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Original Article

Impact of a lean management intervention on waiting time and service efficiency in gynecologic oncology surgical services in a national referral hospital in Indonesia: An interrupted time-series study with lean waste analysis

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Abstract

Long surgical waiting times in gynecologic oncology reflect operational inefficiencies and limited operating room capacity, compromising timely care and patient outcomes. This study specifically focuses on gynecologic oncology surgical services at Dr. Hasan Sadikin Hospital, Bandung, a major national referral hospital in Indonesia. It evaluated the impact of lean-based dedicated operating slots on surgical waiting times and service efficiency. A mixed-methods explanatory sequential design was applied. Quantitative data comprised 24 monthly time points (12 pre-intervention and 12 post-intervention) and were analyzed using interrupted time series analysis, while qualitative data were obtained through in-depth interviews with seven key informants to explain operational changes after the intervention. The intervention introduced one specialized operating room and nine weekly elective surgery slots dedicated to gynecologic oncology. The results demonstrated a significant reduction in mean waiting time, from 8.16 weeks pre-intervention to 3.64 weeks post-intervention. Interrupted Time Series Analysis (ITSA) showed a significant immediate level reduction following implementation, with an estimated change of -2.87 weeks, indicating an immediate reduction in surgical backlog. Trend analysis further demonstrated a significant post-intervention slope change (0.48), reflecting a modification in waiting time trajectory after implementation. Although a slight upward trend was observed afterward due to surgical throughput, waiting times remained substantially lower than in the pre-intervention period. Lean waste analysis revealed reductions in waiting, overprocessing, and inter-unit coordination inefficiencies. These findings indicate that lean-oriented dedicated operating slots improve operational efficiency, enhance patient access, and minimize systemic waste in high-volume oncology surgical services. The study provides empirical evidence supporting structured scheduling and lean principles as effective strategies for improving time-sensitive surgical care in tertiary hospitals.

Keywords: Dedicated operating slots, gynecologic oncology, ITSA analysis, lean management, waiting time

Introduction

Long surgical waiting times have become a persistent global healthcare challenge, reflecting inefficiencies in hospital operational management and the growing imbalance between surgical

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demand and operating room capacity [1-6]. According to the NHS Backlog Data Analysis 2025, the elective surgical backlog reached 7.39 million cases, with 2.82 million patients waiting more than 18 weeks and approximately 180,000 waiting over one year, while the average waiting time increased from 8 weeks in 2019 to 13.4 weeks in 2025 [7]. These trends demonstrate that traditional operating room scheduling systems are increasingly unable to manage growing surgical demand, highlighting the need for more efficient operational management strategies. This issue is particularly critical in gynecologic oncology, where treatment is highly time-sensitive. Delays in surgical intervention are associated with disease progression, increased mortality, and reduced quality of life [8-13]. A global study involving 3,973 patients across 227 centers in 52 countries found that 11.2% experienced surgical delays exceeding eight weeks, particularly in ovarian cancer cases, which are highly sensitive to treatment delay [8]. Patients experiencing delays showed a higher risk of disease progression or death (22.4%) compared with those receiving timely surgery (17.9%) [8]. Moreover, approximately 40–50% of hospitals still utilize less than 80% of their surgical oncology capacity, suggesting substantial inefficiencies in operating room utilization and scheduling [1].

Prolonged surgical waiting times are widely recognized as a form of systemic waste in healthcare delivery. Lean management theory identifies waiting time as one of the most critical forms of non–value-added activities that reduce healthcare efficiency and quality [14]. In surgical services, inefficiencies often arise from unstable scheduling systems, conflicts between elective and emergency cases, underutilization of operating room capacity, and fragmented surgical pathways [15,16]. Therefore, applying lean management principles to optimize surgical flow and eliminate operational waste has become increasingly important in improving hospital performance [17,18]. Global experiences demonstrate that lean-based operational strategies, including improved operating room scheduling, prioritization systems, and dedicated surgical pathways, significantly reduce surgical delays and improve service efficiency [19,20]. One operational strategy aligned with lean principles is the implementation of dedicated operating slots or protected elective surgical pathways, which separate elective cancer surgeries from emergency and non-priority procedures. Studies show that such dedicated pathways can increase elective surgical volume, stabilize operating schedules, and maintain continuity of cancer care [21,22].

The urgency of optimizing surgical management is even greater in Indonesia, where the cancer burden continues to rise. National projections estimate that cancer prevalence could increase by 63%, reaching 6.45 million cases by 2040, significantly increasing demand for surgical oncology services [23]. Studies in Indonesian hospitals report average elective surgery waiting times ranging from 32 to 44 days, with 72.78% of patients waiting up to three months for surgery [24,25]. In tertiary referral hospitals, gynecologic oncology surgery waiting times can reach four to five months, largely due to operating room capacity constraints and inefficient scheduling systems. At Dr. Hasan Sadikin Hospital or Rumah Sakit Dr Hasan Sadikin (RSHS), one of Indonesia's major national referral hospitals, gynecologic oncology services consistently represent the highest surgical case volume, averaging 970 cases annually [26]. Prior to operational intervention, patients frequently experienced surgical waiting times of 4–5 months, reflecting operational bottlenecks within surgical scheduling and operating room utilization [26]. To address this issue, the hospital implemented a lean-oriented operational intervention by introducing dedicated operating slots for gynecologic oncology surgery in November 2024, including the addition of a specialized operating room and nine weekly elective surgery slots. Although preliminary observations suggested a reduction in average waiting time, the effectiveness of this intervention has not yet been formally assessed.

Despite increasing interest in lean-based healthcare management, empirical evaluations of lean-driven operating room capacity interventions remain limited, particularly in low- and middle-income countries. Interrupted time-series analysis (ITSA) has been increasingly recommended as a robust quasi-experimental method for evaluating healthcare system interventions and policy changes [1,13,27-29]. However, evidence assessing the impact of lean-based surgical capacity optimization using ITSA in Indonesia is still scarce. This study, therefore, aimed to evaluate the effectiveness of a lean management intervention through dedicated operating slots in reducing gynecologic oncology surgical waiting times using an interrupted

time-series design at RSHS. The findings are expected to generate empirical evidence on how lean-based operating room management could improve surgical flow, reduce operational waste, and enhance efficiency in tertiary hospital surgical services.

Methods

Study design and setting

This study used a mixed-methods explanatory sequential design, in which quantitative analysis was conducted first and followed by a qualitative study to explain the quantitative findings [30,31]. The quantitative component used a retrospective interrupted time series approach to evaluate the effect of dedicated operating slots on gynecologic oncology surgical services. The study was conducted at RSHS, Bandung, Indonesia, a tertiary referral and teaching hospital under the Indonesian Ministry of Health. The hospital is a major referral center that provides comprehensive clinical services, education, training, and research. Gynecologic oncology is one of its high-volume surgical services. The qualitative component was subsequently conducted to provide contextual understanding of the observed quantitative changes, particularly in relation to lean waste reduction and surgical workflow improvements following the intervention.

