STUDY OF THE AIR POLLUTION LEVEL OF SIMARA AIRPORT WITH THE REFERENCE OF THE PARTICULATES MATTER

A Term Paper

Submitted to the Department of Physics
Amrit Campus, Tribhuvan University, Kathmandu,Nepal
in the Partial Fulfillment for the Requirement of
Master's Degree of Science in Physics

By

Rupesh Jha

Symbol no.:1664

Registration no.:5-2-14-124-2012

December,2020

RECOMMENDATION

This is to certify that **Mr. Rupesh Jha** has carried out the Term Paper of Master's Degree in Physics entitled **"STUDY OF THE AIR POLLUTION LEVEL OF SIMARA AIRPORT WITH THE REFERENCE OF THE PARTICULATES MATTER",** under my supervision and guidance.

I recommend the term paper is the partial fulfillment for the requirement of Master's Degree of Science in Physics.

…….

Mr. Shiromani Gajurel
(Advisor)
Department of physics
Tribhuvan university
Kathmandu,Nepal

ACKNOWLEDGEMENT

I would like to extend my heartfelt appreciation to all my co-operating hands that have supported me throughout my term paper. I wouldn't have been able to complete this research without their assistance.

It provides me unlimited joy to extend my deep gratitude to my renowned advisor, Mr.Shiromani Gajurel for his expert advice and continuous encouragement to produce a fruitful study of this research task.

I would also like to extend profound gratitude to all Asst. Prof.,Assoc. Prof. Of the Department of Physics of Amrit Campus for their invaluable support and suggestion.

I am thankful to the all students of Amrit Campus, Thamel, and Central Department of Physics, Kritipur who share their valuable experiences and behaviours during the study,which is the basis of this academic work.

Sincerely,

Rupesh Jha

EVALUATION

We certified that we have read this Term paper entitled **"STUDY OF THE AIR POLLUTION LEVEL OF SIMARA AIRPORT WITH THE REFERENCE OF THE PARTICULATES MATTER"** and in our opinion it is the excellent work in the scope and quality as Term Paper in the partial fulfillment for the requirement of the Master's Degree of the Science in Physics.

EVALUATION COMMITTEE

The undersigned certifies that the project report entitled "**Study of the air pollution level of Simara airport with the reference of the Particulates matter**" submitted by Rupesh Jha to Amrit Campus, Thamel, Kathmandu for the award of degree of M.Sc. in Physics has been accepted by the external examiner(s) and bound of examiners that the student has successfully defended the project in Viva-Voce examination held today.

…….
Mr. Shiromani Gajurel
(Advisor)
Department of physics
Amrit Campus ,
Thamel, Kathmandu

……..
Prof. Dr. Leela Pradhan Joshi
(HOD)
(Associate Professor)
Amrit Campus,
Thamel, Kathmandu

…….
Pitamber Shrestha
(coordinator)
(Associate Professor)
Amrit Campus
Thamel, Kathmandu

……
Internal Examiner

……
External Examiner

Date: …….

ABSTRACT

The average Particulate Matter AQI of $PM_{2.5}$ within the period of real time observation of the month of October 2020 of Simara Airport is 79.42, according to the WHO this values lies in the AQI range between (51 to 100). During this real time AQI, the Maximum AQI of $PM_{2.5}$ is 165 and the Minimum AQI of $PM_{2.5}$ is found 48. Similarly, the average Particulate Matter AQI of PM_{10} of Simara Airport of real time observation of the month of October 2020 is 40.03 and according to the WHO this value lies in the AQI range between (0 to 50). During this real time AQI, the Maximum AQI of PM_{10} is 115 and the Minimum AQI of PM_{10} is found 17.

