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Optimization of an Innovative Gaseous and Particulates Monitoring Device of Air Quality Set within National Ambient Air Quality Standards (NAAQS) in the Barangay of Villanueva, Misamis Oriental

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Abstract:

This study is collaboration with Environmental Science and Technology (EST) and Electronics and Communication Technology (ECT) students. The study outline to a descriptive-comparative and experimental type, because the Innovated Automatic Utility Model were used to assess the air quality in the Brgy. Tambobong and Brgy. Balacanas, Villanueva, Misamis Oriental. It emphasizes the automation process of which the device will detect the air quality and automatically compare the detected values with the National Ambient Air Quality Standards (NAAQS) and set an alarm if it exceeds set standards. It is beneficial for the residents and its neighboring barangays, because it was given awareness to the people as to quality of air where the public are breathing. The health of the people of the barangay is the prime concern of this study. The study is designed to withstand different weather condition present in the community. The device is a Solar Panel based that has a 5 Volt output, with a battery as backup supply during night time. The prototype design uses sensors that could detect certain pollutant, these sensors are wired to a Micro-controller and programmed to allow the device to give real-time output based on the air pollutants present in the atmosphere and compare the reading with the given National Ambient Air Quality Standards (NAAQS). The prototype is operating twenty four (24) hours and seven (7) days a week to monitor and asses the air quality of the said Barangay. This study presumes to be reliable to monitor the quality of the air. Furthermore, this study aims the awareness on the community of the hazardous pollutants.

***Keywords* — Innovated Automatic Utility Model, National Ambient Air Quality Standards (NAAQS), Solar Panel, Micro-controller.**

I. INTRODUCTION

The air quality in local environment has an impact on the health of the public and the ecosystem. This implies that rural areas may be more polluted than some of the urban areas. The research group has a strong strength about air pollution to address an evaluation and assessment in the area to help the people by giving them an awareness to mitigate the air pollution and maintain and enhance their environment to know about the monoxide (CO), Nitrogen dioxide (NO_2), Sulfur dioxide (SO_2), and Ozone (O_3), and Dust Particles such as: Particulate matter(PM_{10}) and Particulate matter ($PM_{2.5}$). Thus the phenomenon called pollution is an inseparable consequence of the presence of man and his activities. The term air pollution signifies the presence in the ambient atmosphere of substances (e.g., gases, mixtures of gases and particulate matter) generated by the activities of man in concentrations that interfere

with human health, safety or comfort, or injurious to vegetation and animals and other environmental media resulting in chemicals entering in the food chain or being present in drinking water and thereby constituting additional source of human exposure. The direct effect of air pollutants on plants, animals and soil can influence the structure and function of ecosystems, including self regulation ability, thereby affecting the quality of life (WHO 1987).

Air quality in the Philippines has worsened due to several contributory factors such as the increasing number of mobile transports, domestic, agricultural and commercial sectors and industrialization. It started ever since people know how to make metals and materials useful for them and become famous with the introduction of new technologies. Industrial pollution may greatly affect the municipality air quality as well as the residential health.

Misamis Oriental is considered highly industrialized because of the presence of various industries specifically in the municipality of Tagoloan, Jasaan, and Villanueva. Villanueva is one of the blooming municipalities of Misamis Oriental. It has large and small scale industries such as Philippine Sinter Corp., STEAG, Phividec Industrial Estate, CME plant- phoenix petroleum Philippines Inc, Coca-cola, Elegant Steel Plant, and Jacobi Carbons Philippines Inc. Due to its rich industrialization in the municipality, some of the barangay's have been relocated to other areas within the municipality of Villanueva, Misamis Oriental. Two of the barangay's that were relocated during the construction of STEAG State Power Inc. and other industries along Phivedic area were the barangay Tambobong and barangay Balacanas. These two (2) named barangays were in front of the Phividec area across the highway at an elevated location. During day time, wind blows from a direction coming from seashore (sea breeze). During the months of October to May, wind blow from Northeast direction. The location of most of the industries, Villanueva and Tagoloan which lies along the coastline may contribute to the alteration of the air quality with the vicinity and nearby arrears. Pollutants from smoke stacks of industries can be carried by the wind blows. The relocation site of Brgy.Tambobong and Brgy. Balacanas is most likely the recipients of the gaseous and dust pollutants from the industries located along the coastline of Villanueva and Tagoloan.