RSHS serves as a national and regional referral center for nine priority services, including maternal and child health, respiratory diseases, tuberculosis, diabetes, gastro-hepatology, emerging infectious diseases, and mental health, and also functions as a primary center for medical education, training, and research. With a capacity of 1,146 beds, 191 outpatient clinics, and an average annual outpatient and inpatient visits of more than 500,000 and approximately 30,000 patients respectively, the hospital carries out comprehensive health services, education, training, development, research, human resource management, financial and legal management, and information system management. The hospital holds strategic roles as a tertiary hospital, a national general hospital, the main teaching hospital of the Faculty of Medicine at Universitas Padjadjaran, a Public Service Agency, and a national referral hospital for infectious diseases, laboratory services, emerging disease management, and nuclear disaster response.

Intervention

The intervention was implemented in November 2024 to improve access and efficiency of gynecologic oncology surgical services at RSHS. Prior to the intervention, gynecologic oncology cases were scheduled within general elective operating room lists without dedicated time allocation, resulting in competition with other specialties, prolonged waiting times, frequent rescheduling, and inconsistent operating room availability.

Following implementation, a structured scheduling system was introduced, consisting of one dedicated operating room and three fixed elective surgery slots per week exclusively allocated to gynecologic oncology cases. These slots were protected within a predefined weekly operating schedule and were not shared with other surgical specialties, thereby ensuring guaranteed surgical capacity for oncology patients.

Patient allocation to the dedicated slots was performed through a standardized prioritization process based on clinical urgency, disease severity, and waiting time on the surgical list. Cases were reviewed prior to scheduling and assigned in advance to optimize operating room utilization and minimize last-minute cancellations or schedule changes. Coordination between the gynecologic oncology team, operating room management, and scheduling unit was established to ensure adherence to the dedicated slot system.

Interrupted time series analysis (ITSA)

Samples and measurements

The study population included all gynecologic oncology surgical patients recorded in the hospital information system between November 2023 and October 2025. A total sampling technique was applied, using aggregated monthly data to construct the time series [30,32]. The dataset consisted of 24 time points, including 12 months before the intervention (November 2023–October 2024) and 12 months after the intervention (November 2024–October 2025). The primary outcome variables included in ITSA are presented in **Table 1**.

Table 1. Operational definitions and measurement scales of variables included in the interrupted time series analysis (ITSA) of dedicated operating slots in gynecologic oncology surgical services at Dr. Hasan Sadikin Hospital (RSHS) [1,27,29]

Variable	Definition	Measurement scale
Average waiting time for gynecologic oncology surgery (duration) (Y1)	Average number of days required by gynecologic oncology patients from the operation decision date to the surgery date (aggregated monthly).	Ratio
Surgical throughput (volume) (Y2)	Total number of gynecologic oncology surgeries completed per month.	Ratio
Implementation of dedicated operating slots policy (X)	Policy of adding 1 specialized operating room and 9 weekly elective surgery slots dedicated to gynecologic oncology at RSHS, Bandung.	Ratio
Time (T)	Sequence of intervention periods from November 2023 – October 2024 (pre-intervention, T=0) to November 2024 – October 2025 (post-intervention).	Interval
Interaction (time × intervention)	Interaction between time and intervention period representing post-intervention trend changes.	Interval

Interrupted time series analysis (ITSA) model

Quantitative data were obtained from the hospital management information system and operating room management records. The ITSA model was estimated using STATA version 19 (StataCorp LLC, College Station, TX, USA), applying the following segmented regression model: $Yt=\beta 0+\beta 1Tt+\beta 2Xt+\beta 3(Tt\times Xt)+\varepsilon t$, where Yt represents the outcome variable, Tt indicates time, *Xt* represents the intervention, and Tt×Xt captures the post-intervention trend change. Autocorrelation was tested using Durbin–Watson statistic. Statistical significance was determined at $p<0.05$.

Qualitative study

To complement the quantitative findings, qualitative information was collected through in-depth interviews with seven key informants on March 12–16, 2026. The informants consisted of hospital operational managers (n=1), the head of the operating room unit (n=1), gynecologic oncology specialists (n=1), patient operational manager (n=1), and operating room nursing coordinators (n=3). Informants were selected using purposive sampling based on their involvement in surgical service management (**Table 2**). This multidisciplinary composition captures managerial, clinical, and operational perspectives, enabling a comprehensive understanding of the surgical service process.

Table 2. Characteristics of key informants included in the qualitative study at Dr. Hasan Sadikin Hospital (RSHS), Bandung, Indonesia

Key informant (KI) ID	Sex	Role
KI-1	Male (M)	Hospital service/operations manager
KI-2	Male (M)	Head of operating room unit
KI-3	Female (F)	Gynecologic oncology specialist
KI-4	Female (F)	Operating room nurse
KI-5	Female (F)	Operating room nurse
KI-6	Female (F)	Operating room nurse
KI-7	Female (F)	Patient operational manager

Qualitative data were analyzed using the Miles and Huberman framework, including data reduction, data display, and conclusion drawing [31,33]. The collected data and the analysis focused on operational changes after the intervention and on lean waste categories, including transportation, inventory, motion, waiting, overproduction, overprocessing, defects, and underutilization of human potential (**Table 3**). This approach enabled a comprehensive evaluation of how dedicated operating slots improved surgical flow and operating room efficiency.

Table 3. Operationalization of lean management in health care assessed in this study [34]

Type of waste	Definition	Implications in gynecologic oncology surgery	Data source
Transportation	Movement of patients, specimens, or equipment that does not add value	Extends preoperative time and surgery schedule: • Number and complexity of patient transfers • Presence of non-value-added transfers • Layout impact on surgery timeliness • Effectiveness of dedicated slots in minimizing movement	In-depth interview
Inventory	Excess supplies causing costs and risk of expiration	Disrupts surgery readiness and increases costs: • Adequacy and timely availability of equipment and materials • Frequency of shortages/excess • Logistic impact on surgery preparedness	In-depth interview
Motion	Unnecessary staff movements due to inefficient layout/work system	Decreased productivity and staff fatigue: • Frequency of non-value-added staff movement - Main causes of motion waste • Efficiency changes post-intervention	In-depth interview
Waiting	Patient or staff waiting time due to workflow imbalance	Increased surgery waiting times and backlog: • Points with longest waiting time • Main causes of delays • Changes in surgery backlog	In-depth interview
Overproduction	Providing services more or faster than patient needs	Increased workload without added value, longer surgical queues: • Unnecessary procedures or tests • Impact of overproduction on workload and schedule • Appropriateness of prioritization	In-depth interview
Overprocessing	Excess processes that do not add value to patients	Staff time wasted, slowing surgery preparation: • Number of repeated administrative/clinical processes • Identification of non-value-added processes • Streamlining post-intervention	In-depth interview
Defects	Activities performed incorrectly, requiring correction/repetition	Surgery cancellations, delays, operating room flow disruption: • Types of errors causing delays/cancellations • Quality of inter-unit coordination • Changes in cancellation rates	In-depth interview
Underutilization of human potential	Staff potential not fully utilized	Innovation hindered, reduced efficiency and service quality: • Task alignment with staff competencies • Staff involvement in process improvement • Changes in team roles and collaboration	In-depth interview

