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Analysis of Waste in Clinical Pathology Laboratory Services Using a Lean Management Approach at RSAU dr. Esnawan Antariksa in 2025

Hana Oktariani[1], Lili Indrawati[2], Abdul Aziz[3]
[12] Universitas Respati Indonesia
[3] Poltekkes Kemenkes Jakarta III
[1] hanaoktarianidr@gmail.com
[2] lili.indrawati@urindo.ac.id
[3] az.mandiri@yahoo.com

ABSTRACT
Lean management is a strategic framework designed to minimize waste and enhance efficiency across all aspects of production or service delivery within an organization. This study aims to analyze how the implementation of lean management can minimize waste in clinical pathology laboratory services at RSAU dr. Esnawan Antariksa. A mixed-method approach was employed, integrating qualitative and quantitative research within a descriptive analytical framework at RSAU dr. Esnawan Antariksa. The findings are presented in two sections: qualitative results, which include waste identification and Root Cause Analysis (RCA), and quantitative results derived from questionnaires indicating that six out of seven types of waste were identified in the clinical pathology laboratory—namely, defect, overproduction, transportation, waiting, inventory, motion, and overprocessing. The RCA revealed repeated sampling as a key underlying issue. Based on efficiency time analysis, waiting times at the registration desk and during laboratory result verification were associated with a low Process Cycle Efficiency (PCE) of 47%. The study recommends adding registration desks and implementing a Laboratory Information System (LIS) to reduce delays in laboratory result processing. In conclusion, six out of seven types of waste were found in the clinical pathology laboratory at RSAU dr. Esnawan Antariksa. Through the calculation of weighted percentages to assess the impact of each waste type, the strongest relationship was found between overprocessing and overproduction wastes (19.80%). Overprocessing waste—particularly in repeated blood sampling—was identified as the primary concern. Therefore, regular training for analysts responsible for sample collection is recommended to reduce waste and improve laboratory efficiency.

Keywords: Waste in Clinical Pathology Laboratory, Waste Relationship Matrix, Lean Management

INTRODUCTION

RSAU dr. Esnawan Antariksa is a Type B hospital that offers several types of healthcare services, one of which is the Clinical Pathology Laboratory Unit. According to the hospital's quality indicator report from January to May 2024, the average waiting time for laboratory patients was 120 minutes, with no significant improvement over the following six months. Based on interviews with laboratory staff, a clerical error occurred on May 25, 2023, where a leukocyte count was incorrectly recorded as 47,000 instead of 4,700. Furthermore, frequent dysfunctions of the Integrated Record Management (IRM) system have been reported, causing difficulties for laboratory personnel. These issues exemplify types of waste present in the Clinical Pathology Laboratory Unit at RSAU dr. Esnawan Antariksa.

According to an interview with a clinical pathology specialist, the laboratory has never previously applied the Lean Management method. Therefore, this study aims to analyze waste in the Clinical Pathology Laboratory Unit using a Lean Management approach at RSAU dr. Esnawan Antariksa.

Waste refers to any problem or disruption that hampers workflow and fails to contribute positively or add value to the patient care process. Waste is characterized

as any activity that does not add value; as Womack and Jones emphasized, the concept of "value" is defined by the primary customer. In the hospital context, customers include patients, their families, and other stakeholders, but the main customer is the patient. Consequently, most activities and priorities should revolve around the primary customer (Graban, 2016).

Waste should be eliminated or at least minimized to reduce costs, increase service capacity, and enhance patient satisfaction. As noted by Graban (2016), there are seven common categories of waste found in healthcare or hospital services:

1. **Defects:** Any activity that fails to achieve accuracy on the first attempt. This includes time spent correcting errors, such as incorrectly filled forms or administering the wrong medication or dosage.
2. **Overproduction:** Producing more than what is needed or faster than required by the customer. For instance, overstocking medications that may not be used due to fluctuating patient admissions.
3. **Transportation:** Unnecessary movement of patients, specimens, or materials due to inefficient layouts—for example, transferring patients between distant hospital buildings for laboratory or cancer care.
4. **Waiting:** Idle time where no value is added, such as staff waiting for patient data or patients waiting for procedures due to unbalanced workloads.
5. **Inventory:** Excess stock that exceeds operational needs and may lead to waste from expired items, including ineffective medications.
6. **Motion:** Excessive movement of personnel during work processes. For example, laboratory staff walking long distances due to poor spatial organization to locate supplies, equipment, or medicines.
7. **Overprocessing:** Activities that do not increase value or meet patient quality requirements, such as entering unused data into computer systems.

