Department Of Computer Science & Engineering

SOUTHEAST UNIVERSITY

CSE459: Research Methodology

Implementation of Fuzzy Logic in Prediction of Traffic Accidents in Bangladesh

A dissertation submitted to the Southeast University in partial fulfillment of the requirements for the degree of B. Sc. in Computer Science & Engineering

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Letter of Transmittal

October 24, 2022

The Chairman,
Department of Computer Science & Engineering,
Southeast University,
Banani, Dhaka.

Through: Supervisor, Shifat Ahmed

Subject: Submission of Research Report

Dear Sir,

With due respect, we'd like to provide our study paper on Application of Fuzzy logic in Prediction of Traffic Accident of Bangladesh. It will assist in predicting traffic accidents on highways in Bangladesh. It was a delight for us to work on such an intriguing subject. This task has been completed by following your instructions and meeting the standards of Southeast University.
So, we do our best to accomplish our project. We made every attempt to complete the study. We respectfully request your approval of this report. I hope you will appreciate our efforts and forgive any slight inaccuracies.

Thank you.

Sincerely yours,

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Certificate

This is to certify that the following student submitted and was accepted for the research title Application of Fuzzy logic in Prediction of Traffic Accident of Bangladesh to the respected member of the board of examiners of the faculty of Science and Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in CSE. Science and Engineering. This report was completed under our supervision.

Supervisor:

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Abstract

Predicting traffic events is vital for improving road safety. Models for predicting traffic accidents can be used to pinpoint accident causes and lower accident rates. Creating a fuzzy logic model for forecasting traffic accidents in Bangladesh is the goal of this work. The annual average daily traffic (AADT), the road width (rw), the speed (sp), which is measured in distance per unit time, and the roadside market (rm) are the four input variables used in this model. Annual All Accidents (AAA), the model's output, is determined as the total number of accidents that happen on a road in a day for every kilometer of road. This model is used in Bangladesh on the Dhaka-Mymenshingh highway. MATLAB's fuzzy logic toolbox is used here.

Acknowledgements

First and foremost, we want to thank Allah for providing us with this opportunity to do research, work on it, and eventually accomplish it effectively and without difficulty. We consider ourselves fortunate and grateful to our supervisor, Shifat Ahmed, Lecturer & Coordinator, Department of Computer Science Engineering at Southeast University. Providing efficient recommendations and highly effective ideas during the entire semester of this study task assists us in finding the ideal strategy to accomplish it effectively. We also thank the whole faculty of the department of CSE at Southeast University for their insight. Finally, thank you to our group members for their incredible work, as well as to the rest of my university mates for their recommendations, guidance, and support. We are also grateful to our parents for their efforts to offer mental support.

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Chapter 1:

1.1 Introduction

Bangladesh is one of the densely populated country in the world. It has one of the highest rates of road accidents, with thousands of accidents occurring every year. This high incidence of road accidents results in significant loss of life and property, and poses a major public health and safety concern. Leading to numerous social and economic problems. Despite the high incidence of road accidents in Bangladesh, there is a lack of comprehensive road safety strategies and policies that effectively address the root causes of accidents. At least 6,749 accidents took place in 2022. At least 641 people were killed and 1,364 injured in 528 road accidents across the country in May, according to Road Safety Foundation. The increasing number of road accidents in Bangladesh has led to a growing demand for effective road safety measures, including improved infrastructure, stricter enforcement of traffic laws, and more advanced technologies for accident prevention.
Research on road accidents in Bangladesh can help to fill this gap by providing evidence-based insights into the causes of accidents and effective measures for prevention.

Road accidents are complex events that are influenced by many factors, including weather conditions, road conditions, driver behavior, and vehicle characteristics. Mamdani Fuzzy Logic provides a flexible and powerful approach for modeling complex systems and allows for the incorporation of multiple input variables that may interact in non-linear ways. Many of the factors that contribute to road accidents are uncertain or vague, such as driver behavior or road conditions. Mamdani Fuzzy Logic provides a framework for handling uncertainty and vagueness and allows for the representation of knowledge in the form of fuzzy rules that reflect the expert's experience and judgment. The Mamdani Fuzzy Logic system can provide accurate predictions based on the input data, and allows for the quantification of the degree of membership of each input variable to different fuzzy sets, leading to more refined and nuanced predictions. By providing accurate predictions about the likelihood of road accidents, Mamdani Fuzzy Logic has the potential to improve road safety by informing the development of effective road safety strategies and policies, and

by providing real-time information to drivers and other stakeholders to help prevent accidents.

