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Efforts to Increase Efficiency at the Rspad Gatot Soebroto Nuclear Medicine Installation Using the Icor Method

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ABSTRACT

Gatot Soebroto Hospital, as a leading hospital in Indonesia, faces challenges in optimizing the use of resources, particularly in the *Nuclear Medicine Installation*, where the increase in the number of patients is not matched by proportionate revenue growth. This research aims to enhance operational efficiency at the *RSPAD Gatot Soebroto Nuclear Medicine Installation* by utilizing the *Incremental Capital Output Ratio* (ICOR) method. The research method employs a quantitative approach with time series data analysis of financial statements from 2020 to 2024, complemented by semi-structured interviews. Despite advancements in medical technology, the hospital struggles with resource optimization, particularly the mismatch between patient volume growth and income generation. Through a comprehensive analysis, the study identifies inefficiencies in capital utilization and proposes *lean management* principles to minimize waste in hospital processes. The findings reveal fluctuations in investment efficiency, with recommendations for prioritizing impactful investments, optimizing digital systems, and improving collaboration with third parties. This research contributes to both theoretical understanding and practical applications for enhancing hospital performance.

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INTRODUCTION

The Gatot Soebroto Army Central Hospital (RSPAD), which was originally a Dutch army hospital and later transformed into an Indonesian Army military hospital, has a long history that dates back to the colonial period (Yuniarti & Mirfat, 2023). This hospital has gone through various changes and played important roles, especially in providing health services to soldiers, high-ranking officials, and the wider community (Andriani & Nugroho, 2020). In 1977, the Gatot Soebroto Hospital began to provide services for high-ranking state officials, and since 1989, this hospital has opened itself to private services known as the Pavilion dr. R. Darmawan, PS for hospitalization (Hadi & Pratama, 2021). The hospital's historical context and its continuous service to the community reflect its significant contribution to national healthcare (Rizal et al., 2022). Its transformation from a military hospital to a civilian service provider highlights the evolution of healthcare access in Indonesia (Sundari et al., 2020). The integration of private services within RSPAD has led to improved healthcare delivery, with the Pavilion offering specialized medical services (Sulaiman & Kurniawan, 2023). RSPAD's role as a major healthcare institution also represents the intersection of military and civilian healthcare systems in Indonesia (Mulyadi & Sigit, 2021).

In addition, the Nuclear Medicine Installation at Gatot Soebroto Hospital is one of the leading fields, with medical services that use open radiation sources for diagnostics, therapy, and medical research. Nuclear medicine is a very important branch of disease diagnosis and

therapy, supported by various international standards from the WHO and IAEA, as well as the Decree of the Minister of Health of the Republic of Indonesia on Nuclear Medicine Service Standards (Li et al., 2020). The use of nuclear medicine for diagnosis and treatment has shown significant progress in medical fields, offering non-invasive techniques for identifying and managing diseases (Chen & Li, 2021). Nuclear medicine plays a vital role in personalized medicine, enabling precise treatments based on individual patient needs (Liu & Zhang, 2019). International organizations like the IAEA have set guidelines to ensure safety and effectiveness in the application of nuclear medicine in healthcare (Wang et al., 2021). Adherence to these international standards ensures the quality and safety of nuclear medicine practices in Indonesian hospitals (Jiang & Huang, 2022).

The *World Health Organization* (*WHO*) and the *International Atomic Energy Agency* (*IAEA*) define nuclear medicine as a branch of medical science that uses open sources of radiation derived from the disintegration of artificial radionuclide nuclei, to study physiological and biochemical changes at the cellular and molecular level, and to be used for diagnostic, therapeutic, and research purposes. In addition, the Decree of the Minister of Health No. 008 of 2009 also provides clear standards regarding nuclear medicine services, which cover various aspects, including:

a. *In vivo* diagnostic services use radionuclides or radiopharmaceuticals that are observed using gamma cameras to examine changes in the patient's body;
b. *In vitro* diagnostic services that examine patients' blood specimens using radioimmunoassay (RIA) or immunoradiometric assay (IRMA) techniques;
c. Internal radiation therapy that uses an open source of radiation for treatment.

However, despite the rapid growth of the hospital and advancements in medical technology, Gatot Soebroto Hospital still faces challenges in terms of operational efficiency and resource optimization. One of the main issues that arises is the imbalance between the increase in the number of patients and the income generated. In this case, it is necessary to conduct an in-depth analysis of how existing resources, both capital and medical personnel, are used efficiently.

