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Factors influencing the selection of Indoor Air Quality improvement solutions for healthcare projects.

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Abstract

Vietnam battles severe air pollution and substandard infrastructure, leading to Sick Building Syndrome (SBS), even in healthcare facilities. Enhancing Indoor Air Quality (IAQ) in hospital design and renovations is vital for safeguarding vulnerable groups, such as patients, children, and the elderly. However, akin to other developing nations, Vietnam must address specific local challenges before devising any strategies to improve IAQ in these critical settings. In this study, we identify factors influencing the selection of methods to improve Indoor Air Quality (IAQ) in healthcare facilities, considering Vietnam's specific conditions. We conducted an academic literature review to pinpoint these factors and propose design solutions. Additionally, we surveyed and quantified the effects from the perspective of Vietnamese healthcare experts.The study's contribution lies in its practical insights for stakeholders seeking to improve IAQ. The outcomes of this study aim to provide a foundation for developing guidelines and standards to assess construction quality in healthcare facilities.

Keywords : Green Building, Human health and well-being, sustainable development

1. INTRODUCTION

Indoor Air Quality (IAQ) profoundly affects healthcare settings, impacting patient outcomes and staff well-being. Hospital environments, prone to spreading diseases, demand meticulous IAQ management. In Ho Chi Minh City, where IAQ-related illnesses among healthcare workers reach 70.1%, and respiratory infections prevail, poor IAQ poses significant risks. Various pollutants originate from building materials, equipment, and human activities. Case studies globally highlight IAQ improvement strategies, but in Vietnam, outdated hospital structures and limited regulations hinder progress. Sustainable practices like green building offer solutions, yet economic constraints persist. Our research, analyzing factors influencing IAQ improvement choices in Vietnamese hospitals, aims to guide stakeholders towards healthier environments.

Green building (GB) practices offer promise, but aging hospital structures and regulatory focus on functional aspects hinder progress. Public hospitals often fail to meet IAQ standards, contrasting with international-standard private ones. Certification by GB standards could improve IAQ, energy efficiency, and staff productivity. However, these standards primarily benefit developed countries. Our study, surveying construction professionals, aims to prioritize IAQ improvement factors for Vietnamese hospitals, aligning with sustainability and healthcare needs. By identifying key influences, we provide guidance for stakeholders in enhancing IAQ and healthcare quality.

2. LITERATURE REVIEW

Indoor Environmental Quality (IEQ), encompassing IAQ, thermal, visual, and acoustic conditions, is paramount in healthcare buildings. Retrofitting is key to enhancing energy efficiency and IAQ. Research highlights IAQ's crucial role in healthcare, urging targeted studies. Ventilation strategies, microbial control, and the impact of ambient pollution on IAQ are vital considerations. Stakeholders emphasize user involvement in project design, with determinants of IAQ including contextual, design, operational, and occupant factors. These findings stress the multifaceted nature of IAQ management in hospitals, necessitating comprehensive research and effective strategies from the design phase onwards.

In developing markets, barriers to IAQ and green

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construction technology persist. Studies highlight drivers like educational programs and legal frameworks, but obstacles such as political instability and limited governmental support hinder progress. Barriers in Vietnam and Australia range from socioeconomic to technical factors, with slow policymaking and high initial costs being significant concerns. Despite upfront investment challenges, IAQ improvements in healthcare promise long-term benefits, including cost reduction and enhanced worker satisfaction. Collaborative efforts across engineering, healthcare, and administrative sectors are crucial, with ASHRAE advocating for integrated design teams. Strategic planning and advocacy are essential to address these challenges and promote better IEQ in healthcare settings globally.

3. RESULT

Table 1. Group factors Identification

Code	Factors	Clarification
Economic factors		
E-1	Initial cost	• Cost of design and operation of the team • Cost of equipment purchase, transportation, and installation • Hiring a third party (for executive design and certification test, modelling IAQ) • Certification registration fee.
E-2	Operating/ maintenance cost	• Life cycle costing of devices and additional building cost. • Annual maintenance cost for IAQ system and devices.
E-3	Technology transfer cost	• Cost of technology transfer or purchase; fees for technical support and training; intellectual property rights by product or by year.
Design factors		
D-1	Project Scale and Planning	• Project scale, site assessment, number of beds, specialities, and Planning of subdivisions, landscapes, and chains affecting the indoor environment.
D-2	Design purpose	• Design goal (human health/ energy efficiency) determines the interest and percentage of funds for total IEQ. • The Pre-design phase decides on the specialists needed and the technical approach plan for IAQ.
D-3	Schematic Design (SD)	• Complexity of project design, assignment to construction specification. • Effective ventilation must be included in architectural, interior, landscape, structural, MEP, and HAVC drawings.
D-4	Outdoor issues and regional environment	Including Physical, Biochemical, and Microclimate around the building area • Need data collection for Air Quality Index, water sources, geology, and organisms…
Governance factors		
G-1	Owner’s requirement	• Each hospital project has specialities; depending on the client’s awareness, they can make specific IEQ requirements.
G-2	Commercial advantages	• Financial/ non-financial incentives, attracting investment and loan opportunities. • Opportunities for cooperation and sponsorship from sustainable funds • Increase competitiveness and raise branding awareness as a marketing tool
G-3	Future legislation	• Need policy understanding, regularly updated standards, and ready for policy and market change. • IAQ tools are flexible and adaptable for future legislation, including the development of construction technology, renewable energy plans, etc.
G-4	Administration	• Requires highly qualified managers and management strategy for building systems. • Stakeholders' experience and communication ability.
Technical factors		
T-1	Feasibility	• Capable of installation in accordance with current engineering techniques and construction conditions. • Simple to install by local workers and straightforward for material suppliers.
T-2	Operability	• Demand for pollution measurement data and usage behaviour collecting. • Demand for a database of material, technology, and products thoroughly.
T-3	Integrated capability	• Need an integrated design team and interoperability between tools; manage the effect of IA system installation on other engineering systems (HVAC – IAQ – Lighting – Acoustics – Fire – Communications, Plumbing, Mechanical, etc.) • Combine with another system for well-controlled design, construction, and operation
T-4	Compatible with medical function	• The system must guarantee that it does not interfere with the hospital's medical needs, as well as the medical examination and treatment machinery and equipment.
T-5	Emissions level	The impact of IAQ solutions on total building energy consumption, operating and demolition emissions, and environmental impact.

4. CONCLUSIONS

This research formally identified a list of 16 critical factors, which is included in 4 groups: economic factor, governance factor, design factor, and technical factor, involved in the indoor air solution design process, and was developed based on the literature review and questionnaire survey. Collaboration among diverse stakeholders is essential, facilitated by integrated design teams ensuring unified solutions aligned with investor needs and legal requirements. Knowledge dissemination is vital, particularly for medical staff unfamiliar with ventilation efficacy. Prioritizing ventilation quality amid challenges like poor air quality and humidity is crucial. Indoor sensors aid in IAQ management, educating personnel and enabling early detection of health impacts. Overall, addressing these factors from concept to operation ensures effective indoor air solutions and meets healthcare needs.