Overall, the use of Mamdani Fuzzy Logic in this research will provide a powerful tool for modeling complex and multifaceted systems, handling uncertainty and vagueness, and providing accurate predictions that can inform the development of effective road safety measures and improve road safety in our country.

1.2 Motivation

The main motivation of our study is to reduce what kind of problems are responsible for occurring traffic accidents in Bangladesh as we can see so many traffic accidents are being occurred over the years.

Chapter 2:

2.1 Problem Statement

There are many papers that have been published based on reducing road accidents by other authors in other countries. But there are no good studies or publications about Bangladesh's traffic accident prediction. Road accidents in Bangladesh are a growing concern and a major public health issue, with high rates of fatalities and injuries. Despite efforts to improve road safety, the underlying causes of road accidents remain complex and difficult to quantify. In this study, we aim to apply fuzzy logic to analyze and reduce traffic accidents in Bangladesh. This will involve collecting data on the number of vehicles on the road, the speed of the vehicles, and road conditions, and then using Mamdani fuzzy logic to find the specific factors for road accidents. The results of this study will provide a valuable analytic overview of road accidents in Bangladesh, and help to reduce accidents as well as inform the development ministry to add more effective road safety policies and interventions.

2.2 Objectives

Bangladesh is a developing country. Day by day the number of vehicles is increasing rapidly as well as along with traffic accidents. As a result, we'd like to propose a model for predicting traffic accidents and avoiding the circumstances using fuzzy logic implementation. In this paper, we will use the "**Mamdani**" fuzzy logic system. This logic system gives better output rather than any other logic.

2.3 Literature Review

We read and learned about fuzzy logic from a paper by Wang, Chonghua [1]. In this paper, we are going to use fuzzy logic implementation for our research. From Rokade's paper using multiple linear regression, built an accident prediction model. The input variables of the model were traffic volume, lighting conditions, speed, road shoulder width, road cross-section dimensions, traffic signals, and traffic signs. The number of accidents was the output of their model. Their model gave good results [2]. Ghanbari et al. created a decision support system to choose the kind of intelligent transportation system for the highways by using a fuzzy logic model. They applied the model to two highways. Their model gave good results [3]. Putri et al. gave a comparative discussion between Mamdani and Sugeno fuzzy models [4].

SL No.	Title	Author	Year
1.	A Study of Membership Functions on Mamdani-Type Fuzzy Inference System for Industrial Decision Making.	Wang, Chonghua.	2015
2.	Development of accident prediction model.	Rokade S., Singh K., Katiyar S. K., & Gupta S.	2010
3.	Introducing an Intelligent Transportation System Decision Support Model for the Highways in Iran Based on Fuzzy Logic.	Ghanbari M., Mehr A. G., & Nehzat H.	2015
4.	Comparative Analysis of Membership Function on Mamdani Fuzzy Inference System for Decision Making.	Putri Haryana and Robbi Rahim	2017

The research paper "A Study of Membership Functions on Mamdani-Type Fuzzy Inference System for Industrial Decision Making"[1] is likely focused on the use of fuzzy logic in industrial decision making.

In this paper, the authors likely study the impact of different membership functions on the performance and accuracy of Mamdani-type fuzzy inference systems in industrial decision-making applications.

The purpose of this study is likely to investigate the best membership function for a particular decision-making problem, and to determine how the choice of membership function affects the overall accuracy of the fuzzy inference system. The results of the study is to provide insights into how to choose the most appropriate membership function for a specific decision-making task, and how to design fuzzy inference systems that are more effective and efficient for industrial decision making.

In summary, the "A Study of Membership Functions on Mamdani-Type Fuzzy Inference System for Industrial Decision Making"[1] research paper is likely focused on the use of fuzzy logic in industrial decision making, and the impact of different membership functions on the performance and accuracy of Mamdani-type fuzzy inference systems.

