Optimizing Hospital Waste Management through Fly Trap Technology: A Cost and Potential Problem Analysis

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Abstract
The problem that often occurs in hospitals is that regulations related to hospital environmental health still need to be popular in the community. However, the development of technology and science has made agricultural tools and machines experience development and renewal and adapt to environmental conditions. Many types of fly control are available, such as fly traps in temporary garbage shelters in hospitals. This study analyzes operational needs and problems encountered by implementing fly trap technology in hospitals. This study consisted of three stages: budgeting, calculating the Kepner-Tregoe Situation Appraisal (KTSA), and the Kepner-Tregoe Potential Problem Analysis (KTPPA). The total operational costs required for this tool are IDR 887,496.00. Where this cost includes the component of preventing problems that must be faced in fly trap operations. Identification of tool constraints in operation consists of damage to the net on the fly trap, garbage piling up due to overloading in the garbage container, blockage of the entry path for flies to the fly trap, and the garbage collector coming into contact with the waste at the TPS. There are four potential problems in implementing fly traps that we previously identified, where there are possible causes, preventive actions, and contingent actions that can be taken to overcome these potential problems.

Keywords: hospital, fly trap, operational cost, potential problems, action

1. Introduction
The hospital is part of the overall healthcare system that organizes health service activities that are promotive (health development), preventive (disease prevention), curative (disease treatment), and rehabilitative (health restoration) activities [1]. Furthermore, hospitals in outpatient, inpatient, emergency, medical, and non-medical services use technology that can affect the surrounding environment, so it is mandatory to maintain and improve environmental health efforts [2].

Health is one of the essential factors when realizing everyone's physical health. Conditions faced in the community regarding health problems and cleanliness of the home environment [3], [4]. The condition
problems faced by the community are a large population with high growth and the distribution of the population in each region is not evenly distributed, resulting in a low level of education, society, and economy [5]–[9]. The physical and biological environment is inadequate, resulting in only a small proportion of the population enjoying clean water and using sewage and wet or dry waste that meets health requirements [10]. Then, the transmission of infectious diseases is still a lot of people who are infected with the infection. Therefore, the role of the environment is essential in realizing the population's health. In theory, it has not been explained that health is influenced by several factors, including environmental factors, daily habits, health services, and heredity factors that may affect health. One of the disease vectors, such as diarrhea, is a disease close to humans caused by flies. Many aspects trigger the emergence of disease vectors in the population, including poor sanitation, which will cause flies [11].

The problems that often occur in hospitals are regulations related to hospital environmental health that are still not socialized, implementation of environmental impact analysis, efforts to manage and monitor the hospital environment are still administratively oriented, and hospital environmental health activities are still not a priority. One of them is managing hospital waste which for ordinary people may seem to be running as it is and has not been a concern [12].

The development of technology and science has made tools and machines experience development and renewal and adapt to environmental conditions and preferences [13], [14]. Many types of fly control are available, such as fly traps in temporary garbage shelters (TPS) in hospitals. So applying a fly trap must consider various aspects, such as potential problems. Therefore, this study analyzes the operational needs and problems encountered by applying fly trap technology in hospitals.

Flies are one of the insects with a high population in the community, and their presence is difficult to eradicate [15]. Flies can transmit various human diseases, including dysentery, cholera, typhoid, worm infections, eye infections (conjunctivitis and trachoma), and skin infections [16]. Food and organic matter quickly decompose so that disease-causing organisms stick to flies’ feet and body parts. A single fly can carry 6,500,000 microorganisms on the feet and other body parts. Not surprisingly, many people get sick from contaminated food [17].

