UNDERGRADUATE THESIS

DESIGN AND IMPLEMENTATION OF AN ADAPTIVE BANDWIDTH MANAGEMENT SYSTEM USING FUZZY SUGENO AND PER CONNECTION QUEUE (PCQ)

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APPROVAL SHEET

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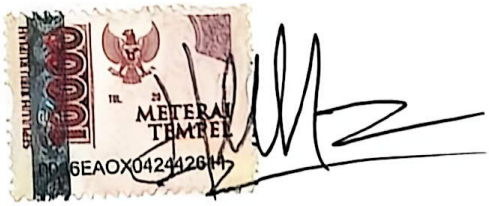

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ABSTRACT

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Thesis Title:	Design and Implementation of an Adaptive Bandwidth Management System Using Fuzzy Sugeno and Per Connection Queue (PCQ)
Supervisor:	1. Dr. Eng. Agussalim, S.Pd., M.T. 2. Ardhon Rakhmadi, S.Tr.T., M.Kom.

Network environments commonly experience dynamic traffic fluctuations, making them vulnerable to Quality of Service (QoS) degradation. Existing bandwidth management approaches have fundamental limitations: static configurations can provide stability under normal conditions but lack adaptability to sudden traffic surges, while previous implementations of Fuzzy Inference Systems have been able to produce adaptive decisions yet still require administrator intervention because they are not directly integrated with network devices. This research develops an adaptive bandwidth management system with a closed-loop control mechanism on a MikroTik router acting as the network gateway. The system architecture consists of a sequential processing flow that classifies network traffic into three priority classes: Real-time, Streaming, and Bulk. The system processes inputs in the form of the number of active clients and network traffic through nine Sugeno Fuzzy rule bases to generate three dynamic pcq-rate limits within a multi-output architecture during each 10 second inference cycle. Transition values are obtained using the weighted average defuzzification method, resulting in smoother bandwidth allocation, while bandwidth limits are enforced directly by an active Python-based controller communicating through the MikroTik API. Evaluation results show that the Sugeno Fuzzy logic is capable of adapting and making autonomous decisions every 10 seconds. Under high-traffic conditions, the system automatically produces a “Highly Restricted” decision, significantly reducing bandwidth allocation for the Streaming and Bulk classes to ensure the stability of the Real-time class as the highest priority. Scenario testing and QoS performance validation demonstrate an improvement in the throughput index from the Fair (2) category to the Very Good (4) category, while packet loss, delay, and jitter are consistently maintained within the Very Good (4) category according to TIPHON standards. The proposed closed-loop adaptive bandwidth management system successfully combines autonomous computational decision making with fair bandwidth distribution through Per Connection Queue (PCQ) in dynamic network environments.

Keywords: Fuzzy Sugeno, Per Connection Queue (PCQ), Adaptive Bandwidth Management, Closed-Loop Control System, Quality of Service (QoS)

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The author recognizes that this thesis still has limitations and may not be entirely free from shortcomings. Therefore, constructive feedback and recommendations are sincerely welcomed to support future improvements. It is hoped that this study will contribute to the advancement of knowledge and serve as a useful reference for researchers and readers interested in this field.

Surabaya, July 10th 2026

Author

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