List of Tables

List of Figures

ABBREVIATIONS

WHO	World Health Organization
PM	Particulates Matter
$PM_{2.5}$	Particulates Matter with diameter 2.5 micrometer
PM_{10}	Particulates Matter with diameter 10 micrometer
AQI	Air Quality Index
APL	Air Pollution Level
EPA	Environmental Protection Agency
SO_2	Sulfur Dioxide
CO	Carbon Monoxide
NO_2	Nitrogen Dioxide
O_3	Ozone
MoSTE	Ministry of Science, Technology and Environment
CANN	Clean air Network Nepal
CEN	Clean Energy Nepal

Contents

CHAPTER 1

INTRODUCTION

`

1.1 Introduction of Simara Airport

Simara is a town in Gadhimai Municipality in Bara District in Province No. 2 of south-eastern Nepal. The formerly Village Development Committee was merged to form a new municipality on 18 May 2014 [1]. Now a day Jeetpursimara is a sub-metropolitan city in Bara District in Province No. 2 of southern Nepal that was formed on 10 March 2017 after merging Gadhimai Municipality, Inarwasira, Amlekhganj, as well as parts of Manharwa, Haraiya and Rampur Tokani to form a new sub-metropolitan city. At the time of the 2011 Nepal census, the former settlements that would make up the sub-metropolitan city had a joint population of 117,094 people living in 21,670 individual households . Jeetpur Simara lies in the Terrai region of Nepal. To the north, it borders Hetauda Sub-metropolitan city, to south and west Birgunj Metropolitan City, and to the east Kalaiya sub-metropolitan city. It is regarded as the youngest sub-metropolitan city in the country [2]. Simara Airport is a domestic airport located in Jeetpur Simara serving Bara District, a district in Province No. 2 in Nepal. It is also the closest airport to Birgunj, Nepal's sixth biggest city.

Figure 1.1: Simara Airport (Source: www. wikipedia.org) [3].

Simara Airport lies in Old-Pipara Simara offering flights to Kathmandu and is the nearest airport from Kathmandu also Mahendra Highway & Tribhuvan Highway links Jeetpur Simara to different regions of Nepal as well as to the Indian Border [4].

1.2 Introduction of Air pollution and Index

World Health Organization (WHO) defines air pollution as contamination of the indoor or outdoor environment by any chemical, physical, or biological agent that modifies the natural characteristics of the atmosphere. Common sources of air pollution are household combustion devices, motor vehicles, industrial facilities, and forest fires. Acid rainfall, Ozone layer depletion, photochemical smog, Global warming, Climatic changes, Imbalance in ecosystem, Air borne diseases are the adverse outputs of air pollution. The major pollutants of air pollutions are Carbon monoxide, Nitrogen oxides, sulfur dioxide, Ozone, Volcanic eruptions, Particulates Matters (PM_{10}, $PM_{2.5}$), Industrial gases etc [5].

Most of the air pollutions are created by people, taking the form of emissions from factories, means of vehicles, aircrafts, aerosol cans, using chemicals fertilizers and pesticides/insecticides, Deforestations, burning woods and fuels etc. are considered as artificial sources known as anthropogenic sources [6].

The Air Quality Index (AQI) is an index for reporting daily air quality. It tells how clean or polluted air is, and what associated health effects. The AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. For each of these pollutants, EPA has established national air quality standards to protect public health. Ground-level ozone and airborne particles are the two pollutants that impose the greatest threat to human health [7].

Its air quality index values are typically grouped into ranges. Each range is assigned a descriptor, a color code, and a standardized public health advisory which is shown in table 1.1 below [8].

Table 1.1 AQI Value with its Health Concern

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

1.3 Air pollution status of Simara Airport

Jeetpursimara is a sub-metropolitan city in Bara District in Province No. 2 and also a popular city.There are various industries which are running and abled to support for country. Jagdamba Steels Pvt. Ltd., Ashok steel Pvt. Ltd, Advance cement (Bhawanipur), Hulas Steel Ltd, Hama Iron & Steel Industries Pvt. Ltd, Puja Soap & Household Products Pvt. Ltd., Yazat Food Pvt. Ltd., Alliance Pharmaceuticals Pvt. Ltd , Nepal Cable & Wire Industries Pvt. Ltd. Etc are the main industries of Jeetpursimara sub-metropolitan city. The releasing of industrial gaseous, smokes, photochemical fog, deforestation, increasing traffic fleet , Crowded of Vehicles, denseness of population and rapid human infrastructure development increase the air pollution of simara airport and Jeetpursimara sub-metropolitan city [9].

1.4 General Objectives

The general objectives of my term paper are:

- To collect all the available data of $PM_{2.5}$ and PM_{10} on the air quality data provided by the Government of Nepal, Ministry of Population and environment, Department of Environment Air Quality Monitoring, Babarmahal and from their websites of the Air pollution station of Simara Airport of the month of October 2020.
- To analyze the available data precisely.
- To test the hypothesis whether there is any significant differences between the average values of Air Quality Index of Simara Airport by using two-sample z- test.