Results

Comparisons of patients characteristics and surgical waiting time between pre- and post-intervention

The characteristics of gynecologic oncology surgery patients at RSHS pre- and post-intervention are presented in **Table 4**. The majority of patients were aged 40–59 years in both the pre- and post-intervention periods, with minimal differences in demographic distribution between the two periods. The mean surgical waiting time decreased from 57.13 days (8.16 weeks) in the pre-

intervention period to 25.50 days (3.64 weeks) in the post-intervention period (**Table 4**). A reduction in the maximum waiting time was also observed after the intervention.

Table 4. Comparison of patient characteristics and surgical waiting time before and after the implementation of dedicated operating slots in gynecologic oncology surgical services at Dr. Hasan Sadikin Hospital (RSHS), Bandung, Indonesia

Characteristic	Pre-intervention (n=381)	Post-intervention (n=773)	*p*-value
Age (years), mean±SD	44.92±14.03, 12–80	46.28±13.02, 10–81	<0.113 [a]
Age (years)			
0–17	8 (2.10)	13 (1.68)	0.782 [b]
18–39	109 (28.61)	210 (27.17)	
40–59	209 (54.86)	423 (54.72)	
≥60	55 (14.44)	127 (16.43)	
Surgical waiting time			
Days	57.13±34.17, 10–346	25.50±18.06, 2–148	<0.001 [a]
Weeks	8.16±4.88, 1.42–49.42	3.64±2.58, 0.28–21.14	<0.001 [a]

[a] Analyzed using independent samples t-test
[b] Analyzed using Chi-square test

Interrupted time series analysis of surgical waiting time

ITSA using Prais–Winsten AR(1) regression demonstrated that the implementation of dedicated operating slots at RSHS significantly reduced gynecologic oncology surgery waiting times (**Table 5**). The pre-intervention trend showed a gradual decrease of 0.38 weeks per period, while the immediate post-intervention effect reduced waiting times by nearly 2.87 weeks, with a subsequent positive slope (0.48) reflecting increased service volume and improved access (**Table 5** and **Figure 1**). The Durbin–Watson statistic (DW transformed=1.97) confirmed that autocorrelation was effectively corrected, ensuring robust and reliable estimates.

Table 5. Interrupted time series analysis of changes (ITSA) in gynecologic oncology surgical waiting time after the implementation of dedicated operating slots at Dr. Hasan Sadikin Hospital (RSHS), Bandung, Indonesia

Variable	Prais–Winsten AR(1) regression with iterated estimates		
	Coefficient	t-value	*p*-value
Time trend (pre-intervention)	-0.38	-5.36	<0.001**
Level change post-intervention (November 2024)	-2.87	-3.34	0.003*
Trend change post-intervention (November 2024)	0.48	3.28	0.004*
Constant	10.23	28.87	<0.001**
Number of observations	24		
F-value	86.31		
p-value	<0.001**		
R-squared	0.8714		
Root mean squared error	1.231		

Durbin–Watson statistic (original)=2.36; Durbin–Watson statistic (transformed)=1.97
*Statistically significant at $p<0.01$
**Statistically significant at $p<0.001$

Lean waste analysis in gynecologic oncology surgical services after implementation of dedicated operating slots: Results from qualitative study

Following the implementation of dedicated operating slots, lean waste analysis demonstrated that transportation, inventory, motion, waiting, overproduction, overprocessing, defects, and underutilization of human potential were substantially minimized through process optimization. Patient flow became more structured through a 30-minute preoperative standard operating procedure, while surgical instrument management and staffing allocation were improved, resulting in reduced unnecessary delays and enhanced operational efficiency. Waiting waste, which was previously the most prominent issue, was significantly reduced after the intervention due to dedicated operating slots and structured scheduling, indicating improved control of surgical backlog and service flow. Overproduction and overprocessing were also reduced through better alignment of diagnostic testing with surgical schedules and standardized clinical procedures. Similarly, defects and underutilization of human potential were minimized through

improved staff coordination, clearer role distribution, and better utilization of multidisciplinary competencies. Detailed findings from the qualitative study for all domains (transportation, inventory, motion, waiting, overproduction, overprocessing, defects, and underutilization of human potential) are presented.

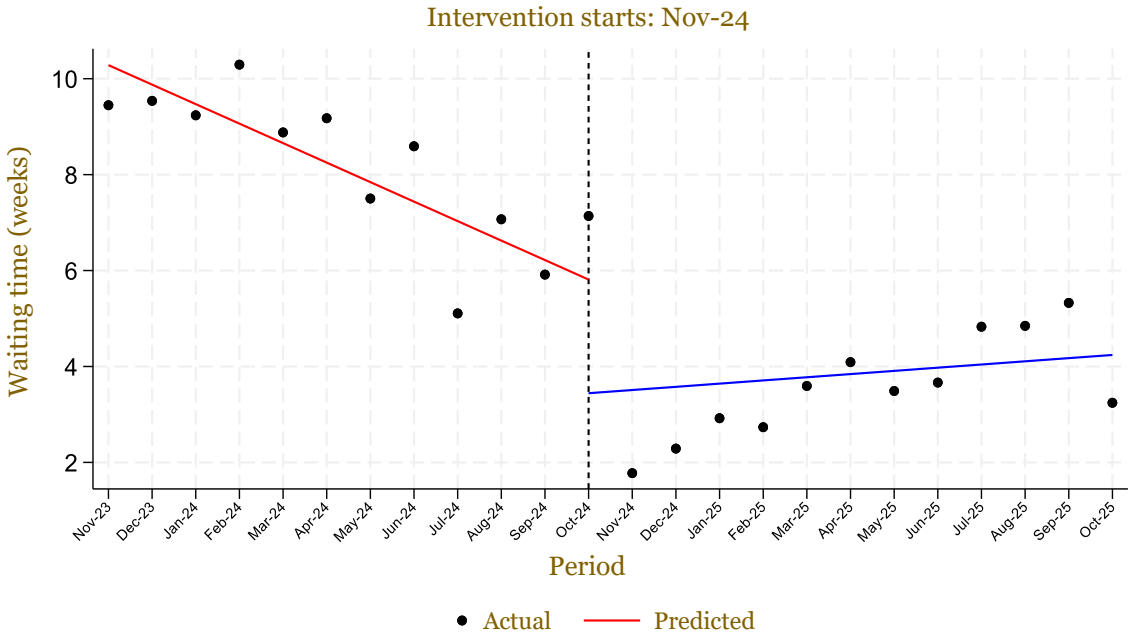

Figure 1. Interrupted time series analysis (ITSA) of gynecologic oncology surgical waiting time at Dr. Hasan Sadikin Hospital (RSHS) before and after the implementation of dedicated operating slots. ITSA regression using Prais–Winsten AR(1).