The research group comes up with an idea to innovate a utility model for air pollution monitoring device to assess the air quality of Brgy. Tambobong and Brgy.Balacanas. This paper innovated a device that assesses the present air quality in terms of the gaseous and particulate matter from the ambient air named, Gaseous and Particulates Monitoring Device (GPMD). It uses an automatic microprocessor to detect the presence of six criteria pollutants with the use of a sensor. The Gaseous and Particulates Monitoring Device (GPMD) was installed at the center of the two barangays (Brgy.Tambobong and Brgy. Balacanas).

The objectives of the study aim to

1.1. Innovate a utility model for the monitoring of air pollutants in Barangay Tambobong and Barangay Balacanas such as:

a) Gaseous pollutants: Carbon monoxide (CO), Nitrogen dioxide (NO_2), Sulfur dioxide (SO_2), and Ozone (O_3)

b) Particulates: Particulate Matter$_{10}$, and Particulate Matter $_{2.5}$

1.2. Install this utility model between Barangay Tambobong and Barangay Balacanas and gather data of gaseous air pollutants particulate matter for eight (8) hours per day in six (6) sampling periods using the installed device.

1.3. Collect data for gaseous and particle pollution using the installed device and compare with National Ambient Air Quality Standards Guideline Value (NAAQS GV) standards.

1.4. Collect data for meteorological factors such as Temperature, Relative Humidity, and Wind Speed for eight (8) hours per day in six sampling periods.

1.5. Evaluate if there is difference significance between sampling periods on the gaseous and particulate pollutants.

1.6. Determine possible health impacts of these gaseous and particle pollution base on the survey data.

II. METHOD

The Conceptual framework showed Fig. 1 the independent and dependent variables of the study. The study was to assessment of Particulate matter10 (PM_{10}), Particulate matter ($PM_{2.5}$) and Gaseous pollutants in Barangay Tambal, Villanueva, Misamis Oriental. Gaseous and Particulates Monitoring Device (GPMD) that reads and monitor the concentrations of Gaseous Pollutants such as: Carbon monoxide (CO), Nitrogen dioxide (NO_2), Sulfur dioxide (SO_2),and Ozone (O_3),and Dust Particles such as: Particulate matter(PM_{10}) and Particulate matter($PM_{2.5}$).

The values were compared to the National Ambient Air Quality Standards Guideline Value (NAAQS GV) standards and a survey questionnaire was used to gather of data to evaluate the health impacts with the use of random sampling method.

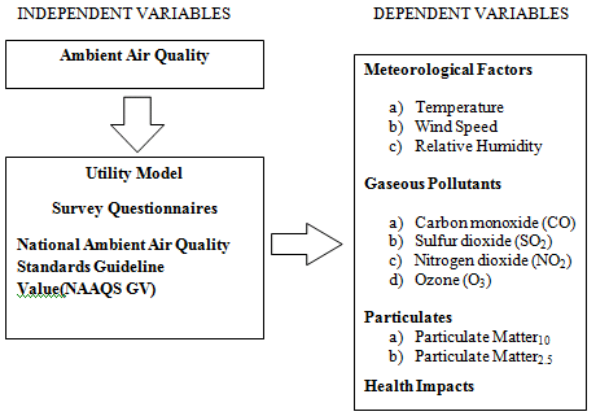

Fig. 1 Conceptual Frameworks showing the independent variables with the dependent variables.

A. Research Design and Setting

This study used a descriptive-comparative and experimental type of research, because the innovated automatic utility model was used to assess the air quality in the barangay Tambobong and barangay Balacanas, Villanueva, Misamis Oriental. It was a comparative type of research, because after detecting the air pollutants the device is set to automatically compare the detected values with the NAAQSGV standard and set an alarm if it exceeds set standards.

Survey questionnaires were distributed among the residents of Barangay Tamobobong and Barangay Balacanas to assess the health conditions of the people. In data gathering, the results from the Gaseous and Particulates Monitoring Device (GPMD) were interpreted together with the gathered results in survey questionnaires and other variables of the study.

