PILOTING DISEASE-RESILIENT AND ENERGY-EFFICIENT SMART AIR-CONDITIONING SYSTEMS IN PUBLIC BUILDINGS

Key Takeaways

1. The Asian Development Bank (ADB) has successfully piloted disease-resilient and energy-efficient smart air-conditioning systems in three public buildings in Colombo, Sri Lanka.

2. The systems have been designed to optimize energy efficiency and maintain indoor air quality for disease resilience, meeting stringent international standards. The systems used climate-friendly refrigerants and leveraged smart digital technologies.

3. The systems have been customized to fit the needs of three public buildings in Sri Lanka, considering geography or climate location, building size, occupancy level, and other relevant factors.

4. Building occupants noted significant improvements in indoor air quality and thermal comfort.

Rethinking Air-Conditioning Design

In September 2020, ADB initiated a program to implement disease-resilient and energy-efficient centralized smart air-conditioning systems for its developing member countries. The program aimed to explore the application of smart technologies and filtering components in the design of air-conditioning systems.

Through the program, ADB launched a technology innovation challenge to identify a centralized air-conditioning system to be piloted in public buildings. Over 200 participants from 37 countries, including start-ups, academia, research organizations, technology providers, and independent researchers participated in the challenge. One smart air-conditioning solution was chosen by technical specialists.

Participants of the Regional Workshop on Disease Resilient and Energy-Efficient Air-Conditioning for Asia and the Pacific

Pilot and Demonstration of the Smart Air-Conditioning System

The disease-resilient and energy-efficient smart air-conditioning design adheres to standards and guidance provided by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), a globally recognized professional organization that sets industry standards for heating, ventilating, air conditioning, and refrigerating. The design meets the World Health Organization guidelines for indoor air quality. It also demonstrated improved thermal comfort, acceptable ventilation rates, and disease resilience, following ASHRAE standards.[1]

The smart air conditioning features a disease-resilient mode that allows the system to operate with higher ventilation rates to reduce the risk of infection and limit the spread of airborne diseases. It also has a digital dashboard that helps facility managers optimize operations and allows occupants to check real-time indexes for indoor air quality, thermal comfort, and viral infection risks in specific zones within a building.

ADB collaborated with the Sri Lanka Ministry of Power and Energy and Sri Lanka Sustainable Energy Authority in deploying the smart air conditioning in three public buildings in Colombo, Sri Lanka. These buildings were the Sri Lanka Postal Headquarters, the Sri Lanka Standards Institution, and the Sri Lanka State Pharmaceuticals Manufacturing Corporation. Each smart air conditioning was customized, considering geography or climate location, building size, occupancy level, and other relevant factors. The smart air conditioning is projected to deliver a 30%–40% reduction in energy consumption with an estimated return on investment within 5 years.

1 ASHRAE provides several standard and guideline documents. The smart air-conditioning design met ASHRAE Standard 55 on Thermal Environmental Condition for Human Occupancy, ASHRAE Standard 62.2 on ventilation and Acceptable Indoor Air Quality in Residential Buildings, and ASHRAE Standard 241 on Control of Infectious Aerosols.

Pilot Building 1: Sri Lanka Postal Headquarters

Aerial view of the Sri Lanka Postal Headquarters

About the building. The Sri Lanka Postal Headquarters serves as the central administrative hub for the country's postal services. It houses the Department of Post which oversees the operations and management of the postal system, including mail processing, delivery, and other related services across Sri Lanka. The headquarters plays a crucial role in coordinating and regulating postal activities, ensuring efficiency, reliability, and adherence to standards.

Why this building. The building was chosen for piloting the smart air-conditioning because of the high number of daily visitors. For the past 5 years, the building had no properly functioning air-conditioning system, leading to significant discomfort among occupants, particularly during the summer months.

Design features. The smart air conditioning was tailored with a suitable filtration system capable of high ventilation flow rates to maintain indoor air quality while ensuring thermal comfort, despite having an open double-height space in the building. The design is capable of adjusting the quantity of clean outdoor air based on prevailing occupancy level to maintain indoor air quality with minimal energy use. The design incorporated large, high-volume, and low-speed fans to enhance air circulation and alleviate discomfort during peak occupancy periods.

Results and feedback. Building occupants reported substantial improvements in thermal comfort, marking a positive shift in their experience within the building.

High volume low-speed fan to improve air circulation inside the building

Smart air handling unit with filtration and efficient cooling units

Pilot Building 2: Sri Lanka Standards Institution

Aerial view of the Sri Lanka Standards Institution building

About the building. The second pilot building is the home of the Sri Lanka Standards Institution, the national agency responsible for developing, promoting, and implementing standards across various industries and sectors. The institution aims to ensure the quality, safety, and reliability of products and services in the country.

Why this building. The building, specifically its top floor, was selected as an ideal site to pilot the smart air conditioning, primarily due to the high levels of heat experienced by occupants. The space relied solely on wall-mounted recirculation air-conditioning units without any ventilation flow rates, and occupants expressed discomfort with direct drafts of cold air.

Energy-efficient and silent ceiling fan with brushless direct current motor and remote control

Installation of heat recovery wheel

Design features. The smart air conditioning installed in this building was a combination of a dedicated outdoor system and a recirculated air-conditioning system. The outdoor system featured a suitable filtration system to deliver clean outdoor air into the space, along with a heat recovery wheel to reclaim heat from exhaust air. High-efficiency ceiling fans were installed to improve air circulation and mitigate discomfort during the hot summer.

Results and feedback. Building occupants reported significant enhancements in thermal comfort. Facility managers found that the real-time dashboards helped to further reduce energy consumption.

Pilot Building 3: State Pharmaceuticals Manufacturing Corporation

Aerial view of the State Pharmaceuticals Manufacturing Corporation building

About the building. The building houses the State Pharmaceuticals Manufacturing Corporation, the government agency responsible for producing pharmaceutical products within Sri Lanka. The agency aims to ensure the availability of essential medicines to the public at affordable prices while maintaining high standards of quality and safety.

Portable filtration system to improve indoor air quality

Why this building. The laboratory area of the building, where numerous chemical experiments and processes take place, was chosen to pilot the smart air conditioning, due to concerns about poor air quality experienced by occupants, particularly caused by volatile organic compounds. The space used to rely on ceiling-mounted exhaust fans.

Design features. The smart air conditioning was designed with appropriate filtration and ventilation and introduced in the laboratory spaces. Recognizing the diverse nature of chemical experiments in each laboratory, individual air delivery systems were implemented to adjust air quantity accordingly. Portable filtration systems with chemical filtration capabilities were provided in each laboratory to absorb several different types of gases.

Results and feedback. With the reduction in total volatile organic compounds, building occupants reported significant improvements in indoor air quality. Furthermore, facility managers found the monitoring tools effective in tracking temperature and humidity levels, which could support the laboratory's efforts toward international certification.

Building managers use a digital dashboard for indoor air quality monitoring

The Future of Air Conditioning

Smart air-conditioning systems are set to transform how we manage indoor air, by delivering energy savings, using climate-friendly refrigerants, reducing airborne disease transmission, and applying advanced digital technologies and sensors to enhance user information and awareness. ADB's pilot project in Sri Lanka is a prime example of the future of air conditioning. By working together and staying innovative, we can make smart air conditioning a common reality, creating healthier and more efficient indoor spaces everywhere.

Indoor air quality sensor (left); live display of building indoor air quality and energy data (right)

THE PROJECT

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