PROCEEDINGS 2026-39
Political Economy Program

Making the Invisible Visible: Democratizing Air Quality Monitoring Through Low-Cost Sensor Technology

A Roundtable Discussion

July 9, 2025

AVR National Engineering Center College of Engineering
University of the Philippines – Diliman

UNIVERSITY OF THE PHILIPPINES
CENTER FOR INTEGRATIVE AND DEVELOPMENT STUDIES

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"The University of the Philippines Center for Integrative and Development Studies (UP CIDS) through its Political Economy Program (PEP), organized the roundtable discussion on July 9, 2025 at the National Engineering Center, UP Diliman, in partnership with the UP College of Engineering, and UP Center for Air Research in Urban Environment (UP CARE) showcasing the latter's air quality monitoring using low-cost customized technologies."

Photo by PEP

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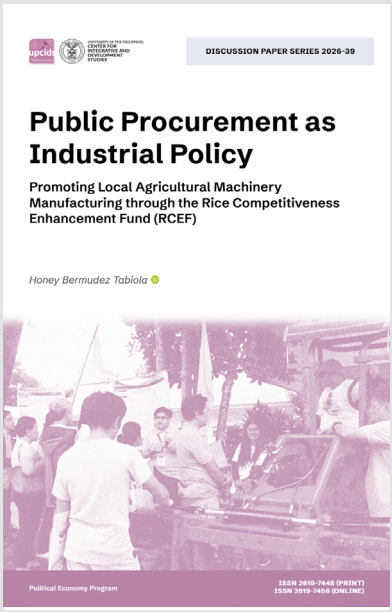

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Promoting Local Agricultural Machinery Manufacturing through the Rice Competitiveness Enhancement Fund (RCEF)

Honey Bermudez Tabiola

Political Economy Program

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DISCUSSION PAPER

Public Procurement as Industrial Policy: Promoting Local Agricultural Machinery Manufacturing through the Rice Competitiveness Enhancement Fund (RCEF)

Introduction

Air pollution continues to be among the most pressing environmental and public health problems both locally and globally. Poor air quality in urban and industrial areas contributes significantly to respiratory ailments, environmental deterioration, and lower standards of living. Accurate, real-time, and affordable air quality monitoring is needed to support evidence-based policy- making, early warning systems, awareness raising, and enforcement of environmental regulations.

In recent years, low-cost sensor technologies have emerged as a promising alternative in real- time environmental monitoring. These sensors can measure gas pollutants, particulate matter, relative humidity, temperature, wind speed, as well as other environmental and meteorological parameters. Although these sensors are not reference-grade instruments, their readings have good agreement with their high-end counterparts. These sensors offer scalability, ease of use, and affordability, making them accessible for communities, small institutions, and even individuals. When paired with data visualization and cloud platforms, they can provide meaningful insights and drive timely interventions to improve air quality.

Engineering simulations help us understand how air moves and how pollution spreads in space. Thanks to major advances in both computer hardware and software, these simulations have become more powerful and widely used. On the hardware side, faster computers, better processors, powerful graphics cards, and cloud computing have made it possible to handle more detailed and complex simulations. At the same time, improvements in software – such as smarter algorithms, better modeling tools, and features powered by artificial intelligence (AI) – have made simulations more accurate, easier to use, and automated. These technologies not only cut down the time and cost of building physical models but also give scientists and engineers more flexibility to test ideas, make quick adjustments, and provide data-driven insights. Today, thanks to these advancements, simulation has become a key tool for solving complex problems and driving innovation.

The project identifies pollutant dispersion and evaluates air quality by using real-time monitoring through low-cost sensor technology. In addition, leveraging computational fluid dynamics (CFD) aids in a more informed and better, if not optimum, placement of sensors by modelling the airflow. This integrated approach provides data-driven tools for proactive indoor air quality (IAQ) management in residential and office settings, as well as tracking outdoor environmental conditions. The system's holistic approach ensures comprehensive air quality assessment, pollutant source identification, pollutant dynamics

understanding, and recommended mitigation strategies. The integration of real-time data with advanced simulations empowers building managers, policymakers, and stakeholders to proactively manage air quality.

