



GREEN ECONOMY ANALYSIS IN HOSPITAL MANAGEMENT TO IMPROVE SUSTAINABILITY AND OPERATIONAL EFFICIENCY

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ABSTRACT

The Green Economy concept in the healthcare sector is an important strategy to improve the sustainability and efficiency of hospital operations. As institutions that operate 24 hours a day, hospitals consume significant amounts of energy and produce medical and non-medical waste that can impact the environment if not managed properly. This study aims to analyze the implementation of Green Economy principles at Bina Kasih Hospital in Pekanbaru, focusing on three main policy instruments: energy efficiency, waste management, and service digitalization systems, and their relationship to improving hospital operational efficiency and sustainability. This study used a mixed method with a quantitative and qualitative design to obtain a comprehensive picture. Quantitative data were obtained from 40 respondents who were purposively selected using a standardized questionnaire. The validity test results showed that all question items had a calculated r value > 0.444 (with 20 samples), thus being declared valid. Meanwhile, the reliability test results using Cronbach's Alpha were 0.906, indicating an excellent level of internal consistency (higher than the minimum limit of 0.60). Qualitative data were collected through in-depth interviews and focus group discussions (FGDs) with key stakeholders in the hospital environment. Data analysis was conducted using univariate, bivariate (Chi-square test), and multivariate (logistic regression) analyses for quantitative data, as well as SWOT analysis and Cost-Benefit Analysis to strengthen the qualitative findings. The results showed that the digitalization system had the strongest influence on operational efficiency ($p=0.001$; $PR=2.754$), followed by waste management ($p=0.023$; $PR=2.056$) and energy efficiency policies ($p=0.045$; $PR=1.821$). Key challenges include limited infrastructure, inconsistent policy enforcement, and low employee awareness. However, the implementation of Green Economy strategies has been shown to improve cost efficiency, strengthen the institution's reputation, and support environmental sustainability.

Keywords: digitalization system; energy efficiency; green economy; hospital sustainability; waste management

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INTRODUCTION

The concept of a Green Economy is increasingly gaining global attention, particularly in the healthcare sector, known as a major contributor to energy consumption, medical waste, and carbon emissions, which have a significant impact on the environment (Fitri,2024)(Söderholm,2020)(Zhang,2023). Hospitals operating 24 hours a day require large amounts of energy, produce medical and non-medical waste, and have the potential to pollute the environment if not managed properly. To support sustainability, developed countries have implemented the Green Hospital concept through the use of renewable energy, energy-efficient building design, and the use of digital systems based on Enterprise Resource Planning (ERP) in waste management (Fitriani et al, 2022)(Vallée, 2024)(Purwaamijaya,2023). In addition, the green accounting approach is also used to assess the cost-effectiveness of environmental management (Khoirina, 2016). Several studies even show that the application of environmentally friendly technologies, such as Fuel Cell Combined Heat and Power (FC-CHP), can increase energy efficiency and reduce carbon emissions (Toughzaoui et al, 2024)(Palapessy et al, 2019).

Hospital concept aligns with the Sustainable Development Goals (SDGs), particularly goals 3 (Good Health and Well-Being), 7 (Affordable and Clean Energy), and 13 (Climate Action). In the national context, the principle of hospital sustainability is reflected in the Asta Cipta Kelestarian Lingkungan Rumah Sakit (Hospital Environmental Sustainability Initiative), which encompasses eight important aspects: energy efficiency, water conservation, waste management, use of environmentally friendly materials, air quality management, green open space, education, and environmentally friendly transportation.