Data gathering using the Gaseous and Particulates Monitoring Device (GPMD) were conducted in two (2) weeks of random sampling period after installation of the utility model in Barangay Tambobong and Barangay Balacanas. The said barangay was a combination of the two (2) barangays which is Barangay Tambobong and Barangay Balacanas. These two barangays is located at the same area. In Villanueva, Misamis Oriental with the coordinates of $8^{o}34'.095"N$ $124^{o}46.52"E$.

The Fig. 2 shows the location map of Brgy.Tambobong and Brgy. Balacanas and the industries nearby which could be the possible sources of pollutants.

Fig. 2 Map showing the two Barangay with nearby Plant Industry

The Gaseous and Particulates Monitoring Device (GPMD) was installed between the two barangays (Brgy.Tambobong & Brgy. Balacanas).Eight (8) hours per day of the six (6) sampling periods within two (2) consecutive weeks was the collection of data with the use of the utility model to assess the air quality of the ambient air. The results were compared to the National Ambient Air Quality Standards Guideline Value (NAAQS GV) standards.

B. Research Development

As shown in the Fig. 3, the device is 10 feet (10ft) in height including the base. The LCD is placed 3 feet (3ft) from the base. The box is fully covered by a metal to withstand any weather conditions in the said barangay.

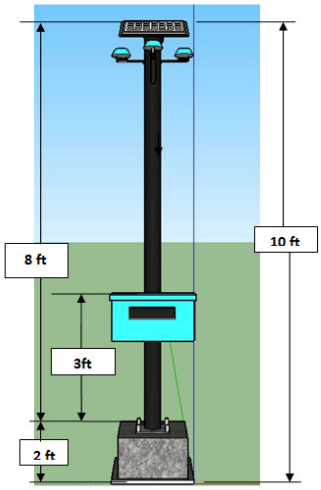

Fig. 3 Device dimensions

In Fig. 4, the Isometric view shows the main parts of the Gaseous and Particulates Monitoring Device (GPMD). It is composed of Solar Panel which was the main source of power for the utility model. The Electronic Horn which was placed under the Solar Panel. The four (4) Sensors for Gaseous and Dust Particulate were covered by a stainless metal to secure its safety from rain. The Pole is metal and circular type. The LCD display which was placed inside the box together with the other circuits and battery. And lastly the base, the base of the pole is cemented to have a strong base capability.

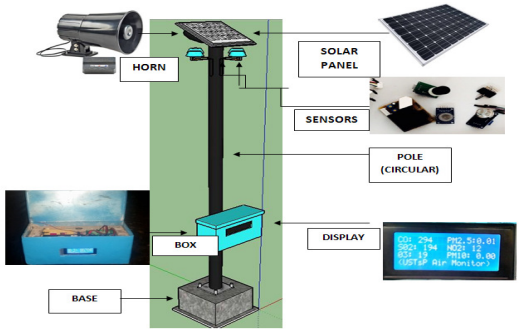

Fig. 4 The Isometric View of the device

C. Evaluation

A survey questionnaire, anemometer, Global Positioning System (GPS) and the Gaseous and Particulates Monitoring Device (GPMD) were used in gathering data. The survey questionnaire consists of the items that determine the health effects of the residents in the area as an information dissemination of local government unit. Digital anemometer was used to determine the relative humidity, wind speed and ambient temperature. The assessment process utilized the five (5) point rating scale as shown in Table 1.

TABLE. 1
ADJECTIVAL EVALUATION RATING

Adjectival Rating	Scale Range
1 Very Poor	1.4 Below
2 Poor	1.5 2.4
3 Fair	2.5 3.4
4 High	3.5 4.4
5 Excellent	4.5 Above

III. RESULTS AND DISCUSSION

The results and findings of the study are based on the stipulated methodology involved in the conduct of the study that highlighted the design, setting, development and evaluation of the Gaseous and Particulates Monitoring Device (GPMD)

A. Design and Setting

In Fig. 5 is the actual photo of prototype. The prototype has 10 feet height including the base. The first sensor is MQ131 it reads for Ozone (O_3) and Nitrogen Dioxide (NO_2). The second sensor is MQ136 it reads for Sulfur Dioxide (SO_2). The third sensor is MQ7 it reads for Carbon Monoxide (CO). The forth sensor is PPD42NS this sensor is used to create Digital Lo Pulse output to Particulate Matters. Lo Pulse Occupancy time is in proportion to PM concentration. From sensor 1 to 3 are conductivity is higher along with gas concentration rising. The solar panel is the supply of the device using a solar energy. Solar energy is derived solar power from the sun. Solar panel has 12 volts, 10 watts supply and it's a back-up chargeable 12 volts 7 amperes battery.