The project seeks to provide actionable insights and reporting tools, fostering healthier, safer, and more productive indoor environments. By addressing these critical areas, the study holds the potential to make significant contributions to public health, productivity, and environmental sustainability, while advancing the state-of-the-art air quality monitoring and management.

Objectives

The RTD aimed to:

1. Share insights on the current state and innovations in air quality monitoring using sensor- based technologies and engineering simulation.

2. Identify key opportunities and benefits in the deployment and scaling of sensor-based monitoring systems.

3. Foster collaboration among government agencies, academic and medical institutions, environmental non-government organizations (NGOs), and other stakeholders.

Opening and Welcome Remarks

Antoinette Raquiza, PhD

Convenor, Political Economy Program, UP CIDS

The roundtable discussion (RTD), "Making the Invisible Visible: Democratizing Air Quality Monitoring through Low-Cost Sensor Technology," commenced with a welcoming address by Dr. Antoinette Raquiza, Convenor of the Political Economy Program (PEP).

Dr. Raquiza underscored the gravity of air pollution as a pressing environmental and public health issue globally, contributing to respiratory illnesses, reduced quality of life, and climate change, and noted the heightened awareness of indoor air quality brought on by the COVID-19 pandemic.

Presentation on Air Quality Monitoring UP CARE Indoor Air Quality (IAQ) Monitoring and Reporting System

Julius Rhoan T. Lustro, PhD

Co-Convener, PEP, UP CIDS
Department of Mechanical Engineering, UP Diliman Project Leader, UP CARE

Dr. Julius Rhoan T. Lustro, Associate Professor at the UP Diliman Department of Mechanical Engineering and Project Leader, presented the engineering simulation component of the Department of Science and Technology – Philippine Council for Industry, Energy, and Emerging Technology Research and Development (DOST-PCIEERD) funded UP Center for Air Research in Urban Environments (UP CARE) program. The program, led by Dr. John Richard Hizon, comprises three projects focusing on developing air quality monitoring sensors, air quality monitoring and reporting systems, and sensors/filters for other pollutants.

Dr. Lustro focused on UP CARE's engineering solutions, specifically the application of a Digital Twin and CFD as a simulation tool to visualize air quality. A Digital Twin creates a digital replica using Computer-Aided Design (CAD) of a physical space, which is then analyzed using CFD software like Ansys. This method involves solving governing equations, such as the Navier-Stokes and continuity equations (representing conservation of momentum and mass), by inputting initial and boundary conditions. The resulting visualizations allow researchers to:

1. Model airflow (velocity contours and vectors) within enclosed spaces;

2. Identify pollutant transport and dispersal mechanisms; and

3. Locate potential "hotspots" where pollutant concentrations are locally confined, informing measures to improve air quality.

The presentation showcased the practical applications and deployment efforts:

- **Sensor Technology:** UP CARE has developed small, "lunchbox"-sized and low-cost sensors deployed in various university offices and communities (e.g., Barangay San Antonio, Pasig City). These devices monitor harmful gases like carbon dioxide (CO_2) and nitrogen oxides, as well as particulate matter. The real-time data captured by these sensors is visualized to track contaminant level over time, with deployments even capturing "life events" like severely poor air quality during New Year celebrations.

- **CFD Case Studies:** Dr. Lustro presented two CFD studies demonstrating the technology's utility:

  - *QC Bus Route 1 CO_2 Study:* The simulation assessed CO_2 exchange inside the bus under fresh air and recirculation modes. The study identified the backside of the bus as having the highest CO_2 concentration and recommended using fresh air mode instead of the common recirculation to improve air quality, as the latter only introduces fresh air when doors open.