In Indonesia, the implementation of green hospitals still faces several obstacles, including limited infrastructure, weak internal policies, and low human resource capacity with specialized expertise in environmental management (Tarkar, 2022)(Tangestani et al, 2025). For example, Muhammad Sani Regional Hospital in the Riau Islands Province has adopted green hospital principles in its medical waste management and energy saving programs. However, limited facilities and minimal staff training remain major obstacles (Molina et al, 2024) . Comparative studies also show variations in achievement between hospitals, for example, PON Hospital has achieved energy efficiency of up to 62.5%, while Embung Fatimah Regional Hospital only achieved 31.3%. In terms of water conservation, Embung Fatimah Regional Hospital is superior (50%) compared to PON Hospital (35%). Non-technical factors such as building design, patient comfort, and community environmental awareness also play a major role in the successful implementation of green hospitals (Nurfikri et al, 2024); (Sigalingging et al, 2021); (Alighardashi, 2024); (Ngatindriatun, 2024); (Khairunnisa, 2021).

In the context of this research, the chosen location is Bina Kasih Hospital Pekanbaru, a private hospital in Riau Province with an average of 70–100 BPJS patient visits per day. The high volume of patient visits makes this hospital a representative location for examining strategies for implementing Green Economy principles, particularly in energy efficiency policies, medical waste management, and service digitization systems. Therefore, more in-depth and systematic research is needed to formulate strategies for implementing Green Economy in hospitals, including Bina Kasih Hospital Pekanbaru. This research is expected to provide a tangible contribution to the development of a hospital management system that is not only operationally efficient but also environmentally sustainable.

METHOD

This study employed a descriptive research design with a qualitative approach and a cross-sectional approach with quantitative methods. This is expected to provide a comprehensive understanding of the effectiveness of energy efficiency policies, waste management, and digitalization systems in supporting operational efficiency and hospital sustainability. A mixed methods approach was used to combine the strengths of quantitative and qualitative methods to obtain a comprehensive picture of the implementation of the Green Economy in hospitals. The study began with a literature review and policy analysis to identify concepts, regulations, and best practices related to the implementation of the Green Economy in the healthcare sector. The research location was Bina Kasih Hospital in Pekanbaru, a private hospital operating in Riau Province.

Quantitative data was collected through questionnaires distributed to medical personnel and hospital management, focusing on three main variables: energy efficiency policies, medical waste management, and the digitalization system. Qualitative data was obtained through in-depth interviews with hospital stakeholders and Focus Group Discussions (FGDs) to explore experiences, challenges, and opportunities in implementing the Green Economy in the hospital environment. To ensure the feasibility of the research instruments, validity and reliability tests were conducted using SPSS. The validity test used the Pearson Product Moment method, with the criterion that a statement item is valid if the calculated r value is greater than the tabulated r value. The test results showed that all items had calculated r values greater than 0.444 (with a sample size of 20 in RS

Angkatan Udara dr. Sukirman Lanud Roesmin Nurjadin – Pekanbaru), thus being declared valid. Next, a reliability test was conducted using the Cronbach's Alpha method to assess internal consistency between questions. The overall Cronbach's Alpha value of 0.906 indicates an excellent level of reliability. Specifically, the reliability values per variable are as follows: Energy efficiency Policy (Cronbach's Alpha 0.906), Waste Management (Cronbach's Alpha 0.950), and Digitalization System (Cronbach's Alpha 0.932). Therefore, this research instrument is declared valid and reliable for use in analyzing the implementation of a green economy at Bina Kasih Hospital, Pekanbaru.

Data analysis was conducted in several stages. For quantitative data, univariate, bivariate (Chi-square test), and multivariate (logistic regression) analyses were used. Meanwhile, qualitative data were analyzed using SWOT and Cost-Benefit analyses, resulting in a deeper and more integrative understanding of the research findings. The sampling method used was purposive sampling, a technique for selecting respondents based on specific considerations or criteria aligned with the research objectives. This technique was chosen because the researchers needed respondents with the most relevant knowledge and experience regarding the variables studied. The sample size was set at 40 respondents, taking into account length of service, work unit, and direct involvement in hospital operational activities related to energy policy, waste management, and digitalization systems. This number is expected to provide a representative picture of the application of green economy principles in improving operational efficiency and hospital sustainability. This study also applies the principles of research ethics and has obtained ethical feasibility approval from the Ethics Committee of the Cendekia Utama Kudus Institute of Health Technology under number 52/EC/KEPITEKES-CU/VII/2025.