Fig. 5 Installation of Air Quality Monitoring Device for Gaseous and Particle Pollution

Gaseous and particulate pollutants were being monitored in six days within two weeks using the innovated device. The values of these air pollutants that exceed or below the standard found from National Ambient Air Quality Standard (NAAQS) are detrimental to the environment because it could lead to some negative effects such as acid rain, eutrophication, haze, effects on wildlife, ozone depletion, crop and forest damage, global warming, and may pose adverse impacts on human health.

The innovation of utility model for the monitoring of air pollutants such as Carbon Monoxide (CO), Nitrogen dioxide (NO_2), Sulfur dioxide (SO_2), Ozone (O_3), Particulate $Matter_{10}$, and Particulate $Matter_{2.5}$ was successfully installed between of the two barangays, Barangay Tambobong and Barangay Balacanas. The utility model runs for 24 hrs and automatically save the data results in its micro SD Card. The gathering of data was conducted for within eight (8) hours per day in six (6) sampling periods using the installed device.

B. Implementation of the Device - Gaseous and Particle Pollutant Data Gathering Results

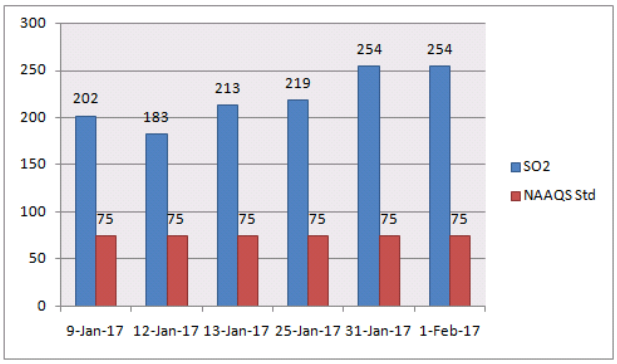

Fig. 6 The average value of Carbon Monoxide as being compared to National Ambient Air Quality Standard Guideline Value (NAAQSGV)

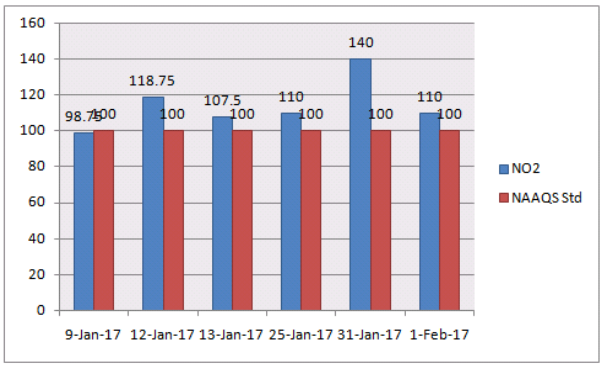

Fig. 7 The average value of Nitrogen Dioxide as being compared to National Ambient Air Quality Standard (NAAQS).

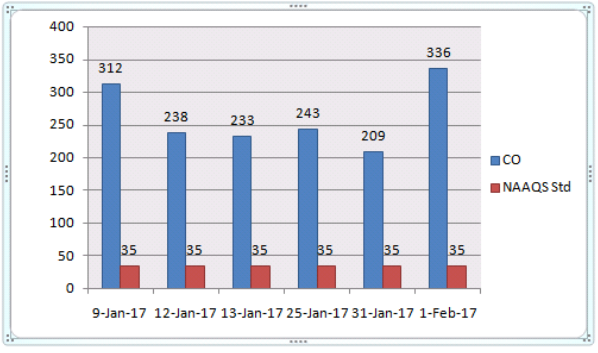

Fig. 8 The average value of Sulfur Dioxide as being compared to National Ambient Air Quality Standard Guideline Value (NAAQSGV)

