IRIS
Journal for Young Scientists
ISSN 2278 – 618X (Print)
ISSN 2278 – 6384 (Online)

http://www.patnawomenscollege.in/journal

A fuzzy model to study the effect of noise pollution on students' life

• **Vaishnavi** • **Sakshi Rani** • **Kavya Keshri**
• **Seema Mishra**

Received : July, 2022
Accepted : August, 2022
Corresponding Author : **Seema Mishra**

Abstract: *Noise is sound considered unpleasant, loud and disruptive to hearing. Noise pollution affects the health and daily work of humans. The present study is to determine the effects on students' life due to noise pollution in metropolitan cities. A fuzzy model was constructed to analyze how the students are affected in these 7 metropolitan cities, Delhi, Mumbai, Chennai, Lucknow, Kolkata, Hyderabad, and Bangalore, due to noise pollution like traffic noise, construction noise etc. It has been shown that the level of noise pollution is highest in Chennai, followed by Hyderabad, Mumbai, Kolkata, Bengaluru, Delhi and Lucknow respectively in the year 2017. The obtained results are compatible with the scenario of health issues caused by noise pollution faced by students in these areas.*

Keywords: *Noise level, metropolitan cities, noise pollution, membership function, linguistic variable.*

Vaishnavi
B.Sc. III year, Mathematics (Hons.), Session:2019-2022,
Patna Women's College (Autonomous),
Patna University, Patna, Bihar, India

Sakshi Rani
B.Sc. III year, Mathematics (Hons.), Session:2019-2022,
Patna Women's College (Autonomous),
Patna University, Patna, Bihar, India

Kavya Keshri
B.Sc. III year, Mathematics (Hons.), Session:2019-2022,
Patna Women's College (Autonomous),
Patna University, Patna, Bihar, India

Seema Mishra
Assistant Professor, Department of Mathematics
Patna Women's College (Autonomous),
Bailey Road, Patna–800 001, Bihar, India
E-mail : seema.math@patnawomenscollege.in

Introduction:

Noise pollution is enormous environmental trouble in unexpectedly creating built-up metropolitan cities like Delhi, Mumbai. Traffic noise is probably the most rigorous and pervasive type of noise pollution. Traffic noise has grown to be serious trouble at present because of insufficient urban planning of the metropolis in the past. Homes, schools, offices, hospitals, business enterprise centers, and other community structures have been routinely constructed close to the most important roads of the municipality barring buffer zones or sufficient soundproofing. The trouble has been compounded by increasing traffic volumes (two-wheelers, heavy motor vehicles, and different vehicles) ways past the expectations of our early

city planners. When it comes to finance and business, time is vitally valuable. Taking into consideration that This alarming extend in the extent of visitors is surely inversely associated with the degradation of the environment. Noise pollution is one of the foremost environmental pollutants that are encountered in everyday lifestyles and has direct outcomes on human performance. Sound stress is a simple measure of the vibrations of air that makes up sound, and because the vary that the human listeners can become aware of is very wide, these levels are measured on the logarithmic scale with units of decibel (dB).

Noise pollution influences millions of human beings on daily basis. The most common health hassle it causes is Noise-Induced Hearing Loss (NIHL). Exposure to loud noise can additionally cause high blood pressure, coronary heart disease, sleep disturbances and stress. These health troubles can affect all age groups, particularly children and students. Many college students who stay near noisy airports or streets have been found to go through stress and other problems, such as impairments in memory, attention level, and studying skills. Several authors have done research in this direction (Ouis, 2001, Kumar and Jain,1994, Dixit et al.,1982, Pancholy et. al., 1967).