The "Development of Accident Prediction Model"[2] research paper is to focuses on the development of a statistical model to predict accidents in a particular field or context.

The purpose of the study is to identify the factors that contribute to accidents and develop a model that can be used to predict the likelihood of accidents based on these factors. The study involves collecting data on accidents and their causes, as well as relevant demographic and environmental information. The authors then used statistical techniques such as regression analysis or machine learning to build a model that can predict accidents based on this data.

The results of the study is to provide valuable insights into the causes of accidents and help organizations to prevent accidents by identifying and mitigating the factors that contribute to them. The model developed in the study may also be useful for organizations to allocate

resources and make decisions related to accident prevention and safety management.

The "Introducing an Intelligent Transportation System Decision Support Model for the Highways in Iran Based on Fuzzy Logic"[3] research paper focuses on the development of a decision support system for transportation in Iran based on fuzzy logic.

The purposes of the authors of this paper is to address the challenges faced by transportation managers in Iran and develop a system that can provide support in making informed decisions related to transportation management. The system used fuzzy logic to model the complexities and uncertainties inherent in transportation decision making, such as traffic congestion, road conditions, weather, and other factors.

The study involved collecting data on transportation systems in Iran and analyzing the information to identify the key factors that influence transportation decisions. The authors used fuzzy logic to model these factors and develop a decision support system that can provide recommendations to transportation managers based on the data and the fuzzy logic model.

The results of the study provided valuable insights into the use of fuzzy logic in transportation decision making and help to improve the efficiency and effectiveness of transportation management in Iran. The decision support system developed in the study may also serve as a useful tool for transportation managers to make informed decisions related to transportation planning and management.

The "Comparative Analysis of Membership Function on Mamdani Fuzzy Inference System for Decision Making"[4] research paper focused on the comparison of different membership functions in the context of Mamdani-type fuzzy inference systems for decision making.

In this paper, the authors likely compare different types of membership functions, such as trapezoidal, Gaussian, or S-shaped functions, and study their impact on the performance and accuracy of Mamdani-type fuzzy inference systems in decision making applications.

The purpose of the study is likely to identify the best membership function for a particular decision-making problem and determine how the choice of membership function affects the overall accuracy of the fuzzy inference system. The results of the study may provide insights into how to choose the most appropriate membership function for a specific decision-making task, and how to design fuzzy inference systems that are more effective and efficient for decision making.

Chapter 3

3.1 Methodology

Fuzzy logic: Fuzzy logic is a control method for solving system problems that can be used with a wide range of systems, including general systems, small systems, embedded systems, PC networks, and multichannel or workstation-based data acquisition and control systems. This technique can be applied to either hardware or software by itself or to both. More specifically, fuzzy logic is a branch of multivalued logic that focuses on approximation rather than precision in reasoning.

Fuzzy classification: Fuzzy classification analysis is usually used to classify the training data set (a data set that is used to induce the Membership function) and to predict the testing data. The training data set contains a number of examples. An example contains a value for a dependent attribute and several attribute values can be either nominal or non-nominal.

Mamdani Fuzzy Logic: Mamdani fuzzy inference was first introduced as a method to create a control system by synthesizing a set of linguistic control rules obtained from experienced human operators [1]. In a Mamdani system, the output of each rule is a fuzzy set.

Since Mamdani systems have more intuitive and easier-to-understand rule bases, they are well suited to expert system applications where the rules are created from human expert knowledge. The Max-min approach is another name for Mamdani. Ebrahim Mamdani first popularized this technique in 1975 [4].

3.2 Data Collection

Vehicle Count

Time Interval	Car (Weekdays/ Weekend)	Bus (Weekdays/ Weekend)	Truck (Weekdays/ Weekend)	Total Count on weekdays	Total Count on weekend
0-5 mins	75/30	13/8	12/17	100	55
60 min	900/360	156/96	144/204	1200	660
24 hours	21600/8640	3744/2304	3456/4896	28800	15840
1 month	648000/259200	112320/ 69120	103680/ 146880	864000	475200
1 year	7776000/ 3110400	1347840/ 829440	1244160/ 1762560	10368000	5702400

First we have visited Mohakhali bus terminal then Gabtoli bus terminal to collect the data based on bus. After that we had a discussion with highway traffic police. Then to justify the validity of the data, we separately started to count vehicles from different point (Banani, Gazipur, Chandra) of the highway. Then we considered the value of data which we have collected manually from three different point.