  - *Marikina Shoe Factory Study:* This study analyzed the dispersal of Total Volatile Organic Compounds (TVOC), primarily toluene from adhesives, in a small-scale factory. Initial attempts to improve airflow by repositioning fans proved challenging. The simulation ultimately suggested that changing the layout of the system would be a simplest, cost-effective engineering solution to mitigate pollution.

Dr. Lustro concluded by stating that while his part focused on engineering simulations, the subsequent presentation by Dr. Hizon would delve into the low-cost sensor monitoring aspect of the UP CARE project.

UP CARE Technology for Air Quality Monitoring

John Richard E. Hizon, PhD

Electrical and Electronics Engineering Institute, UP Diliman Program Leader, UP CARE

Dr. John Richard Hizon, Program Leader of the UP CARE delivered a presentation detailing the development and deployment of low-cost sensor technology for enhanced air quality monitoring.

Dr. Hizon began by stressing the silent and cumulative danger of air pollution, which is linked to staggering costs and public health issues, making long-term monitoring crucial. A major challenge identified is the high cost and limited coverage of traditional reference sensors, which low-cost sensor technology aims to address by providing additional sampling points.

Citing a 2016 study, Dr. Hizon highlighted mobile sources as the number one contributor to air pollution in urban areas like Metro Manila. He presented a spatial heat map demonstrating that air pollution is concentrated along major roads, like Katipunan in Quezon City, and diminishes rapidly away from traffic, illustrating the need for street-level, high-resolution data that traditional monitoring stations cannot provide.

The UP CARE program seeks to build comprehensive infrastructure for indoor and outdoor air quality monitoring, develop software applications to translate sensor data into easily understandable information, and empower communities through technology.

Furthermore, the UP CARE system operates as an IoT ("Internet of Things") network, with various sensors transmitting data wirelessly to the proprietary CareHive cloud platform maintained on UP CARE's own servers. This platform performs analytics and provides data via a Representational State Transfer Application Programming Interface (REST API), allowing for the ingestion of data from both UP CARE-built and compatible external sensor boxes.

Since 2022, the UP CARE team has deployed 36 sensor prototypes across the Philippines, including areas in Metro Manila (Pasig City and Quezon City), Baguio, and Puerto Princesa in Palawan. The team utilized collocation studies with reference sensors, primarily held by the Environmental Management Bureau (EMB) of the Department of Natural and Environmental Resources (DENR) to verify data quality. Initial comparisons showed that while the reference sensors are more sensitive – being regulatory standard – the low-cost sensors accurately follow the pollution trends. By applying machine learning techniques to correct the sensor readings, the team successfully improved the R-squared value (closeness of measurement to the reference) from 0.77 to 0.85.

Key insights from the deployment include:

- **Localized Pollution:** Hourly trends in Pasig City showed pollution peaks around 5:00 PM near specific barangay halls, attributed to local activities like evening street food vendors (grilling). This demonstrates the platform's utility in managing activity impact.

- **Connectivity Challenges:** Deployment outside Metro Manila, particularly in Baguio and La Trinidad in Benguet, highlighted significant connectivity issues such frequent signal loss, necessitating a push toward alternative data access methods beyond commercial Wi- Fi/cellular signals.

- **Event Monitoring:** The sensors successfully captured significant pollution events, including high PM2.5 and PM10 levels during New Year's celebrations across all sites (Manila and Baguio), the October 2024 smog event, and an April 2024 fire within UP Diliman. The sensors showcased their effectiveness in verifying regional impacts of remote events.

Dr. Hizon presented two studies using the sensors in different transportation modalities:

- **Bus Carousel:** PM2.5 levels were generally lower than in modern jeeps but still exceeded the World Health Organization (WHO) guideline of 15 $\mu g/m^3$ during certain events. CO_2 levels also spiked when buses were full.