Lean management represents a continuous effort to eliminate waste and increase value in both goods and services, with the ultimate goal of delivering value to customers (Febianti et al., 2018). Lean focuses on the continuous transformation of waste into customer-perceived value. It is a systematic strategy aimed at achieving precision in process improvement, reducing errors, and minimizing waste (Kim et al., 2006, as cited in Febianti et al., 2018). Lean management is characterized as a methodology that enhances customer value by eliminating all non–value-added activities (Doss & Orr, 2007, as cited in Adinda, 2022). As Graban (2009, cited in Anggraini & Putri, 2020) stated, hospitals apply lean methods to maximize the quality of patient services by addressing two main issues: reducing errors and minimizing waiting times.

The Waste Relationship Matrix (WRM) serves as a measurement and analytical tool that structures waste types into rows and columns. Each row represents the impact of a particular type of waste on six other types, while each column represents the interdependencies among wastes as influenced by others (Rochman et al., 2014, cited in Anggraini & Putri, 2020). The results of these relationships are then analyzed to identify root causes through Root Cause Analysis (RCA). Each waste type is denoted by an acronym: O (Overproduction), I (Inventory), D (Defect), M (Motion), P (Process/Overprocessing), T (Transportation), and W (Waiting) (Rawabdeh, 2005, as cited in Anggraini & Putri, 2020).

METHODS

This study employed a mixed-methods approach, integrating qualitative and quantitative research within a descriptive analytical framework conducted at RSAU Dr. Esnawan Antariksa. The qualitative method involved in-depth interviews with laboratory personnel and patients who voluntarily participated. Patient respondents were selected based on the average daily number of patients in the laboratory unit; if the population exceeded 100 individuals per day, 10–15% were chosen for interviews. This sampling strategy mirrors practices noted in other qualitative studies, emphasizing the need for representative participant selection to accurately capture diverse experiences (Endris et al., 2022; Siimane & Nts'ihlele, 2024; Nwosu et al., 2024; Tolera et al., 2024; . Meanwhile, all laboratory personnel, including 18 medical laboratory technologists and 3 administrative staff — such as the unit head, clinical pathology specialist, analysts, and administrative officers — were interviewed to gain comprehensive insights into operational inefficiencies and sources of waste within the laboratory processes. Similar approaches in qualitative research in medical settings highlight the importance of addressing multiple perspectives to fully understand complex operational dynamics (Zulkefli et al., 2022; Agbere et al., 2021; Mulindwa et al., 2024).

The quantitative component of the study utilized empirical numerical data to perform statistical analyses and validate findings derived from the qualitative phase. Data were collected through the Waste Relationship Matrix (WRM) questionnaire, which was distributed to all laboratory personnel to identify and quantify relationships among different types of waste. Utilizing a structured questionnaire like the WRM has been supported by various sources as a reliable means to gather quantifiable data related to waste management processes in healthcare environments (Kankanamge et al., 2025; Tolera et al., 2024; Variacion et al., 2025). Respondents were selected using a total sampling method, involving the same 21 participants from the laboratory and administrative units. Such methodologies are underpinned by a strong theoretical framework that asserts the relevance of a mixed-methods design in exploring waste management issues across different contexts (Porter & Collins, 2021; Goolden & Shorten, 2025).

The study focused on analyzing waste throughout the entire service process—from patient registration to the delivery of laboratory results. This comprehensive examination aligns with established best practices in health services research, which encourage the assessment of entire service delivery pathways to pinpoint inefficiencies and opportunities for improvement (Lei et al., 2023; Huang & Tseng, 2020; Cuenca et al., 2022). The inclusion criteria encompassed both new and returning patients in the laboratory unit who agreed to participate, as well as staff members on duty as designated by the unit head, while the exclusion criterion applied to patients who declined participation. Such strict criteria are critical in qualitative research to ensure that findings reflect the experiences of the most relevant groups, providing a clearer picture of the operational landscape (Horoś & Ruppenthal, 2021; Gunartin et al., 2020; Knutsson et al., 2021).