RESULT

Table 1.
Characteristics of Respondents (n=40)

Characteristics	f	%
Age (years)		
Age		
20 - 30 Years	16	40
31 - 50 Years	24	60
Gender		
Man	11	27.5
Woman	29	72.5
Education		
High School/Vocational School	4	10
D3	2	5
S1	9	22.5
S1 Nursing	25	62.5
Work unit		
Cleaning Service	2	5
Nurse	26	65
Staff	10	25
Security	2	2
Years of service		
< 5 Years	27	67.5
> 5 Years	13	32.5

The characteristics of respondents in this study include age, gender, education, job position, and length of service of employees of Bina Kasih Hospital Pekanbaru July 2025. Based on the results of the study shown in the table above, it is known that the majority of respondents are in the age group of 31–50 years as many as 24 respondents (60%), while the age of 20–30 years is 16 respondents (40%). In terms of gender, the majority of respondents are women, namely 29 respondents (72.5%), while 11 respondents (27.5%) are men. Based on education level, most respondents have a Bachelor's degree in Nursing, namely 25 respondents (62.5%), then S1 as many as 9 respondents (22.5%), high school/vocational school as many as 4 respondents (10%), and D3 as many as 2 respondents (5%). When viewed from work position, the majority of respondents work as nurses,

namely 26 respondents (65%), followed by staff as many as 10 respondents (25%), and cleaning service as many as 2 respondents (5%).

Meanwhile, based on length of service, the majority of respondents had worked for less than 5 years, namely 27 respondents (67.5%), while respondents with a service period of more than 5 years numbered 13 respondents (32.5%). Thus, the characteristics of respondents in this study were dominated by productive age employees 31–50 years old, the majority of whom were female, had a Bachelor's degree in Nursing, worked as nurses, and had a service period of less than 5 years.

Table 2.

Univariate Analysis of Each Variable

Variables	f	%
Energy Efficiency Policy		
Low	21	52.5
High	19	47.5
Waste Management		
Low	13	32.5
High	27	67.5
Digitalization System		
Low	10	25
High	30	75
Operational Efficiency and Sustainability		
Efficient	24	60
In Efficient	16	40

Table 2 shows that of the 40 respondents, the majority (52.5%) stated that energy efficiency policies were still considered low, while 47.5% stated that they were high. Regarding the waste management variable, the majority of respondents rated its implementation as high, at 67.5%, while 32.5% rated it low. Furthermore, regarding the digitalization system variable, the majority of respondents stated that it was high, at 75%, compared to 25% who rated it low. Meanwhile, in the operational efficiency and sustainability variables, respondents with efficient assessments dominated with a percentage of 60%, higher than those who assessed inefficiency at 40%.

Table 3.

Crosstabulation of Policy Energy Efficiency with Operational Efficiency and Sustainability

Energy Efficiency Policy	Operational Efficiency and Sustainability						p-value
					Total		
	Efficient		In- efficient				
	f	%	f	%	f	%	
High	15	78.9	4	21.6	19	100	0.045
Low	9	12.5	12	57.1	21	100	

Table 3 shows the relationship between energy-saving behavior and the implementation of operational efficiency at Bina Kasih Hospital, Pekanbaru. Of the 19 respondents with high energy-saving behavior, the majority (15 people) (78.9%) were in the efficient category, while only 4 people (21.1%) were in the inefficient category. Conversely, of the 21 respondents with low energy-saving behavior, the majority (12 people) (57.1%) were in the inefficient category, while only 9 people (42.9%) were included in the efficient category. The results of the statistical test with Chi-Square show a p-value = 0.045 ($p < 0.05$), which means there is a statistically significant relationship between energy efficiency policies and the implementation of operational efficiency.

Table 4.