Transportation waste

Transportation waste refers to unnecessary movement of patients, equipment, or materials that does not add value to the service process. In healthcare, this occurs when patients are moved repeatedly, service flows are inefficient, or the distribution of medical tools and materials is poorly organized, causing delays and reducing operational efficiency.

The implementation of dedicated surgery slots supported an organized and efficient patient flow, from pre-surgery sorting, scheduling, and classification, to transfer to the OR. Coordination among wards, anesthesia teams, and the operating room is effective, and unnecessary transfers are rare. While distance and occasional operational delays may slightly affect transfer time, these are situational rather than systemic. Thus, dedicated slots have successfully structured patient transportation and minimized waste in gynecologic oncology surgery at RSHS Bandung.

"From an operational management perspective, we ensure that each patient's flow is clear—from registration, triage, surgery scheduling, to discharge. All units must coordinate so patients do not accumulate at one point, and all available facilities are optimally used." (KI-1)

"Fast-track patients are selected to reduce surgical queue length. Patients already registered in the OB-GYN department are sorted by the scheduling section to identify those with delayed or lengthy surgeries." (KI-2)

"Patient data are submitted to the scheduling unit, which then assigns patients to elective or fast-track schedules." (KI-4)

"Patients are called according to the schedule, and staff in the operating room will escort them." (KI-5)
"So far, the transfer of patients and equipment has been effective. Dedicated slots help reduce unnecessary transfers." (KI-4)

"Patients are sent from the ward to the OR one hour before surgery... transfers only occur if metastasis is involved." (KI-3)

While the distance between wards and the operating room can affect transport time, a 30-minute pre-transfer standard operating procedure ensures punctuality.

"Patient transfers must occur 30 minutes before the scheduled start." (KI-6)

"Fast-track patients enter the admission unit one day before surgery, then proceed to the inpatient ward and are visited by the anesthesiology team." (KI-7)

"Sometimes there is waiting time for patient transfer, but not consistently; it happens occasionally." (KI-4)

Inventory waste

Inventory waste is related to the accumulation or use of equipment and materials. Waste inventory occurs when equipment, materials, or resources are accumulated or provided beyond service needs, adding no value to patients. In healthcare services, inventory waste arises when medical devices or consumables are overprepared, unused, inefficiently managed during service delivery, or insufficient, thereby disrupting service continuity. Several key informants discussed how the implementation of dedicated surgery slots affected inventory management in the operating room. Following the implementation of dedicated operating slots, the volume of gynecologic oncology surgeries increased, leading to higher use of medical devices and consumables. This increase appeared to reflect greater service demand rather than unnecessary preparation, and required corresponding adjustments in the management of equipment, consumables, and personnel to maintain efficiency and minimize waste.

"Yes, the change really exists. So it's a challenge, not a problem, but a challenge if we, uh, call it that. Uh, our challenge is that automatically, with the increase in the number of patients who will undergo surgery, it will automatically increase the number related to the equipment. Special supporting equipment and consumables that will be used, uh, will be used by the patients, like that." (KI-2)

"So, from an operational management perspective, we have to make sure that every increase in the number of surgical patients is balanced with the proper arrangement of equipment, consumables, and human resources. The challenge is indeed to prepare all resources so that the service runs smoothly, not because there is waste." (KI-1)

"Yes, there is definitely a change because, uh, with the increasing number of patients, it will automatically increase the use of, uh, special consumables. Uh, the strategy, yes, is, uh, by intensifying coordination, uh, of services. We have a special group for scheduling. So if, for example, the schedule conflicts with our special equipment, we will, uh, coordinate regarding the arrangement of surgeries or the schedule, like that." (KI-2)

Some limitations in equipment were noted, particularly for laparoscopic procedures, when the number of scheduled operations exceeded the available instruments. The implementation of dedicated operating slots also required adequate readiness in both human resources and supporting devices. Nevertheless, equipment and consumables were generally considered sufficient, and these limitations did not substantially disrupt the surgical schedule.

"Sometimes there is a lack of equipment. For example, we are only available for the fast track. In a day, it could be 6 or 7, but we only have a few sets. For the air opting alone, we only have 6 sets. Suppose oncology that day is 6, while other sections also have other operations. That's where sometimes we maximize the equipment we have. Especially with laparoscopy, because

there is only one tool. Which stages do patients often experience waiting time? Equipment, waiting for equipment. It can still run with the equipment we modified." (KI-4)

"By daring to open the fast track, uh, in OB/GYN, we must automatically dare to increase the number of human resources as well as, uh, other supporting surgical equipment." (KI-2)

"So far, it's been safe. Sometimes, if, for example, the pharmacy preparation is empty, it affects the room. "Because the major sets are limited, so when the first patient is given equipment, the second patient is given equipment, the third patient we take the first equipment and sterilize it." (KI-5)

"The surgery schedule is fine, because gynecologic oncology doesn't use equipment like drills or special tools." (KI-7)

These findings indicate that inventory waste in the operating room is generally low. Increased usage corresponds to higher surgical volume rather than over-preparation. Temporary equipment shortages, particularly for specialized instruments, are managed through careful scheduling and optimization of available resources. From a lean management perspective, no significant inventory waste was observed after the implementation of dedicated slots, though potential shortages during peak operation volumes should be anticipated with stronger logistics management, planning, and increased hospital resource capacity to ensure sustainable and efficient surgical services.

Motion waste

Motion waste refers to additional movements performed by healthcare staff during service delivery that do not add value for patients. In healthcare, motion waste includes activities such as searching for equipment that is not readily available, unnecessary staff movement, or inefficient workflows due to suboptimal room layout or work processes. This waste increases service time and reduces the efficiency of healthcare staff in the operating room. Based on in-depth interviews, it was found that additional movements by staff could still occur during surgery, particularly when the need for extra equipment became apparent only intraoperatively. This situation was partly related to the dynamic nature of patients' clinical conditions and, in some cases, to equipment not being available in the required location at the time of surgery. However, such occurrences were not reported to happen consistently.

"Eee, yes, sometimes, yes. Sometimes there still are, because the number of surgical procedures, so to speak, sometimes it is found during intraoperative time." (KI-2)

"Often, yes? Not really if often, but there are certain times." (KI-4)

"Well, the equipment is there." (KI-4)

In addition to equipment-related factors, limited human resources could also affect the efficiency of staff movements in the operating room. At certain times, staff were required to retrieve additional instruments because insufficient personnel were available to manage equipment during surgery.