Several previous studies have discussed efficiency in the health sector using various methods. For example, Iswanto (2015) used *Data Envelopment Analysis* (DEA) to measure the efficiency of hospitals in Indonesia. Similarly, Zhang et al. (2021) examined spatial accessibility and equity in healthcare services. However, research that specifically applies the *Incremental Capital Output Ratio* (ICOR) method in the context of nuclear medicine installations is still very limited. Mahmud (2008) used ICOR as a barometer of national economic efficiency, but its application at the micro level, especially in hospital management, remains underexplored.

This research offers novelty by integrating the ICOR method—commonly used in macroeconomic analysis—into the micro-context of hospital management, particularly in nuclear medicine installations. In addition, this study combines ICOR with *Lean Management* principles to identify and reduce waste in operational processes, which has not been widely applied in previous studies. The use of *Monte Carlo simulation* for queue management optimization also adds a quantitative and predictive dimension that supports evidence-based decision-making in health services.

Incremental Capital Output Ratio (ICOR) is one of the indicators that will be used in this study to measure efficiency in *Nuclear Medical Installations*. ICOR measures the relationship between capital increase and increased output or income generated. In this case, *RSPAD Gatot Soebroto* faces the challenge of matching the increase in investment with a significant increase in income, which shows the potential for waste in the use of capital.

To deal with this efficiency problem, *lean management* emerged as an approach that can be applied to optimize operational processes in hospitals. *Lean Management* focuses on reducing waste in various aspects, such as time, resources, and processes, with the aim of improving the quality of patient service and operational effectiveness. This approach involves not only minor improvements but also a thorough transformation in the way hospital operations are run.

The implementation of *lean management* at Gatot Soebroto Hospital aims to identify waste in the workflow and formulate measures to reduce this waste, as well as optimize the use of existing resources. Thus, this study will analyze how *lean principles* can be applied to improve operational efficiency, which will later be evaluated through ICOR measurement.

This study aims to measure operational efficiency at the *Nuclear Medicine Installation* of Gatot Soebroto Hospital by calculating ICOR and analyzing how *lean management* methods can be applied to improve efficiency and service quality. The results of this study are expected to provide insights and recommendations for improvements that are data-based and can be applied to improve overall hospital performance.

Based on the above background, the problem formulation of this thesis is: The increase in capital in the *Nuclear Medicine Installation* of Gatot Soebroto Hospital was not followed by an increase in efficiency; the performance of the *Nuclear Medicine Installation* section of Gatot Soebroto Hospital has not been optimal.

Research Objective: To measure the value of ICOR in the *Nuclear Medicine Installation* section of Gatot Soebroto Hospital. Formulate performance improvement measures using *Lean Management* methods. The benefits of this thesis research are: The benefits obtained from this research include theoretical benefits and direct benefits for hospitals. Theoretically, it can be studied to combine the financial analysis method with the ICOR method and formulate measures to improve the efficiency (performance) of the nuclear installation section of the *Gatot Soebroto Hospital* using the *Lean Management* method. The benefit for hospitals is that hospitals, especially nuclear medicine facilities, can consider investing in equipment with cutting-edge medical technology.

METHOD

This research uses a quantitative method with a descriptive and verifiable approach, conducted at the *Nuclear Medicine Installation* of Gatot Soebroto Hospital from January to June 2025. The data used consisted of secondary data in the form of financial statements for 2020–2024, which included capital expenditure, operational expenditure, and revenue, as well as primary data obtained through semi-structured interviews with installation managers, financial staff, and medical personnel. Data collection techniques were carried out through literature studies, documentation, and interviews. Data analysis was performed by calculating the *Incremental Capital Output Ratio* (ICOR) to measure investment efficiency, followed by *lean management* analysis to identify seven types of waste in operational workflows, and

Monte Carlo simulation to analyze and optimize the patient queue system. The research procedure was carried out through the stages of preliminary study, method formulation, data collection, data analysis, and formulation of conclusions and recommendations.

RESULTS AND DISCUSSION

Evaluation of Investment Efficiency Based on ICOR

A. ICOR Calculation Results and Interpretation of Investment Efficiency Fluctuations

Based on the ICOR calculations that have been carried out, the following is an explanation and interpretation of the fluctuations in investment efficiency at Gatot Soebroto Hospital from 2020 to 2024.

