RESEARCH ARTICLE

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A Study of Short Period Indoor Air Pollution Analysis in Home Level and its Recommendations

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Abstract

India had a large number of villages (6.50 lakhs) around the cities and Tamil Nadu state has 12,619 villages around the town. Due to urbanization, village people have less number of job opportunities in their own village. The house holds women in villages use their country's wood fuel for low-cost, long-term cooking. The rural outside air has more air pollution than indoor air pollution in a ratio of 2:1 in villages. The most significant parameters were identified and air quality levels at the specific place were determined with help of $PM_{2.5}$, $PM_{10,}$ temperature and humidity. The village women are affected more by skin allergy, asthma, eye power loss in advance, and cancer at various levels due to long usage of country wood. In general, village men use tobacco-based items like cigarettes and other items. This project deals with monitoring indoor air pollution in a village house (for a middle-class family) and better understanding indoor air quality in real-time. Also, it focuses on village women facing other health-related problems like asthma, eye problems and cancer in large numbers, continuously increasing day by day in a village environment. It affects the normal work done by the villagers. A powerful statistical tool also used to compare the relationship between the indoor parameters in a selected village.

Keywords: Air at room, Pure air inside, Dust air rich, Discomfort living, Sick always, Sad mood.

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Introduction

In India, after independence, many villages (6.50 Lakhs)are available around the cities, particularly in Tamil Nadu state, having 12,619 villages as panchayat.

The Tamil Nadu state has a total of 38 districts. In the Dindigul district, nine taluks are available around the town. The Palani is a worship-based place in Palani town for Lord Murugan. The Palani taluk contains around 29 villages. The Kanakanpatty village is situated very close to Palani town. It has a population of 4587 with 2315 male category and 2272 women category. The total number of houses in this village is around 1311. The geographical location of Kanakanpatty village has a coordinate of Latitude: 110˚27′ 1.22″ N and longitude:77˚31′ 15.24″ E. This study has a focus of air quality in Kanakanpatty village home.

India had large numbers of villages during independence and later on it was converted into urban areas. Some villages have not had proper drainage system, drinking water facility and primary health center for the past 25 years. Now the situation is slowly altered and some of the villages have last their glory due to urbanization. In India most of the people were lived in villages only. The observation was made in a village for indoor air pollution in a medium-income family. The main source of air pollution in a village is due to usage of some of the items in daily life on a small scale. The source of indoor pollution items are mosquito coils, country wood and kerosene usage for cooking, toilet cleaners, nail polish, shoe polish, incense sticks(Agar patti), Gum Benjamin, Candles, and benzamine. The polluted indoor air consists of AQI, PM2.5, PM10, PM1.0, HCHO, CO, CO_2, TVOC, Temperature and humidity. It involves the local change in climatic conditions and health-related problems. The use of mosquito coil for long exposure

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Figure 1: Dindigul district, nine taluks

produces health-related problems in the human body.[1] Normally mosquito coils are only used in Asia and Africa.[2] Also, it was found that there is no involvement of the introduction of diseases like Lung cancer in human body.[3] During the burning of incense sticks emits gases like benzene, toluene, xylenes and aldehydes.[4] The impact of candle burning during Saints' Day periods would be released more benzenes.[5] The benzoin gum resin was used in religious ritual festivals and also used against ski irritation treatments[6]

If the building roof is made up of asbestos, then health-related problems were occur due to indoor pollution. We must also take care of all other indoor pollution parameters like carbon monoxide, Lead, Mould, Radon and volatile organic compounds (VOCs). The air quality index AQI values in the range of (0-500) and color code indication depend on the amount of indoor air pollution inside a building.[6] The health-related symptoms of headache, eye irritation, fatigue, dry throat, sinus congestion, dizziness and nausea occur without any reason, indicating indoor air pollution in the workplace.[7]

When we continuously monitor the indoor parameters in a home, we can easily control indoor air pollution in it. There is a possibility that introducing more windows in the building or creating forced ventilation in the building would reduce indoor air pollution.[8] The air monitoring stations in India give information about the emission of air pollutants in Industries/ automobiles or outside environments in a particular place where the monitoring station is located.[9,10] The polluted air also contains some of heavy metals like Ni, Cu, Pb.[11] Some urban residential environment contains NO_2 pollutants.[12] When the particulate(PM10) increases continuously, it will affect human health.[13] It consists of fine and coarse dust particles called suspended particulate matter(SPM).[14] The fine particulate and dust took part in local climatic conditions changes.

Methodology

Location of the study

The place selected for this analysis is a home situated in Kanakanpatty village at Palani taluk and Dindigul district.

Materials Required

The smart indoor air quality monitors- (1) Prana Air (Basic Type-I), (2) SMILEDRIVE smart air quality monitor and (3) Sensible air quality monitor –Prana Air (type-II) were also used.