In summation, this study's methodological structure, combining qualitative interviews with quantitative questionnaires, supports robust findings that address critical issues of waste management in healthcare settings. The mixed-methods approach is particularly beneficial, as underscored in related literature, suggesting that integrating these methods enhances the richness of data and facilitates stronger validation of results (Jackson et al., 2022; Börühan & Özbiltekin-Pala, 2021; Lee &

Huang, 2023). Furthermore, the focus on participant selection, comprehensive data types, and systematic methodologies aligns with contemporary qualitative and quantitative research trends aimed at improving operational efficiencies within public health domains (Siwawa, 2024; SUNA et al., 2020).

RESULTS AND DISCUSSION

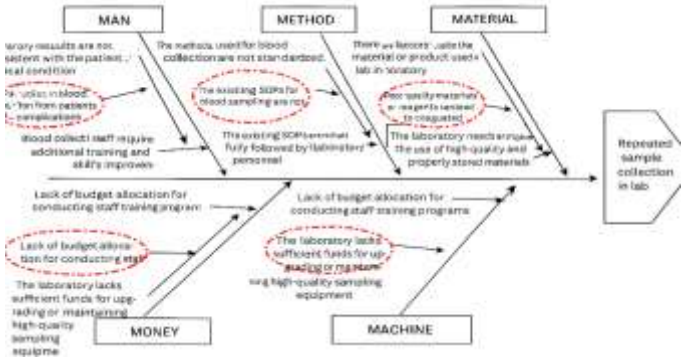
At the initial stage, a Seven Waste Identification was conducted to identify types of waste occurring within the service flow of the Clinical Pathology Laboratory Unit. The types of waste identified throughout the laboratory service process at RSAU dr. Esnawan Antariksa are as follows:

a. **Defects** in the clinical pathology laboratory service included errors such as incorrect recording of patient gender, duplicate sample names and numbers, misplaced commas in laboratory results, and switched patient identification labels or stickers.
b. **Overproduction** was found in the excessive delivery of reagents, which led to reduced reagent requests in subsequent months.
c. **Transportation waste** was identified in the form of bureaucratic complexities during the registration process that confused patients—especially new ones—and in the physical separation of the queue ticket counter and registration area, which were located in different buildings.
d. **Waiting waste** occurred during data entry, blood sampling, and result verification processes. Long queues were typically observed after extended holidays or when system network disruptions occurred, further delaying patient services.
e. **Inventory waste** was not identified in this unit because items categorized as inventory—such as SEP (Eligibility Letter) documents—were returned to the insurance department and not stored in the laboratory.
f. **Motion waste** involved manual delivery of laboratory results to respective outpatient departments and the need for staff to physically transport work forms before beginning laboratory analyses.
g. **Overprocessing** included repeated blood sampling due to hemolyzed or clotted samples, difficulties arising from small veins or obese patients, mismatched test results compared with clinical conditions, and excessive blood volume requirements.

These findings align with the research conducted by Wardani et al. (2023), who also identified similar waste types in the laboratory unit of Hospital B, particularly waiting time waste, where patients experienced delays in receiving laboratory results due to postponed data entry and insufficient human resources. Other related issues included long cashier queues due to outdated standard operating procedures (SOPs) and delays in result delivery caused by result backlogs, especially when the number of analysts and administrative staff was inadequate.

