

ANALYSIS OF POLICIES FOR SUSTAINABLE INDOOR AIR QUALITY MANAGEMENT IN HOSPITAL BUILDINGS

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Abstract

Indoor air quality that meets standards is free from pollutants. Activities carried out in hospitals can be a source of pollution that can affect indoor air quality, thereby impacting the health of workers, patients, and visitors. This study was conducted to formulate a sustainable indoor air quality management policy at Hospital X in Pekanbaru City. This activity was carried out from January to May 2025 using a qualitative approach. Data collection involved observation, interviews, document or report review, and documentation. The data sources in this study were primary and secondary data. Data analysis used the strengths, weaknesses, opportunities, threats (SWOT) matrix to determine policy strategies for indoor air quality management in hospitals. The results of the study indicate that hospitals have four strategies for indoor air quality management policies. The first is SO (Strengths-Opportunities), which involves implementing policies in line with the hospital management's commitment to indoor air quality management and collaborating with relevant stakeholders. The second is WO (Weaknesses-Opportunities), which involves improving governance regarding indoor air quality in hospitals. The third is ST (Strengths-Threats) by conducting monitoring and improving cleaning activities related to indoor air quality management in hospitals, and fourth, WT (Weakness-Threats) by establishing indoor air quality standards and conducting regular indoor air quality measurements in hospitals. Thus, the results of this study can be applied and contribute to and be generalized to hospitals in Pekanbaru City for the sustainable improvement of indoor air quality management in hospitals.

Keywords: policy, management, indoor air quality, hospital

1. Introduction

Indoor air quality in hospitals is a major factor that can affect the health of patients, medical staff, and visitors. Hospitals are healthcare facilities that pose risks from activities carried out within them, making certain locations vulnerable to air quality issues, such as wards, intensive care units, operating rooms, and emergency rooms (Loureiro et al., 2025). Poor air quality in hospital rooms can be a medium for the spread of pathogenic microorganisms that cause nosocomial infections, which are infections that patients experience during their treatment and did not have when they were admitted to the hospital (Sahli et al., 2021). Nosocomial infections are a serious problem that increase patient morbidity and mortality and place an additional burden on healthcare facilities. Therefore, the management and monitoring of air quality in inpatient rooms, operating rooms, and other critical areas must meet strict health standards to minimize the risk of infection spread (Panikhom & Chaiklieng, 2024).

Indoor air quality in hospitals is compromised by pollutants such as particulates, VOCs, CO, CO₂, and microorganisms, leading to an increase in hospital-acquired infections and antibiotic-resistant bacteria, posing significant health risks to patients and healthcare workers (O. P. Bansal, 2024). The air quality in hospital rooms is greatly influenced by several factors, including temperature, dust, germs, occupancy density, and room sanitation. This is therefore a benchmark for determining whether the air quality in hospital rooms meets the applicable regulations (Rahayu et al., 2019). This shows that indoor air quality is an important consideration in maintaining a healthy hospital environment. Indicators for determining good air quality are largely determined by the hospital environment and conditions.

The Ministry of Environment and Forestry reported an improvement in national air quality, with the air quality index increasing from 84.1 (2020) to 88.06 in 2022. However, automatic air quality monitoring is only available in 15 locations, and comprehensive monitoring in health facilities is still limited. This air quality index is related to the control of pollutants that can affect the risk of HAI in hospital rooms (Kementerian Lingkungan Hidup dan Kehutanan, 2020). Data from the Central Statistics Agency (BPS) has not yet released detailed statistics on indoor air quality in hospitals, but the Indonesian Environmental Statistics publication presents air quality data that forms the basis for health risk assessments in various environments, including health facilities (Badan Pusat Statistik, 2023).

In addition, indoor air quality in hospitals is also influenced by building design, building operations, and factors related to occupants. Ventilation in hospitals remains a challenge, as high levels of carbon monoxide, bioaerosols, and chemical compounds remain in the indoor air despite the presence of mechanical ventilation systems. To address this public health issue, policymakers must support the implementation of indoor air quality (IAQ) monitoring systems throughout hospital buildings (Antunes et al., 2022). In response to several issues regarding indoor air quality in hospitals, it is necessary to follow up with appropriate policies and strategic measures for managing indoor air quality in hospitals. Therefore, the purpose of this study is to formulate sustainable indoor air quality management policies in hospitals.