Considering Speed: 70km/h, 80km/h, 90km/h
Considering Average Road Width: 15.48m per side/way.
Roadside Market: 60

3.3 Implementation

We have inputted the data in MATLAB software to apply and do calculations of Mamdani fuzzy logic to get the result. Here are some screenshots of the software given below:

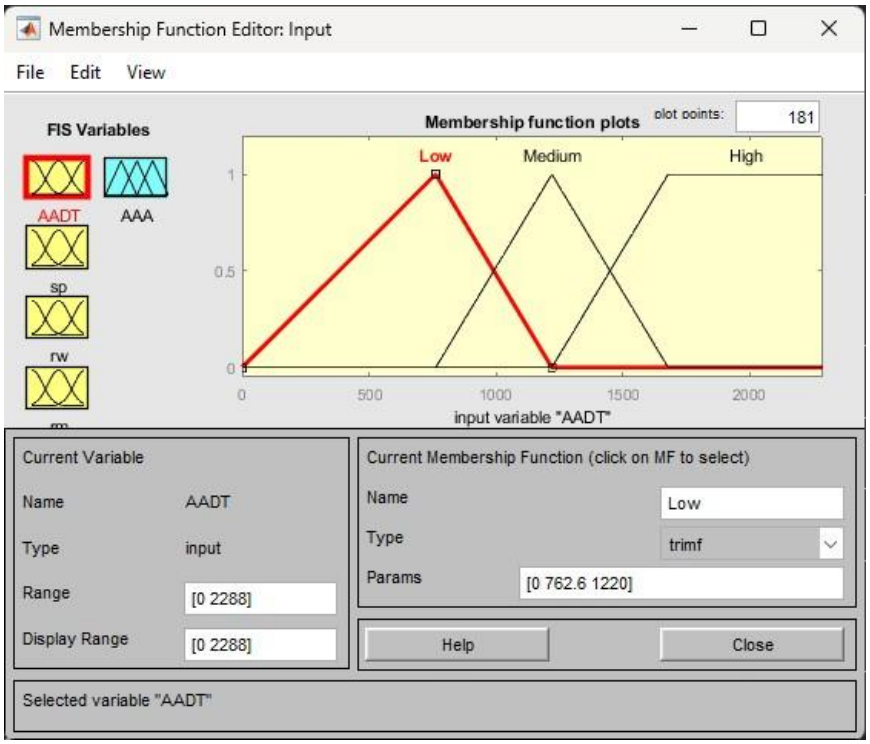

Fig 3.1: AADT

AADT stands for Annual Average Daily Traffic. In the above figure we can see a field called range, where we have to input average data of how many vehicles travels through a specific road. We have inputted from 0-2288 for Dhaka – Mymensingh road as our annual average daily traffic was 2288. After Inputting the value/data a graphical representation will be shown and it also can be edited. We can see in the graphical representation that there are three triangular membership function as Low, Medium & High. We can adjust these parameters through params field.