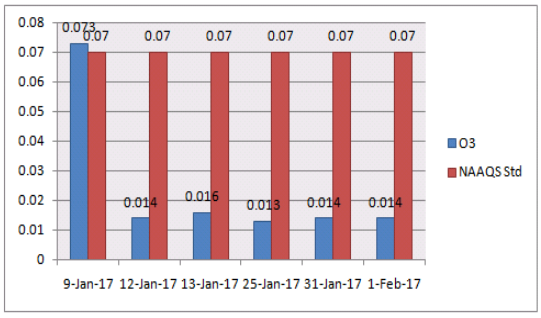

Fig. 9 The average value of Ozone as being compared to National Ambient Air Quality Standard Guideline Value (NAAQSGV)

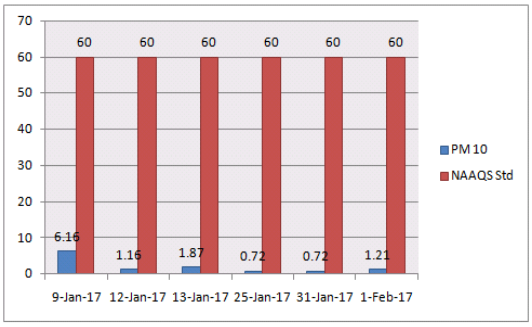

Fig. 10 The average value of Particulate Matter 10 as being compared to National Ambient Air Quality Standard Guideline Value (NAAQSGV)

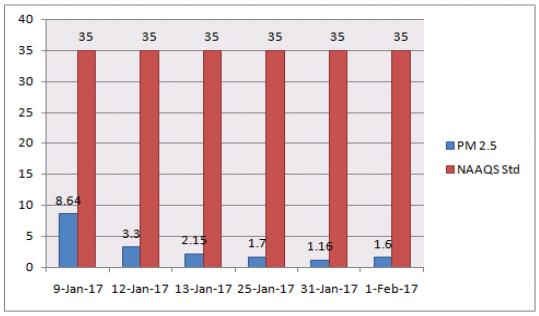

Fig. 11 The average value of Particulate Matter 2.5 as being compared to National Ambient Air Quality Standard Guideline Value (NAAQSGV)

Temperature, Relative Humidity, and Wind Speed

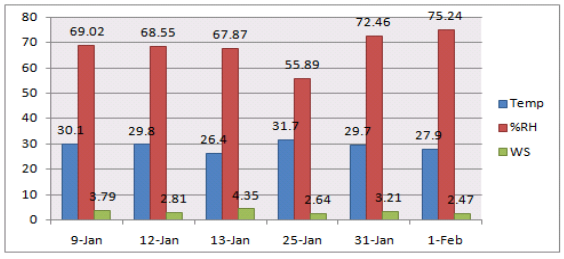

Fig. 12 Temperature, %Relative Humidity and Wind Speed in Barangay Tambobong and Barangay Balacanas, Villianueva Misamis Oriental

Fig. 12 shows the relationship of temperature, % Relative Humidty, and Wind Speed of the different days in Brgy. Tambobong and Brgy.Balacanas.Temperature, relative humidity, and wind speed are important factors to consider when assisting air quality. Understanding the interaction between air pollution and meteorology can be a valuable tool for urban planners to mitigate negative effects of air pollution (Bhaskar, et al, 2010). The most important role of meteorology is in dispersion, transformation and removal of air pollutants from the atmosphere (Ocak, et al. 2008).

Based on our data, air temperature ranges between 26.4o-31.7o from January 9, 2017-February 1, 2017. The lowest temperature, 26.4o was observed in Jan. 13, 2017 and the temperature 31.7o, was observed in January 25, 2017. The Relative humidity ranged from 55.89% to 75.2% during the sampling period. The minimum relative humidity was observed on January 25, 2017 and the maximum relative humidity was observed on February 1, 2017. Wind Speed varied from 4.35 km/h to 2.47 km/h during the sampling period. The lowest wind speed average was observed on February 1, 2017 and the highest wind speed average was observed on January 25, 2017.