The fuzzy set concept used is an extension of the classical thought of a set concept proposed by Zadeh in 1965 (Zadeh, 1965). With the proposed methodology, Zadeh introduced a mathematical method with which decision-making by the use of fuzzy descriptions of some records becomes possible. The foundation of this idea is the fuzzy set, which is a set that does not have sincerely described limits and can contain factors solely to some degree; in different words, elements can have a certain diploma of membership (Mamdani and Assilian, 1975). Hence, appropriate functions are used—namely, membership functions—that determine the membership degree of every element in a fuzzy set. Using this, in this research work, a fuzzy model was constructed (by using MATLAB R2013a) that predicts the effects on students' life due to noise pollution. The constructed model was used to analyze the effects on students in metropolitan cities. The time interval of the study was taken for the year 2017. The two inputs were the Day Noise Level and Night Noise Level. For input values, the yearly average of noise ambience was taken. Triangular membership functions were used for both input and output variables and constructed 25 IF-THEN rules to obtain the annoyance values. The results obtained have been then used to provide precautionary measures in the affected areas by the students and steps needed to be taken by the government to control the noise pollution.

Materials and Methods:

Fuzzy Logic is derived from fuzzy set theory. Many degrees of membership (between 0 and 1) are allowed. Thus, a membership function $\mu_A(x)$ is associated with a fuzzy set A such that this function maps every element of the universe of discourse X to the interval [0,1]. The mapping is written as: $\mu_A(x)$: $X \rightarrow [0,1]$. A triangular membership function of a fuzzy set is specified by three parameters {a, b, c} and is given by

$$\mu_A(x) = \begin{cases} 0 & if\ x \le a \\ \dfrac{x-a}{b-a} & if\ a \le x \le b \\ \dfrac{c-x}{c-b} & if\ b \le x \le c \\ 0 & if\ x \ge c \end{cases}$$

Linguistic variables are variables whose values are words or sentences in a natural or artificial language. For example, height is a linguistic variable if values are linguistic rather than

numerical, i.e., short, very short, tall, etc. rather than 150cm, 167 cm.

To obtain a fuzzy model, for analyzing the effects of noise pollution in students' life in the considered metropolitan cities, index values of input noise level, Day Noise Level and Night Noise Level were collected from the Central Pollution Control Board (CPCB) database of the year 2017. CPCB monitors all types of pollution around India. The yearly data on noise pollution were directly obtained from the CPCB official site. For this study, the yearly average of each noise level index for each city (10 stations) were further calculated separately. A triangular membership function were used for both input and output variables and constructed 25 IF-THEN rules to obtain the annoyance values.

The construction of the fuzzy model comprises of following steps:

Step 1: Fuzzification of input variables - For this study, two kinds of noise levels were considered, Day Noise Level and Night Noise Level as input variables and for each input variable, 5 linguistic variables low, medium, high, very high and extremely high were used.

Step 2: Fuzzification of output variable - The output variable was the "Annoyance" of noise pollution. 4 linguistic variables, low, medium, high and very high were used.

Step 3: Construction of Inference Rule - In this step, several rules were formed which established the connection between the input and output variables. In this construction, IF-THEN rules along with connectors OR or AND were used. 25 combinations were constructed in this step.

Step 4: Defuzzification of output variables - In this step, the fuzzy output was translated into a single crisp value. There are several forms of defuzzification including the centre of gravity (COG), mean of maximum (MOM), and centre average methods. In this study, the MOM method of defuzzification was used. The MOM method calculates the average of crisp values of output (control signal) that correspond to the conclusions with maximum firing strength. In this method, the defuzzied value was taken as the element with the highest membership values. When there is more than one element having maximum membership values, the mean value of the maxima is taken. Let A be a fuzzy set with membership function $\mu_A(x)$ defined over x X, where X is a universe of discourse. The defuzzified value is let say x* of a fuzzy set and is defined as,

$$x^* = \frac{\sum_{x_i \in M} x_i}{|M|}$$

Here, M={ x_i | $\mu_A(x_i)$ is equal to the height of the fuzzy set A} and |M| is the cardinality of the set |M| is the cardinality of the set M

Table 1. Total Range of input variables

Noise Level	Range
Day Noise Level	[0,115]
Night Noise Level	[0,115]

The linguistic variables and corresponding membership functions for the input variable are as follows:

1. The linguistic variables for Day Noise Level are given in Table 2 and the corresponding membership function of Day Noise Level is given in Fig. 1.

