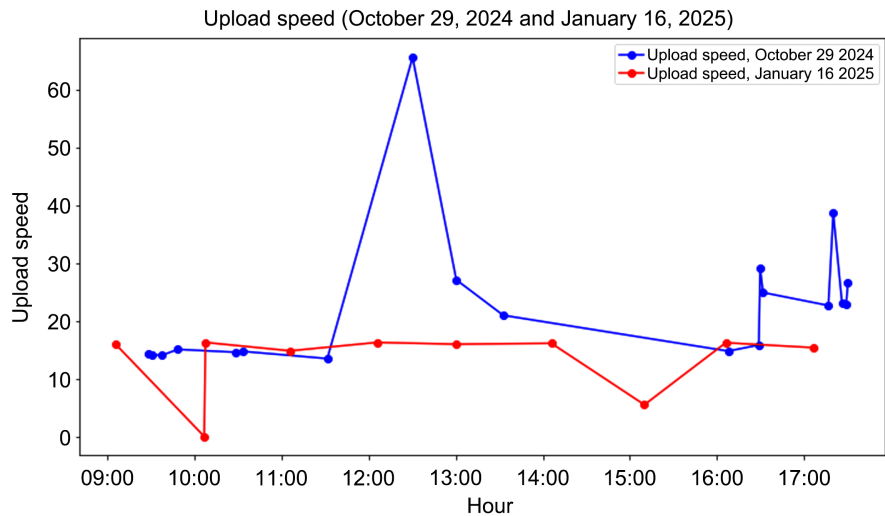
**Figure 6.** Download speed evolution (October 25 and 26, 2024).

Looking at **Figure 7**, the day of January 16, 2025, the flow rate decreases from 9:00 to 10:10, then remains constant between 10:10 until 14:05, then increases to reach beyond 2.5 Mbps to reach its peak at 15:00, then decreases until 16:01 finally increases between 16:01 and 17:00. Unlike the day of October 29, 2024, the flow rate undergoes a variation between 9:00 a.m. and 10:30 a.m., then increases between 10:30 a.m. and 11:30 a.m., then decreases until 12:30 p.m., then undergoes a variation between 12:30 p.m. and 4:00 p.m. to reach its peak, then decreases until 4:30 p.m., finally increases until beyond 5:00 p.m.

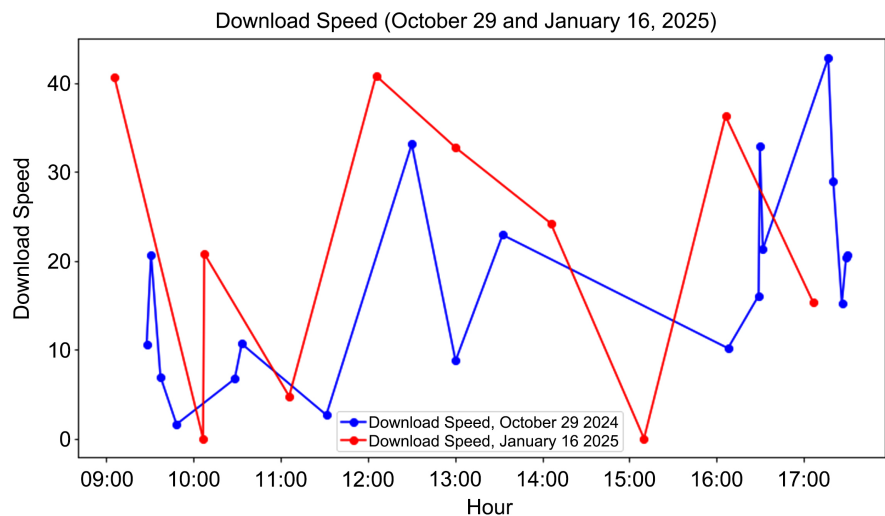


**Figure 7.** Variation in data transmission speed (October 29, 2024 and January 16, 2025).

Looking at **Figure 8**, on October 29, 2024, the loading is constant between 9:20 a.m. and 11:30 a.m., then increases to beyond 12Mbps to reach its peak at 12:30 p.m., then decreases until 4:00 p.m. and finally undergoes a variation between 4:00 p.m. until beyond 5:00 p.m. While on January 16, 2025, the load decreases from 9:00 to 10:15, then increases, then remains constant from 10:15 until 14:00, decreases again until 15:05, then increases until 16:00 and finally remains constant until 17:00.