- **Modern Jeep (Antipolo-Cubao Route):** This route showed higher PM2.5 levels compared to the dedicated EDSA Carousel route, likely due to greater exposure to mixed traffic. The modern jeeps exhibited extremely

high CO_2 concentrations (up to 8,000 PPM) when full, indicating severe ventilation issues and overcrowding, which poses health risks.

The presentation concluded by acknowledging the multidisciplinary team essential to the project and encouraging participants to view the current data visualizations on the project's website at upcare.ph.

Reaction from the Panel

Engr. Chadbert Nikko Aquino
EMB-DENR

The first reactor, Engr. Chadbert Nikko E. Aquino, commenced by thanking the organizers for involving the EMB in the timely and relevant roundtable discussion, especially given the ongoing effort to update the Philippines' air quality policies and standards. Engr. Aquino highly commended the UP CARE project for its innovative, science-based approach to air quality management, noting that the data and insights presented were highly aligned with the observations and priorities of the EMB-DENR.

Engr. Aquino confirmed that the EMB is currently focused on developing more stringent guidelines and standards in key areas:

- **Ambient Air Quality Standards.**

- **Mobile Sources:** The target is to move the standard for four-wheel vehicles from Euro 4 to Euro 5 emissions, with a hopeful implementation date around 2027.

- **Stationary Sources:** Recognizing that stationary sources are the second largest contributor to air pollution, the EMB is also imposing tighter standards in this sector, utilizing data such as that gathered by UP CARE.

The EMB expressed strong interest in exploring the use of low-cost sensor technology, such as the UP CARE system, to expand the national air quality monitoring network. Engr. Aquino highlighted that current reliance on expensive reference method equipment poses significant challenges related to procurement and network expansion. He stated that local sensor technology would be helpful to cover a wider range of pollution sources – such as mobile, stationary, and area sources – and crucially, enabling the monitoring of indoor air quality, which he stressed is a major consideration for human health.

Engr. Aquino concluded by expressing hope that this science- and evidence-based innovation will continue to inform and shape future air quality policies for the benefit of the public.

Following the reaction from Engr. Aquino, the discussion shifted to the second reactor.

Dr. Lustro first reinforced the commitment to science-based policy-making to effectively address complex environmental issues. While the scheduled reactor, the Executive Director (ED) of the Occupational Safety and Health Center (OSHC) of the Department of Labor and Employment (DOLE), was unable to attend, the program was fortunate to be joined by Engr. Rey Mark Fernando, an Industrial Hygienist from the OSHC-DOLE.

Engr. Fernando is a direct collaborator with the UP CARE team, specifically concerning the collocation of indoor air quality sensors. Dr. Lustro noted that a successful collocation activity was conducted in the previous month, and there are plans for further rounds of collocation to continually enhance the performance and accuracy of the sensors. Engr. Fernando was then invited to provide his reaction.

Engr. Rey Mark Fernando

OSHC-DOLE

Engr. Rey Mark Fernando emphasized the OSHC's deep support for projects related to occupational safety and health programs, highlighting the critical role of IAQ in maintaining a healthy and comfortable working environment. Engr. Fernando stressed that poor IAQ can lead to adverse health conditions, negatively affecting workers, with long-term exposure potentially causing severe illnesses ranging from respiratory diseases to heart disease and even cancer.

Citing the 2021 Integrated Survey of Labor and Employment published by the Philippine Statistics Authority (PSA), he presented data on occupational diseases that may be linked to poor IAQ among formal establishments employing at least 20 workers from 2021 to 2022. The majority of reported related diseases were due to COVID-19 infection. Focusing on IAQ-related illnesses, the data showed that around 60 percent of the government population registered had effects related to IAQ diseases, with 1.6 percent related to tuberculosis, 0.8 percent to occupational asthma, and 0.7 percent to

occupational lung diseases. Engr. Fernando connected the discussion of IAQ with broader concerns about climate change, referencing an International Labor Organization (ILO) report from April 2024 that emphasized how climate change can alter the concentration of indoor air pollutants, both those originating inside (like molds and volatile organic compounds) and those transported from the outside.