Crosstabulation of Waste Management with Operational Efficiency and Sustainability

Cross-tabulation of Waste Management with Operational Efficiency and Sustainability							
Waste Management	Operational Efficiency and Sustainability				Total	p-value	
	Efficient		In- efficient				
	f	%	f	%			
High	20	74.1	7	25.9	27	100	0.023
Low	4	30.8	9	69.2	13	100	

Table 4 shows the relationship between waste management and the implementation of operational efficiency at Bina Kasih Hospital Pekanbaru. Of the 27 respondents with high waste management, the majority, namely 20 people (74.1%) were in the efficient category, while 7 people (25.9%) were in the inefficient category. Conversely, of the 13 respondents with low waste management,

the majority, namely 9 people (69.2%) were in the inefficient category, and only 4 people (30.8%) were included in the efficient category. The results of the statistical test with Chi-Square showed a $p\text{-value} = 0.023$ ($p < 0.05$), which means there is a statistically significant relationship between waste management and the implementation of operational efficiency.

Table 5.

Crosstabulation of Digitalization System with Operational Efficiency and Sustainability						
Digitalization System	Operational Efficiency and Sustainability				Total	
	Efficient		In- efficient			
	f	%	f	%	f	%
High	23	76.7	7	23.3	30	100
Low	1	10	9	90	10	100

Table 5 shows the relationship between the digitalization system and the implementation of operational efficiency and sustainability at Bina Kasih Hospital, Pekanbaru. Of the 30 respondents with a high digitalization system, the majority (23 people) (76.7%) were in the efficient category, while 7 people (23.3%) were in the inefficient category. Conversely, of the 10 respondents with a low digitalization system, the majority (90%) were in the inefficient category, and only 1 person (10%) was included in the efficient category. The results of the statistical test with Chi-Square showed a $p\text{-value} = 0.001$ ($p < 0.05$), which means there is a statistically significant relationship between the digitalization system and the implementation of operational efficiency and sustainability.

Table 6.

Multivariate Analysis

Variabel Independen	B	Sig. (p-value)	Prevalence Ratio (95.0% CI)
Kebijakan Efisiensi Energi	1,732	0,045	1,821 (1,005–3,297)
Manajemen Limbah	2,012	0,023	2,056 (1,218–3,472)
Sistem Digitalisasi	2,944	0,001	2,754 (1,657–4,578)

The regression coefficient (B) of 1.732 with a $p\text{-value}$ of 0.045 (<0.05) indicates that energy efficiency policies significantly influence hospital operational efficiency. The prevalence ratio (PR) of 1.821 (95% CI: 1.005–3.297) indicates that hospitals that implement energy efficiency policies effectively are 1.8 times more likely to achieve operational efficiency than those that do not. The regression coefficient (B) of 2.012 with a $p\text{-value}$ of 0.023 (<0.05) indicates that waste management also significantly influences operational efficiency. The PR value of 2.056 (95% CI: 1.218–3.472) indicates that hospitals with effective waste management are twice as likely to achieve operational efficiency as those with poor waste management. The digitalization system has the highest regression coefficient (B) of 2.944 with a $p\text{-value}$ of 0.001, indicating a very significant effect on operational efficiency. The PR value of 2.754 (95% CI: 1.657–4.578) indicates that optimal implementation of the digitalization system increases the opportunity for operational efficiency by up to 2.7 times compared to hospitals that have not implemented the digital system effectively.

DISCUSSION

The Relationship between Energy Efficiency Policy and Improving Hospital Operational Efficiency

An energy efficiency policy is a strategic organizational instrument aimed at managing energy use effectively, efficiently, and sustainably. Implementing this policy not only serves to reduce excessive energy consumption but also supports the achievement of operational sustainability. In the hospital context, energy efficiency policies are implemented through optimizing the use of electrical equipment, utilizing natural lighting, implementing energy-saving technologies, and measurable internal regulation-based energy management. This strategy has direct implications for increasing operational efficiency, as it can reduce energy costs while maintaining the continuity of healthcare services (Orsini, 2024)(Wardana, 2024)(Yusuf, 2024).