Flies cannot be eradicated but can be controlled safely and not harmful [18]. Flies eat foods that humans eat daily, such as sugar, milk, protein, fat, human and animal feces, blood, fermented food, and decay [19]. The variety of bait attracts flies because it contains food that flies like and has a distinctive aroma [20]. The sense of smell in flies consists of antennae and pulp, which are very sensitive to odor stimuli. Therefore, fly traps control the density of large numbers of adult flies [21]. Fly traps are placed outside the house in the open air and protected from the shadows of the trees. The fly trap uses an inverted cone plus a small hole in the cone 2-3 inches apart. When the fly is complete, the fly will fly up and enter the fly trap through the small hole at the end of the cone. Fly traps are cube-shaped, each measuring 30x30 cm with a circle diameter (base) measuring 7 cm for flies to enter [22].

When it comes to fly control, various mechanisms are available, each with its advantages and considerations. Fly traps, such as sticky traps, have gained popularity for several reasons. Firstly, they offer a non-toxic solution [23], making them safe for use in homes or food-handling areas where chemical sprays may not be suitable. Additionally, fly traps are odorless [24], avoiding unpleasant smells of certain insecticides. These traps provide a targeted approach [25], attracting and capturing flies without harming other beneficial insects or the environment.

Moreover, they typically require low maintenance, allowing them to capture flies continuously with minimal intervention. Some fly traps are also reusable, enabling the replacement or cleaning of adhesive surfaces. However, it's essential to consider factors like fly species, infestation severity, and specific circumstances when selecting a control mechanism, as the effectiveness may vary among different methods. Alternatives like fly swatters offer immediate control but are more suitable for isolated fly incidents. Insecticides can be effective but involve chemicals [26], [27]. UV light traps attract flies through light and electrocute or trap them [28], [29], while biological control agents use predatory insects or animals to reduce fly populations. Each method has pros and cons, so choosing the most appropriate approach depends on the specific situation and personal preferences.

Over the years, research on fly traps and their effectiveness in fly control has been conducted. These studies often focus on specific types of traps, trap designs, or the integration of traps with other control methods. The results of these research studies can vary depending on the specific variables being tested and the conditions under which the experiments are conducted. Some key findings from previous research include:

1. Effectiveness: Studies have shown that fly traps, particularly sticky traps and UV light traps, can effectively capture flies and reduce fly populations [28], [29]. However, the level of effectiveness can
vary depending on factors such as trap design, bait attractiveness, trap placement, and environmental conditions.

2. Species-Specific Attraction: Certain fly trap designs and baits are more effective in attracting specific fly species [30], [31]. Researchers have explored different bait formulations and trap designs to optimize attraction for target fly species while minimizing non-target captures.

The effectiveness of fly traps can depend on factors such as fly species composition, trap placement, trap maintenance, and environmental conditions.

2. Material and Methods

This study consisted of three stages: budgeting, calculating the Kepner-Tregoe Situation Appraisal (KTSA), and the Kepner-Tregoe Potential Problem Analysis (KTPPA). Overall, the stages of assessing the cost benefits of implementing fly traps in hospitals can be seen in Figure 1.

![Figure 1. Evaluation framework of this study](Source: Authors Analysis, 2023)

The budgeting or preparation of the budget is an estimate of expenses made based on the results of the business analysis that has been carried out. Capex is an expenditure to create a design. Capex is the purchase of fixed assets to increase the value of an item's assets and expand the company's ability to increase profits. Capex is written as an asset on the balance sheet if the goods or services purchased are used continuously for more than one year. Operating expenses are operational costs incurred by a business through its normal day-to-day operations. This includes rent, equipment, inventory costs, insurance, installation costs, and funds allocated for research and development. Maintenance or maintenance costs are several budget funds intended to maintain business assets in optimal condition during use. Regular inspection and maintenance are needed so the equipment can always be in prime condition. Therefore, it is highly recommended that companies allocate special funds for maintenance expenses regularly.

