American Journal of Environment and Climate (AJEC)

ISSN: 2832-403X (ONLINE)

VOLUME 3 ISSUE 3 (2024)

PUBLISHED BY

E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Environment and Climate (AJEC)

Volume 3 Issue 3, Year 2024
ISSN: 2832-403X (Online)
DOI: https://doi.org/10.54536/ajec.v3i3.3127
https://journals.e-palli.com/home/index.php/ajec

Maintaining Indoor Air Quality in Government Offices with Frontline Services

Raul Winston R. Lim[1*], Judy Marie R. Zoleta[1]

Article Information

Received: July 15, 2024

Accepted: August 18, 2024

Published: August 20, 2024

Keywords

Carbon Dioxide (CO_2), Frontline Services, Government Offices, Indoor Air Quality (IAQ), Parts Per Million (PPM)

ABSTRACT

This study sought to assess the Indoor Air Quality (IAQ) of the Local Government Unit of Matungao, Lanao del Norte Frontline Offices, by measuring the Carbon Dioxide (CO_2) level. The study also sought to assess if minor interventions (putting indoor plants and opening of windows and doors on the first hour in the morning) can significantly affect the CO_2 level in the offices. The offices involved in the study are those that offer frontline services for the community. Paired T-test was utilized in the study. In the first and second week of the data gathering, the offices were assessed based on their regular operations, and on the third week, the interventions were made for all the offices. The first and second week of the assessment shows that, the Rural Health Unit (RHU) and Human Resource and Management Office (HRMO) are the offices which have average CO_2 levels that are close to 1000ppm, which implies that these offices do not have efficient air ventilation. On the third week of assessment, the result still shows the same, with RHU and HRMO, and other offices are still on the normal range. The results shows that even with the interventions made on all of the eight offices, CO_2 level didn't show a significant change.

INTRODUCTION

One of the mandates of Local Government Units (LGU) is to serve the general public with essential services from healthcare to permit issuances, with offices delivering frontline services, Carbon Dioxide and other pollutants inside the office, increases as persons occupying these offices increases. Indoor Air Quality (IAQ) gradually decreases as time goes by, especially in a room with no proper ventilation; trapped CO_2 gets circulated and inhaled again by people, which poses a health risk either short-term or long-term, IAQ (2000) reports that increased levels result in drowsiness, lethargy and a general sense that air is stale. Effects may be experienced right after exposure or after a long time (Zoleta & Magdale, 2018).

US EPA stated that the term "indoor air quality (IAQ)" describes the quality of the air inside and surrounding buildings and other structures, focusing on how it affects the comfort and health of building inhabitants. The chance of experiencing indoor health issues can be decreased by being in control of prevalent indoor pollutants, including the level of "Carbon Dioxide (CO_2)". Although the average person exhales between 35,000 - 50,000 parts per million (PPM) of CO_2, "ASHRAE" standard 62.1 (2013) estimates that normal CO_2 levels in a space area are between 200 – 700 ppm. WHO (2010) estimates the normal range at 350-1000 ppm. "Indoor Air Quality (IAQ)" asserts that normal levels should be maintained at 1000 ppm in classrooms and 800 ppm in offices (Zoleta & Magdale, 2018). Most air conditioning units do not help in improving IAQ, for they only control the temperature and humidity of the room; with the use of air conditioning, the room must be air-tight sealed to reduce power usage; by this practice, the room will be in a confined space with CO_2 only circulating and building up inside..

Most local government units do not have policies for monitoring and maintaining IAQ in its offices, and this is a problem for both the personnel and clients; poor IAQ results in health risks and can also decrease productivity of personnel, in addition to causing visitors to express dissatisfaction(Wyon, 2004)[4]. Without monitoring and intervention of the poor IAQ, inefficient delivery of public services may become an issue in LGUs.