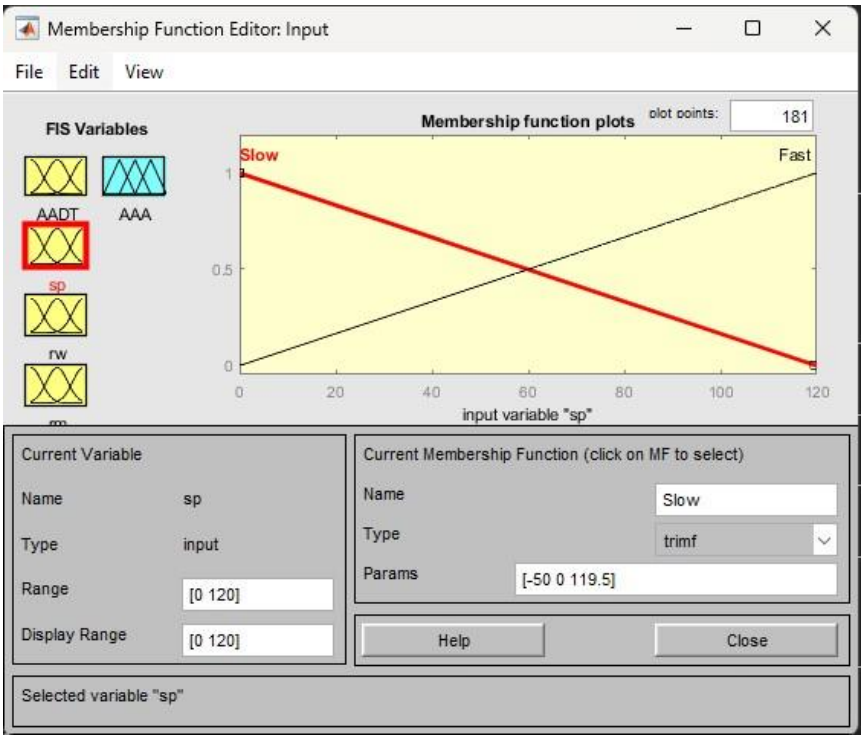

Fig 3.2: SP

SP stands for speed. Here in the range, we have to input data. We have inputted from 0-120 as we considered highest top speed of the vehicle 120. After Inputting the value/data a graphical representation will be shown and it also can be edited. In the graphical representation we consider 0 as good and 1 as bad. When the vehicle is running so fast, the straight line is reaching 1 and when the vehicle is running slowly, another straight line is reaching 0 downward. We can adjust straight line parameters in the params box also.

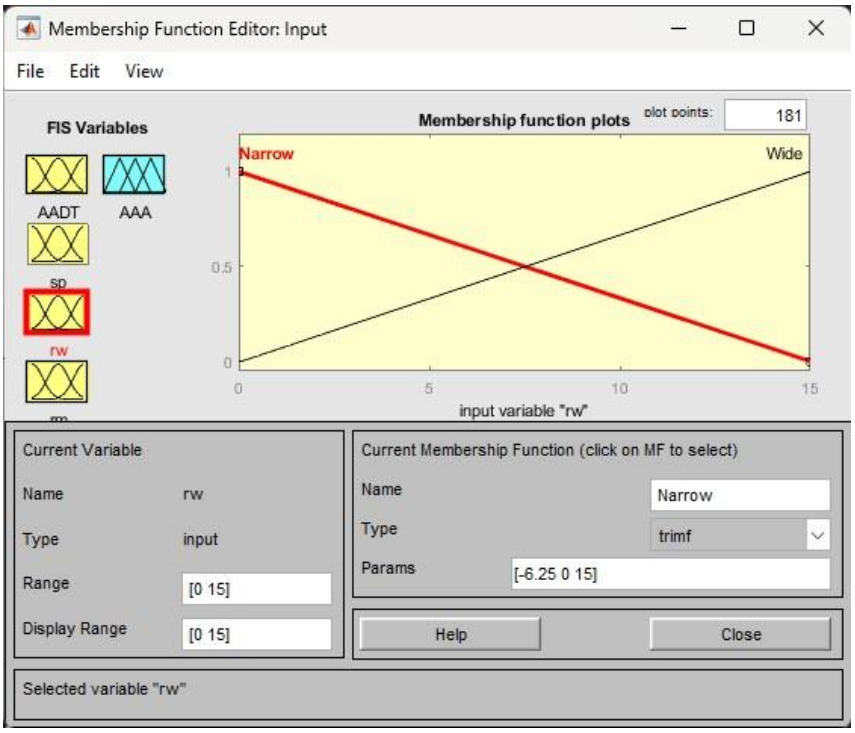

Fig 3.3: RW

RW stands for Road width. We know width of a road can be differ based on location. As we have chosen Dhaka – Mymensingh road for our research purpose, somewhere the width was 18-20 m and somewhere 10-12 m. We considered an average width of 15.48m for our research purpose which we inputted in the range field. In the graphical representation we can see that there are two straight lines. One is for narrow and the other is for wide. We can edit these lines parameters through params field.