Table 2. Linguistic variables for Day Noise Level

Range	Interval	Linguistic Variable
0-50	[0 25 50]	Low
45-65	[45 55 65]	Medium
60-80	[60 70 80]	High
75-95	[75 85 95]	Very High
95-115	[95 105 115]	Extremely High

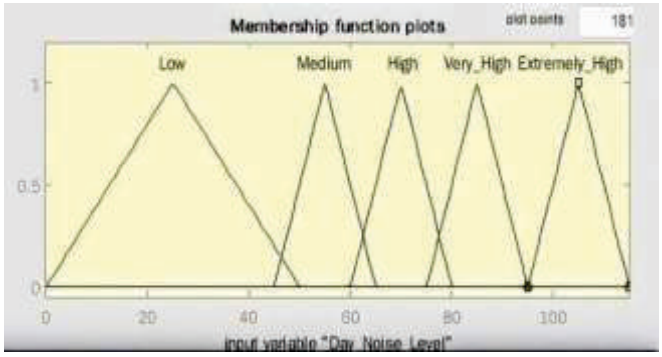

Fig. 1. Membership function of "Day Noise Level"

2. The linguistic variables for Night Noise Level are given in Table 3 and the corresponding membership function of Night Noise Level is given in Fig. 2.

Table 3. Linguistic variables for Night Noise Level

Range	Interval	Linguistic Variable
0-50	[0 25 50]	Low
45-65	[45 55 65]	Medium
60-80	[60 70 80]	High
75-95	[75 85 95]	Very High
95-115	[95 105 115]	Extremely High

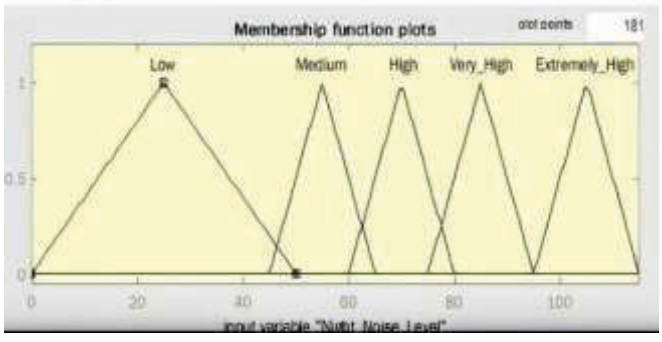

Fig. 2. Membership function of "Night Noise Level"

For the output variable 'annoyance', the total range was chosen between 0 to 1. The linguistic variables for annoyance is given in Table 4 and the corresponding membership function is given in Fig.3.

Table 4. Linguistic variables for Annoyance

Range	Interval	Linguistic Variable
0-0.1	[0 0.15 0.1]	Low
0.25-0.55	[0.25 0.4 0.55]	Medium
0.5-0.8	[0.5 0.65 0.8]	High
0.75-1	[0.75 0.875 1]	Very High

Fig. 3. Membership function of "Annoyance"

The combination of a few inference rules are as follows:

1. If Day Noise Level is Low & Night Noise Level is Low, then annoyance is Low.
2. If Day Noise Level is Low & Night Noise Level is Medium, then annoyance is Low.
3. If Day Noise Level is Low & Night Noise Level is High, then annoyance is Medium.
4. If Day Noise Level is Low & Night Noise Level is Very High, then annoyance is Medium.
5. If Day Noise Level is Low & Night Noise Level is Extremely High., then annoyance is High.