2. Method

This study was conducted at Hospital X over a period of five months from January to May 2025. This study used a descriptive qualitative approach to describe the state and condition of indoor air quality in this hospital so that it could be analyzed to obtain a selected strategy design regarding hospital policy in managing indoor air quality in a sustainable manner. The data sources in this study were primary and secondary data. The primary data required were interviews with hospital management and staff consisting of 12 people and observations. The technique for selecting informants in this study used purposive sampling. The criteria for selecting informants consisted of inclusion criteria, namely that informants had knowledge and understanding that was the focus of the study, were directly involved in the activities being studied, had experience and the ability to communicate well, and were willing to be informants. The exclusion criteria were unwillingness to be interviewed, absence at the time of data collection, and inability to provide information relevant to the research objectives. The interview procedure carried out in the preparation stage included the preparation of interview guidelines, research permits, and informed consent. During the interview implementation stage, semi-structured interviews were conducted by asking main questions and developing follow-up questions (probing) based on the informants' answers. Data were collected through voice recordings and field notes. Secondary data was obtained from literature studies, document reviews or reports, and field documentation. The credibility of the data obtained was tested through triangulation of data sources and data collection techniques by comparing the data from the research sources, namely hospital management and hospital staff, with data sources from checklists, interviews, documentation, and observations. Data analysis used SWOT analysis (strengths, weaknesses, opportunities, threats). SWOT analysis organizes the main strengths, weaknesses, opportunities, and threats of the hospital into an organized list and presents them in a simple grid. Strengths and weaknesses originate from within the hospital. Opportunities and Threats are external factors that affect the hospital. Next, a SWOT matrix is created as a tool to compile the hospital's strategic factors that can clearly illustrate how the external opportunities and threats faced by the hospital can be adjusted to its strengths and weaknesses.

3. Results and Discussion

3.1 Results

The results of indoor air quality measurements combined with the results of interviews, observations (hospital conditions), and internal policy reviews were analyzed using the SWOT approach by analyzing internal and external factors to obtain a comprehensive picture of indoor air quality management in hospitals. A summary of the interview and observation results can be seen in the following table 1:

Table 1. Summary of interview and observation results

Hasil Wawancara	Hasil Observasi
<i>"There are many activities in the hospital and the number of visitors who come to visit is also high, which can sometimes disturb the rest of patients and nurses on duty" (IU 1, 2, 3) (IP 1,2,3,4)</i>	The number of visitors for one patient can be more than two people.
<i>"Hospital rooms are cleaned twice a day, in the morning and afternoon" (IU 1,2,3,4,5,6)</i>	Cleaning staff are available and clean twice a day.
<i>"There are workers responsible for maintaining hospital cleanliness" (IU 1,2,3)</i>	There are cleaning staff responsible for each room and floor.
<i>"There are no standard operating procedures related to indoor air quality, only general guidelines for environmental health in hospitals" (IU 1,2,3)</i>	There are no specific standard operating procedures for indoor air quality.
<i>"We have been performing regular maintenance on the air conditioning every 6 months, and if there are any complaints or reports to management, we will recheck it" (IU 4,5,6).</i>	Routine maintenance of the air conditioning is recorded.
<i>"Regular measurements are taken of the temperature" (IP 1,2,3,4,5,6).</i>	Temperature measurements have been conducted, but only in certain rooms such as the operating room
<i>"The hospital is committed to managing air quality as it is closely related to improving hospital accreditation, but we need to make many improvements and add all the equipment that is not yet available and operational in the hospital" (IU 1,2,3).</i>	A policy focused on indoor air quality needs to be established.
<i>"The training conducted is still insufficient, as it only involves representatives of the workers" (IP 1,2,3,4).</i>	Training is only provided to a few people.