Theoretical Framework

This study is mainly anchored on the concept of Matte (2011) on the IAQ concept of conditioned space and Herwagen's(2000) IAQ concept of conditioned space the concept suggests that with a confined space or rooms, outdoor pollution when gets inside a room can add up with the existing indoor pollutants especially with indoor CO_2. Herwagen (2000) presents that with good planning designs of buildings; it provides occupant productivity which means an increase in performance.

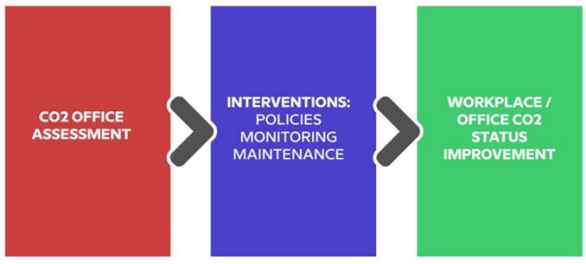

Figure 1: Framework of the study

[1] Liceo de Cagayan University, Philippines
[*] Corresponding author's e-mail: raulwinstonlim6@gmail.com

MATERIALS AND METHODS

Research Setting

The study is conducted in the Municipal Local Government Unit of Matungao, Province of Lanao del Norte. Eight (8) office spaces out of the 23 in the LGU are included in the study. The study only includes offices with frontline services.

Research Design

The study employed quantitative research method in a descriptive type. The research focuses on gathering numerical data on CO_2 level in Parts Per Million (PPM). The collected Carbon Dioxide (CO_2) Level data is then used as a basis to describe the indoor air quality(IAQ)

Sampling Procedure

Only three (3) locations per office were sampled during the data-gathering process.

The sampling used is ambient air sampling. Determining the ambient air quality of the offices as it relates to the CO_2 level, each data per location per office was documented using a geotagging app in a mobile phone and was tabulated in Microsoft Excel file for data storage and data processing.

Data Gathering Procedure

The data-gathering process was conducted for Three (3) weeks, from Monday to Friday each week, for ten (10) working days. Each day, the researcher measured the level of CO_2 in the morning (8:00H - 9:00H), in the noon (12:00H-13:00H) and in the afternoon (16:00H-17:00H), and this has been done in the three corners of the office included in the study; with a total of nine (9) CO_2 assessments per day per office.

In the first two weeks of the data gathering, the office were sampled as to their regular office operations. After Two weeks of data gathering, the researcher then presented the data to the Management Committee of the LGU, which includes the Municipal Mayor and Vice Mayor. The researcher then recommended that during the third week of the data collection, some changes in office practices and set up are to be implemented to improve the IAQ of each office; the recommendations are the following;(1) every morning the personnel of the offices opens all the doors and windows of the office to let in some fresh air for 1 hour; (2)adding indoor plants in the office which is close to the area where the researcher collects the data, the indoor plants used are those that are only common in the area and are considered indoor plants.

Statistical Instrument/Equipment

All CO_2 level measurements are carried out using CO_2 meter LUTRON GC-2028. This portable device gives CO_2 values in ppm directly.

Statistical Treatment

The collected data (CO_2 level) is be tabulated in a data sheet, the average results from the data collection process are compared to the standard measurements to determine the status of CO_2 level of the office. The study utilized Paired T-test to compare if there is significant difference of average CO_2 levels between Week 1 and Week 2 and Week 3 for the all the offices.

RESULTS AND DISCUSSIONS

Problem 1: What is the Status of Indoor CO_2 in the Government Offices with Frontline Services before the Interventions?