These findings are consistent with the Theory of Planned Behavior, which explains that behavior within an organization is strongly influenced by implemented norms, policies, and controls. Clear,

consistent, and measurable energy policies shape employee behavior patterns to implement energy-saving practices sustainably (Yusuf, 2024). Thus, a comprehensively designed energy efficiency policy fully supported by management is an important determinant in achieving hospital operational efficiency. These findings are also relevant to Herzberg's motivation theory, which asserts that motivating factors, such as achievement and responsibility, can improve individual performance. In this context, energy efficiency policies function as motivating factors that encourage active employee participation, not only because of the economic benefits they generate, but also because of their contribution to environmental sustainability (Rahman, 2024).

Previous studies reinforce these findings, emphasizing the importance of increasing human resource capacity in supporting environmentally friendly energy programs through training related to new and renewable energy (EBT), energy conservation, and green fuel. However, the support of the trained workforce is still at a low level, requiring continuous strengthening (Erwinsyah, 2021). The strategy towards a green economy within the framework of sustainable hospitals requires consistent management evaluation to ensure the achievement of environmental targets (Perdini, 2023). Meanwhile, other research identifies six main dimensions of hospital sustainability in Indonesia: ecology, economy, social, technology, environmental health, and institutional, consisting of 42 attributes and 151 sub-attributes. The assessment shows that the status of hospital environmental management is in the fairly sustainable category with a score of 71.23%. Leveraging factors that influence successful implementation include waste management, energy conservation, organizational culture, leadership, and budget performance (Sutanto et al, 2020)(Chías, 2017). Thus, energy efficiency policies have been shown to have a significant relationship with improving hospital operational efficiency. These policies are not merely administrative regulations, but rather strategic instruments that determine an organization's success in achieving operational efficiency and sustainability. Therefore, the formulation and implementation of appropriate, consistent energy efficiency policies, accompanied by ongoing evaluation, are essential to support hospitals' transformation toward a green economy that is oriented toward sustainability.

The Relationship between Waste Management and Improving Hospital Operational Efficiency

Waste management focuses on an organization's strategy for managing, processing, and disposing of waste efficiently and safely, thereby reducing waste, reducing environmental impact, and supporting operational sustainability. Implementing good waste management enables organizations to optimize resource utilization, including through waste sorting from source, implementing the principles of reduce, reuse, recycle (3R), and utilizing environmentally friendly waste processing technologies. These practices contribute directly to increased operational efficiency by reducing additional costs, minimizing the risk of pollution, and creating a safer and healthier work environment. In the context of hospitals, as healthcare institutions with high production of medical and non-medical waste, waste management is a fundamental aspect. Hospitals are required to maintain service continuity while ensuring occupational health and safety. Hospitals that implement good waste management tend to be more operationally efficient, while poor waste management leads to increased processing costs, potential environmental pollution, and a decline in the quality of healthcare services.

Research at Bogor City Community Health Centers (Puskesmas) showed that all Community Health Centers (Puskesmas) do not have their own medical waste processing facilities, so waste is temporarily stored before being handed over to a licensed third party. Analytical Hierarchy Process (AHP) assessment confirmed that appointing a licensed vendor was the most effective alternative, with a score of 68%. However, challenges include limited land, procedural weaknesses, and the lack of cost internalization. The potential for pollution also remains high due to limited wastewater treatment facilities (WWTP) and low use of personal protective equipment (PPE) by cleaning staff. This situation indicates the need for sustainable financing strategies and infrastructure improvements to optimize waste management (Debora et al, 2023)

Research study The Sahabat Hospital also demonstrated that medical waste management has been implemented in accordance with regulations (PP No. 101/2014; Permenkes No. 7/2019; PermenLHK No. P.56/2015). However, weaknesses remain, such as the lack of a written policy governing waste reduction and sorting. This has resulted in an increase in the amount of medical waste stored at the B3 Waste TPS, increasing operational costs and creating a risk of biological exposure for cleaning staff (Habibi, 2020).