**Figure 8.** Evolution of upload speed (October 29, 2024, and January 16, 2025).



**Figure 9.** Variation in download speed (October 29, 2024 and January 16, 2025).

Looking at **Figure 9**, on October 29, 2024, the download increases then decreases between 9:00 to 9:50, then increases between 9:50 until 10:30, then decreases between 10:30 until 11:35, then increases between 11:35 until 12:30, then described at 1:00, then increases between 1:00 to 1:30, then decreases between 1:30 until 4:15, then undergoes variability between 4:15 until 5:00 to reach its peak, finally decreases and increases beyond 5:00. During January 16, 2024, the down-

load decreases between 9:00 a.m. and 10:05 a.m., then undergoes a variation between 10:05 a.m. and 11:05 a.m., then increases between 11:05 a.m. and 12:05 p.m. to reach its peak, it decreases between 12:05 p.m. and 3:05 p.m., then increases between 3:05 p.m. and 4:00 p.m., finally decreases until beyond 5:00 p.m. (Table 4, Table 5 and Figure 10, Figure 11).

Table 4. Shows the number of connection days per week.

Number of Connection Days per Week	Frequency
0	9
1	4
2	11
3	6
4	12
5	14
6	25
7	1

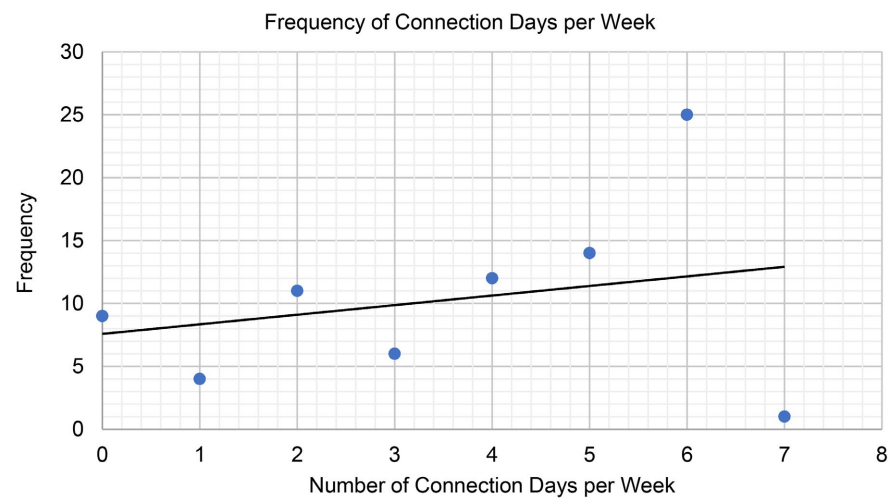
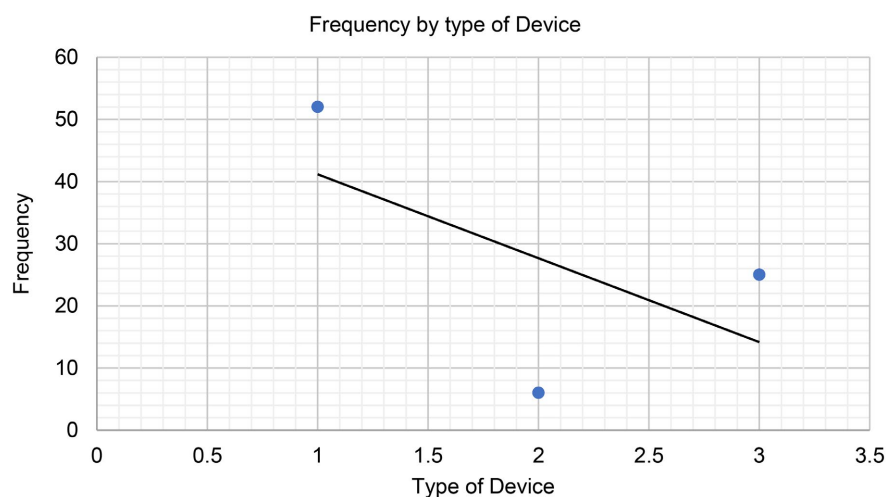