1.5 Limitation of the Study

This study has following limitations:

- The findings of the study will be useful for the analysis of AQI of Simara Airport in October.
- This study totally depends on the air quality secondary data provided by the Department of Environment Air Quality Monitoring, Babarmahal about Simara Airport.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Review

There is wider increase in the number of street market in the main cities around the world, especially in the developing countries of Asia, Latin America and Africa. It has been found that the lack of gainful employment coupled with poverty in rural areas has pushed people out of their villages in search of a better existence in the cities, which increases the denseness of population in cities. Simara city is one of the polluted cities in Nepal. The highest levels in the urban traffic areas/ fleets and industrials excretion increases the denseness of air pollution [10]. Although the ambient air quality data in the various cities are still highly fragmented, they do indicate serious air pollution in the simara and especially the high particulate pollution in urban areas suggests substantial health impacts [11].

The fast growing road traffic fleet is an important source of air pollution in the cities, especially with the congested traffic conditions and the high elevation. Nepal is the fastest urbanizing country in South Asia with an annual growth rate of 7% [12]. As Nepal's economy is dependent on tourism due to its natural beauty and rich cultural and archeological significance, the high level of particulate pollution will directly impact our beauty and damage the physical structure, archeological and monuments. where there is only one domestic airport of Bara District can have negative impact about the image of the city [13].

Several mechanisms have been reported for PM air pollution associated cardio vascular reflects, including inducing systemic inflammation, oxidative stress, increased blood coagulate ability, and autonomic and vascular imbalance, investigated the molecular mechanisms by which $PM_{2.5}$ mediates inflammatory responses in chronic exposure [14].

Several seminars and task forces have been formulated to control the issue but no concrete solution has been met. Air pollution has been a burning issue but adequate air quality monitoring

stations have been limited only to a few places like Kathmandu, Kavre, Pokhara, Chitwan, and Rupandehi. No sufficient study regarding air quality of urban and suburban regions has been done and categorically published on the basis of pollution level. It has been generalized that poor air quality is having adverse effect on people's health; however, studies are limited and no sufficient studies have been done longitudinally to find out short and long term effects, seasonal patterns, geographical variations, and other issues of air quality affecting human health. Knowledge and awareness of poor air quality's threat on human health have not reached the public level. which has blindfolded them from taking basic precaution measures [15]. Various programs are still running to control and reduce the air pollution status in Nepal by Government and Non-Government Organizations but fails to control it.

The Grimm laser aerosol spectrometers and dust monitors based on the physical principle of light scattering or attenuation of the intensity of a light beam [16].

From Beer- Lambert Law,

$$I = I_o e^{-k.x} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where,

k = Mass extinction (attenuation) coefficient

I_o = Initial intensity of light beam/radiation

I = Intensity of light beam after Scattering

x = Thickness or size of Dust

2.2 Specific Objective

The specific objective of this term paper is;

- To analyze the Air quality index of Simara Airport.

CHAPTER 3

METHODOLOGY

3.1 Methodology

we have collected the essential information for our term paper work through data collection procedures. Under data collection procedures, we have used the secondary data collection. We collect all the available data of $PM_{2.5}$ and PM_{10} on the air quality data provided by the Government of Nepal, Ministry of Population and environment, Department of Environment Air Quality Monitoring and from their websites of the Air pollution stations of Simara Airport of the month of October 2020. After collecting the available data, we have analyzed these data and interpreted using statistical techniques. We classified and grouped these data on the basis of particulate matter and qualitative calculation as follows.

- We classified the data in to $PM_{2.5}$ and PM_{10} from 1st to 31st October of 2020.
- We classified the data in to maximum, minimum and average particulate matter of Air Pollution of Simara Airport of October 2020.

3.2 Mean and Standard Deviation

The **arithmetic mean** is also called the average value of Samples. Symbolically, if we have a data set consisting of the values $a_1, a_2, a_3, \ldots a_n$, then the arithmetic mean A is defined by the formula:

$$A = 1/n\sum^{n}_{i=1}(a_i) = \{ a_1 + a_2 + a_3 + \ldots + a_n\}/n \quad \ldots (2)$$

Where

n is the total number observations [17].