"Not efficient because, for example, during surgery at a certain hour, the on-loop care is not one person per on-loop. So when it's lacking, one has to go out again to the depot to fetch it." (KI-3)

These statements indicate that insufficient staff or suboptimal task distribution can require healthcare staff to perform extra movements to obtain needed equipment. This shows that additional movements, such as fetching or searching for equipment, can still occur in certain situations. However, these situations are not always caused by service system unpreparedness but by the dynamic clinical condition of the patient requiring additional attention during surgery.

Nevertheless, most informants reported that the efficiency of healthcare staff in the operating room improved following the implementation of dedicated surgery slots. This improvement was commonly associated with better team readiness, greater alertness, and more effective coordination during the surgical process.

"Increased. Automatically increased. "Faster, more alert, because we don't want to go home late." (KI-2)

However, some additional movement still occurred under certain circumstances, particularly when documentation was incomplete and staff needed to manage administrative requirements before surgery could proceed.

"If, for example, the checklist or IDO is not ready, we have to photocopy first." (KI-7)

External factors could also contribute to additional activity. One informant noted that delays related to the presence or absence of patients' family members occasionally disrupted the workflow and required staff to spend additional time waiting or coordinating.

"Usually that is often the patient's family; sometimes when the patient's schedule has been called, it turns out the family is not there, so we still have to wait for the patient's family." (KI-5)

Based on interviews with informants, motion waste in gynecologic oncology surgery at RSHS was still present under certain conditions, although it was generally limited. Additional staff movement mainly occurred when extra equipment was needed during surgery, when personnel were insufficient to manage instruments, or when documentation was incomplete. Occasional external factors, such as delays related to patient attendants, also contributed to extra activity. However, these situations were not reported to occur consistently. Informants indicated that the implementation of dedicated operating slots improved staff efficiency by making service processes more organized, increasing team preparedness, and strengthening coordination. Therefore, although some motion waste persisted, its overall impact on operating room efficiency appeared to be minimal.

Waiting waste

One of the most prominent gaps in service provision at RSHS was the long waiting time for gynecologic oncology surgeries. Patients often experienced delays not only in the operating room but also during the preceding stages, such as consultations and scheduling at the polyclinic. Before the implementation of dedicated surgery slots, the mismatch between the high number of patients and the limited operating room capacity was a major cause of waiting. When asked about their experiences with waiting, informants commented.

"...Because the number of patients was high and the operating rooms were few, naturally patients had to wait a long time for surgery. The waiting mostly happened at the polyclinic before patients were scheduled for surgery." (KI-2)

"Previously, there were only two operating rooms, and the turnover time was long, so the queue became very long." (KI-3)

"Now, with dedicated slots and additional rooms, the surgery schedule is more structured, and patients wait much less." (KI-1)

"After the policy, the waiting time between surgeries has become much shorter, and the workflow is more streamlined." (KI-4)

"Before, patients could wait up to six months; now it is reduced to one month or even a week." (KI-6)

Even with previous contact with hospital services, patients still experienced delays due to the limited capacity and scheduling constraints. This lack of structural organization hindered timely access to surgery. Coordination between polyclinics, operating rooms, and surgical teams is essential to reduce waiting time. The implementation of dedicated surgery slots helped streamline service flow and reduced waiting waste significantly, although waiting can still occur for patients requiring medical stabilization before surgery.

Overproduction

Another notable finding in gynecologic oncology surgery was the minimal occurrence of overproduction waste, defined as procedures or examinations performed beyond what was clinically required. Based on the in-depth interviews, participants consistently indicated that surgical actions, diagnostic tests, and perioperative preparations were undertaken according to clinical indications and patient safety considerations rather than routine excess.

"All procedures performed provide added value to the patient, and we ensure that every action, test, or preparation is done according to the necessary medical indications, not excessively." (KI-1)

"Well, in my view, everything provides added value. No, everything is the same. Basically, the process focuses on patient safety, so we prioritize examinations according to the patient's condition..." (KI-2)

"Procedures are efficient and only performed when necessary, according to priority." (KI-5)

These accounts suggest that overproduction waste was limited in the gynecologic oncology surgical pathway. Participants emphasized that clinical management was primarily driven by patient needs and procedural priorities. The implementation of a dedicated operating slot appeared to improve service efficiency and shorten waiting times without encouraging unnecessary interventions, thereby supporting both patient safety and appropriate care.

Overprocessing

Overprocessing waste refers to unnecessary service steps that do not add value to patient care, such as redundant diagnostic tests, repeated documentation, or avoidable administrative procedures. Based on the interviews, informants indicated that this type of waste was more apparent during the early phase of implementing dedicated surgery slots, when staff were still adapting to the new system and coordination across service units had not yet been fully established.

"Eee, in the beginning, yes. In the beginning, yes, but now we have carried out a lot of coordination regarding these services so that, ee, the patient service can be as optimal as possible and the queue or waiting time is not that long. Initially, maybe because of orientation or adaptation processes, some things were left behind, but over time we have done a lot of coordination and learning so that documentation is now handled well." (KI-2)

Informants described that, over time, coordination improved and processes became more streamlined. Preoperative examinations were no longer performed routinely for all patients, but were conducted selectively according to clinical condition and surgical readiness.

"*For example, patients under forty generally do not undergo echocardiograms or chest exams if their overall condition is good. However, if the patient's general condition is deemed to have any limitations, even under forty, lab tests and additional examinations are still conducted."* (KI-2)

This approach was supported by continued coordination between units to ensure that patients were adequately prepared for surgery without introducing unnecessary steps.

"The strategy is to intensify coordination of services. We have a special group regarding scheduling." (KI-2)

At the same time, informants emphasized that some preoperative reassessment remained essential to maintain patient safety.

"Yes, everything must be checked again before surgery. That is to ensure the patient is ready for surgery." (KI-4)

Procedures performed during surgery were also described as being aligned with clinical needs rather than carried out excessively.

"Yes, that is the procedure." (KI-3)

Nevertheless, minor forms of overprocessing were still identified, particularly in relation to repeated laboratory testing and duplication between paper-based and electronic documentation systems.

"Waste... Maybe because some lab checks are sometimes unnecessary... For example, the patient was already checked a week before pre-op, but sometimes we check again when they arrive here. Operating Room Service Document consists of hard copies with electronic medical record soft copy." (KI-6)

Overall, these findings indicate that overprocessing waste was initially present during the transition period but decreased as coordination and workflow adaptation improved. The implementation of dedicated surgery slots appeared to support more selective preoperative assessment and better inter-unit communication, thereby reducing unnecessary administrative and clinical processes while maintaining patient safety.

Defects

Defect waste refers to errors in the service process that may result in delays, repeated procedures, cancellations, or failure to meet established care standards. In the context of gynecologic oncology surgery at RSHS, this type of waste included errors in patient preparation, incomplete documentation, equipment problems, or other conditions with the potential to disrupt scheduled procedures. Based on the interviews, informants generally indicated that such events were uncommon after the implementation of dedicated surgery slots.