Table 1: Week 1 Average Daily Carbon Dioxide (CO2) Reading

Offices	Week 1				
	10-02-2023	10-03-2023	10-04-2023	10-05-2023	10-06-2023
HRMO	630.00	843.22	972.22	828.67	699.44
RHU	578.00	636.56	905.11	830.89	571.22
TB-DOTS	394.22	515.44	463.44	556.11	398.00
Mayor's Office	678.56	621.67	546.67	619.33	485.11
Cashier/BPLO	406.56	429.89	451.56	486.44	418.78
MA/MCR	439.56	413.56	446.89	449.11	422.89
MSWDO	417.22	424.00	404.00	418.44	449.00
MPDO/MEO	417.11	401.56	422.67	396.00	399.89

Table 1 shows that the offices of HRMO and RHU have average CO_2 levels that are above 700ppm and close to 1,000ppm, during Tuesday 10-03-2023, Wednesday 10-04-2023 and Thursday 10-05-2023. Though compared WHO standard, this result is on the normal range, it is still important to note that this levels are close to dangerous levels and could reach beyond 1,000ppm during a sudden influx of people. This implies that these two offices have inefficient air ventilation and are accommodating high number of people. Other offices on the other hand do not have issues on CO_2 levels.

Table 2: Average Daily Carbon Dioxide (CO_2) Reading

Offices	Week 2				
	10-16-2023	10-17-2023	10-18-2023	10-19-2023	10-20-2023
HRMO	771.44	857.22	724.11	865.22	738.22
RHU	756.78	691.89	765.11	800.89	1,019.11
TB-DOTS	393.33	384.44	404.44	447.78	425.33
Mayor's Office	569.44	653.22	473.44	518.89	451.56
Cashier/BPLO	488.33	406.44	408.11	397.89	404.33
MA/MCR	454.22	443.89	411.33	407.67	413.56
MSWDO	409.33	409.33	428.44	422.22	400.00
MPDO/MEO	415.56	392.22	451.44	429.44	430.22

Table 2 shows that the offices of HRMO and RHU still have an average CO_2 levels that are above 700ppm throughout the week (except during Tuesday 10-03-2023 for RHU), however during Friday 10-20-2023 the office of RHU reached 1,019.11ppm, which is a dangerous level according to WHO standard. The result implies that both RHU and HRMO have an issue with air ventilation, sudden influx of people results to dangerous CO_2 level.

Problem 2. What is the Status of Indoor CO_2 in the Government Offices with Frontline Services after the Interventions?

Table 3: Week 3 Average Daily Carbon Dioxide (CO2) Reading

Offices	Week 3				
	10-02-2023	10-03-2023	10-04-2023	10-05-2023	10-06-2023
HRMO	656.22	960.78	780.00	950.44	901.33
RHU	917.89	737.11	896.89	604.67	889.11
TB-DOTS	358.00	606.33	642.11	448.56	412.22
Mayor's Office	543.56	533.67	468.44	492.44	548.78
Cashier/BPLO	403.67	397.56	426.22	432.44	450.22
MA/MCR	423.44	412.00	446.22	438.44	453.44
MSWDO	389.11	392.78	432.22	456.22	470.11
MPDO/MEO	436.44	419.44	477.44	491.89	444.78

Table 3 shows the result of sampling during the application of the interventions, during this week each offices are practicing the routine of opening the doors and windows for 1 hour in the morning and are placing indoor plants in office corners and with crowded places, this is done after the recommendation of the researcher to the Management Committee of the LGU. The table shows that the office of RHU and HRMO still has CO_2 levels above 700ppm and are still close to 1,000ppm, which implies that the interventions done in this offices did not decrease the CO_2 level and did not help in making better IAQ of the offices.

Problem 3. Is there a Significant Difference in the Status of Indoor CO_2 in the Government Offices Involved in the Study?

