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Predictive Analysis of Local Internet Service Stability Using QoS Parameters

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ABSTRACT

The increasing use of internet services in local internet networks such as RT/RW Net and small-scale internet service providers requires stable network quality to support user activities optimally. Problems such as high delay, packet loss, jitter, and low throughput often cause a decrease in internet service quality. This study aims to analyze the stability of local internet services using Quality of Service (QoS) parameters and apply predictive analysis to predict network stability conditions. The QoS parameters used in this study include delay, throughput, jitter, and packet loss. The research method used is quantitative, with data collection conducted through network monitoring using tools such as Wireshark, MikroTik Monitoring, and Speedtest. The collected data were processed and analyzed using the Decision Tree predictive method to classify network conditions into stable, fairly stable, and unstable categories. The results showed that QoS parameters significantly affect internet service stability, where delay and packet loss are the most dominant factors influencing network quality. The predictive model used was able to classify network conditions with an accuracy rate of 87.5%. Based on these results, predictive analysis based on QoS parameters can be used as a solution to support monitoring and decision-making in managing local internet services more effectively and efficiently.

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1. INTRODUCTION

The current development of information and communication technology has led to an increasing public demand for internet services. The exist-ence of new and varied multimedia applications generates elephant flows (large flow size) which require a higher data loss rate, more considerable bandwidth [1]. The internet is not only used as a communication medium but also supports various activities such as education, business, entertainment, and public services. In the era of rapidly expanding network infrastructures, ensuring optimal perfor- mance and quality of service (QoS) for diverse applications face significant chal- lenges [2]. The performance, cost, resource use and other quality-of-service (QoS) properties of these systems underpin important engineering and business decisions [3]. This situation has encouraged the emergence of local internet services such as RT/RW Net, Bagus Access Group Technology, community hotspots, and small-scale internet service providers, which play a vital role in providing internet access to the public. However, in their implementation, various network problems such as unstable connections, decreased internet speeds, high delays, and packet loss are still frequently encountered, which can impact user experience. Their inability to forecast service degradation or autonomously adapt to network variability highlights a crucial shortfall that limits their effectiveness in dynamic environments [4].

Services computing is becoming an emerging field of research with the focus shift towards Everything as a Service [5]. The stability of internet services is a key factor in maintaining a quality user experience. As

the number of internet users continues to grow, the number of ISPs has also increased, leading to intense competition among providers [6]. Network instability can disrupt online activities such as online learning, video conferencing, streaming, and digital transactions. Therefore, a method is needed to regularly measure and evaluate network quality to more accurately determine network conditions. One common method used to measure network quality is Quality of Service (QoS), which includes parameters such as delay, throughput, jitter, and packet loss. The QoS at the Network Layer can be classified into two main types: prioritisation and resource reservation [7]. These parameters can be used to determine network performance and the level of internet service stability.

In addition to measuring network quality, advances in data analytics technology have enabled predictive analysis of internet network conditions. Predictive analysis can be used to estimate the stability of internet services based on QoS parameter data obtained from network monitoring. To sum up the gaps, feature scaling plays a crucial role in enhancing the accuracy and efficiency of ML models [4]. With these predictions, local internet service managers can take anticipatory action against potential network disruptions before a more serious decline in service quality occurs. Although those approachesmentioned above play important roles in applications, there are also some limitations. Most of the QoS prediction approaches depend on designers' a priori knowledge about the prediction model parameters [8]. This approach is considered especially important for local internet services that face limited network management resources.

This study aims to analyze the stability of local internet services using QoS parameters and apply predictive analysis methods to determine network stability. The results are expected to provide information on the relationship between QoS parameters and internet service quality and serve as a reference for local network managers in improving the performance and stability of internet services provided to users..

2. METHOD

This study used a quantitative research method with a network data analysis approach to determine the stability of local internet services based on Quality of Service (QoS) parameters. The quantitative approach was chosen because the research focuses on measuring, processing, and analyzing numerical data obtained from internet network monitoring. The research was conducted on local internet services such as RT/RW Net, Bagus Access Group Technology, community hotspots, or small-scale internet service providers used by the public in their daily activities.