ICOR is used to measure investment efficiency by comparing the amount of capital expenditure with changes in income. Here is the ICOR calculation for each year:

1) Year 2021:
   - ICOR = 0.81326: This value shows that for every Rp 1 invested, Gatot Soebroto Hospital generates around Rp 813.26 additional income. This shows good efficiency, with relatively low capital expenditure compared to a significant increase in revenue.
2) Year 2022:
   - ICOR = 14.86: This very high increase in ICOR indicates that although revenues increased slightly, the investments made in 2022 were not worth the increase. This means that for every Rp 1 invested, only around Rp 14.86 additional income is obtained, which indicates inefficiency in the use of capital.
3) Year 2023:
   - ICOR = 1,667: In 2023, despite an increase in revenue, investment efficiency began to decline. More capital expenditure is needed to obtain relatively smaller additional revenue compared to the previous year, although it is still more efficient than in 2022.
4) Year 2024:
   - ICOR = 2.023: In 2024, ICOR is increasing, which indicates that investment efficiency is declining. More capital is needed to generate revenue growth similar to previous years. This shows that RSPAD needs to re-evaluate its investment management strategy.

Interpretation of Investment Efficiency Fluctuations

Based on the results of the ICOR calculation above, there are significant fluctuations in the investment efficiency of Gatot Soebroto Hospital from 2021 to 2024. Some important points to note:

1) Investment Efficiency in 2021:

   The year 2021 showed a good level of efficiency with a relatively low ICOR value (0.81326). This shows that the investments made in that year are quite effective in generating additional income.
2) Efficiency Decline in 2022:

   The sharp increase in ICOR in 2022 (14.86) indicates that this year's investment is less efficient. Although revenues are increasing, large capital expenditures do not provide a comparable increase in revenue, which may be due to investments that do not directly support an increase in service volumes or hospital revenues.

3) Efficiency Fluctuations in 2023 and 2024:

After a drastic decline in 2022, investment efficiency improved slightly again in 2023 (1,667), but still higher than the standard figure set (3). The year 2024 shows a further decline in efficiency with an ICOR of 2,023, which suggests that more capital is needed to generate less revenue than in previous years.

Evaluation of Investment Strategy

With the ICOR standard that has been set, which is 3, which means that for every Rp 1 invested, it is expected to generate Rp 3 or more in income, we can conclude:

a. In 2021, the investment was very efficient as ICOR was substandard.
b. In 2022 to 2024, an ICOR higher than 3 indicates that investment efficiency is declining. RSPAD Gatot Soebroto needs more capital to get revenue growth similar to previous years.

Based on the details of the capital expenditure that has been presented, the following are in-depth recommendations related to the investment efficiency strategy at Gatot Soebroto Hospital for 2020 to 2024, with a focus on the management of recorded capital expenditures and their impact on increasing revenue. These recommendations aim to increase the effectiveness of the use of hospital budgets and optimize the results of each investment made.

Utilization of Allocation for Equipment and Machinery:

In the period 2020 to 2024, the largest portion of capital expenditure each year is allocated to the procurement of equipment and machinery, with significant figures, such as in 2020, where expenditure on equipment and machinery reached IDR 60.27 billion, and in 2024 it is estimated to reach IDR 103.8 billion. Given the size of this allocation, RSPAD needs to ensure that the procurement of medical equipment has a significant impact on increasing hospital service capacity. Therefore, the evaluation of the need for new medical equipment must be carried out in more detail, so that the procurement is relevant to the needs of patients and the latest medical technology trends. The application of new technologies should be focused on areas that directly support operational efficiency, such as hospital management systems and the digitization of medical records.

Other Capital Expenditure Management (Non-Machined Infrastructure):

Other capital expenditures that include the development of facilities, information systems, and renovations also showed a significant increase from 2021 to 2024, with a projection of reaching IDR 49.7 billion in 2024. Investment in non-machine infrastructure needs to be directed to strengthen hospital information systems, especially in terms of patient data management and digital hospital operational management. The development of an integrated IT system can improve administrative efficiency and simplify the claims process, payment, and patient service. In addition, facility improvements and renovations should be focused on aspects that can improve patient comfort and speed up the flow of services, such as the development of inpatient rooms or emergency services.