In statistics, the **standard deviation** is a measure of the amount of variation of a set of values from the mean of sample. The formula for the sample standard deviation (SD) of a data set consisting of the values $a_1, a_2, a_3, \ldots a_n$, with the arithmetic mean As is

$$SD = \sqrt{\{1/n\sum^{n}_{i=1}(a_i - A)^2\}} \quad \ldots (3)$$ Where i= 1, 2, 3, …, n [18].

3.3 Two – Sample z-test

In statistics, the two-sample z- test analysis the deviation of value sample from its mean that examines the influence of two different categorical independent variables. The two-sample z-test not only aims at assessing the main effect of each independent variable but also if there is any significance difference between them [19].

By using z-test we can examine the test of hypothesis as,

i. **Null Hypothesis (H_0):** There is no significant difference between the average of given two groups of variables.

ii. **Alternate hypothesis (H_1):** There is significant difference between the average of given two groups of variables [20].

3.4 Use of Software

After collecting the AQI data in of $PM_{2.5}$ and PM_{10} of Simara Airport of October of 2020, we calculate the Average AQI of PM ($PM_{2.5}$ and PM_{10}), Maximum AQI of PM, Minimum AQI of PM, standard deviation of AQI of PM by using MS Excel software. Histograms are plotted by using MS Excel software.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Analysis of Data

After collecting all the available data of AQI provided by Department of Environment Air Quality Monitoring updated from their websites of the Air pollution index of Simara Airport of the October 2020, we have analyzed these data to achieve the specific objectives.

Firstly, we separated the data into $PM_{2.5}$ and PM_{10} of October 2020.After that, we have drawn few histograms which shows $PM_{2.5}$ and PM_{10} of Simara Airport which are discussed below:

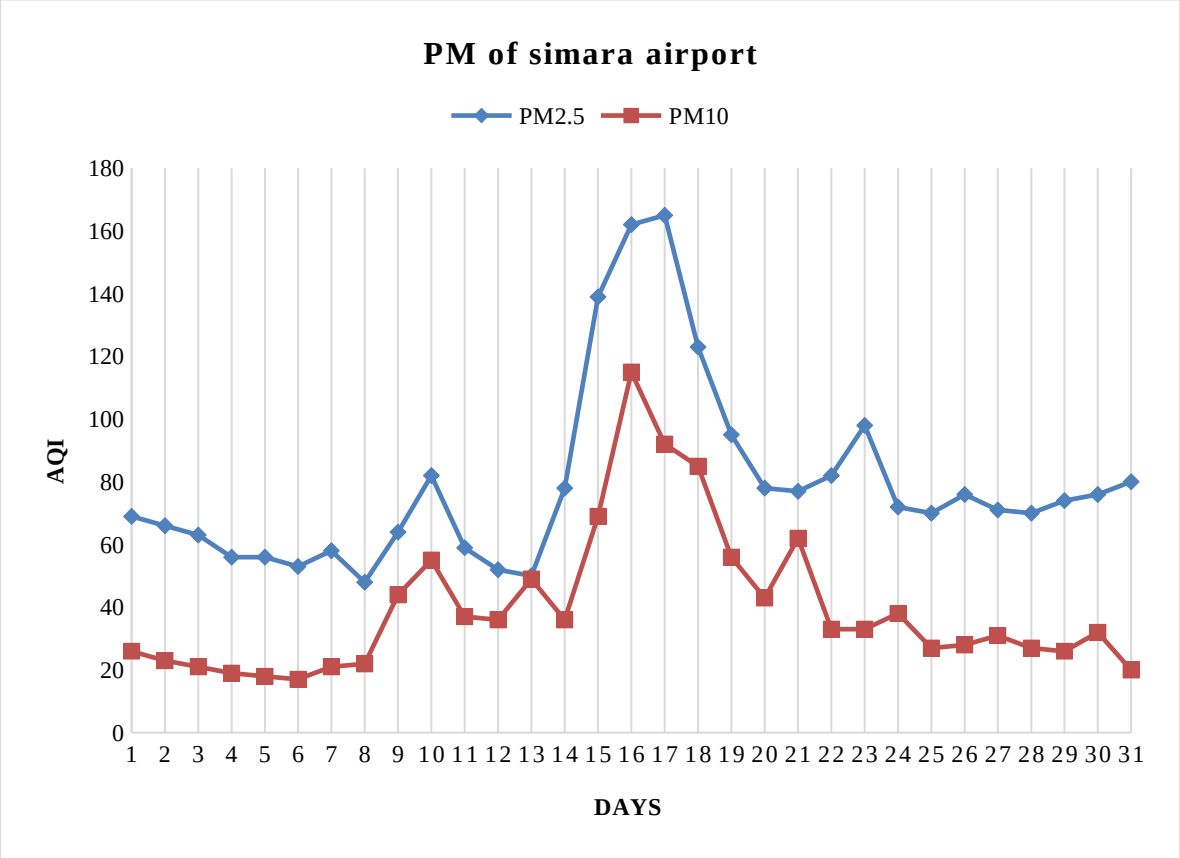

Figure 4.1: Particulate Matter of Simara Airport October 2020 (Source:Appendix)

Above Figure 4.1 shows the AQI of Particulate Matter of Simara Airport of October month of 2020 in which the $PM_{2.5}$ is greater than the PM_{10}. The AQI of $PM_{2.5}$ is maximum 165 on 17th

October. AQI of $PM_{2.5}$ slightly decreases up to 8th October from first October. After 8th October it gradual increases up to 10th October and also decreases towards 12th of October. AQI of $PM_{2.5}$ sharply increases from 14th to 17th October then after sharply decreases up to 20th October. The minimum AQI of $PM_{2.5}$ is 48 on 8th October. Similarly, nearly same nature of histogram is seen in the AQI of PM_{10}. The maximum AQI of PM_{10} is seen as 115 on 16th October and minimum AQI of PM_{10} is seen as 17 on 6th October.