Beyond technical aspects, waste management is also closely related to employee motivation and responsibility. Implementing a shared waste management policy can foster awareness that waste control not only provides financial benefits for hospitals but also impacts public health and environmental sustainability. More broadly, hospital waste management is part of the implementation of a green economy (Fitri, 2020)(Fitriani, 2022) Tangestani, 2025)(Alighardashi, 2024)(Debora et al, 2023). The concept of a green economy emphasizes efficient resource utilization, environmental innovation, and sustainable development. In the hospital context, integrating green economy principles through waste management supports the achievement of sustainability-oriented operational efficiency . The findings of this study indicate that waste management is significantly related to increased hospital operational efficiency. Therefore, waste management should be viewed not merely as a technical activity, but as a strategic instrument in transforming hospitals into efficient, sustainable organizations aligned with green economy principles (Tulebayeva, 2020)(Fitri, 2024)(Fitriani,2022).

The Relationship between Service Digitalization and Improving Hospital Operational Efficiency

A digitalization system is an organizational strategy for integrating information technology into work processes to make them faster, more accurate, and more efficient. The implementation of digitalization allows organizations to minimize the use of manual documents, accelerate workflows, and improve service quality through more structured data management. By implementing an optimal digitalization system, hospitals are able to optimize resource utilization, including through the use of electronic medical records (EMRs), the implementation of a Hospital Management Information System (SIMRS), and the automation of administrative processes. This strategy directly contributes to improving hospital operational efficiency (Mutiarahati, 2022)

The results of the study showed that respondents with a high level of digitalization were more likely to be in the efficient category compared to those with a low level of digitalization. This finding is consistent with the theory of organizational innovation, which asserts that adopting new technologies can improve operational performance and efficiency (Maharani, 2024). In the context of hospitals with complex services and demands for speed and accuracy in patient data management, digitalization plays a crucial role. Implementing digital systems can streamline administrative processes, accelerate access to medical information, and reduce the risk of recording errors. Therefore, hospitals that optimally implement digitalization are more likely to achieve operational efficiency, while hospitals with a low level of digitalization face the risk of service delays, increased operational costs, and decreased quality of healthcare services. Other research also confirms that digital strategies have a broad impact on the external dimensions of hospitals, particularly in terms of service marketing. Digital marketing has been shown to reach more consumers through social media, expand market access, increase patient loyalty, strengthen brand image, and raise public awareness of healthcare services. This demonstrates that digitalization is not only relevant to internal operational management but also strategic in strengthening hospital competitiveness in the community (Mutiarahati, 2022).

Green Economy Policy Strategy in Improving Sustainability and Operational Efficiency

The results of this study support previous theories and findings that digitalization systems are not merely technical innovations, but rather strategic instruments that determine an organization's success in achieving operational efficiency. Therefore, the formulation and implementation of

appropriate, integrated, and sustainable digitalization are crucial strategies to support the sustainability of hospital operational management, in line with green economy principles that emphasize efficiency, sustainability, and resource optimization. The results of interviews with four informants, consisting of two main informants (nurses and operational maintenance staff) and two key informants (representatives of the Environmental and Sanitation Service and the Head of General Affairs and IT), showed that there were variations in views regarding the implementation of energy saving policies, waste management, and digitalization systems in supporting hospital operational efficiency.

Regarding the energy-saving policy aspect, a key informant from a nurse assessed that the policy is more visible in daily practices such as turning off the lights and air conditioning when the room is empty. She said, "Usually when the room is empty, we turn off the AC and lights. It's become a habit, although sometimes people still forget." A key informant from the Operational Maintenance staff added that the energy-saving policy has been outlined in internal regulations, although its implementation still depends heavily on employee awareness. From the perspective of a key informant, a representative from the Environmental and Sanitation Service emphasized that the energy-saving policy is not only internal, but also part of local government regulations that must be complied with. Meanwhile, the Head of General Affairs and IT stated that the energy-saving policy has been part of the hospital's efficiency strategy, but oversight constraints and the lack of sanctions have made its implementation inconsistent.