When facing several problems simultaneously, the Kepner-Tregoe Situation Appraisal (KTSA) is useful in deciding which problem has the highest priority. After that, we can analyze the problem with the highest priority. KTSA prepares individuals or teams to take rational action. As a result, individuals or teams can develop a better understanding of problem identification and efficient time to solve those problems. These results can keep individuals or teams focused on priority issues. The first stage we can do is to make a list to isolate and clarify all the problems that are of concern to us that we are facing simultaneously. Then in the second stage, try to decide which problem needs attention first. The priority of each problem will be evaluated using the following criteria: timing, trend, and impact. The criteria are assessed with high attention criteria (H), moderate attention levels (M), and low attention levels (L) [32].
Kepner-Tregoe Potential Problem Analysis (KTPPA) is one of four types of Kepner-Tregoe techniques, besides KTSA (Situation Appraisal), KTPA (Problem Analysis), and KTDA (Decision Analysis). KTPPA aims not only to ensure the successful implementation of the solution we choose but also to minimize the risk of problems occurring that could interfere with the implementation of the solution or the expected results from implementing the solution. The KTPPA table explores potential problems, identifies potential causes of these problems, compiles a preventive action plan to prevent these problems from occurring, and creates a contingent action plan for countermeasures if potential problems occur [32].

A systematic approach is crucial when using the observation method to identify potential problems. To begin, establish clear objectives outlining the specific aspects to observe, such as the functioning of fly traps, waste disposal practices, and the condition of the TPS area. Develop observation guidelines or checklists to ensure consistency and comprehensiveness during the process. Conduct site visits, closely observing operations and activities related to fly control and waste management. Take detailed notes, capture visual documentation, and engage with stakeholders to gather additional insights and perspectives. Compare the observations with established standards, guidelines, or best practices in the field to identify any deviations or areas requiring improvement. Analyze and prioritize the collected observations, looking for patterns or recurring issues, and consider their potential impact and urgency. Validate findings by seeking input from other team members or experts. This systematic observation method provides valuable insights into potential problems, allowing for a thorough examination of operational processes, equipment, and practices to identify areas for improvement and intervention.

3. Results and Discussion

The object of the study is the design of a fly trap device to be implemented on containers at the Temporary Storage Site (TPS) of the public hospital RSUD X. The containers used at the TPS are closed containers with a capacity of 6 m³ and dimensions of 3.3 meters in length, 1.8 meters in width, and 1.2 meters in height. The study aims to develop a fly trap specifically designed for these containers to control fly populations in the TPS area.

In loading fly traps at the hospital by analyzing the bill of quantity, the tools needed were found, such as wooden rafters, wire gauze, yellow funnels, and nails for capital expenditures. Operating Expenses include tools such as astrakhan (shrimp), masks, hand scoops, basil oil, humidifiers, and personal protective equipment (PPE). The maintenance expense of Rp100,000.00 might have been estimated based on the expected maintenance requirements for the fly trap device, including potential costs for replacement parts or servicing.

The information was obtained through market research, supplier quotations, and interviews with relevant stakeholders to find the price of each item in the list. Here’s a general breakdown of how the prices could have been determined:

1. Wooden rafters: The price may have been sourced from local suppliers or hardware stores that provide wooden rafters. The listed price of Rp999.00 per piece suggests that it was obtained from a specific supplier or market research.
2. Wire gauze: Similarly, the price of Rp13,000.00 per sheet could have been obtained from supplier quotations or market research on the average price of wire gauze.
3. Yellow funnel: The price of Rp14,851.00 per piece may have been based on market research or quotations from suppliers offering yellow funnels.
4. Nail: The price of Rp3,000.00 for one ounce of nails could have been obtained from local hardware stores or supplier quotations.

The exact process applies to the operating expenses:

1. Astrakan (shrimp): The price of Rp40,000.00 per 0.5 kg could have been sourced from market research or supplier quotations for the specific product.
2. Face mask: The price of Rp20,500.00 per piece might have been obtained through market research on the average price of face masks or supplier quotations.
3. Handscon: The price of Rp89,000.00 per box could have been based on supplier quotations or market research on hand sanitizer products.
4. Basil oil 10 ml: The price of Rp94,000.00 for one bottle might have been sourced from supplier quotations or market research on the average price of basil oil.
5. Humidifiers: The price of Rp137,100.00 per unit may have been obtained through market research or supplier quotations for humidifiers with the required specifications.
6. PPE: The price of Rp11,000.00 per piece could have been sourced from market research on the average price of personal protective equipment or supplier quotations.
A complete description of the operational costs of the fly trap can be seen in Table 1. Table 1 used for the container used at the Temporary Storage Site (TPS) has a capacity of 6 m³.