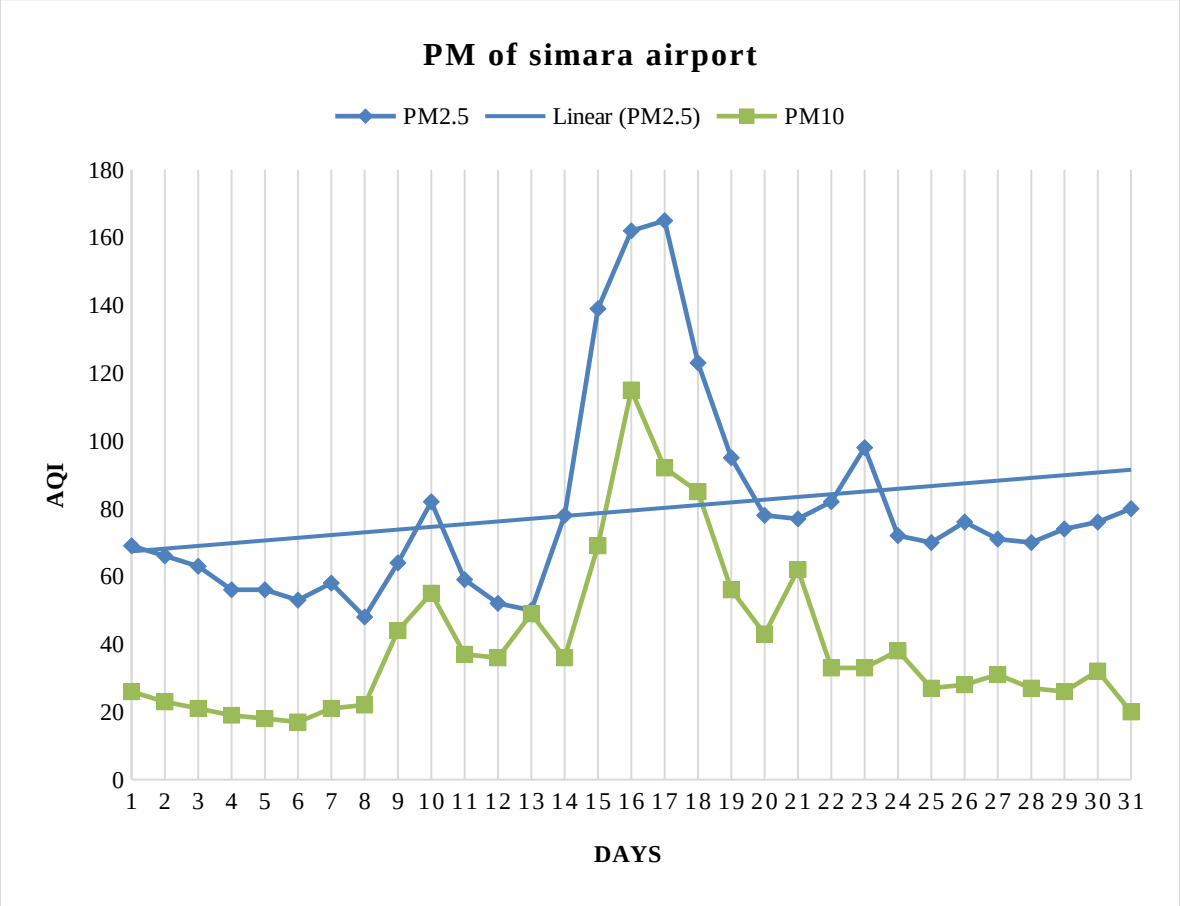

Figure 4.2: Linear fit of data $PM_{2.5}$ of Simara Airport October 2020 (Source:Appendix)

The above histogram shows the Linear best fit of Particulate Matter of $PM_{2.5}$ of Simara Airport.