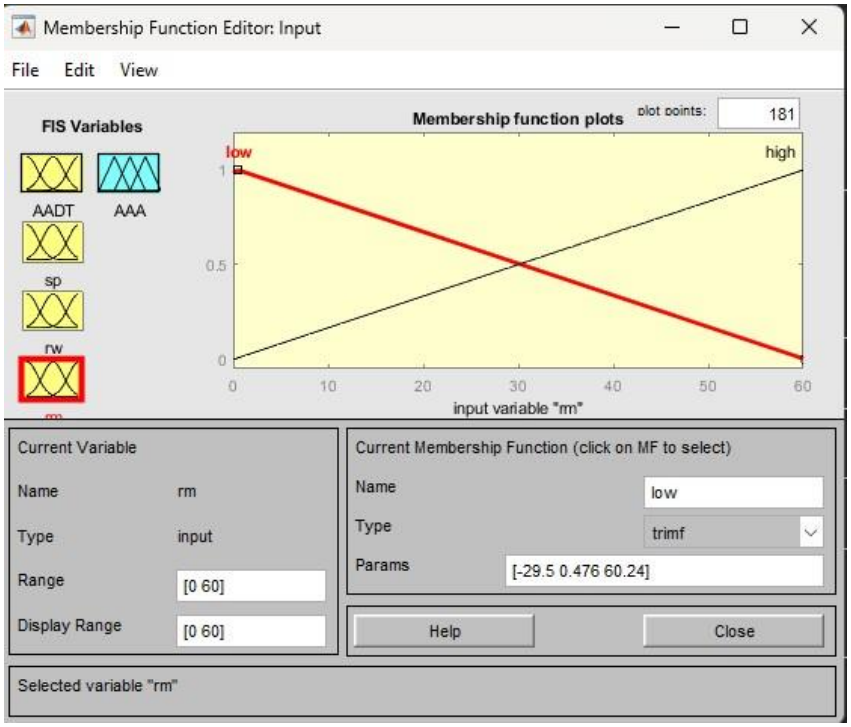

Fig 3.4: RM

RM Stands for Roadside Market. There is 60+ markets are situated in the roadside starting from Dhaka to Mymensingh. We considered a round figure 60 market on average for the better calculation and to get a better result. In the graphical representation, we can see two straight lines. One is for low and one is for high. Low means the number of markets is low and high means the number of markets is high in the roadside. We can edit these lines through changing parameters from params box.

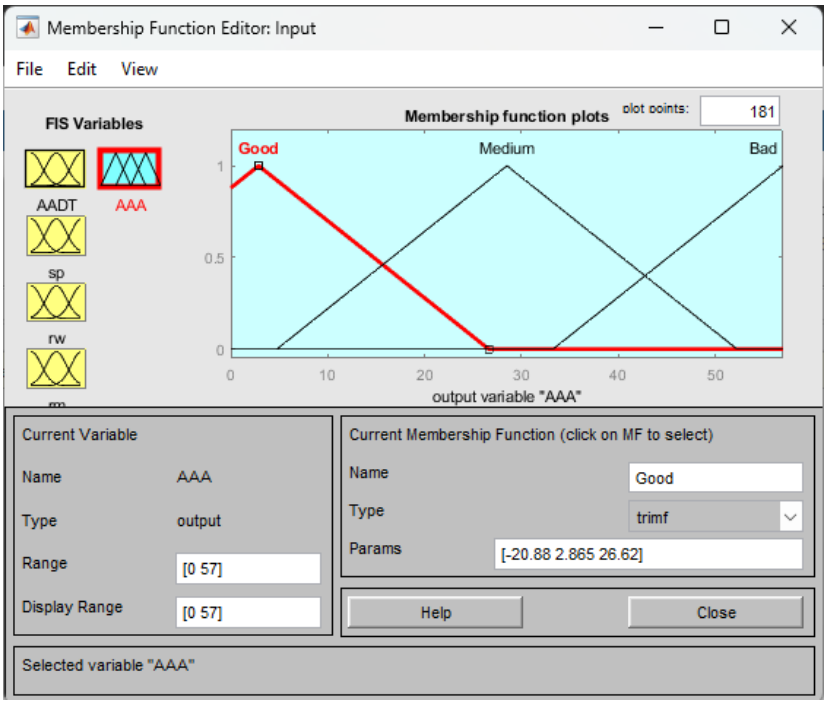

Fig 3.5: AAA

AAA stands for Annual Average Accidents. Annually nearly 60 accidents occur each year. It can be differed over the years. So, we considered 57 accidents yearly for our research purpose. We can see there triangle membership function as good, medium and high. These functions' parameters can be edited through param box.