The defuzzified values of the output variables are given as follows (Tables 5-11):

Table 5. Chennai

Station	Output
Eye Hospital	0.503
T. Nagar	0.65
Perambur	0.65
Guindy	0.65
Tripalicane	0.4
Pallikaranai	0.732
Velachery	0.65
Washermanpet	0.65
Anna Nagar	0.4
Sowcarpet	0.65

Table 6. Hyderabad

Station	Output
Abids	0.65
TSPCB	0.65
Jeedimetla	0.65
Zoo	0.4
Jubilee Hills	0.4
Tarnaka	0.503
Gaddapotharam	0.65
Gachibowli	0.4
Paradise	0.65
Kukatpally	0.65

Table 7. Mumbai

Station	Output
Thane	0.4
Vashi Hospital	0.771
Ashp	0.65
Bandra	0.65
MPCB,HQ	0.455
M&M Kandivali	0.4
Ambassador Hall	0.65
L&T Powai	0.4
Pepsico Chembur	0.4
Andheri	0.65

Table 8. Kolkata

Station	Output
SSKM	0.4
Golpark	0.65
Head Quarter	0.4
Pautli	0.65
New Market	0.771
Birati	0.4
RG Kar	0.4
Tollygunge	0.547
Bag Bazar	0.65
Taratala	0.503

Table 9. Bengaluru

Station	Output
Parisara Bhavan	0.455
Peenya	0.4
Nisarga Bhavan	0.4
Marathahalli	0.547
BTM	0.65
Yeshwantpur	0.595
R.V.C.E	0.4
White Field	0.65
Domlur	0.455
Nihmans	0.65
Parisara Bhavan	0.455

Table 10. Delhi

Station	Output
CPCB HQ	0.4
DCE	0.4
ITO	0.65
NSIT	0.4
Civil Lines	0.65
RK Puram	0.4
Anand Vihar	0.65
Mandir Marg	0.4
Punjabi Bagh	0.503
Dilshad Garden	0.4

Table 11. Lucknow

Station	Output
Hazratgaunj	0.65
P.G.I	0.4
Indira Nagar	0.4
Gomti Nagar	0.4
Chinhat	0.4
IT College	0.503
CSS Airport	0.65
ROC Aliganj	0.4
Vibhuti Khand	0.4
Talkatora	0.455

The constructed fuzzy model was used for the evaluation of noise pollution effects on students' life in these 7 cities for the year 2017. After application on collected data, the study shows that Chennai has the highest noise level followed by Hyderabad, Mumbai, Kolkata, Bengaluru, Delhi and Lucknow. The annoyance is very high for the value more than 0.6. The annoyance value is medium for a value less than 0.4. When the annoyance is high (> 0.5), health problems increase in students. They get hearing problems; psychological problems and they find it difficult to concentrate while studying.

Conclusion:

The output 'annoyance' gives us a clear view of the effects noise pollution had on the lives of students in the year 2017 in the mentioned cities. Students suffer many problems when the 'annoyance' is high, they find it difficult to communicate on school/college campuses, they also suffer problems in concentrating while at home due to traffic and construction noises. All age groups are equally affected by the hazards of noise pollution. Kids and toddlers when exposed to high sound levels can permanently lose their ability to listen. Noise pollution also costs the efficiency of working professionals. Considering these facts brought up in this study, the government should take initiatives to minimize noise pollution. Few steps have been taken, like, the 'Odd-Even' scheme in Delhi or 'Honk More, Wait More' in Mumbai and many others. Irrespective of this fact, there is still a lot of scope for improvement. Policymakers must take noise pollution seriously and take more measures to minimize problems faced by students.

References:

Dixit G.R, Mahadevan T.N and Kapoor R.K, (1982). A noise pollution survey of Bombay, *Scavenger*, 122:20–25.

Kumar K. and Jain V.K. (1994). A study of noise in various modes of transport in Delhi, *Applied Acoustics*, 43(1):57–65.

Mamdani E.H and Assilian S. (1975). An experiment in linguistic synthesis with a fuzzy logic controller. *International Journal of Man-Machine Studies,* 7(1):1–13.

Ouis D. (2001). Annoyance from road traffic noise: a review, *Journal of Environmental Psychology*, 21(1): 101–120.

Pancholy M., Chhapgar, A.F., and Singhal S.P. (1967). Noise survey in Calcutta, *Journal of Scientific & Industrial Research*, 26:314–316.

Zadeh L.A. (1965). Fuzzy Sets, Information and Control, 8:338-353.