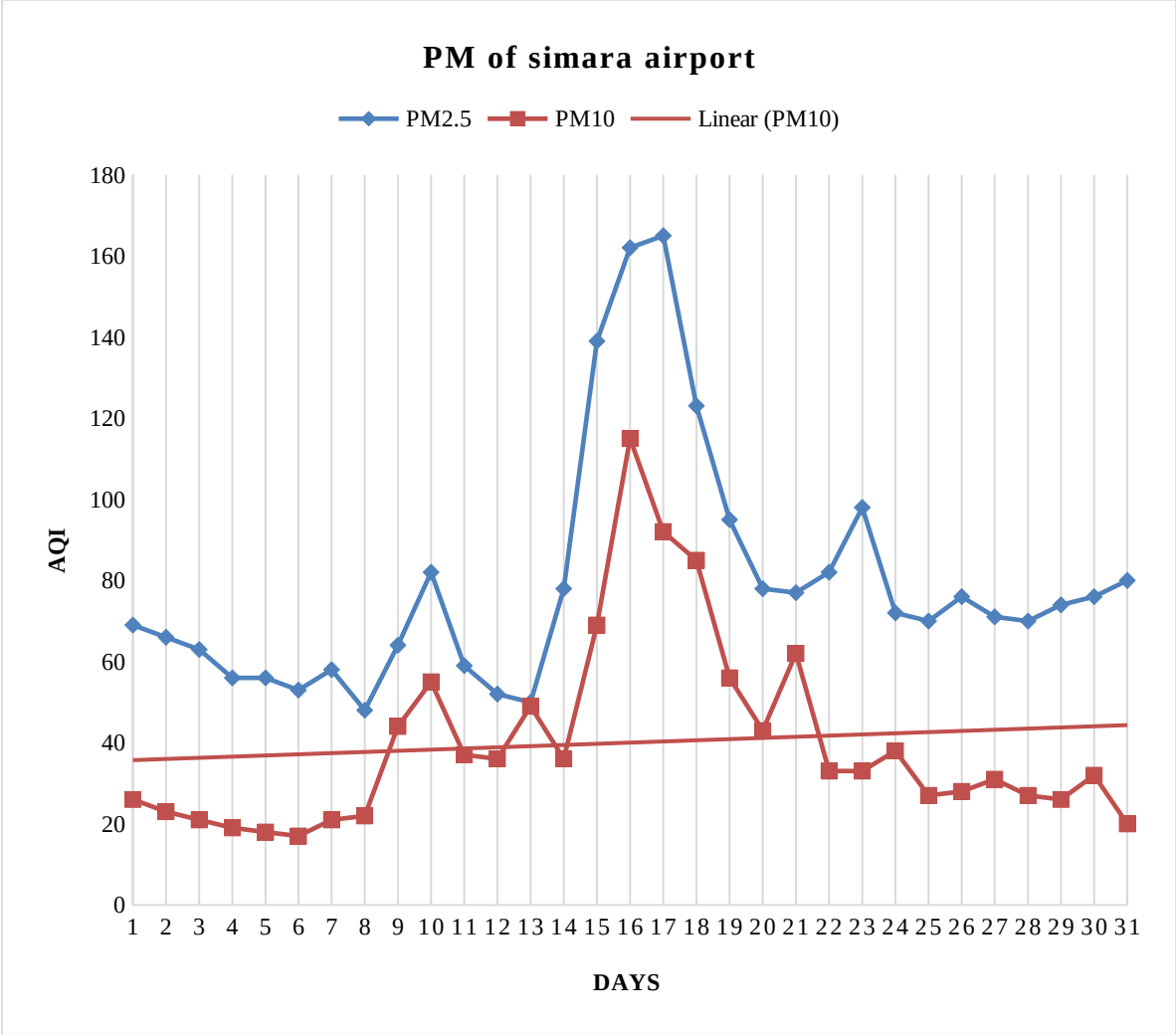

Figure 4.3: Linear fit of data of PM_{10} of Simara Airport October 2020 (Source:Appendix)

The above histogram shows the Linear best fit of Particulate Matter of of PM_{10} of Simara Airport.

4.1 Computation of Test Statistic of Two-sample z- test

Table 4.1: Average and Standard Deviation of $PM_{2.5}$ and PM_{10} (Two sample)

Days	**$PM_{2.5}$ (A_1)**	**PM_{10} (A_2)**	**$S_1 = \sqrt{\{\sum (A_1 - \bar{A}_1)^2/(N_1-1)\}}$**	**$S_2 = \sqrt{\{\sum (A_2 - \bar{A}_2))^2/(N_2-1)\}}$**
1	69	26		
2	66	23		
3	63	21		
4	56	19		
5	56	18		
6	53	17		
7	58	21		
8	48	22		
9	64	44		
10	82	55		
11	59	37		
12	52	36		
13	50	49		
14	78	36		
15	139	69		
16	162	115		
17	165	92		
18	123	85		
19	95	56		
20	78	43		
21	77	62		
22	82	33		
23	98	33		
24	72	38		
25	70	27		
26	76	28		
27	71	31		
28	70	27		
29	74	26		
30	76	32		
31	80	20		
Average	**79.42**	**40.03**	**29.78**	**23.32**

After that Two-sample mean z- test is done as follows:

4.2 Testing of Hypothesis

i. **Null Hypothesis (H_0):** There is no significant difference between the average AQI of $PM_{2.5}$ and PM_{10}.

ii. **Alternate hypothesis (H_1):** There is significant difference between the average AQI of $PM_{2.5}$ and PM_{10}.

z- Value (Calculated) = $(\bar{A}_1 - \bar{A}_2) / \sqrt{\{(S_1^2/N_1) + (S_2^2/N_2)\}}$

= $(79.42-40.03) / \sqrt{\{(29.78^2/31) + (23.32^2/31)\}}$

Therefore,

z- Value (Calculated) = 5.77

Degree of freedom = $(N_1-1) + (N_2-1)$

= 60

z- Value (tabulated) = 2.58 (99% confidence interval)

= 1.96 (95% confidence interval)

Table 4.3 Two sample z- test

Source of variation	**Sum of squares deviation from mean**	**Degrees of freedom**	**standard deviation**	**z- value (Calculated)**
sample A_1	26622.63	30	29.78	5.77
sample A_2	16305.02	30	23.32	
Total		60		

Degree of freedom (d.f): 60

Critical value: The tabulated value of z i.e., z_{tab} at 99% confidence interval is 2.58.

Decision: since $z_{tab} < z_{cal}$ at 99% confidence interval so null hypothesis is rejected. Therefore, we conclude that there is significant difference between the average AQI of $PM_{2.5}$ and PM_{10} of Simara Airport.

Critical value: The tabulated value of z i.e., z_{tab} at 95% confidence interval is 1.96.

Decision: since $z_{tab} < z_{cal}$ at 95% confidence interval ,so null hypothesis is rejected. Therefore, we conclude that there is significant difference between the average AQI of $PM_{2.5}$ and PM_{10} of Simara Airport.