He asserted that accurate real-time air quality monitoring and data transmission are crucial for data-driven decisions, such as optimizing ventilation strategies and evaluating air purification methods to minimize occupant exposure to harmful pollutants. He reiterated that good IAQ is a vital component of a healthy work environment, directly leading to increased workers' productivity and long-term health and well-being. The OSHC, he stated, fully supports the initiative to make air quality monitoring more accessible not only to workers and building occupants but also to management and decision-makers who are key to implementing necessary workplace interventions.

Engr. Fernando noted the evolving landscape of air quality monitoring, driven by advanced technology, better data presentation, and public engagement. He acknowledged the previous speakers' presentations on different strategies, specifically mentioning the use of local sensors, IoT integration, and AI strategies employed by companies worldwide to predict and provide assessments for safety officers, enabling them to implement effective control measures. The use of cloud-based platforms and data dashboards was also emphasized, allowing workers, not just safety officers, to access performance data for their buildings. He expressed the OSHC’s profound appreciation for UP CARE and its initiative to advance IAQ monitoring technology through local sensor systems, aiming for a productive, competitive, and resilient workforce, and reaffirmed the OSHC's commitment to continuous consultative and collaborative mechanisms to ensure the project's full implementation.

Engr. Geomari De Guzman

Daikin Philippines

Engr. Geomari De Guzman of Daikin Philippines began by expressing gratitude to UP CARE for the opportunity to participate and contribute to their program. He immediately praised the team's efforts in engineering simulation, particularly the use of CFD, which allows for the visualization of air dynamics

before a building's construction or operation. He emphasized the shared goal of focusing on providing solutions early in the design phase, rather than waiting for issues to materialize in existing structures.

Engr. De Guzman also commended Dr. Hizon's work on utilizing sensors to spread awareness, especially regarding outdoor air quality. As an air conditioning company primarily focused on the controlled indoor environment, he noted that Daikin integrates its own sensors with its remote control and AC systems. He then highlighted a significant challenge faced when proposing ventilation solutions to private companies and developers: the prevailing preference for natural ventilation over mechanical systems, primarily due to cost constraints. He stressed that while natural ventilation appears to cost "basically nothing," the reality of high pollution levels in Metro Manila makes the data provided by UP CARE invaluable.

He pointed out that people spend approximately 80-90 percent of their day indoors (including commuting) and drew a contrast between immediately effective contaminated water and the long-term effects of poor air quality, whose cause-and-effect link might be obscured over years. Engr. De Guzman argued that if private stakeholders fully understood how polluted the outdoor air is, they might reconsider their budgetary constraints and shift toward mechanical ventilation – but only with the necessary proper filtration. He warned against simply introducing outside air without filtration, referencing concerns even in modern public transport like jeepneys, where recirculation is often preferred but fresh, unfiltered air can introduce more pollution. He concluded his remarks by expressing hope for a future partnership with UP CARE and posed a question regarding their future plans: whether they intend to expand their air quality studies from the outdoor to the indoor space, offering Daikin's expertise in controlled indoor environments for potential collaboration.

Ms. Vanessa Vinarao

Quezon City Climate Change Department

Ms. Vanessa Vinarao of the Quezon City Climate Change Mitigation Division highlighted Quezon City's commitment to air quality monitoring, noting that the city currently operates an air quality monitoring network that includes one reference station and 40 strategically located low-cost sensors. Ms. Vinarao explained that given Quezon City's immense size, investing solely in expensive

reference stations for comprehensive coverage would not be economical; thus, the deployment of low-cost sensors is a practical necessity. She expressed gratitude to UP CARE for involving Quezon City in the research, as their data is vital for data-driven policy implementation.