1. Root Cause Analysis (RCA)

The Root Cause Analysis (RCA) utilized an interrelationship diagram tool to identify various problems and differentiate cause-and-effect relationships, allowing for the systematic identification of root causes. Based on these findings, a Fishbone Diagram (Ishikawa Diagram) was developed to analyze the main causes of overprocessing waste, particularly repeated sampling events. During interviews and observations, thirteen laboratory staff members reported that repeated sampling was a recurrent issue. The main contributing factors are summarized as follows:



a) Man

Laboratory personnel often face difficulties in drawing blood from patients with challenging conditions, which may result in hemolyzed samples or test results inconsistent with the patient's clinical condition. This issue is attributed to a lack of specific training. Based on interview results, no specialized training on blood sampling techniques has been conducted at RSAU dr. Esnawan Antariksa to date.

b) Machine

Laboratory equipment requires calibration according to the scheduled maintenance period. However, field observations revealed that calibration certificates were not visibly attached to the machines, suggesting that some equipment had not been calibrated for an extended period.

c) Material

Repeated sampling also occurred due to clot formation in the samples. This issue arose either from inadequate staff skills or from substandard quality of laboratory supplies used during sampling.

d) Method

Although Standard Operating Procedures (SOPs) exist for sample collection, non-compliance among laboratory personnel negatively affects the accuracy and reliability of results.

e) Money

Limited financial resources for staff training have hindered the development of adequate technical skills among laboratory personnel.

These findings are consistent with Purwandari et al. (2017), who reported in their study at Sultan Agung Islamic Hospital, Semarang, that there were no specialized training programs aimed at improving staff competence in service delivery. Observations indicated frequent verification and labeling errors requiring reconfirmation from physicians to laboratory staff, thereby prolonging service duration. Similarly, Anggraeni and Dewi (2021), in a case study at Clinic P, emphasized that non-compliance with standard blood collection procedures necessitates immediate intervention through SOP socialization, supervision during implementation, and comprehensive training covering all stages from equipment preparation to procedure finalization.

Table 1. *Time Calculation Results for Value-Added (VA), Non-Value-Added (NVA), and Necessary Non-Value-Added (NNVA) Activities Based on Patient Questionnaires at RSAU dr. Esnawan Antariksa.*

No.	Type of Activity	Total Time from Respondents (seconds)
Patients register specifically at the laboratory counter		
1.	Value Added (VA)	105
2.	Non-Value Added (NVA)	68
3.	Necessary Non-Value Added (NNVA)	50
	Lead Time	223
	Process Cycle Efficiency (PCE)	105 / 223 × 100% = 47%
	Percentage of Non-Value Added	118 / 223 × 100% = 53%
BPJS patients submit SEP and laboratory examination forms at the counter		
1.	Value Added (VA)	60
2.	Non-Value Added (NVA)	50
3.	Necessary Non-Value Added (NNVA)	5
	Lead Time	125
	Process Cycle Efficiency (PCE)	70 / 125 × 100% = 56%
	Percentage of Non-Value Added	55 / 125 × 100% = 44%
Private patients make prior payments at the cashier / YANMAS		
1.	Value Added (VA)	12
2.	Non-Value Added (NVA)	0
3.	Necessary Non-Value Added (NNVA)	0
	Lead Time	12
	Process Cycle Efficiency (PCE)	12 / 12 × 100% = 100%
	Percentage of Non-Value Added	0%
Patients wait for a call for blood sampling		
1.	Value Added (VA)	137
2.	Non-Value Added (NVA)	25
3.	Necessary Non-Value Added (NNVA)	30
	Lead Time	192
	Process Cycle Efficiency (PCE)	137 / 192 × 100% = 71%
	Percentage of Non-Value Added	55 / 192 × 100% = 29%
Patients proceed to the sampling room for blood collection		
1.	Value Added (VA)	130
2.	Non-Value Added (NVA)	5
3.	Necessary Non-Value Added (NNVA)	12
	Lead Time	147

No.	Type of Activity	Total Time from Respondents (seconds)
	Process Cycle Efficiency (PCE)	130 / 147 × 100% = 88%
	Percentage of Non-Value Added	17 / 147 × 100% = 12%
Patients wait for a call for laboratory registration		
1.	Value Added (VA)	106
2.	Non-Value Added (NVA)	0
3.	Necessary Non-Value Added (NNVA)	75
	Lead Time	181
	Process Cycle Efficiency (PCE)	116 / 181 × 100% = 64%
	Percentage of Non-Value Added	65 / 181 × 100% = 36%

Table 2. Process Cycle Efficiency (PCE) and Non-Value Added Percentage for Patients Waiting for Laboratory Expertise Results