Table 4: Paired T-test result of CO_2 levels across Week 1 and Week 2

Offices	Week1 & Week2			
	Level of Significance	t value	p value	Result
HRMO	0.05	0.0530	0.9600	Not Significant
RHU	0.05	1.0147	0.3677	Not Significant
TB-DOTS	0.05	1.7957	0.147	Not Significant
Mayor's Office	0.05	2.2122	0.0914	Not Significant
Cashier/BPLO	0.05	0.6307	0.5625	Not Significant
MA/MCR	0.05	0.595	0.5839	Not Significant
MSWDO	0.05	0.7181	0.5124	Not Significant
MPDO/MEO	0.05	1.8132	0.144	Not Significant

Table 4 shows offices of HRMO obtaining 0.9600, RHU obtaining 0.3677, TB-DOTS obtaining 0.147, and Mayor's Office obtaining 0.0914, having no significant difference in CO_2 levels across week one (1) and week two (2); same with the offices of Cashier/BPLO obtaining 0.5625, MA/MCR obtaining 0.5839, MSWDO obtaining 0.5124 and MPDO/MEO obtaining 0.144 shows that there is no significant difference of CO_2 level across week 1 and week 2.

Table 5: Paired T-test result of CO_2 levels across Week 2 and Week 3

Offices	**Week2 & Week3**			
	Level of Significance	**t value**	**p value**	**Result**
HRMO	0.05	0.7028	0.4999	Not Significant
RHU	0.05	0.0335	0.9749	Not Significant
TB-DOTS	0.05	1.3616	0.245	Not Significant
Mayor's Office	0.05	0.4612	0.6686	Not Significant
Cashier/BPLO	0.05	0.043	0.9678	Not Significant
MA/MCR	0.05	0.5242	0.6279	Not Significant
MSWDO	0.05	0.8384	0.449	Not Significant
MPDO/MEO	0.05	3.6147	0.0225	Significant

Table 5 shows that the offices of HRMO-0.4999, RHU-0.9749, TB-DOTS-0.2450, and Mayor's Office-0.6686) and offices that accommodates many clients and staff, still having no significant difference in CO_2 levels across week two (2) and week three (3), this clearly shows that even with the intervention done in week three (3), the CO_2 levels were not affected in these offices. Out of all the offices in the study, only the MPDO/MEO showed a significant difference of average daily reading across three weeks, MPDO/MEO obtained 0.0225, however data shows that the CO_2 level did not decrease but instead increased during Week 3, this implies that there was a sudden influx of people in the office during the sampling period. The rest of the offices did not show a significant difference across week two (2) and week three(3).

Problem 4. What Recommendations Can be Proposed Based on the Findings of the Study?

Based on the data and results presented in this study, minor interventions in improving the CO_2 status of the frontline offices involved in the study, such as opening the doors and windows every morning, and putting indoor plants inside the offices, cannot decrease the levels of indoor CO_2. However, these interventions may be continued by the offices, the institution and its management committee may go further in its interventions to improve the indoor air quality of the offices and even for other offices not involved in the study. In summary, conclusions and recommendations; presents the recommendations proposed based on the study's findings for the institution to consider in improving the CO_2 status of their offices.

CONCLUSION

Based on the findings, the researcher concluded that HRMO and RHU have CO_2 levels that are above the normal range, and obtained the highest value of CO_2 level across the 3 weeks of sampling period. Hence these areas are said to be poorly ventilated. The rest of the offices have obtained values that are in the normal range of CO_2 levels across the 3 weeks of the sampling period and, therefore, have adequate ventilation. This suggest that there are more occupants than the room can handle, causing more build up CO_2.

RECOMMENDATIONS

Considering the foregoing findings and conclusions, the researcher recommends the following:

1. The institution may consider installing air vents / exhaust fans especially in offices with inadequate air ventilation due to uncontrolled influx of clients. This will allow the entry of fresh air in offices and increases air circulation.
2. Air circulation/ventilation may be considered in construction of infrastructures for any government projects to prevent Indoor Air Quality issues.
3. The institution may consider consulting an architect in the design phase of buildings/offices construction and in renovations.
4. The institution may increase the number of indoor plants as these may continually absorb more CO_2 and therefore reinforce its reduction to normal levels.
5. The Institution may consider passing a local policy to periodically monitor CO_2 levels in offices to avoid health and safety hazards associated with poor IAQ.

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