She provided a concrete example of a policy implemented based on sensor data: the school suspension guidelines on poor air quality. These guidelines use scientifically devised alert levels (e.g., Alert Level 3) to mandate class suspensions, ensuring that such decisions are science-based and not arbitrary. Addressing IAQ, Ms. Vinarao stated that the city recently amended its green building code to incorporate IAQ standards. This amendment encourages all businesses, both new and existing, to retrofit their buildings to ensure the safety and well-being of occupants. The core function of the sensors for the LGU is to focus projects and allocate resources effectively.

She welcomed UP CARE's initiative on locally developed sensors, noting that the city currently incurs substantial costs for procuring and subscribing to their existing sensors, which consumes a significant portion of the department's budget.

Ms. Vinarao concluded by emphasizing the critical importance of the partnership highlighted by the project – that between the research community, the local government, the private sector, and the national government – before offering her final congratulations to the research team.

Open Forum

The open forum commenced with a question from Engr. Sago of the Technological University of the Philippines (TUP), who noted that most of UP CARE's sensors were deployed in the northern part of Metro Manila and asked about plans for expansion into the southern part. Dr. Hizon confirmed that a new research project was starting in Manila, where sites for sensor deployment were being studied. Regarding the southern areas, since the current research program was concluding, the next phase involved direct discussions with LGUs to explore providing access to the technology.

Engr. Sago followed up with a personal concern related to his doctoral research on modeling air pollutants, particularly Particulate Matter (PM). He lamented the major constraint of limited data access, stating he could only access data from two stations for PM2.5 and four stations for PM10 in Metro Manila. He specifically mentioned that the EMB reference sensor at his university's Taguig campus only had a working PM10 component, posing a significant problem for establishing an annual dispersion model. Engr. Aquino acknowledged the data constraint caused by operational challenges in their stations. He assured that EMB-NCR conducts manual reference sampling every six days, which provides still-representative data available upon request. He also stated that EMB is working on a sustainable procurement and sustainability plan for existing and upcoming stations to expand the network. Dr. Hizon added that while manual data collection is slower, other regions like Davao (Region XI) and Central Luzon (Region III) have newer reference stations that could be explored for modeling purposes if an urban focus wasn't strictly necessary. Dr. Lustro supported this sentiment, noting that the scarcity of air quality data often drives students towards water quality research, and reiterated UP CARE's commitment to campaigning for more air quality data. He shared that two recent graduate students studied PM2.5 in Taguig and MRT, investigating vertical variation and infiltration in buildings and train coach. He noted that limited budget meant their studieswere necessarily short-term (around two weeks), and emphasized the need for longer-lasting projects to generate historical data.

Mr. Arale from 350 Pilipinas asked if UP CARE had a plan to manufacture and commercialize the low-cost sensor technology for purchase by other cities. He noted the data could justify active transport projects beyond just class suspensions. Dr. Hizon affirmed they are exploring opportunities to make the technology accessible through developing a startup. He emphasized that

the value is not just the "box" (the sensor) but the subscription-like service that includes combining information and data presentation. He expressed encouragement for the support, taking note of the importance of addressing indoor air quality next. Ms. Vinarao also thanked Mr. Arale for recognizing QC's efforts, sharing that the city is part of Cities for Energy (C4E) and has a commitment to clean air accelerators, working towards the difficult target of the WHO standard and utilizing peer-to-peer exchanges with international cities.

Dr. Lustro then directed a question to Engr. Aquino regarding the status of the policy on using low-cost air quality technology that was reportedly under development. Engr. Aquino confirmed the policy has been under development for several years, aimed at expanding the monitoring network by certifying or recognizing air quality monitoring equipment lacking EPA accreditation. He explained that guidelines are being established, including a requirement for one year of collocation (January to December) with reference equipment to cover all extreme seasons, assessing correlation and data capture rate. He noted the policy is currently finished at the EMB technical working group level and is awaiting review by the DENR becoming an administrative order.