### Table 1. The Operational Costs of The Fly Trap

<table>
<thead>
<tr>
<th>No.</th>
<th>Tools and materials</th>
<th>Value</th>
<th>Unit</th>
<th>Unit price</th>
<th>Total price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Wooden rafters</td>
<td>8</td>
<td>pcs</td>
<td>Rp999.00</td>
<td>Rp7,992.00</td>
</tr>
<tr>
<td>2.</td>
<td>Wire gauze</td>
<td>9</td>
<td>pcs</td>
<td>Rp13,000.00</td>
<td>Rp117,000.00</td>
</tr>
<tr>
<td>3.</td>
<td>Yellow funnel</td>
<td>4</td>
<td>pcs</td>
<td>Rp14,851.00</td>
<td>Rp59,404.00</td>
</tr>
<tr>
<td>4.</td>
<td>Nail</td>
<td>1</td>
<td>ounce</td>
<td>Rp3,000.00</td>
<td>Rp3,000.00</td>
</tr>
<tr>
<td></td>
<td><strong>Total price</strong></td>
<td></td>
<td></td>
<td></td>
<td>Rp187,396.00</td>
</tr>
</tbody>
</table>

**Operating Expenses**

<table>
<thead>
<tr>
<th>No.</th>
<th>Problem</th>
<th>Value</th>
<th>Unit</th>
<th>Unit price</th>
<th>Total price</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Atrakan (shrimp)</td>
<td>0.5</td>
<td>kg</td>
<td>Rp40,000.00</td>
<td>Rp20,000.00</td>
</tr>
<tr>
<td>6.</td>
<td>Face mask</td>
<td>10</td>
<td>pcs</td>
<td>Rp20,500.00</td>
<td>Rp205,000.00</td>
</tr>
<tr>
<td>7.</td>
<td>Handscon</td>
<td>1</td>
<td>box</td>
<td>Rp89,000.00</td>
<td>Rp89,000.00</td>
</tr>
<tr>
<td>8.</td>
<td>Basil oil 10 ml</td>
<td>1</td>
<td>pcs</td>
<td>Rp94,000.00</td>
<td>Rp94,000.00</td>
</tr>
<tr>
<td>9.</td>
<td>Humidifiers</td>
<td>1</td>
<td>unit</td>
<td>Rp137,100.00</td>
<td>Rp137,100.00</td>
</tr>
<tr>
<td>10.</td>
<td>PPE</td>
<td>5</td>
<td>pcs</td>
<td>Rp11,000.00</td>
<td>Rp55,000.00</td>
</tr>
<tr>
<td></td>
<td><strong>Total price</strong></td>
<td></td>
<td></td>
<td></td>
<td>Rp600,100.00</td>
</tr>
<tr>
<td>11.</td>
<td>Maintenance Expenses</td>
<td></td>
<td></td>
<td></td>
<td>Rp100,000.00</td>
</tr>
<tr>
<td>12.</td>
<td>Fly trap maintenance costs</td>
<td></td>
<td></td>
<td></td>
<td>Rp887,496.00</td>
</tr>
</tbody>
</table>

**Total price**

Source: Authors Analysis, 2023

The results of the KT-SA analysis can be seen in Table 2. Identification of tool constraints in operation consists of damage to the nets on the fly trap, garbage piling up due to overload in the garbage container, blockage of the entry path for the flies on the fly trap, and garbage collectors coming into contact with the waste.