No.	Type of Activity	Total Time from Respondents (seconds)
Patients waiting for laboratory expertise results		
1.	Value Added (VA)	2,621
2.	Non-Value Added (NVA)	0
3.	Necessary Non-Value Added (NNVA)	2,920
	Lead Time	**5,541**
	Process Cycle Efficiency (PCE)	2,621 / 5,541 × 100% = **47%**
	Percentage of Non-Value Added	2,920 / 5,541 × 100% = **53%**

The results above represent the time measurements of respondents who came to the laboratory for examination. Based on the findings, patients generally perceived two activities as inefficient: waiting at the registration counter and waiting for laboratory expertise results. This perception aligns with the Process Cycle Efficiency (PCE) results of both activities, each showing the lowest efficiency rate of 47%. In the time analysis table of respondents visiting the laboratory, the same two activities—registration waiting time and waiting for laboratory expertise **results**—were consistently identified as the most inefficient processes.

1. During the laboratory registration process, respondents reported an average Value Added (VA) time of 105 seconds, Non-Value Added (NVA) time of 68 seconds, and Necessary Non-Value Added (NNVA) time of 50 seconds, resulting in a lead time of 223 seconds. This corresponds to a PCE of 47%, which is relatively lower compared to other processes.
2. During the waiting process for laboratory expertise results, respondents reported an average VA of 2,621 seconds, NVA of 0 seconds, and NNVA of 2,920 seconds, resulting in a lead time of 5,541 seconds and a PCE of 47%, which is also the lowest among all examined processes.

According to Ahmad et al. (2021), PCE analysis is used to identify the degree of waste present in a process. A higher PCE indicates lower operational costs, while a lower

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PCE suggests the dominance of non-value-added time over value-added activities. During patient observation, the process mapping revealed the following:

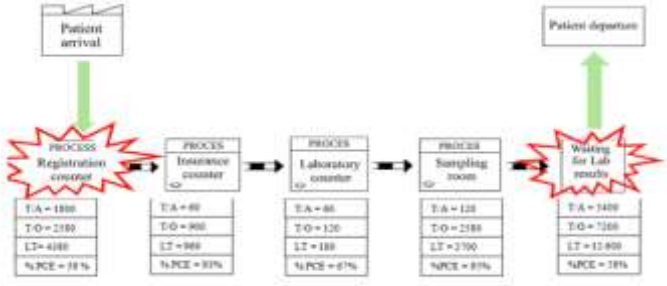

Figure 2. Current State Map Analysis of the Clinical Pathology Laboratory Service

The observation results from patient "Mrs. A" showed that the longest Time Off occurred in two stages: the registration counter process (2,580 seconds) and waiting for laboratory expertise results (7,200 seconds). The PCE values for these stages were 41% and 33%, respectively—both significantly lower than other process segments. Based on the lowest PCE findings, the researcher proposed a process improvement scheme using the ECRS approach (Eliminate, Combine, Re-arrange, Simplify) to enhance workflow efficiency.

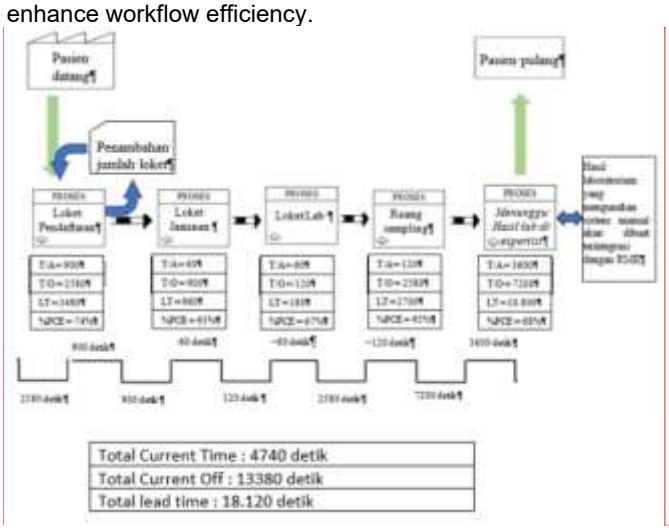

Figure 3. Future State Map Analysis of the Clinical Pathology Laboratory Service

Based on the current state map, a future state map was developed with improvement recommendations. For the registration counter, adding a dedicated laboratory registration desk could increase the PCE from 58% to 74%, while optimizing the laboratory expertise process could raise PCE from 58% to 68%. These changes are expected to reduce lead time and consequently improve the quality of laboratory services.