Ms. Elaine Ang from Active Asia inquired about UP CARE's plans to partner with other Higher Education Institutions (HEIs) or State Universities and Colleges (SUCs) to champion the study approach and technology, especially in cities where LGUs are not yet heavily invested in air quality monitoring. Dr. Hizon responded that they plan to offer an academic program and training through the UP National Engineering Center (NEC) to ensure the necessary technical background is available for wider technology adoption. They are also entertaining case-to-case requests from other schools for access to their devices and are currently working with a colleague from Anthropology to translate complex data (like PM2.5 or AQI) into more relatable information, such as the concept of "kulob", in order to make the technology more accessible to the public.

Finally, Dr. Raquiza asked Engr. Fernando how the agency ensures industry compliance with clean air standards, particularly in cost-intensive factory environments. Engr. Fernando explained that the mandate comes from the Occupational Safety and Health Standards (Republic Act No. 11058), specifically Rule 1070 (Work Environment Measurement). Employers must conduct Hazard Identification, Risk Assessment, and Control (HIRAC) and measure the level of concentration of hazards in the workplace through OSHC or third-party providers. He acknowledged that while there is currently no

written standard for IAQ, there is an ongoing movement towards establishing one, which was triggered by the high percentage of COVID-19 cases in indoor settings during the pandemic. He confirmed that the OSHC is working to establish a reference standard and scrutinize equipment that can measure it. Engr. Fernando also shared that an OSHC research project in 2023 studied various CO_2 monitors, concluding that the Non-Dispersive Infrared (NDIR) sensor is the most capable. Dr. Hizon added that OSHC's efforts are critical for future standards, emphasizing the complexity of indoor air flow and structure, and the need for more indoor studies.

Engr. De Guzman provided a final sharing on Daikin's IAQ initiatives. He explained that their control systems incorporate sensors that monitor PM2.5 and CO_2 levels. This allows for Demand Control Ventilation, where the system automatically triggers fresh air units only when the CO_2 level exceeds a threshold (e.g., 1000 PPM) and turns off at a lower level (e.g., 500 PPM). This method ensures better IAQ while saving energy by preventing the constant operation of ventilation, which introduces heat load unnecessarily. He also mentioned the availability of standalone air purifiers as a passive solution for existing buildings that cannot retrofit mechanical ventilation.

Dr. Lustro synthesized the discussion, noting the importance of standards, collocation, and local IAQ guideline development, as international standards often lack local context.

The discussion underscored the essential lesson learned from the pandemic: the necessity of being concerned with air quality. Dr. Lustro emphasized that this issue, often overlooked, has been thrust into the spotlight, necessitating a change in mindset to address factors like air quality, especially in light of the compounding effects of climate change on daily life.

Synthesis

Dr. Mylene Cayetano

Professor
Institute of Environmental Science and Meteorology, UP Diliman

Dr. Mylene Cayetano thanked UP CIDS PEP for providing the platform. Tasked with synthesizing the roundtable discussion from her 25-year perspective in air pollution research, she confirmed her long- standing interest, which dates back to her undergraduate thesis on IAQ.

Dr. Cayetano provided a brief synthesis of the presentations, noting that Dr. Lustro's findings on CO_2 levels in indoor public spaces, such as Quezon City buses, highlight CO_2's utility as an indicator of ventilation quality – higher levels signal poor ventilation. She affirmed that Dr. Hizon's UP CARE technologies maintain a "gold standard" for screening air pollution because they are properly collocated, validated, and verified against EMB-DENR sites, ensuring high data quality.

Turning to the reactors, she expressed satisfaction that 100 percent of the distinguished reactors affirmed UP CARE's technologies.

Specifically, the affirmation from Engr. Aquino was noted as a strong signal of support from regulatory agencies for locally built technologies, which is a crucial step towards democratizing air quality monitoring. She looked forward to the finalization of the EMB-DENR policy that will certify local monitoring technologies.

She also acknowledged Engr. Fernando for recognizing the importance of monitoring air quality in indoor workspaces for a productive and safe Filipino workforce, and expressed anticipation for the development of Philippine IAQ standards.