Capital Expenditure Allocation for Covid-19 Management:

From 2022 to 2023, RSPAD allocated spending for handling Covid-19, both for medical equipment and emergency facilities. Although the pandemic situation has subsided, the

experience of the Covid-19 pandemic shows the importance of hospital preparedness in dealing with the health crisis. Therefore, it is recommended to set aside a portion of the budget for emergency handling capacity, which includes the procurement of personal protective equipment (PPE), ventilators, and other emergency facilities. In addition, planning a rapid response system for future emergency situations is also very important to maintain preparedness.

Capital Expenditure Efficiency by Prioritizing Sustainable Investments:

With a projected capital expenditure of more than IDR 153 billion in 2024, capital expenditure efficiency is very important. RSPAD needs to prioritize investments that have a direct impact on improving medical services and operational efficiency. One approach that can be taken is to halt or postpone non-priority investment projects that do not have a direct impact on increasing revenue or patient services. Evaluate each investment using clear performance indicators, such as impact on increasing patient numbers, speed of service, and patient satisfaction. The use of benchmarking or comparative studies against other hospitals can help determine more appropriate investment priorities.

Utilization of Data for Decision Making:

RSPAD Gatot Soebroto should apply more in-depth data analysis to identify capital usage trends and their impact on income increases. With an annual monitoring and evaluation system of capital expenditures being carried out, as well as involving various departments, including management and financial managers, hospitals can ensure that each investment is integrated with the hospital's primary objectives. The use of business analytics and data modeling to predict future investment needs will be very helpful in optimizing more efficient budget allocation.

Strengthening Collaboration with Third Parties:

RSPAD may also expand collaboration with third parties to obtain grants or financial assistance for the procurement of medical equipment and facilities. Given the potential for cooperation with the government, universities, or international institutions, it is important for RSPAD to continue to actively seek other sources of funding to reduce the burden of internal capital expenditure. Thus, RSPAD can expand service capacity without relying entirely on limited internal budgets.

With these steps, it is hoped that Gatot Soebroto Hospital can continue to improve the efficiency of the use of the investment budget, as well as optimize the results of every capital expenditure spent, both for improving facilities, medical equipment, and other operational needs. This will ensure that the hospital can function optimally without unnecessary waste.

B. Assessment of the Suitability Between Capital Expenditure and Revenue Increase

1) Evaluating the Suitability of Capital Expenditure with Increased Revenue

As the primary method used to measure investment efficiency, the Incremental Capital Output Ratio (ICOR) measures how much capital expenditure is required to produce the change in income that occurs each year. By comparing capital expenditure to revenue change (ΔY), it can be assessed whether the investment made produces a proportionate output.

Based on the data collected, there are fluctuations in the value of ICOR which shows an inconsistent relationship between capital expenditure and income generated:

a. In 2021, ICOR reached 0.81, which shows that for every Rp 1 invested, RSPAD Gatot Soebroto generates around Rp 0.81 in additional income. This indicates that the investment in that year is relatively efficient.
b. In 2022, ICOR jumped significantly to 14.86. This shows that for every Rp 1 invested, RSPAD only generates Rp 0.067 in additional income. This shows that capital expenditure in that year is inefficient, because despite the large investment, the results obtained are not comparable.
c. In 2023 and 2024, despite the increase in revenue, the ICOR value remains higher than the efficiency standard (set in the number 3), with 1.67 and 2.02, respectively. This indicates that while revenues continue to increase, investment efficiency is declining, which means more capital is needed to generate similar revenue growth.

In general, although the revenue of RSPAD Gatot Soebroto increased during the period 2020 to 2024, the larger capital expenditure in 2022, 2023, and 2024 is not fully proportional to the increase in revenue earned. Significant fluctuations in ICOR indicate that some investments do not provide optimal returns, so there is potential to improve the efficiency of capital expenditure use.