From table 1 above, based on the results of interviews and observations, an internal and external analysis of the hospital was conducted in accordance with the hospital's current conditions. The results of this summary describe the strengths, weaknesses, opportunities, and threats facing the hospital, which will reveal the hospital's current condition. The analysis of the external and internal environmental aspects of Hospital X can be seen in table 2 as follows:

Table 2. Strengths-Weaknesses-Opportunities-Threats

Strengths	Weaknesses
<ul style="list-style-type: none"> a. Clean hospital environment b. Regular air conditioning maintenance c. Room cleaning has been carried out d. Hospital management commitment 	<ul style="list-style-type: none"> a. Air quality measurements have not been conducted in hospital rooms b. Standard operating procedures for indoor air quality are not available in hospitals c. Occupancy density does not meet standards d. There is a lack of training
Opportunities	Threats
<ul style="list-style-type: none"> a. Government policy on indoor air quality b. Cooperation with relevant stakeholders c. Corporate social responsibility in the environmental field d. Commitment to improving hospital accreditation 	<ul style="list-style-type: none"> a. Lack of supervision regarding hospital air quality b. Climate change c. Other hospital competitors that are more focused on air quality management d. The public lacks understanding about indoor air quality

From table 2 above, it can be seen that there are several strategic issues related to the strengths, weaknesses, opportunities, and threats faced by hospitals. Next, to determine the alternatives, a SWOT matrix is created. This SWOT matrix is created based on the results of an analysis of both external and internal strategic factors, consisting of strengths, weaknesses, opportunities, and threats. From the results of the SWOT matrix that has been created, four main strategies can be formulated, namely SO, WO, ST, and WT. The results of this analysis can be used as a basis for hospital management to formulate alternative strategies to be implemented in hospitals to improve indoor air quality in inpatient rooms. This SWOT analysis is used to systematically identify various factors for formulating strategies in hospitals. This analysis is based on logic that can maximize strengths and opportunities, while at the same time minimizing weaknesses and threats. The strategic decision-making process is always related to the development of the hospital's vision, mission, objectives, strategies, and policies. Thus, strategic planning must analyze the hospital's strategic factors (strengths, weaknesses, opportunities, and threats) in the current conditions. The strategy produced in this SWOT matrix can be used as a reference for the hospital to formulate policies for managing air quality in hospital inpatient rooms, as shown in the following table.

Table 3. SWOT matrix

Internal factors External factors	Strengths	Weakness
	<ul style="list-style-type: none"> a. Clean hospital environment b. Regular air conditioning maintenance c. Room cleaning has been carried out d. Hospital management commitment 	<ul style="list-style-type: none"> a. Air quality measurements have not been conducted in hospital rooms b. Standard operating procedures for indoor air quality are not available in hospitals c. Occupancy density does not meet standards d. There is a lack of training
Opportunity	SO Strategy	WO Strategy
<ul style="list-style-type: none"> a. Government policy on indoor air quality b. Cooperation with relevant stakeholders c. Corporate social responsibility in the environmental field 	<ul style="list-style-type: none"> a. Hospitals must be committed to implementing regulations in accordance with applicable policies regarding indoor air quality as one of the indicators for improving hospital accreditation. b. Improve and maintain hospital cleanliness and 	<ul style="list-style-type: none"> a. Conduct air quality measurements in accordance with applicable regulations b. Create standard operating procedures for air quality in hospital rooms c. Conduct training to improve knowledge

d. Commitment to improving hospital accreditation	create a regular air conditioning maintenance schedule. c. Develop cooperation with relevant stakeholders and CSR in the environmental field.	
Threats	ST Strategy	WT Strategy
a. Lack of supervision regarding hospital air quality b. Climate change c. Other hospital competitors that are more focused on air quality management d. The public lacks understanding about indoor air quality	a. Improving monitoring and cleaning of rooms to improve indoor air quality in hospitals b. Making hospitals a model for implementing indoor air quality management in hospitals	a. Implementing standard operating procedures or policies that are created and must be obeyed by all personnel in the hospital.

From Table 2 above, four strategies can be developed for hospitals to manage indoor air quality in inpatient rooms, namely SO (Strengths-Opportunities), WO (Weaknesses-Opportunities), ST (Strengths-Threats), and WT (Weaknesses-Threats). These strategies can be implemented simultaneously and support each other. Based on all of the above analyses, a summary of various alternatives that can be implemented by hospitals can be compiled as follows:

1. Hospitals are committed to implementing policies that are in line with hospital management's commitment to managing indoor air quality and collaborating with relevant stakeholders.
2. Improve indoor air quality management in hospitals by conducting indoor air quality measurements, establishing standard operating procedures for indoor air quality, and providing training.
3. Enhance room monitoring and cleaning to improve indoor air quality in hospitals so that they can become model hospitals.
4. Implement standard operating procedures and policies for indoor air quality in hospitals.