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2. Waste Relationship Matrix Results

Table 3. Waste Interrelationship Analysis at RSAU dr. Esnawan Antariksa

F/T	O	I	D	M	T	P	W	Score	(%)
O	0	18	0	14	8	14	6	60	**10.1%**
I	16	0	10	4	10	14	4	58	**9.7%**
D	16	14	0	10	6	14	24	84	**14.1%**
M	14	12	10	0	24	6	22	88	**14.8%**
T	20	10	16	18	0	14	26	104	**17.4%**
P	32	16	8	20	16	0	26	118	**19.8%**
W	14	10	6	18	18	18	0	84	**14.1%**
Score	112	80	50	84	82	80	108	596	
(%)	**18.8%**	**13.4%**	**8.4%**	**14.1%**	**13.8%**	**13.4%**	**18.1%**		**100**

Legend:

O = Overproduction
I = Inventory
D = Defect
M = Motion
T = Transportation
P = Overprocessing
W = Waiting

Based on the Waste Relationship Matrix (WRM) analysis, the highest percentage of interrelated waste was found between Overproduction and Overprocessing, contributing 19.8% of all identified waste relationships.

Discussion

1. Waste Identification Analysis in the Clinical Pathology Laboratory

The waste identification analysis at the RSAU dr. Esnawan Antariksa laboratory was conducted through observations and interviews. Six out of the seven waste types were identified:

a. **Defects**, such as incorrect gender entries or mislabelled samples.
b. **Overproduction**, such as excessive reagent distribution.
c. **Transportation waste**, resulting from complex bureaucratic procedures confusing patients.
d. **Waiting waste**, caused by data entry delays or post-holiday patient surges.
e. **Motion waste**, involving manual delivery of laboratory results.
f. **Overprocessing**, due to repeated sampling caused by hemolyzed or clotted blood.

Critical waste identification was carried out through a waste assessment model, which systematically quantifies the criticality level of each waste type using a comprehensive questionnaire. This model comprises three main stages: (1) identification of the seven waste categories, (2) development of a Waste Relationship Matrix (WRM), and (3) waste assessment questionnaire evaluation. The WRM method effectively illustrates causal relationships between different forms of waste.

2. Root Cause Analysis (RCA)

During interviews and observations, thirteen laboratory staff identified recurring issues related to Overprocessing waste, particularly repeated sample collections. Analysis indicated that repeated sampling was primarily caused by difficulties in blood collection among patients with complicating conditions, resulting in hemolyzed or clinically inconsistent results. This problem is closely associated with the lack of specialized training for laboratory staff. Management must therefore implement periodic evaluations and training programs to maintain laboratory service quality.

The root causes identified are as follows:

a. **Man** – Staff face challenges in drawing blood from difficult patients, leading to hemolyzed samples. This is mainly due to insufficient training, as no specialized courses on blood collection are currently offered at RSAU dr. Esnawan Antariksa.
b. **Machine** – Some laboratory equipment lacks recent calibration records, suggesting overdue maintenance.
c. **Material** – Repeated sampling occurs due to clot formation, possibly caused by low-quality supplies or inadequate handling skills.
d. **Method** – Existing Standard Operating Procedures (SOPs) are not consistently followed by staff, compromising result accuracy.
e. **Money** – Limited training budgets have hindered skill development among laboratory personnel.

3. Analysis of VA, NVA, and NNVA Activities

The analysis revealed two inefficient activities: waiting at the registration counter and waiting for laboratory expertise results.

a. The registration process showed an average VA of 105 seconds, NVA of 68 seconds, and NNVA of 50 seconds, resulting in a lead time of 223 seconds and PCE of 47%.
b. The laboratory expertise waiting process showed a VA of 2,621 seconds, NVA of 0 seconds, and NNVA of 2,920 seconds, yielding a lead time of 5,541 seconds and PCE of 47%.