C. Evaluation

The Design and Installation of Air Quality Monitoring Device for Gaseous and Particle Pollution is evaluated using quantitative statistics utilizing survey, observation or analysis of the subject and measures the data gathered from a range of selected respondents.

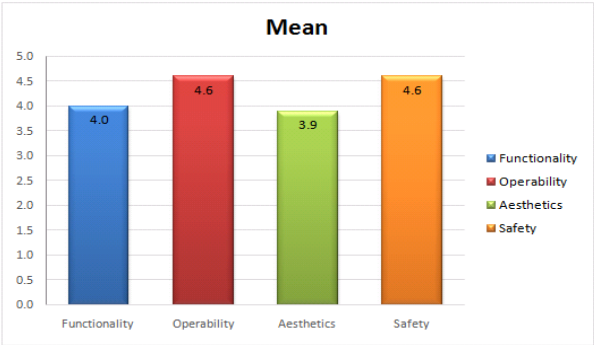

Fig. 13 Mean Responses

In Fig. 13 the bar graph shows the mean responses of the Innovative Design and Installation of Air

Quality Monitoring Device for Gaseous and Particle Pollution base on the different categories. The mean result on the category Functionality is 4.0, thus, it implies that the respondent rated Very Satisfactory in terms of assessing and monitoring the category of the pollutants. Also the device's Operability has a numerical rating of 4.6 corresponding to Excellent adjectival rating which implies that the overall operations of the device is convenient and easy for the respondents. Moreover the Aesthetic category has 3.9 total mean responses, having a satisfactory adjectival rating, depicts that the overall appearance of the device is presentable. Furthermore, on the Safety of the device, 4.6 numerical rating was rated by the respondents corresponding to a Very Satisfactory adjectival rating indicates the safeness and harm free operations of the device.

The device's over-all mean shows a numerical value of 4.27 which is Very Satisfactory. This implies that the device is acceptable in terms of its functionality, operability, aesthetics and safety.

IV. CONCLUSIONS AND RECOMMENDATIONS

The essential arguments were outlined on the design, development, implementation and evaluation of the Innovative Design and Installation of Air Quality Monitoring for Gaseous and Particle Pollution. The circuits of the machine electronically operates through the input and output connected together to perform the air monitoring system. The input devices were sensors (MQ131),(MQ136), (MQ7), (PPD42NS). The device is driven by a solar panel which automatically supply to the battery on the device when night time occurs. The technical assessment of the machine was to reach awareness to the community who are living on places with factories and power plants. We conducted survey using carefully designed questionnaire reading health issues distributed to randomly selected survey participants from residence of Brgy. Tambobong and Brgy. Balacanas.

Based from the findings of the study, the following conclusions, were derived:

1. Gaseous pollutants: Carbon monoxide (CO), Nitrogen dioxide (NO_2), Sulfur dioxide (SO_2), and Ozone (O_3).
2. Some air pollutant can affect human health directly by inhalation that directly harms the throat and the lungs and reaches to other internal organs.
3. The development of air quality monitoring device was verified as necessary in the quality of the air. Throughout the implementation stage the device was capable of producing the desired data. The device can contribute a big impact in the Community. This lead to inform the residence of how safe the air in Barangay Tambobong and Balacanas Villanueva, Misamis Oriental.Which enables the residence to be aware once the air is unsafe and polluted

The recommendations were append on the suggestion as to the best course of action to the least significant advantage air quality monitor device which was ascribe to its composite working principle. Furthermore, the device performs an essential role to the community.

The researchers would like to propose the following recommendations:

1. The cemented platform of the device should be will-finished and polished to improve its appearance.
2. Calibrate the innovative device in order to have accurate results in gathering data and improvement in the materials that been used.
3. The device must be automatically automated through wireless connection, using GSM, so that the people will monitor can assess the pollutants even when not on the site.
4. Also, a proper air quality monitoring and environmental awareness program in those residential areas living near in the industrial zone, especially Barangay Tambobong and Barangay Balacanas.institution to acquire such at a lower cost compared to the Original Equipment Manufactured (OEM) trainers.

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