Statistical Analysis Methods

The observed data was collected and stored in an Excel sheet for further processing. The data is compared with its Indian standard limit for further processing. It gives a solution to an observer whether the available data is - within the range, below the range or above the range. The increased values have an impact on health-related problems in a home.

The Multiple regression method is used for the analysis of data of indoor air pollution at the home level. It also indicates the variable relationship between them.

Sensor and Its Applications

Temperature and Humidity Sensor

The most important parameters in indoor air pollution are temperature and humidity.

The LM35 sensor (Figure 2) is used for temperature measurements. The sensor technical details are:

This type of sensor given an analog-type output sensor. The input voltage applied is 5V. The maximum input may be 30V. The minimum temperature sense is -55℃. The precision of the sensor is 1℃. The operating voltage may be: 4 to 30 V. The maximum temperature measured is 150℃.

The temperature sensor, which is highly suitable for air pollution measurements. It is a sensor used for (DHT11 sensor) temperature measurement and humidity measurement. The power supply required is 3 to 5 V. It works well for the range of 20 to 80% humidity readings with 5% accuracy. The temperature reading is measured by this sensor in the range of 0 to 50℃ with +/-2℃ accuracy.

Carbon dioxide sensor

A carbon dioxide sensor also used with the specification of MG-811 series. It is more sensitive to CO_2 gas particularly. The operating voltage is VCC: 6V DC. The output may be in the form of Analog mode. The tree consumed the maximum amount of carbon dioxide. When its values high then it creates health-related problems.

Formaldehyde (HCHO) gas sensor

It is an odor gas available in the form of scent, shoe polish and nail polishes in home places. Some of the perfumes are available in spray type. Male and female people also liked the spray scents with different flavors. It leads to asthma when it values reach high.

Wi-Fi Module

Any computer data may be transferred from one place to another by wired internet or wireless (Wi-Fi))systems. If we are using the Arduino Uno board , it is a special kind IC board in this series, which has a built-in Wi-Fi module with TC/IP protocol and a supply voltage of 3.3V. It is very much helpful for remote sensor control activities.

Main sources of home-indoor air pollution

The Agarpatti is used in daily pooja room to worship god in a room. It emits odor gas like sandal and other flavors. It is a

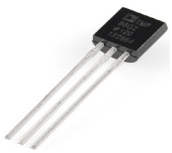


Figure 2: Temperature sensor LM35

source of indoor air pollution in a small percentage. It also affects air quality inside the local room by fast movement of particles inside it. Excess amounts inhale produce health-related problems.

The village people cooking was done in an open space and a small room with a small hole opening to remove it. The country wood is usually used for their cooking. A small amount of coconut (coconut shell waste, coconut husk) was used as solid fuel. It emits all types of particles. It particularly emits more amount of polluted air surrounding it. The smoke in the open cooking produces more eye irritation and more coughing. More amount of heat may be wasted in all directions.

Kerosene Stove

It is derived from petroleum. It is a complex mixture of paraffin's(55.2%), naphthenes (40.9%), and aromatic hydrocarbons(3.9%). It is a long chain of hydrocarbons having 11-13 carbons. Also it has a property of low viscosity, clean liquid and blue-dyed. It is used as an insecticide, fuel for small lamps and fuel for domestic heaters and furnaces. It's boiling point may be around 150-300℃. Its chemical formula is $-C_{12}H_{26}$-$C_{15}H_{32}$.

LPG gas stove

It is a hydrocarbon of propane (C_3H_8) and butane (C_4H_{10}). It is easily burnt in the air. It is a standard cooking fuel in towns/ urban areas and small percentage in village. It produces less amount of smoke. The strong odor produces headache, nausea and dizziness for a short time. Its boiling point may be around 42℃.

Figure 3:

Petrol fuel

It is fueling most of the 2-wheeler scooters and 4-wheeler cars and operates in towns and urban areas. It produces indoor air pollution as well as outdoor air pollution. It produces carbon dioxide, monoxide, and particulate matter in the exhaust port. It produces less amount of carbon mono oxide when compared with the combustion ignition engine.