Fig 3.6: Output

In the rules viewer we can see that there are 3*2*2*2 = 24 rules that have been implemented to develop Mamdani FIS Model. There are 3 types in AADT which are Low, Medium and High. There are 2 types of sp we have considered and they are Slow and Fast. Again there are 2 types of rw they are Narrow and Wide then there are 2 types of rm and they are Low and High and lastly there are 3 types of AAA which are Good, Medium and Bad. These are membership functions for AAA.

Chapter 4

4.1 Result & Discussion

In this study, to construct fuzzy model are used: annual average daily traffic (AADT), road width (rw), speed (sp), roadside market(rm) and the annual all accidents (AAA). The data have been collected in one month duration for Dhaka-Mymensingh Road and are presented in Table 1. To develop the Mamdani FIS model are used 3x2x2x2 = 24 mechanical rules.

Table 1

Month	January
AADT	2288
Speed	70-90
Road Width	15.48m
Roadside Market	60
AAA	57

Applied these rules in the Dhaka-Tangail highway. The applied values is given below in the

Table 2.

Month	January
AADT	1508
SP	84
rw	11.7
rm	20.8
AAA Predicted	28
AAA Observed	13
Absolute Error	15

4.2 Limitations

Conducting research on traffic accidents in Bangladesh is challenging due to several limitations. Some of the major limitations include:

Data Collection: Accurate and comprehensive data on traffic accidents in Bangladesh is limited. Official data may be incomplete or inaccurate.

Lack of Resources: Research in Bangladesh is often limited by a lack of financial and logistical resources. This can make it challenging to conduct large-scale studies and gather data from a representative sample of the population.

Cultural Attitudes: Cultural attitudes towards traffic accidents can impact the accuracy of data collected. For example, some individuals may be reluctant to report accidents or discuss their experiences due to social stigma or a fear of legal consequences.

Data Confidentiality: Transportation company owner doesn't want to disclose the real data and also tries to manipulate.

Limited Knowledge: There is limited knowledge about the root causes of traffic accidents in Bangladesh, making it challenging to develop effective solutions. This can make it difficult to determine the most effective strategies for reducing the number of accidents and their impact on society.

Despite these limitations, research on traffic accidents in Bangladesh is important to help address this growing public health and safety concern. By working together, researchers, government agencies, and non-government organizations can overcome these limitations and make progress in reducing the number of accidents and their impact on society.

4.3 Future Work

Future work in the area of road accident research in Bangladesh should focus on the following areas:

Data Collection and Analysis: Improving the accuracy and comprehensiveness of data on road accidents in Bangladesh is a priority.

Driver Behavior: Further research should be conducted to better understand the factors that contribute to reckless and dangerous driving practices in Bangladesh.

Road Infrastructure: Research is needed to assess the current state of road infrastructure in Bangladesh and identify areas for improvement.

Enforcement of Traffic Laws: Further research is needed to assess the effectiveness of current traffic law enforcement practices in Bangladesh and identify areas for improvement.

Impact of Accidents: Research is needed to better understand the impact of road accidents on individuals, families, and communities in Bangladesh.

In conclusion, future work in the area of road accident research in Bangladesh should focus on gathering accurate data, understanding the root causes of accidents, and developing effective strategies to reduce the number of accidents and their impact on society. By working together, researchers, government agencies, and non-government organizations can help make Bangladesh's roads safer for everyone.

4.4 Conclusions

In conclusion, this research aimed to investigate the use of Mamdani-type fuzzy inference systems in predicting road accidents in Bangladesh. The study analyzed various factors that contribute to road accidents in Bangladesh, and used a Mamdani-type fuzzy inference system to make predictions about the likelihood of accidents occurring in different conditions.

The results of the study showed that Mamdani-type fuzzy inference systems can be effectively used to predict road accidents in Bangladesh, and that the system was able to provide accurate and reliable predictions based on the input data.

Bibliography

AADT – Annual Average Daily Traffic

SP - Speed

RW – Road Width

RM – Roadside Market

AAA - Annual All Accidents

Reference Link

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