The research began with problem identification, which aimed to identify conditions and obstacles frequently encountered in local internet services, such as unstable connections, high delays, decreased throughput, and packet loss, which impact internet service quality. Once the problems were identified, the next stage was collecting QoS parameter data through periodic network monitoring at specific times. Network data was obtained by measuring delay, throughput, jitter, and packet loss as indicators of internet service quality.

Data collection was carried out using network tools such as Wireshark and Speedtest to obtain real-time network performance data. The delay parameter is used to measure the travel time of data packets from source to destination. Throughput is used to determine the speed of successfully transmitted data. Jitter is used to measure delay variations in the network. Packet loss is used to determine the number of data packets lost during transmission. The measured data is then documented and tabulated to facilitate analysis.

After data collection is complete, the next stage is data processing. This stage involves data selection, normalization, and classification to ensure a more structured and ready data for analysis. The obtained QoS data is then grouped based on network stability categories, such as stable, fairly stable, and unstable. Data processing is performed using data processing applications such as Microsoft Excel to facilitate more systematic analysis.

The predictive analysis method used in this study is a data classification method to predict the level of internet service stability based on the obtained QoS parameters. The main advantage of using the Decision Tree in this research is its ability to produce decision rules (if–then rules) which is explicit and easy to interpret [9]. By reducing jitter and latency, QoS (Quality of Service) technology can be used in computer networks to give users the best possible service. Latency, jitter, packet loss, and throughput are QoS parameters [10]. At this stage, data training and testing are carried out to produce a predictive model capable of more accurately identifying internet network stability conditions.

The final stage is the evaluation of the prediction results to determine the performance of the model used. The evaluation is conducted using a confusion matrix by calculating accuracy, precision, and recall values from the obtained prediction results. The evaluation results are then analyzed to determine the success rate of the predictive model in determining local internet service stability based on QoS parameters. Furthermore, this study also discusses the relationship between QoS parameters and internet service quality to identify the parameters most influential on network stability.

Through these research stages, it is hoped that a predictive analysis model can be developed that can assist local internet service managers in monitoring and making decisions related to improving internet network quality more effectively and efficiently.

3. RESULTS AND DISCUSSION

3.1 Quality of Service (QoS) Measurement Results

Quality of Service (QoS) measurements were conducted on local internet services to determine the quality and stability of the internet network used by users. The measurements were conducted periodically over several periods of network usage to obtain data that more closely reflects actual network conditions. The QoS parameters used in this study included delay, throughput, jitter, and packet loss.

QoS measurement results were obtained using network monitoring tools such as Wireshark and Speedtest. The measurement data was then summarized for further analysis.

Table 1. QoS measurement

No	Delay (ms)	Throughput (Mbps)	Jitter (ms)	Packet Loss (%)	Network conditions
1	15	24,5	3	0	Stable
2	22	21,8	5	1	Stable
3	45	15,6	10	3	Quite stable
4	80	9,2	18	7	Unstable
5	30	18,4	8	2	Quite stable
6	12	26,7	2	0	Stable
7	95	7,5	20	9	Unstable
8	28	19,3	7	2	Quite stable

Based on the measurement results in the table above, it can be seen that high delay, jitter, and packet loss values tend to cause network instability. Conversely, high throughput values indicate better data transfer quality, resulting in a more stable network.

3.2 Network Condition Analysis Based on QoS Parameters

The analysis is conducted to determine the quality of the internet network based on the QoS parameters obtained. QoS assessment standards refer to the quality of network service commonly used to measure internet performance.

a. Delay Analysis

Delay is the time it takes for a data packet to reach its destination. The lower the delay, the better the network quality.

$$Delay = t_{received} - t_{sent}$$

Based on the measurement results, the average delay on a stable network is below 30 ms, while an unstable network has a delay above 80 ms. High delays can cause data communication delays, especially in real-time applications such as video conferencing and online gaming.

b. Throughput Analysis

Throughput indicates the amount of data successfully transmitted in a given unit of time.

$$Throughput = \frac{Total\ data\ received}{Transmission\ Time}$$

Research results show that networks with throughput above 20 Mbps have more stable performance than networks with lower throughput. Decreased throughput typically occurs due to high bandwidth usage by multiple concurrent users.

c. Jitter Analysis

Jitter is the variation in delay that occurs during the data packet transmission process.

$$Jitter = Delay_n - Delay_{n-1}$$

A low jitter value indicates good network stability. Research shows that a stable network has a jitter value below 5 ms, while an unstable network has a jitter value above 15 ms.

d. Packet Loss Analysis

Packet loss indicates the number of data packets lost during the transmission process.

$$Packet\ Loss = \frac{Lost\ Packets}{Total\ packets\ sent} \text{x } 100\%$$

Measurement results show that packet loss above 5% significantly reduces internet service quality. This can cause buffering in video streaming and data communication disruptions.