According to Ahmad et al. (2021), higher PCE indicates greater process efficiency and lower operating costs, whereas lower PCE reflects excessive non-value-added time. Similarly, Febianti et al. (2021) found that Hospital X recorded a PCE of 20.4%, primarily due to waiting waste, which improved to 42.4% after recommended interventions. Long waiting times remain one of the most common causes of patient dissatisfaction (Pratiwi, 2017), particularly when administrative processes lack efficiency.

The findings of this study therefore conclude that two activities—registration waiting and laboratory expertise waiting—are the least efficient within RSAU dr. Esnawan Antariksa's clinical pathology laboratory. Management must prioritize these processes for improvement to enhance patient satisfaction and service quality.

4. Waste Relationship Matrix Analysis

The WRM analysis revealed that Overprocessing waste (19.8%) had the most significant influence on other waste types. This waste was mainly caused by repeated blood sampling, often observed in patients with physical complications, leading to hemolyzed samples and clinically inconsistent results. According to Riswanto (2013), blood collection techniques are part of the pre-analytical phase that determines laboratory result accuracy. Supporting this, Aryani and Dewi (2022) noted that venipuncture difficulties may arise due to patient conditions such as obesity, edema, hematoma, burns, dialysis, post-mastectomy, or pediatric and geriatric factors.

Based on these findings, Overprocessing waste (19.8%) represents the most critical inefficiency in the RSAU dr. Esnawan Antariksa laboratory. Management should implement continuous staff evaluation and targeted training to minimize sampling errors and uphold laboratory service quality.

5. Current State Map Analysis of Patient "Mrs. A"

The process mapping of patient "Mrs. A" indicated the longest Time Off during two processes: registration (2,580 seconds) and laboratory expertise waiting (7,200

seconds). “Time Off,” as defined by the Indonesian Dictionary (KBBI), refers to inactive or rest time. These prolonged idle periods resulted in low efficiency, with PCE values of 41% and 33%, respectively, yielding a total lead time of 19,020 seconds (4,380 seconds for registration and 10,800 seconds for expertise waiting).

This significantly deviates from the minimum laboratory service standard stipulated in Minister of Health Decree No. 129/Menkes/SK/II/2008, which sets an ideal process duration of no more than 140 minutes (8,400 seconds). After process mapping and evaluation, corrective measures were implemented: (1) adding a dedicated registration counter, and (2) integrating the Laboratory Information System (LIS) with the Electronic Medical Record (EMR). These improvements increased PCE from 41% to 74% in registration and from 33% to 68% in laboratory expertise.

In conclusion, the findings highlight the necessity for continuous service evaluation based on national laboratory quality standards. Inefficient service times, largely due to accumulated waste, must be systematically addressed to optimize service performance and patient satisfaction in the clinical pathology laboratory of RSAU dr. Esnawan Antariksa.

CONCLUSION

1. In the dr. ENAWAN ANTARIKSA Air Force Hospital (RSAU) laboratory unit, six out of the seven types of waste were identified: defects, overproduction, transportation, waiting, motion, and overprocessing. Inventory waste was not found in the RSAU dr. ESNAWAN ANTARIKSA laboratory unit.
2. Based on the calculation of Value-Added (VA), Non-Value-Added (NVA), and Necessary Non-Value-Added (NNVA) activities, the results indicate that patients, on average, perceived two activities as less efficient: waiting at the registration counter and waiting for laboratory results during the expert sign-off process.
3. Utilizing data processing through the Waste Relationship Matrix, the highest percentage result was obtained for the waste type that contributes most significantly to other forms of waste, namely overprocessing, recorded at 19.8%.
4. Overprocessing waste is the priority area for intervention, primarily due to the issue of repeated blood sample collection. A Root Cause Analysis (RCA) was therefore conducted for the overprocessing waste, specifically the repeated blood sample collection, to determine its underlying causes.
5. During the direct observation phase by the researcher, both aforementioned processes yielded a lower Process Cycle Efficiency (PCE) compared to other processes: 41% at the registration counter and 33% PCE during the laboratory result expert sign-off process. Post-improvement results indicate that the patient registration process at the laboratory counter achieved a PCE of 74%, and the process of patients waiting for expert sign-off on laboratory results achieved a PCE of 68%.

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