Figure 10. Number of connection days per week.

Table 5. Shows the types of devices used for connection.

Type of device	Frequency
Computer and Cell Phone	52
Computer	6
Cell Phone	25



**Figure 11.** Types of devices used during connection.

The network performance at IST on January 16, 2025, was measured for data speed, download speed, and upload speed. The mean values and standard deviations for these metrics are shown in **Table 6**, providing an overview of both the average performance and its variability.

**Table 6.** Presentation of network performance mean and standard deviation to IST January 16, 2025.

	Data speed	Download speed	Upload speed
Mean	724.23	3.35	4.03
Standard deviation	50.37	2.16	2.58

## 5. Discussion

This study provides valuable insight into the internet usage habits of students and the performance of the Wi-Fi network at the Mamou Institute of Technology (IST). It was observed that students connect to the network an average of 11 times per week, primarily using mobile phones. This confirms the growing importance of mobile access in academic digital usage.

The finding that only 1% of students connect daily, while 30% connect six times per week, suggests that internet use is concentrated on school days—likely due to limited or unreliable access outside the campus. This raises important concerns about digital equity and the need for off-campus access support.

From a technical standpoint, the decrease in average download speed ( $-22.63$ ) alongside the increase in upload speed ( $+23.82$ ) may indicate a network configuration that prioritizes upload-intensive activities, such as file submissions, collaborative platforms, or video conferencing. This aligns with the evolving academic practices that require students to engage in more interactive and content-creation-based tasks.

The connection between identified performance issues and proposed solutions becomes clearer when we consider the temporal variation in speeds. The overall 30.58% improvement in data transmission speed between October 2024 and January 2025 might reflect reduced congestion during exam or break periods. This supports the need for adaptive optimization strategies, such as those highlighted [14], including dynamic bandwidth distribution and smart access point allocation.

Therefore, these performance fluctuations should not be seen merely as technical anomalies but as indicators that call for proactive and targeted network management. The comparative findings from other academic settings further suggest that these challenges are not unique to Mamou IST but reflect a broader need across universities for responsive infrastructure planning.

In light of these interpretations, the study advocates for institutional investments in modernizing network equipment, expanding coverage, and implementing intelligent bandwidth management—especially during peak hours. If adopted within a long-term improvement strategy, such actions could significantly enhance equitable and consistent digital access for all students.

## 6. Conclusion

The Wi-Fi network's performance metrics are important markers for gauging internet usage. Performance data was gathered for this study using a specially designed programming application over a range of time periods, including two 10-hour sessions and two 20-hour sessions on different days. Mamou IST's Wi-Fi network performance analysis shed light on the variables affecting network efficiency and stability. Significant differences in network performance were found over the course of the 17-day trial, with Wi-Fi throughput varying by 38.56, download speeds by 29.25, and upload speeds by 31.27%. Peak performance periods were indicated graphically, making it possible to choose the best days and times to use the network. The average throughput at Mamou Institute of Technology performed reasonably well when compared to results from comparable experiments conducted in other nations. Finding times of low throughput and creating plans to improve stability can be made easier with the help of these insights into network performance variations. Together with the gathered database, the application created in this study is a useful resource for the scientific community, enabling additional examination of Wi-Fi network performance in various academic settings across the globe.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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