"No, cancellations... no, no, no, no, no... I mean, there were no cancellations due to equipment." (KI-2)

This finding suggests that equipment readiness and operating room facilities were generally adequate to support the continuity of surgical services. Informants also emphasized that strict preoperative verification remained an important strategy to prevent avoidable errors and ensure that all requirements for surgery were fulfilled before the procedure began.

"Yes, everything must be checked again before surgery." (KI-4)

Although defects related to internal service processes were reported to be minimal, some challenges persisted due to factors outside the immediate control of the operating room team. One recurring issue was the limited availability of postoperative high-care or intensive care beds for patients with complex conditions.

"But maybe because the availability of inpatient high care or intensive care rooms is one of the main challenges. In my point of view, RSHS is now a national referral hospital, not just a regional one. Naturally, the patients sent here have multiple complex diseases." (KI-2)

In addition, postponements or cancellations were more often attributed to the patient's clinical condition rather than to procedural or equipment-related problems.

"Mostly because of the patient's condition." (KI-5)

Overall, these findings indicate that defect waste in gynecologic oncology surgery was relatively low. Informants highlighted that careful verification of patient readiness, equipment, and documentation helped prevent service errors that could otherwise lead to delays or repeated procedures. The remaining barriers were largely related to external system constraints, particularly postoperative bed availability and the complexity of referred patients, rather than deficiencies in the dedicated surgery slot system itself.

Underutilization of human potential

Underutilization of human potential refers to situations in which healthcare workers' skills, competencies, and capacities are not optimally used in service delivery. This may occur when staff are not assigned according to their professional roles, are excluded from decision-making, or have limited opportunities to contribute to service improvement. Based on the interviews, informants generally indicated that healthcare workers in the operating room were performing duties in accordance with their competencies and were actively involved in efforts to improve service processes, including the implementation of dedicated surgery slots.

"Healthcare staff already work according to their roles and are involved in process improvements, so even if the workload increases, everything remains efficient and optimal in service." (KI-1)

This view was supported by other informants, who also emphasized the alignment between staff responsibilities and professional competencies. Informants further noted that staff were involved in ongoing service improvement initiatives.

"Oh yes, clearly." (KI-2)

Although the implementation of dedicated surgery slots was perceived to increase workload, the additional demands were generally considered manageable within the existing work system.

"Of course, with the fast track, workload will increase." (KI-2)

"In my point of view, it is appropriate." (KI-2)

Overall, these findings suggest that underutilization of human potential was minimal in gynecologic oncology surgery at RSHS. Informants indicated that staff were deployed according to their competencies, remained involved in process improvement, and were able to accommodate the increased service demands associated with dedicated surgery slots. Rather than limiting staff potential, the system appeared to promote more productive use of human resources through better coordination and enhanced contribution to service quality. Nevertheless, appropriate workload distribution, staffing arrangements, and task allocation remain important to sustain effective, efficient, and patient-safety-oriented surgical services.

Changes in gynecologic oncology surgical service flow and efficiency after the implementation of dedicated surgery slots

The analysis of the gynecologic oncology surgical service process flow before and after the implementation of dedicated surgery slots indicates significant changes in service efficiency

(**Figure 2** and **Figure 3**). Prior to the policy implementation, the surgical service process was relatively longer and less structured due to limited operating room capacity and a high volume of referred patients. This situation led to various forms of waste in the service process, particularly long surgical waiting times (waiting), repeated diagnostic tests (overprocessing), and suboptimal coordination between service units (**Figure 2**). Consequently, patients often had to remain on surgical waiting lists for extended periods before receiving surgical treatment.

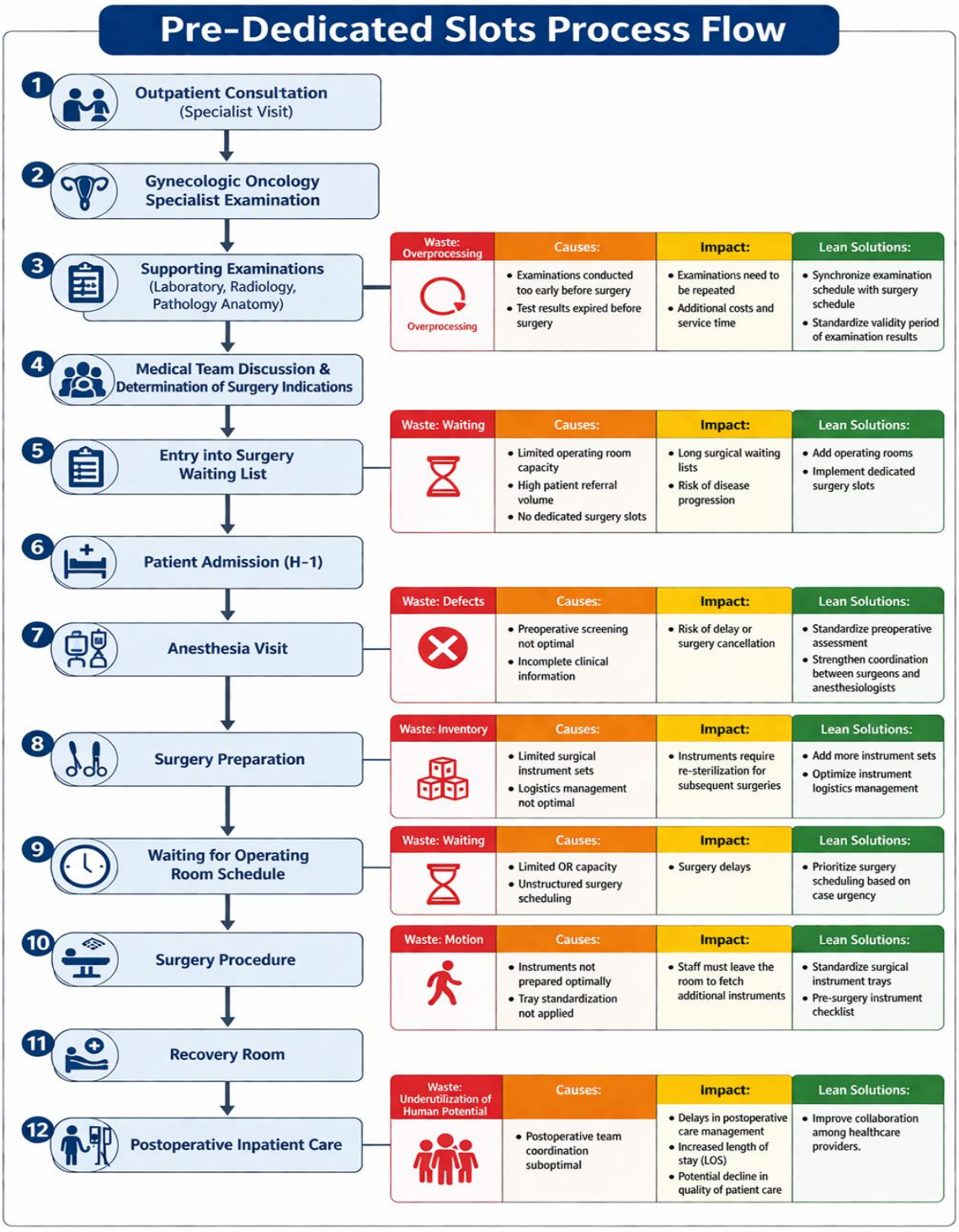

Figure 2. Pre-implementation gynecologic oncology surgical service flow at Dr. Hasan Sadikin Hospital (RSHS), highlighting multiple sources of lean waste, delays, and operational inefficiencies before the introduction of dedicated operating slots