2) Identify Potential for Improving Investment Efficiency

a. Evaluation of Investment Priorities

Capital expenditure used for the procurement of equipment and machinery makes up the largest part of the capital expenditure budget, which reaches more than 70% annually. However, most of these tools and machines are not directly related to increasing the volume of medical services or rapid operational efficiency. Therefore, hospitals need to prioritize investments in equipment that can increase higher service capacity and more efficient medical technology, as well as ensure that these investments are in line with the demands and needs of patients at that time.

b. Optimizing the Use of Digital Systems and IT Infrastructure

Investment in information systems and non-machine infrastructure, although not as large as spending on equipment and machinery, has also increased. Strengthening more efficient IT infrastructure can support patient data management and speed up hospital administration processes. The use of technology to improve the quality of hospital management can provide faster and more efficient results by reducing operational costs and accelerating service flows. Therefore, allocating a portion of the capital expenditure budget for the development of better IT systems can help improve overall efficiency.

c. Diversification of Funding Sources

Alternatively, RSPAD Gatot Soebroto can develop cooperation with third parties such as the government, universities, or private institutions that can provide grants or additional investment support. This will reduce reliance on internal capital expenditure and provide room for hospitals to optimize the allocation of existing funds.

3) Recommendations to Improve Investment Efficiency

Based on the above analysis, there are several steps that can be taken to improve the efficiency of capital expenditure and ensure that each investment has the maximum impact on increasing revenue:

a. Focus on Technology That Has a Direct Impact

RSPAD needs to focus more on investments that can directly improve service capacity and medical quality. For example, investments in digital medical record systems, medical devices with advanced technology that allow faster and more accurate diagnosis, and equipment that improves the efficiency of medical personnel.

b. Evaluation of Patient Needs

It is necessary to conduct a needs analysis to ensure that capital expenditure is only carried out for goods and services that are really needed by patients. Patient satisfaction surveys and medical equipment usage data can be used to determine whether the invested equipment has a significant impact on services.

c. Continuous Monitoring and Auditing

The implementation of continuous monitoring of every investment and capital expenditure, to ensure that the budget allocation is in accordance with the needs of the hospital and the desired results. In addition, conducting regular efficiency audits to evaluate whether the results of the investments made are in accordance with expectations.

Based on the evaluation carried out, it can be concluded that although the capital expenditure carried out by the Gatot Soebroto Hospital has resulted in an increase in income, the fluctuating value of ICOR and tends to be high in recent years shows an imbalance between investment and the results obtained. Therefore, there is great potential to improve investment efficiency by optimizing budget allocation in areas that have a direct impact on increasing hospital capacity and operational efficiency, as well as by improving investment management and priorities.

Analysis of the Implementation of Lean Management in Service Processes

Waste in hospital workflows is often associated with inefficiencies in processes, whether related to time, resources, or operational steps that do not add value to patients. Therefore, the identification and reduction of waste is essential to increase operational efficiency and reduce unnecessary costs, so that hospitals can provide better services with more optimal resources.

Identify Waste in Workflow

Waste in hospital workflows can be found in various forms known in Lean Management as the "Seven Wastes". Some of the wastes found in the workflow of RSPAD Gatot Soebroto include:

1) Overproduction: Excessive diagnostic tests or unnecessary medical procedures lead to waste of time and operational costs. For example, repeated tests without clear indications extend service times and increase costs.
2) Waiting: Long wait times, whether for test results or the process of scheduling medical procedures, are a form of waste that can slow down the flow of patient services. Delays often occur due to inefficient scheduling processes.

3) Transportation: Inefficient patient transportation or medical materials can increase lead times and increase the risk of errors. It also increases unnecessary operational costs.
4) Excess Motion: Excessive movement by ineffective medical personnel or nurses in the workflow—for example, inefficient movement when moving medical equipment—can lead to staff fatigue and slow down the work process.
5) Defects: Defects or errors in medical or administrative procedures that require repair or repetition, such as errors in patient data input, can extend service time and increase costs.
6) Inventory: Excess or under-stock of medical materials can lead to waste. Excess stock requires more storage space, while lack of stock can hinder the service process.
7) Overprocessing: Unnecessary steps in medical procedures or services that are not up to standard, leading to waste of time and resources.

Application of Lean Management Principles to Reduce Waste

Lean Management aims to create more value with less waste. Here are some Lean principles that can be applied at RSPAD Gatot Soebroto to reduce waste in workflows:

1) Zero Waiting

Zero waiting focuses on reducing patient wait times at every stage of the hospital's service process. Long wait times, whether to get test results, queues in the treatment room, or wait for the scheduling of medical procedures, are major wastes that affect patient efficiency and satisfaction.

For RSPAD, the principle of zero waiting can be applied by improving the scheduling and coordination system between departments. For example, a more flexible scheduling system and technology-based patient management system will reduce delays in patient care. In addition, coordination between departments such as laboratories, treatment rooms, and examination rooms can improve the efficiency of patient flow, thereby reducing wait times.