CHAPTER 5

CONCLUSION AND CONCLUDING REMARK

5.1 Conclusion

The average Particulate Matter AQI of $PM_{2.5}$ within the period of real time observation of the month of October 2020 of Simara Airport is 79.42, according to the WHO this values lies in the AQI range between (51 to 100). During this real time AQI, the Maximum AQI of $PM_{2.5}$ is 165 and the Minimum AQI of $PM_{2.5}$ is found 48. Similarly, the average Particulate Matter AQI of PM_{10} of Simara Airport of real time observation of the month of October 2020 is 40.03 and according to the WHO this value lies in the AQI range between (0 to 50). During this real time AQI, the Maximum AQI of PM_{10} is 115 and the Minimum AQI of PM_{10} is found 17

The z- test in both 99% and 95% confidence interval, the null hypothesis is rejected, which shows, there is significant difference between the average AQI of $PM_{2.5}$ and PM_{10} of Simara Airport.

5.2 Future Prospects

The gaseous pollutants like as ozone (O_3), nitrogen dioxide (NO_2), Carbon Monoxide (CO), Sulfur Dioxide (SO_2) etc are also contributed in air pollution, so such parameter should be included in future work.

REFERENCES

[1] *https://en.wikipedia.org/wiki/Pipara_Simara* (viewed on November 2, 2020)

[2] *https://en.wikipedia.org/wiki/Jeetpursimara* (viewed on November 2, 2020)

[3] *https://en.wikipedia.org/wiki/photo/Jeetpursimara* (viewed on November 2, 2020)

[4] *https://en.wikipedia.org/wiki/Simara_Airport* (viewed on November 2, 2020)

[5] Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide – Global update 2005 – *Summary of risk assessment*, World Health Organization, (2006).

[6] *https://en.wikipedia.org/wiki/Air_quality_index* (viewed on November 3, 2020)

[7] B. Tuladhar, and A.K. Raut. *Environmental Health Impacts of Nepal'sBrick Kilns.* Nepal, Biophys. J., **22**, 5, 20-21, (2002).

[8] *https:// aqicn.org* (viewed on November 4, 2020)

[9] CEN report on, *Air quality status and management in Kathmandu Valley: Make the city air breathable*, Kathmandu: Clean Energy Nepal and Clean Air Network, Nepal (2014).

[10] W.H.O, *Report No. NEP/ENV/171, (*Ambient and household Air pollution and health of Nepal), WHO Nepal (2011).

[11] D.R. Gautam, *Air Pollution: Its Causes and Consequences with Reference To Kathmandu Metropolitan City*, The Third Pole, J. Geophys., **10**, 27–33 (2015).

[12] *Nepal: World Development Indicators (WDI)*, Nepal report on WDI, Washington DC, World Bank (2014).

[13] IUCN. 2019. *Urban Air Quality Change and Policy Measures: A Review report of Recent Condition in Nepal*, IUCN 38-39 (2019).

[14] P.M. Mannucci, and G.S. Tell, *Expert position paper on air pollution and cardiovascular disease*, European Heart, J. Biopphys., **31**, 2, 73–79 (2015).

[15] A. Saraf, *Health Impact of particulate Pollution in Adult: A Case Study of Kathmandu*, Nepal, NHRC, 7-9 (2013).

[16] *https://www.grimm-aerosol.com* (viewed on November 4 , 2020).

[17] *https://en.wikipedia.org/wiki/Arithmetic_mean* (viewed on November 5, 2020).

[18] *https://en.wikipedia.org/wiki/Standard_deviation* (viewed on November 5, 2020).

[19] *https://www.scribbr.com/statistics/t-test* (viewed on November 7, 2020).

[20] *https://www.researchoptimus.com/article/what-is-t-test.php* (viewed on November 7, 2020).

APPENDIX

Table: Air Pollution (PM) Data of Simara Airport

Day	$PM_{2.5}$	PM_{10}
1	69	26
2	66	23
3	63	21
4	56	19
5	56	18
6	53	17
7	58	21
8	48	22
9	64	44
10	82	55
11	59	37
12	52	36
13	50	49
14	78	36
15	139	69
16	162	115
17	165	92
18	123	85
19	95	56
20	78	43
21	77	62
22	82	33
23	98	33
24	72	38
25	70	27
26	76	28
27	71	31
28	70	27
29	74	26
30	76	32
31	80	20
Maximum	**165**	**115**
Minimum	**48**	**17**
Average	**79.42**	**40.03**