After implementing dedicated surgery slots, the service process became more structured due to the allocation of operating rooms specifically designated for certain cases, including gynecologic oncology (**Figure 3**). The presence of dedicated slots allowed surgical scheduling to

be more systematic, significantly reducing patient waiting times. Additionally, coordination between outpatient units, diagnostic units, admission, and operating rooms improved because surgery schedules were clearly established. These improvements also reduced service process waste, such as repeated diagnostic tests, and increased preoperative preparation efficiency.

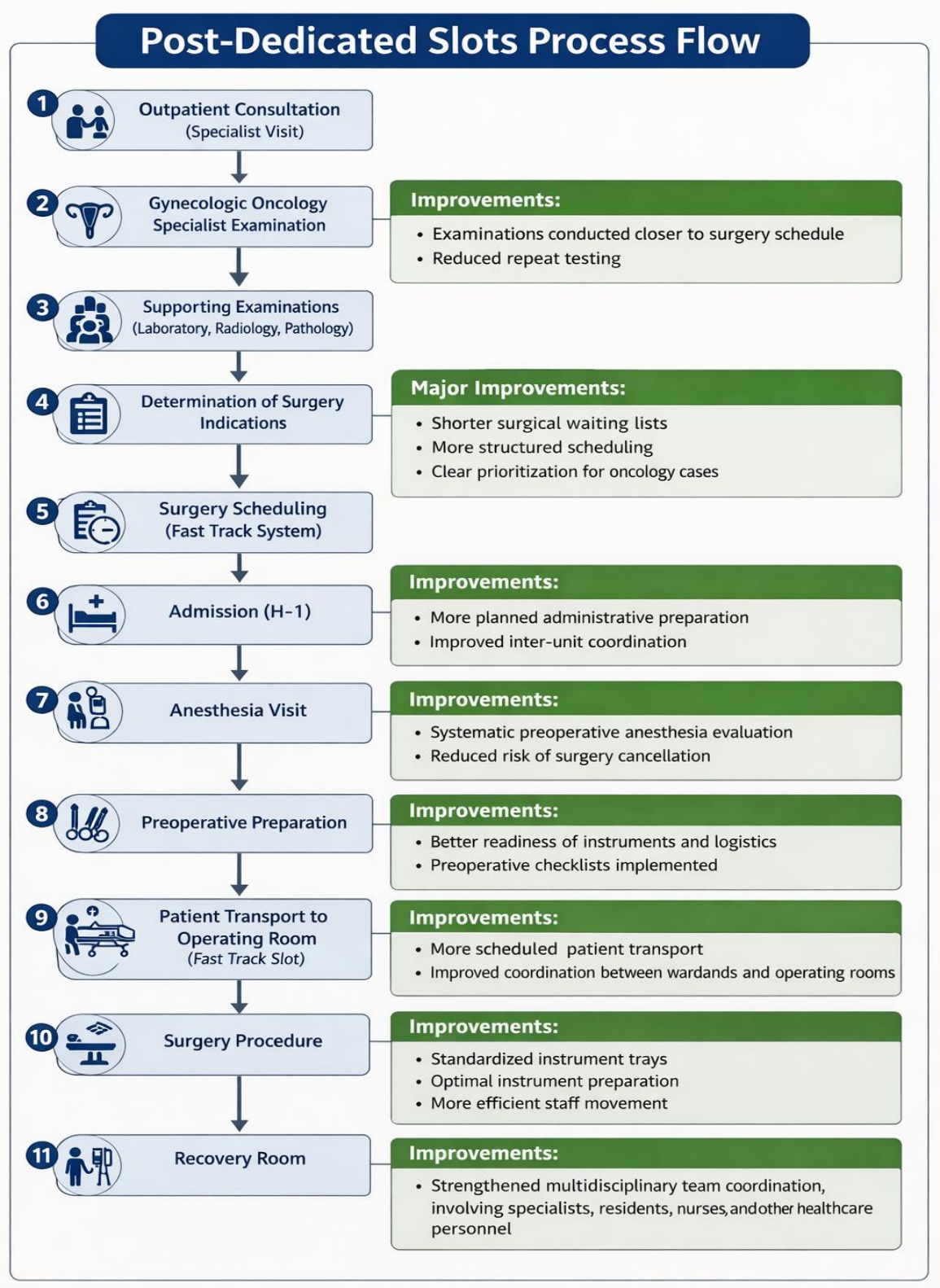

Figure 3. Lean-optimized post-implementation gynecologic oncology surgical service flow at Dr. Hasan Sadikin Hospital (RSHS), showing improved efficiency and reduced delays after the implementation of dedicated operating slots.

Based on the process flow analysis before the implementation of dedicated surgery slots, several forms of waste were identified across service stages, from initial outpatient examinations

to postoperative care. These wastes included the eight major Lean categories: transportation, inventory, motion, waiting, overproduction, overprocessing, defects, and underutilization of human potential (**Table 6**). Inefficiencies manifested as unintegrated administrative coordination, limited availability of surgical instruments, unnecessary staff movement during surgery, and long patient waiting times due to limited operating room capacity. Additionally, some waste is associated with diagnostic and administrative processes, such as examinations conducted too early, necessitating repeats, and non-standardized clinical data verification. These inefficiencies impact hospital operational efficiency, increase service costs, and extend patient service time. Therefore, identifying waste in the service process is crucial for improving surgical service efficiency and quality. The identification results are presented as specific activities, associated problems, and recommended improvements to reduce waste in service delivery.