2) Zero Overproduction

Zero overproduction means avoiding unnecessary or excessively performed medical tests or procedures, which can lead to wasted time, effort, and cost. Any medical measures should be relevant to the patient's condition and based on clear medical indications.

RSPAD can implement zero overproduction by ensuring that any diagnostic test or medical procedure is based on the patient's needs and carried out in accordance with medical protocols. The use of digital systems to check a patient's medical history can help doctors to perform only the procedures that are absolutely necessary, which in turn avoids unnecessary expenses and speeds up the flow of services.

3) Zero Defects

Zero defects is the principle of minimizing or eliminating errors in any medical or administrative procedure. Defects in medical procedures, such as misdiagnosis, medication administration errors, or administrative errors can be fatal and prolong service time.

To implement zero defects, RSPAD needs to ensure that standard operating procedures (SOPs) are strictly implemented. In addition, providing regular training for medical and administrative staff to maintain the quality of processes and work results is essential. An

integrated electronic medical record system can also help reduce administrative errors and ensure accurate patient information.

4) Zero Excess Motion

Zero excess motion means reducing unnecessary movements or activities performed by medical staff, such as moving medical equipment or moving places without a clear purpose.

At RSPAD, the implementation of zero excess motion can be done by designing a more efficient workspace. For example, organizing medical devices in an organized manner and placing them in an easily accessible position according to the frequency of use, as well as using technology to reduce reliance on manual handling. With better arrangements, medical staff can reduce the time spent moving aimlessly and focus more on patient care.

5) Zero Inventory

Zero inventory focuses on efficient inventory management to avoid excess stock that can trigger waste in the form of storage and space costs. RSPAD must manage the inventory of medicines and medical devices so that there is no excess stock that leads to waste.

The implementation of zero inventory at RSPAD can be achieved through the implementation of the Just-in-Time (JIT) system in the management of medical materials. With JIT, medicines and medical equipment are only ordered and supplied based on real needs, not estimates. These systems help reduce storage costs and ensure that expired or damaged medical items can be minimized.

6) Zero Overprocessing

Zero overprocessing aims to avoid unnecessary steps in the medical workflow. Excessive or unnecessary medical procedures can slow down the process and waste resources.

RSPAD can apply this principle by ensuring that every step in the medical care process provides immediate added value to patients. Procedures that are not compliant or non-standardized should be simplified. For example, if there is a medical procedure that can be completed in one step instead of two, the hospital will have to redesign its workflow to reduce wasted time and effort.

7) Zero Transport

Zero Transport aims to reduce inefficient transportation processes, be it moving patients between rooms or untimely delivery of medical materials. Any unnecessary move leads to a waste of time and potentially increases the risk of error.

RSPAD can reduce zero transport by optimizing internal hospital logistics. For example, placing treatment rooms and diagnostic rooms closer to each other to reduce the need for patient transfers or ensure medical devices are prepared in the right location. RSPAD can also utilize monitoring systems to manage the delivery and transportation of medical materials in a more timely manner, reducing the time required for transfer and avoiding unnecessary shipments.

