



UNDERGRADUATE THESIS

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

HAFIDZ IRHAM AR RIDLO
NPM 22081010068

THESIS ADVISORS

Dr. Eng. Agussalim, S.Pd., M.T.
Ardhon Rakhmadi, S.Tr.T., M.Kom.

**MINISTRY OF HIGHER EDUCATION, SCIENCE, AND TECHNOLOGY
UNIVERSITAS PEMBANGUNAN NASIONAL VETERAN JAWA TIMUR
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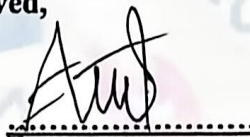
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By:
HAFIDZ IRHAM AR RIDLO
NPM. 22081010068

Has been defended before, and accepted by, the Board of Assessors of the Thesis Examination of the Informatics Study Program, Faculty of Computer Science, Universitas Pembangunan Nasional Veteran Jawa Timur, on July 10, 2026:

Approved,

Dr. Eng. Agussalim, S.Pd., M.T.
NIP. 19850811 201903 1 005



(Advisor I)

Ardhon Rakhmadi, S.Tr.T., M.Kom.
NIP. 19910805 202406 1 002



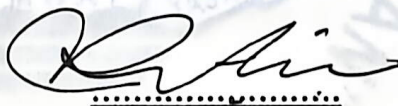
(Advisor II)

Henni Endah Wahanani, S.T. M.Kom.
NIP. 19780922 202121 2 005



(Head Assessor)

Retno Mumpuni, S.Kom., M.Sc
NIP. 19870716 202521 2 045



(Assessor I)

Acknowledge by,

Dean of the Faculty of Computer Science



Prof. Dr. Ir. Novirina Hendrasarie, MT.
NIP. 19681126 199403 2 001

APPROVAL SHEET

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By:
HAFIDZ IRHAM AR RIDLO
NPM. 22081010068

Approved to proceed to the Thesis Examination



Approved by,

**Coordinator of Informatics Study Program
Faculty of Computer Science**

Dr. Intan Yuniar Purbasari, S.Kom. M.Sc.
NIP. 19800602 202521 2 029

STATEMENT OF ORIGINALITY

I am the undersigned:

Student Name : Hafidz Irham Ar Ridlo
NPM : 22081010068
Degree Program : Bachelor (S1)
Study Program : Informatics
Faculty : Faculty of Computer Science

Hereby declares that this undergraduate thesis contains no part of any other scientific work that has been submitted to obtain an academic degree at any higher education institution. Furthermore, it does not contain any work or opinions previously written or published by others, except for those which are explicitly cited in this thesis and listed completely in references.

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Surabaya, July 10, 2026
Declarant,



HAFIDZ IRHAM AR RIDLO
NPM. 22081010068

ABSTRACT

Student Name / NPM: Hafidz Irham Ar Ridlo / 22081010068
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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