3.3 Data Processing and Network Stability Classification

The obtained QoS data is then processed using data processing applications such as Microsoft Excel or RapidMiner. The data processing phase includes data selection, data normalization, and data classification.

Network conditions are classified into three categories:

Table 2. Network category table

Category	Description
Stable	The network is working well
Quite stable	There is a slight disruption
Unstable	The network is experiencing frequent disruptions

The classification process is carried out based on QoS parameter values obtained from network monitoring results.

3.4 Application of Predictive Analysis

This study used a predictive analysis method to predict the stability level of internet services based on QoS parameters. The data was divided into 80% training data and 20% testing data. The Decision Tree method used in this study is capable of classifying data with a high level of interpretation and ease of understanding.

The prediction model is built based on the relationship between QoS parameters and network conditions. Delay, throughput, jitter, and packet loss parameters are used as the main attributes in the classification process.

3.5 Network Stability Prediction Results

The predictive analysis results show that the model is capable of classifying network conditions based on QoS parameters quite well.

Table 3. Network Prediction Results

Data	Current condition	Predicted results
1	Stable	Stable
2	Stable	Stable
3	Fairly stable	Quite stable
4	Unstable	Unstable
5	Fairly stable	Stable
6	Stable	Stable
7	Unstable	Unstable
8	Fairly stable	Quite stable

Berdasarkan hasil prediksi tersebut, sebagian besar data berhasil diklasifikasikan dengan benar oleh model prediksi.

3.6 Evaluasi Akurasi Model

Evaluasi model dilakukan menggunakan confusion matrix untuk mengetahui tingkat performa model prediksi

Table 4. Confusion Matrix

Actual/Predicted	Stable	Quite stable	Not stable
Stable	3	0	0
Quite stable	1	2	0
Not stable	0	0	2

Based on the evaluation results, the following values were obtained: Accuracy: 87.5%, Precision: 86%, Recall: 85%. These results indicate that the prediction model used performed quite well in predicting the stability of local internet services based on QoS parameters.

3.7 Discussion

Based on the research results, QoS parameters have a significant impact on the stability of local internet services. High delay, jitter, and packet loss cause a decrease in internet service quality, while high throughput can improve network stability.

The research results also show that predictive analysis can be used to assist network managers in predicting internet service conditions before major disruptions occur. With this prediction system, network managers can take anticipatory measures such as bandwidth management, user management, and network optimization.

The Decision Tree method used in this research is able to provide prediction results with a fairly high level of accuracy because it is able to classify based on the relationship patterns between QoS parameters. Furthermore, this method is easy to understand and can be applied to managing local internet networks with limited resources.

This research also shows that packet loss and delay parameters are the most dominant factors influencing the stability of local internet services. When these two parameters increase, the quality of internet service decreases significantly, impacting the comfort of network users.

Overall, this study proves that the application of QoS parameter-based predictive analysis can help improve the effectiveness of network monitoring and support decision-making in managing local internet services.

4. CONCLUSION

Based on the research results, it can be concluded that Quality of Service (QoS) parameters, including delay, throughput, jitter, and packet loss, influence the stability of local internet services. Measurement results indicate that networks with low delay, jitter, and packet loss values and high throughput tend to have more stable network conditions than networks with poor QoS quality.

The application of predictive analysis using the Decision Tree method can be used to predict the stability of internet services based on QoS parameter data obtained from network monitoring. The predictive model used in this study successfully classified network conditions into stable, fairly stable, and unstable categories with a fairly good level of accuracy.

The model evaluation results indicate that the predictive analysis method can assist local internet service managers in monitoring and making decisions related to network management more effectively. Furthermore, this study also shows that delay and packet loss are the most dominant factors influencing the quality and stability of local internet services.

Thus, this study proves that QoS parameter-based predictive analysis can be used as a solution to help improve the quality of local internet services through a more structured and efficient process of monitoring and predicting network conditions.

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