Regarding waste management, a key informant from a nurse emphasized that medical and non-medical waste has been sorted, but employee consistency remains a problem. He stated, "Trash bins have been separated according to waste type, but not all employees are disciplined." Operational Maintenance Staff assessed that waste management is mostly managed by special units or third parties, so employees outside these units do not understand the detailed procedures. A key informant from the Environmental and Sanitation Service emphasized the importance of hospital compliance with B3 waste management regulations, including sorting, storage, and transportation. The Head of General Affairs and IT acknowledged that waste management costs are a major challenge, but remain a priority because they are related to occupational safety, environmental health, and the hospital's image.

Meanwhile, regarding the digitalization system aspect, key informants tended to have a positive view. Nurses stated that electronic medical records helped speed up access to patient data and reduce the risk of recording errors. She said, "Now medical records are faster, just open the system. No need to search for manual files anymore." Operational Maintenance staff assessed that digitalization in the administration and finance areas increased work efficiency and transparency. From the perspective of key informants, the Environmental and Sanitation Service saw digitalization as a modernization effort that aligns with government policy regarding the development of Green Hospitals. The Head of the General and IT Division added that although digitalization accelerates the service process, technical obstacles such as network disruptions and limited user competency must be immediately addressed for optimal implementation.

In general, qualitative data indicates that all three variables energy saving policies, waste management, and digitalization systems are perceived to significantly contribute to hospital operational efficiency. However, there are differences in focus among informants: nurses placed greater emphasis on daily practice, operational maintenance staff on internal regulations, the Environmental Service on regulatory compliance, and the Head of General Affairs and IT on strategic policies and implementation barriers. This demonstrates that hospital operational efficiency requires a multi-level approach, involving individual awareness, management support, and compliance with external regulations.

Matrix SWOT Analysis of Green Economy Implementation

Based on the results of the SWOT analysis, several strategies for developing hospital management towards implementing sustainable green economy principles were formulated. In the Strength-Opportunity (S/O) strategy, hospitals can leverage their internal strengths to optimally seize external opportunities. A key step is to leverage management commitment and compliance from waste management vendors to apply for participation in local government programs based on green economy incentives. Furthermore, optimizing the number of BPJS patients can also be used as a means to strengthen the hospital's image as an environmentally friendly institution (green branding). Another effort supporting this strategy is the development of a Hospital Management Information System (SIMRS) as part of a digitalization strategy to improve service efficiency and operational transparency.

Furthermore, in the Weakness-Opportunity (W/O) strategy, hospitals need to address internal weaknesses by capitalizing on opportunities in the external environment. One such effort is building renewable energy infrastructure, such as solar panels, by leveraging external funding support. Furthermore, increasing human resource capacity through training related to energy efficiency, waste management, and digitalization is crucial, which can be implemented through collaboration with universities or research institutions. Hospitals also need to develop documented, written internal policies to meet national green hospital standards, so that all operational activities have a clear and measurable policy basis.

In the Strength-Threat (S/T) strategy, internal strengths are used to address external threats. Hospitals can optimize collaboration with officially licensed waste management vendors to minimize the risk of violating environmental regulations. Furthermore, adopting an energy-saving culture, such as turning off air conditioners and lights in unused rooms, can be a concrete step in addressing the challenge of high energy operational costs. Furthermore, hospitals can leverage their large patient population as a compelling argument when seeking support from local governments, both in the form of policies and environmental incentives.

Finally, in the Weakness-Threat (W/T) strategy, hospitals need to take defensive measures to minimize internal weaknesses while anticipating external threats. Strategies that can be implemented include diversifying energy sources with energy-efficient systems to mitigate the impact of fluctuating electricity rates from PLN. Furthermore, it is crucial to establish a regular monitoring and evaluation system to ensure that energy-saving and waste management policies are implemented consistently and sustainably. From the Cost-Benefit Analysis (CBA) perspective, several informants emphasized that the hospital has not yet fully implemented energy saving consistently. A nurse said: *"Actually, there are energy saving regulations, but their implementation is not always adhered to, for example, the lights and air conditioners are often still on even though the room is empty."* This indicates that the non-financial costs that must be borne are weak staff compliance, lack of supervision, and the absence of clear sanctions. Operational maintenance staff added: *"When talking about policies, they are indeed in internal regulations, but it comes back to the awareness of each employee."* Another cost that arises is the need for ongoing training and education so that all employees are truly accustomed to energy-efficient work patterns.