Prana Air –smart air quality Monitor

Figure 4:

Figure 5:

Figure 6:

Figure 7:

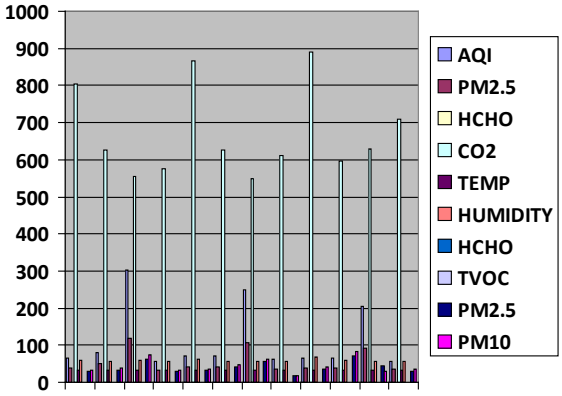
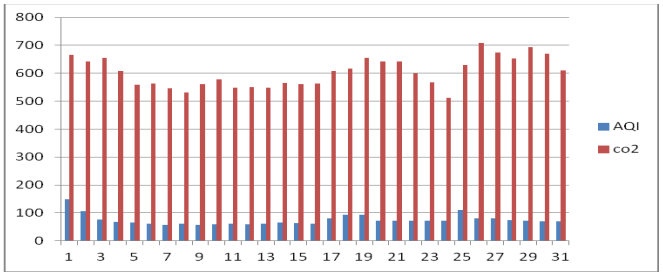


Figure 8:



Graph 2: The graph is drawn between AQI Vs CO_2

Result and Discussion

Round mosquito coil/mosquito repellant incense

	ROOM1(10X10)				ROOM2(16X10)				TOILET(6X4)			
AQI	65	80	304	55	70	71	250	61	65	66	206	56
PM2.5	39	49	118	33	42	43	106	37	38	40	91	37
HCHO	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CO2	805	625	555	575	865	625	550	610	890	595	630	710
TEMP	31.7	32.0	31.4	31.4	31.4	32.6	31.9	32.0	31.5	33.0	32.7	32.5
HUMIDITY	59	57	58	57	63	56	57	56	68	58	55	57
HCHO	0.005	0.004	0.002	0.002	0.002	0.004	0.003	0.002	0.003	0.003	0.004	0.003
TVOC	0.001	0.002	0.002	0.001	0.001	0.001	0.002	0.000	0.000	0.003	0.000	0.000
PM2.5	30	33	62	30	32	41	57	17	36	72	44	31
PM10	34	38	73	32	37	47	63	19	42	83	31	37

Table 1

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.362724984
R Square	0.131569414
Adjusted R Square	0.128478914
Standard Error	3.749003538
Observations	283

ANOVA

	df	SS	MS	F	Significance F
Regression	1	598.3535	598.35352	42.5722	3.1645E-10
Residual	281	3949.463	14.055028		
Total	282	4547.816			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	40.74908561	1.61898	25.169598	5.7E-74	37.5622166	43.9359546	37.5622166	43.93595463
74	-0.174834154	0.026796	-6.524738	3.2E-10	-0.227579704	-0.1220886	-0.227579704	-0.1220886

Gum Benjamin

It is a gum resin consisting of benzoic acid, obtained from various trees of the genus Styrax. Mostly it is obtained from Java and Sumatra island trees. It is also used as perfume and ointment. It also acts as an antiseptic agent for a wound. Its chemical formula is $C_6H_5CHOHCOC_6H5$ and its chemical name is : 2-hydroxy 2-phenulacetophenone. It emits high indoor air pollutants like PM2.5, PM10, and CO in the local atmosphere at a room.

The graph is drawn between AQI VS indoor air pollution parameters.

All the indoor air pollution parameters for the candle source are drawn. Each value gives information about indoor air pollution. They are different types of candles used. They are made from coconut, vegetable, paraffin, soy, and beeswax. It releases dangerous chemicals such as toluene.

The graph shows that when the AQI is above 500 and the carbon dioxide is less than 200 ppm.

Statistical approach of air pollution variables and its value verification:

The above table gives information about the statistical significance depending on the coefficient value. The R square value is less than 0.01, which is less than 0.4. There is less significance is available between variables. But the p value is less than 0.05 and the f-value is 42.57, which gives information about the strong relationship between variables (Table 1).

Conclusion

In this study, we concluded that indoor air pollution was found in the rural side village near Palani due to more transportation in that area. The middle-class village peoples depend upon their two-wheelers for their transportation and carry country wood and kerosene for their cooking. The introduction of gas stove for their cooking reduce half of the indoor air pollution and use of electric stove operated by solar radiation reduces further by (25-35)% . The individual usage of bike may be avoided and pollution-free bi-cycle usage may reduce air pollution by 10% more. The less usage of cents, nail polish, shoe police and toilet cleaner at the home level would reduce indoor air pollution further (1-2)%. So that we, can easily control air pollution in a certain level.

Recommendations

To avoid the construction of home nearby the roadside and introducing more windows in a home also reduce indoor air pollution per mentally. A small amount of indoor plants also reduce indoor pollution by 1%. The mosquito coil/liquid produces health-related problems like asthma and allergies may be avoided and a natural mosquito coil may be used (Neem tree leaf). The air purifier is not needed in rural side homes. To avoid the introduction of industry near by village houses also helpful to maintain the green environment in the village side.

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