1. The problem of net damage on the fly trap was identified through observation and assessment of the condition of the traps. If the nets are damaged, it can hinder the effectiveness of the fly control process. Given that the nets are made of high-quality wire netting, the timing (H: High) indicates that it is a problem that needs immediate attention. The impact (H: High) is also high because the damage to the nets can disrupt the fly control process, making it a critical issue.

2. The problem of garbage piling up due to overloaded waste containers was identified through visual inspection of the TPS area and monitoring the waste disposal process. The timing (M: Medium) suggests a recurring problem that needs attention but may not be as urgent as other issues. The impact (M: Medium) indicates that it moderately affects waste management, as excessive garbage can lead to sanitation and hygiene concerns.

3. The problem of blocked entry for flies on the fly trap may have been identified through regular monitoring and observation of the traps. If the entry points for flies are obstructed, it can reduce the trap's effectiveness. The timing (M: Medium) suggests that it is a problem that occurs occasionally and needs attention. The impact (M: Medium) reflects that it has a moderate effect on fly control, but it can be addressed using alternative entry holes.

4. The problem of garbage collectors coming into contact with waste at the TPS may have been identified through discussions or feedback from the TPS officers involved in waste collection. The timing (M: Medium) indicates that it is an ongoing concern that requires attention to ensure the safety and well-being of the personnel. The impact (H: High) reflects that it significantly affects the health and safety of the garbage collectors, making it an important issue to address.

### Table 2. KT – SA (Kepner Tregoe Situation Appraisal)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Net damage on the fly trap</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>1</td>
<td>Not easily damaged because it uses the best quality (wire netting); Damage can stop the fly vector control process.</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------</td>
<td>----------------</td>
<td>-----------------</td>
<td>----------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2.</td>
<td>Garbage piles up due to the overloading of waste containers</td>
<td>M</td>
<td>L</td>
<td>M</td>
<td>4</td>
<td>Garbage generation at the hospital in large quantities.</td>
</tr>
<tr>
<td>3.</td>
<td>Blocked entry of flies on the fly trap</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>3</td>
<td>Four holes/pathways for flies to enter the fly trap have been provided so</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>flies can enter the trap through other holes.</td>
</tr>
<tr>
<td>4.</td>
<td>Garbage collectors meet waste at the TPS</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td>2</td>
<td>Personal protective equipment has been provided for TPS officers.</td>
</tr>
</tbody>
</table>

Source: Authors Analysis, 2023

There are four potential problems in implementing fly traps that we previously identified, where there are possible causes, preventive actions, and contingent actions that can be taken to overcome these potential problems. Where Table 3 shows the analysis that was carried out.

**Table 3.** KT – PPA (Kepner Tregoe Potential Problem Analysis)

<table>
<thead>
<tr>
<th>Potential Problem</th>
<th>Possible Cause</th>
<th>Preventive Action</th>
<th>Contingent Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net damage on the fly trap</td>
<td>Hit the trash under the fly trap</td>
<td>Monitoring and transporting waste so that it does not exceed the capacity of the waste container</td>
<td>Repairing fly trap nets</td>
</tr>
<tr>
<td>Garbage piles up due to the overloading of waste containers</td>
<td>Delay in garbage collection</td>
<td>Create a garbage collection schedule</td>
<td>Providing spare containers to anticipate overloading</td>
</tr>
<tr>
<td>Blocked entry of flies on the fly trap</td>
<td>The fly intensity is too high</td>
<td>Provide four holes/pathways for flies to enter the fly trap so that flies can enter the fly trap through other holes.</td>
<td>Clean the entry route of flies</td>
</tr>
<tr>
<td>Garbage collectors meet waste at the TPS</td>
<td>Officers do not comply with the rules for wearing Personal Protective Equipment (PPE).</td>
<td>Socialization needs to be given to TPS officers, and monitoring must be carried out.</td>
<td>Give sanctions or warnings to TPS officers who do not use PPE.</td>
</tr>
</tbody>
</table>

Source: Authors Analysis, 2023

**Discussion**

Flytrap is a means of controlling flies by trapping flies in large numbers of intensities. As is the condition in the public TPS of this hospital, an attractive place for flies to breed and find food is a dark container. The eco-friendly fly trap is a modification of appropriate technology that can trap flies but is still environmentally friendly [33]. Based on the criteria and requirements for appropriate technology, this tool has many advantages because this technology is relatively economical (viable), can be accounted for (technically feasible), and can adapt well to the cultural and social environment in something local that we live in.