Meanwhile, in terms of benefits, most informants see tangible benefits if energy-saving policies are implemented well. For example, the Head of General Affairs and IT Operations stated: *"If energy saving is implemented seriously, it will clearly reduce the burden of hospital electricity costs, especially since we know that electricity costs are quite a large portion of operations."* In addition to financial benefits, informants from the Environment and Forestry Department also highlighted the sustainability aspect: *"Energy saving is not just about costs, but part of environmental regulations. If the hospital is consistent, its image will improve as a green hospital"*. Thus, it can be qualitatively concluded that implementing energy efficiency in hospitals faces non-financial costs in the form of technical constraints (lack of supervision, limited technology), behavioral constraints

(low staff awareness), and perceived high initial investment requirements. However, perceived benefits include operational cost savings, improved organizational image, compliance with government regulations, and contributions to green economy principles.

From the results of qualitative data analysis, SWOT analysis, and Cost-Benefit Analysis (CBA), it can be concluded that the Green Economy strategy, through its three main policy instruments of energy efficiency, waste management, and digitalization, provides tangible benefits for the sustainability and efficiency of hospital operations. These three instruments serve not only as technical measures but also as managerial strategies that integrate environmental, social, and economic aspects into daily operational practices. However, implementing this strategy still faces several challenges. The main obstacles identified include the relatively high initial costs required for procuring environmentally friendly technology, developing digital infrastructure, and providing waste management facilities. Furthermore, consistency in policy implementation is often hampered by a weak organizational culture and the lack of ongoing monitoring and evaluation mechanisms. Another crucial factor is limited employee competency, particularly in mastering digital technology and understanding the principles of energy efficiency and proper waste management.

However, when viewed from a long-term perspective, the benefits far outweigh the obstacles. Implementing Green Economy policies has been proven to generate cost efficiencies through energy savings, reduced waste management costs, and increased productivity thanks to digital systems. Furthermore, hospitals' success in adopting environmentally friendly policies also supports compliance with national and international health and environmental regulations. This compliance not only reduces the risk of administrative sanctions but also strengthens the hospital's reputation as a sustainability-oriented institution. Another positive impact is improved service quality, in terms of speed, accuracy, and patient safety, which ultimately contributes to increased public trust.

The researchers' assumption is that the success of Green Economy implementation is not solely determined by internal hospital policies. External factors such as government regulatory support, technological developments, and public awareness also play a significant role. Meanwhile, internally, individual employee awareness, management commitment, and human resource capacity building are key determinants in ensuring consistent strategy implementation. With multi-level synergy between internal policies, managerial support, individual participation, and compliance with external regulations, hospitals can achieve operational efficiency while maintaining environmental sustainability. Thus, it can be emphasized that the Green Economy strategy is not only a normative approach, but rather a strategic need that can place hospitals in a more adaptive, competitive, and sustainable position in facing the dynamics of the modern health sector.

CONCLUSION

This research demonstrates that the implementation of Green Economy strategies through energy-saving policies, waste management, and digitalization systems is significantly associated with increased hospital operational efficiency. These three instruments have been shown to function not only as technical measures but also as managerial strategies that contribute to operational sustainability while simultaneously meeting the principles of resource efficiency. These findings confirm that the successful implementation of the Green Economy in hospitals is influenced by multi-level synergy, including individual employee awareness, management commitment, and external regulatory support. Therefore, the research hypothesis that the implementation of energy-saving policies, waste management, and digitalization systems supports increased operational efficiency and hospital sustainability is accepted. As a direction for further research, it is necessary to develop an application-based system that is capable of monitoring energy consumption in real time and supporting day-to-day waste management, so that the implementation of the Green Economy can be carried out more consistently, measurably, and adaptively to the dynamics of modern health services.

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