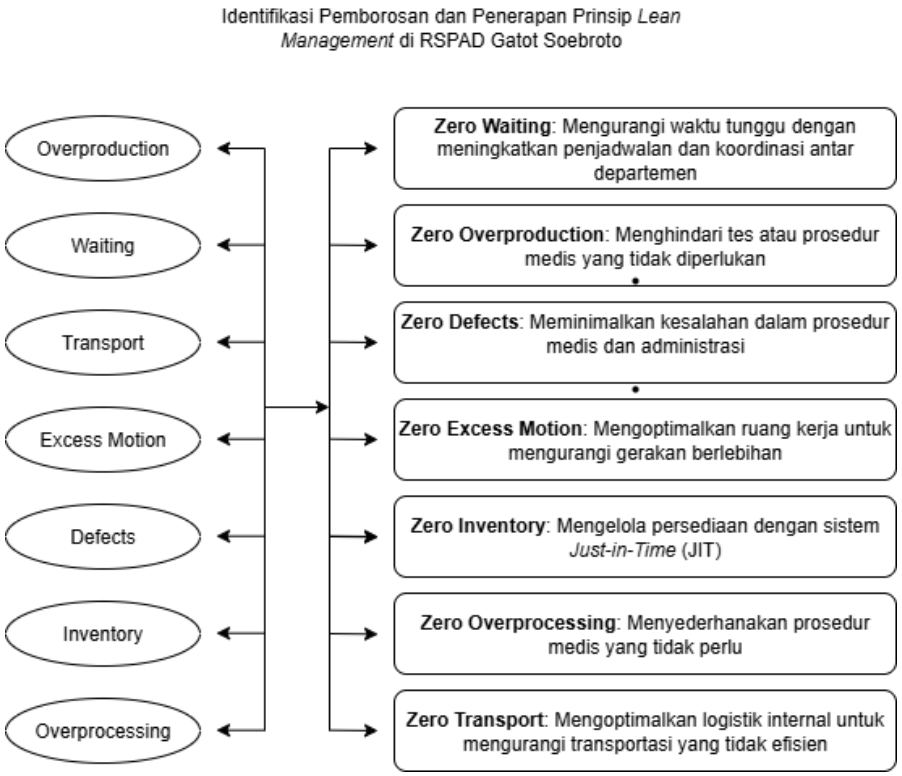


Figure 1. Identification of Waste and Application of Lean Management Principles at Gatot Soebroto Hospital

Source: Research Analysis Results (2025)

The policy taken by Gatot Soebroto Hospital will have a positive impact on improving cost efficiency and the quality of hospital services. With the right implementation of lean management, hospitals can reduce waste in various aspects, which in turn will speed up the service process, reduce wait times, and optimize the use of resources. Operational costs can also be reduced, so that hospitals can provide better services with a more efficient budget.

These policies must be implemented gradually and with careful planning, including socialization to all relevant parties and intensive training to all staff. In addition, it is also important to periodically monitor and evaluate the results of the implementation of this policy so that it can continue to be improved and adjusted to developments and needs in the field.

The Impact of Queue Management on Service Efficiency

In order to improve service efficiency at Gatot Soebroto Hospital, improving the queue system is a crucial strategic step. A lean management approach focused on reducing wasted time is implemented through Monte Carlo simulations, which allow modeling uncertainties such as patient arrival time, duration of care, and drug availability status.

This simulation uses a single phase multi-channel queue model, reflecting the real situation in hospitals with multiple service lines and one service facility per line. The delay factor due to imported drugs is also taken into account, where the status of the drug is determined at random and affects the waiting time up to ± 2 weeks.

The simulation results showed that the average patient wait time was about 2,165 hours. Despite the delays due to drug imports, the queue system is still able to maintain smooth service

and prevent a significant buildup of waiting times. This shows that the data-based approach and continuous improvement principles of lean management can be applied effectively to monitor, analyze, and optimize service processes on an ongoing basis.

Thus, this simulation-based queue management not only provides a realistic picture of the condition of the system, but also provides a more accurate decision-making basis to improve the overall quality of hospital services.

CONCLUSION

Based on the results of the research that has been conducted, the following can be concluded: Based on the results of calculations using the *ICOR* (*Incremental Capital Output Ratio*) approach, the efficiency of resource use in the *Nuclear Medicine Installation* section shows that there is still waste in the workflow and the use of inputs compared to the service output produced. The measured *ICOR* value reflects an imbalance between additional inputs (e.g., time, labor, and logistics) and increased output (number of patients served or quality of service), thus indicating the need for improved service process governance to bring *ICOR* closer to ideal values. In an effort to improve the efficiency and performance of services, *lean management* principles have been implemented as a key strategy. Seven types of waste were successfully identified and evaluated, including patient waiting times, excess inventory, and movements and processes that do not provide added value. Improvement steps are directed at optimizing the queue system through *Monte Carlo simulations*, improving coordination between units, implementing a *Just-in-Time* system for inventory management, and strengthening training for medical personnel to ensure they can carry out procedures according to standards. This *lean approach* has proven to provide strategic direction in the formulation of policies to improve efficiency in the hospital environment. Based on the findings of the study, it is recommended that hospitals prioritize investments in medical equipment that directly increase service capacity, systematically apply *lean management* principles to reduce waste, and develop data-based monitoring systems for decision-making. Regular training of staff on the principles of operational efficiency and strengthening collaboration with external parties for funding support is also urgently needed. For further research, this method could be applied to other units or enhanced by using more comprehensive efficiency measurement tools such as *Data Envelopment Analysis* (DEA).

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