3.2 Discussion

Strategies that can be implemented to improve indoor air quality in hospitals can be carried out using four strategies in accordance with the analysis in the SWOT matrix. From the results of this study, the first strategy is SO (Strengths-Opportunity), which can be implemented through the hospital's commitment to implementing policies on indoor air quality management and collaborating with relevant stakeholders. This is also one of the indicators for improving hospital accreditation. As a measure of control and management of indoor air quality in hospitals, in implementing this policy, hospital management needs to have a strong commitment to implementing policies related to indoor air quality in hospitals. Previous studies have found that to support commitment and implementation of indoor air quality in hospitals, hospitals need to control chemical and microbiological contaminants in the air for monitoring indoor air quality in hospitals (Leung & Chan, 2006). This is a form of commitment from the hospital to prioritize air quality in hospital rooms, which needs to be improved to become better in the future in a sustainable manner (Aryani et al., 2025). This demonstrates the hospital's strong commitment to improving its accreditation, with one of the assessment items related to the physical environment of the hospital.

The second strategy is WO (Weakness-Opportunity), which can be implemented by improving indoor air quality management in hospitals through indoor air quality measurements, indoor air quality SOPs, and training. Hospitals can carry out periodic indoor air quality measurements in inpatient rooms in collaboration with relevant stakeholders, so that the results of these measurements become a benchmark for hospitals. Create specific SOPs regarding indoor air quality in hospital inpatient rooms based on references from applicable government policies and regulations. These SOPs serve as a reference for hospitals in managing indoor air quality in inpatient rooms. Several things that need to be included in the SOP are limiting the number of patients, patient attendants, and visitors in inpatient rooms, implementing visiting hours set by the hospital, monitoring indoor air quality in inpatient rooms, and cleaning rooms at least twice a day (morning and evening). And conducting regular training in collaboration with relevant stakeholders, particularly on the subject of indoor air quality management in hospitals, can involve cooperation with the health department in the supervision of hospitals and other hospitals as partners in the implementation of indoor air quality management in inpatient wards. Through this training, it is hoped that the potential of healthcare workers can be explored and their skills developed. Since the behavior of visitors, staff, and patients affects air quality, this strategy can improve indoor air quality in hospitals (Ibrahim et al., 2024).

The third strategy is ST (Strengths-Threats), which can be implemented by increasing monitoring and cleaning of rooms to improve indoor air quality in hospitals so that they can become model hospitals. One way to implement this is through rewards and punishments. Awards are a form of appreciation given by companies to their employees. By giving awards to outstanding employees, this will motivate other employees to improve. This will contribute significantly to the progress of the hospital, and it is hoped that the rewards given to healthcare workers will support the management of indoor air quality in accordance with hospital policy. In addition, it is necessary to monitor room cleaning at least twice a day (morning and evening) as this can reduce germs in the hospital (Febrianna et al., 2025). In addition to air monitoring (monitoring particles, microbes), anti-epidemic measures (including cleaning, disinfection, environmental control) are also carried out, which are also capable of reducing the number of airborne particles, microorganism vortices, and pathogens (Fedor et al., 2022).

The fourth strategy is WT (Weakness-Threats), which can be implemented by applying SOPs and indoor air quality policies in hospitals. The implementation of these SOPs is a follow-up to the strong commitment of the hospital's top management to manage indoor air quality in inpatient rooms and is supported by the hospital's management team as the implementing body. Thus, these SOPs serve as a reference or guideline for hospitals to ensure that standards are met (Eren & Demir, 2024). The implementation of these policies and SOPs will also serve as a benchmark for the success of improving indoor air quality in hospitals if all hospital units comply with indoor air quality standards.

4. Conclusion

Effective strategies can be implemented to improve indoor air quality in hospitals. With the implementation of these four strategies in air quality management, it is possible to improve indoor air quality in hospitals. Therefore, the recommendation that researchers can give to hospital management is to implement and prioritize one of the strategies that can be applied in hospitals in accordance with the conditions currently experienced by the hospital, so that it will have a positive impact on the sustainable improvement of indoor air quality in hospitals.

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