Table 6. Identification of lean waste, related operational problems, and recommended improvement strategies in gynecologic oncology surgical services at Dr. Hasan Sadikin Hospital (RSHS) before the implementation of dedicated operating slots

Type of waste	Identified activities	Problems	Recommended improvements
Transportation	• Patient call by admission • Patient transport from ward to OR • Administrative coordination between units	• Patient call system not integrated; coordination manual	• Integrate hospital information system- Digitize patient calling system • Improve coordination between wards, admission, and OR
Inventory	• Preparation of surgical instruments- Provision of tools and materials • Instrument sterilization	• Limited instrument sets cause delays waiting for sterilization	• Add more instrument sets • Optimize logistics management • Improve sterilization efficiency
Motion	• Nurses fetching additional instruments • Staff movement searching instruments • Unstandardized instrument setup	• Incomplete preparation and unstandardized trays cause extra movement	• Standardize surgical trays • Reorganize instruments by procedure flow • Implement pre-surgery checklist
Waiting	• Patient waiting in surgery list- Waiting for OR availability • Waiting for administrative process	• Limited OR capacity and high referrals cause long waiting times	• Add dedicated slots with fast-track system • Prioritize cases for scheduling • Improve coordination between inpatient units and OR
Overproduction	• Lab tests done too early- Radiology before definite surgery schedule • Diagnostic tests not immediately used	• Tests conducted too early; results underutilized	• Synchronize diagnostics with surgery schedule • Schedule tests closer to surgery • Evaluate test necessity selectively
Overprocessing	• Repeated lab tests • Repeated radiology	• Previous results expired; tests repeated	• Standardize diagnostic result validity • Improve coordination between diagnostic and OR units • Integrate examination data in HIS

Type of waste	Identified activities	Problems	Recommended improvements
Defects	• Repeated administrative verification • Pre-op patient screening- Pre-op anesthesia evaluation • Clinical data verification	• Incomplete clinical info may delay/cancel surgery	• Standardize preoperative assessment • Strengthen coordination between surgeons and anesthesiologists • Implement pre-op evaluation checklist
Underutilization of Human Potential	• Postoperative team coordination • Utilization of staff competencies • Staff involvement in service evaluation	• Staff competencies not fully used; multidisciplinary coordination suboptimal	• Strengthen multidisciplinary team coordination • Optimize use of staff competencies • Conduct regular case discussions and service evaluation

Discussion

The implementation of dedicated operating slots in gynecologic oncology surgery at RSHS led to a substantial reduction in surgical waiting times, from 57.13 days (8.16 weeks) pre-intervention to 25.50 days (3.64 weeks) post-intervention, effectively cutting waiting times by over 50%. These findings align with the global literature emphasizing the critical impact of surgical delays on patient outcomes. The eight-week delay was associated with worsened prognosis in patients with endometrial, ovarian, and cervical cancers, underscoring the urgency of backlog mitigation strategies [2,35]. Prolonged waiting periods in tertiary training hospitals have compromised timely management of malignancy cases and supported the rationale for structured interventions such as dedicated operating room slots [2]. The delays in gynecologic cancer surgeries were linked to increased disease progression and mortality, reinforcing the need for interventions that optimize surgical access [8]. Operational strategies such as extending operating room hours, when combined with adequate staffing and patient prioritization, have been shown to reduce elective surgical backlogs, consistent with the rationale of dedicated surgery slots implemented in this study [2,36]. Referral management, patient prioritization, and Lean Healthcare principles are critical strategies to reduce waiting times and improve patient flow [37,38]. The prolonged waiting times are not only associated with poorer oncological outcomes but also with psychological stress, particularly among high-risk patient subsets [11,39,40].

The lean waste analysis conducted in this study revealed that transportation, inventory, motion, waiting, overproduction, overprocessing, defects, and underutilization of human potential were effectively minimized through process optimization. For instance, patient transfers were systematized with a 30-minute preoperative standard operating procedure, surgical instrument management and staffing were optimized, and administrative coordination was streamlined, reducing unnecessary delays and improving efficiency. Waiting waste, which was previously the most prominent, was significantly reduced due to dedicated slots and structured scheduling, demonstrating that strategic operational interventions can directly improve patient outcomes [2,35]. Overproduction and overprocessing were limited by aligning diagnostic tests with surgical schedules and standardizing clinical procedures, while defects and underutilization of human potential were minimized by optimizing staff competencies and enhancing multidisciplinary coordination. Overall, these results provide strong empirical evidence that integrating Lean Healthcare principles with dedicated surgery slots can substantially improve service efficiency, reduce clinical risks associated with surgical delays, and align with international best practices for managing elective oncology surgeries, thereby enhancing both operational performance and patient prognosis [8,11,37].

This study has some limitations that need to be acknowledged. The quantitative analysis used an interrupted time-series design without a control group, so the observed improvements cannot be attributed solely to the intervention with complete certainty. Other factors, such as

changes in referral volume, staffing, case complexity, or hospital operational policies during the study period, may also have contributed to the reduction in waiting time and increase in surgical throughput. In addition, the analysis was based on monthly aggregated data from a single hospital with only 24 time points, which limited the assessment of long-term sustainability and reduced the generalizability of the findings to other hospitals with different capacities, referral systems, and organizational structures. The study also focused mainly on operational outcomes, particularly waiting time and surgical throughput, and did not evaluate broader clinical, patient-centered, or economic outcomes. Therefore, the effects of the intervention on surgical complications, oncologic outcomes, patient satisfaction, and cost-effectiveness remain unclear. The qualitative findings were derived from post-intervention interviews with a small number of purposively selected informants and may have been influenced by subjective interpretation or social desirability bias. Moreover, because the intervention consisted of several components introduced simultaneously, including dedicated operating room allocation, fixed weekly slots, and improved inter-unit coordination, the specific contribution of each component could not be distinguished.

Conclusion

The implementation of dedicated operating slots was associated with a marked improvement in the efficiency of gynecologic oncology surgery services at RSHS. The average waiting time decreased from 8.16 weeks in the pre-intervention period to 3.64 weeks in the post-intervention period. Interrupted time series analysis using Prais–Winsten AR(1) regression showed a significant immediate level change after the intervention, with an estimated reduction of 2.87 weeks, indicating a prompt decrease in surgical backlog. A significant post-intervention slope change was also observed, suggesting that the trajectory of waiting time changed following implementation. Although a slight upward trend emerged during the post-intervention period, waiting times remained substantially lower than those observed before the intervention. In addition to reducing waiting time, the intervention appeared to improve surgical throughput and overall system efficiency. Lean waste analysis showed reductions in waiting-related delays, unnecessary processing, and inefficiencies in inter-unit coordination. Following implementation, the surgical pathway became more structured and standardized, which supported better operating room utilization and improved coordination across units. Overall, the dedicated operating slot policy, implemented within a Lean framework, was effective in improving the efficiency of gynecologic oncology surgical services.

Ethics approval

Ethical approval for this study was obtained from the Research Ethics Committee of Dr. Hasan Sadikin Hospital (RSHS), Bandung, Indonesia (No. DP.04.03/D.XIII.13/135/2026; Registration No. 02.26.135), issued on 12 March 2026. All study procedures were conducted in accordance with institutional ethical standards and applicable regulations.

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Competing interests

All the authors declare that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization, or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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