This tool uses perforated anti-mosquito wire mesh and is arranged in the container. The choice of material from the perforated wire is intended so that the smell of garbage can be smelled inside so flies can also be attracted to enter the fly trap. Flies are phototrophic insects that are very fond of light. Therefore, a bright yellow funnel is made to attract flies to enter the fly trap. Furthermore, the funnel is made conical so that when the fly enters the tool, it cannot find its way back out. So that when flies fly in a vertical direction, namely towards the direction of light or light, but the walls of the bright room are covered by wire mesh, the flies will be trapped in the fly trap. The total operational costs required for this tool is IDR 887,496.00, which includes preventing problems that must be faced in fly trap operations. Damage to the net on the fly
trap can occur due to hitting the trash under the fly trap. This risk can be reduced by monitoring and transporting waste so that it does not exceed the capacity of the waste container. Of course, if this happens frequently, repairs to the fly trap nets must be carried out periodically. Garbage accumulates due to overloading the waste container, which can occur due to delays in waste transportation. Operations must make a garbage collection schedule. In addition, officers must provide spare containers to anticipate overloading.

For several key reasons, fly traps play a crucial role in waste management at TPS hospitals. Firstly, they are essential for effective fly control. Flies are naturally attracted to waste, particularly organic waste, and can serve as carriers for various diseases. By implementing fly traps, hospitals can efficiently manage and reduce the fly population within the TPS area. This helps minimize the risk of fly-borne illnesses and prevents the spread of pathogens. Secondly, fly traps contribute to maintaining hygiene and sanitation standards. Flies can contaminate their surroundings by landing on waste materials and subsequently transferring pathogens to other surfaces, food, or even individuals. By utilizing fly traps, hospitals can prevent flies from coming into contact with waste, thereby reducing the spread of contaminants.

Additionally, fly traps aid in odor control. Accumulated waste often emits unpleasant odors, which can negatively impact the environment and cause discomfort for hospital staff, patients, and visitors. Fly traps help minimize the presence of flies attracted to the odorous waste, consequently reducing the dissemination of foul smells within the TPS area. Moreover, fly traps contribute to maintaining a visually pleasing and presentable environment. The sight of swarming flies can create a negative impression and undermine the overall cleanliness and professionalism of the hospital. Hospitals can effectively manage the fly population by implementing fly traps, leading to a more aesthetically appealing environment. Lastly, using fly traps ensures compliance with regulatory requirements. Local health regulations and standards often mandate proper waste management practices, including fly control measures.

4. Conclusion

The entire amount of IDR 887,496.00 that must be spent on operating costs for the fly trap tool in the hospital is specified. At the same time, this cost considers avoiding issues that must be dealt with when operating fly traps. The potential problem with the net of the fly trap, garbage piling up as a result of overloading in the garbage container, blockage of the entry path for flies to the fly trap, and the garbage collector coming into contact with the waste at the TPS are all examples of tool constraints that can be identified during operation. In the implementation of fly traps, there are a total of four potential difficulties that we have previously recognized. Each of these potential problems has a plausible cause, preventative steps, and contingent actions that may be performed to resolve the potential problems.

First, it is necessary to carry out further research regarding the effect of the type of bait that is more effective in overcoming the intensity of flies using eco-friendly fly traps. Second, carry out further research by paying attention to the size of the fly trap, which is more practical, and the acceptance response of the hospital environment. Third, it is necessary to carry out in-depth research so that the potential of Basil can be used on a large scale. A study is needed regarding the quantity and layout of the fly trap according to the size of the TPS so that the flies can be trapped optimally.

5. References