She appreciated Engr. De Guzman's insight into how UP CARE's outdoor and indoor data visualization can drive decisions on air cleaning mechanisms (natural vs. mechanical ventilation) and the potential for technologies to automatically choose the best method based on real-time outdoor air quality.

Finally, she praised Ms. Vinarao's presentation of Quezon City's remarkable practice of using over 30 low-cost sensors, guided by the C4E direction, to implement data-driven policies like class suspensions and IAQ retrofitting.

Dr. Cayetano then shared her own insights, highlighting the plus factor of UP CARE's technology: Filipino technology. She argued that this local development is key in democratizing air quality monitoring because local scientists and engineers are readily available for immediate assistance in maintenance, operations, data analysis, and service. This eliminates costly delays and bureaucratic hurdles associated with procuring foreign parts, shipping spectrometers abroad, or waiting for technical engineers from overseas, which is crucial for individuals and LGUs needing immediate information and control during pollution episodes.

In closing, Dr. Cayetano summarized the program as underscoring the critical need for accessible and effective air quality monitoring. She stressed the importance of interdisciplinary collaboration among government, academe, the private sector, and LGUs. While acknowledging challenges, she concluded with a renewed commitment to "making the invisible visible" and working together for cleaner air and a healthier future.

Closing Remarks

Antoinette Raquiza, PhD

Convenor, Political Economy Program, UP CIDS

Dr. Raquiza first expressed deep gratitude and congratulations to UP CARE, specifically Dr. Hizon, Dr. Lustro, and their team, acknowledging that the event served as a highly educational introduction to their work for the PEP. She extended thanks to all the reactors: Engr. Aquino, Engr. Fernando, Engr. De Guzman, Ms. Vinarao, and Dr. Cayetano.

Dr. Raquiza positioned UP CARE's initiative as a concrete example of Filipino capacity and ingenuity. However, she noted the tough competition presented by the national tendency to depend on foreign technology, a preference often driven by relative affordability and immediate availability. She countered this by stating that UPCARE demonstrates both the supply-side capacity (science and technology) and the demand-side willingness (LGUs, industry, and the general public) to embrace local solutions.

Dr. Raquiza highlighted two key takeaways from the discussion. First was the critical need for science-based policymaking, which, as Dr. Cayetano noted, requires real-time information and innovation customized to local conditions. The second point, inspired by Ms. Vinarao's comments, was the long-term benefit of local technology being cheaper and more low-cost. Dr. Raquiza recalled a private conversation with Dr. Hizon about the goal to eventually achieve an ambitious cost reduction ("5-5"), underscoring the objective to make the technology accessible not just to LGUs, but also to micro, small, and medium enterprises (MSMEs), commuters, laborers, and workers.

She concluded by expressing the PEP's profound hope that the conversations initiated during the program would continue, leading to more concrete collaborations and discussions.

Center for Integrative and Development Studies

Established in 1985 by University of the Philippines (UP) President Edgardo J. Angara, the UP Center for Integrative and Development Studies (UP CIDS) is the policy research unit of the University that connects disciplines and scholars across the several units of the UP System. It is mandated to encourage collaborative and rigorous research addressing issues of national significance by supporting scholars and securing funding, enabling them to produce outputs and recommendations for public policy.

The UP CIDS currently has twelve research programs that are clustered under the areas of education and capacity building, development, and social, political, and cultural studies. It publishes policy briefs, monographs, webinar/conference/forum proceedings, and the Philippine Journal for Public Policy, all of which can be downloaded free from the UP CIDS website.

The Program

The Political Economy Program (PEP) seeks to contribute to building the momentum for development policies and programs that promote domestic production, higher productivity, and the just distribution of development resources. It however also recognizes that such initiatives often fall by the wayside due to factors such as lack of resources and public awareness, policy gaps, vested interests, partisan politics, and the dominance of the free market orthodoxy in policy circles.

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