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Developing cost containment strategies for soft tissue tumor management using lean principles in hospitals

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Abstract

Hospitals in low- and middle-income countries face increasing financial pressure due to discrepancies between reimbursement tariffs and actual service costs. This study aimed to analyze the unit cost and Cost Recovery Rate (CRR) of soft tissue tumor (STT) surgical services at Hospital "X" in Makassar, Indonesia, using Activity-Based Costing (ABC), and to formulate cost containment strategies through a lean management approach. A mixed-methods study with an explanatory sequential design was employed. Quantitative data were used to calculate unit costs and financial performance (CRR), followed by qualitative data collection through observations and in-depth interviews to identify inefficiencies and sources of waste in service delivery. The results showed that the unit cost of STT surgery was IDR 9,045,213 per case, which was lower than the hospital tariff (IDR 15,737,000) but significantly higher than the INA-CBGs reimbursement rate (IDR 4,248,900), resulting in a negative margin of IDR 4,796,313 per procedure. Qualitative findings revealed inefficiencies in service flow, with an average waiting time of 243 minutes. Waiting time was identified as the dominant form of waste, primarily caused by physician delays and weak coordination among surgical teams. STT surgical services at Hospital "X" are financially unsustainable under current reimbursement schemes. The gap between actual costs and INA-CBGs tariffs, combined with operational inefficiencies, contributes significantly to negative financial performance. The study highlights the importance of implementing lean-based cost containment strategies, including waste elimination, improved scheduling coordination, standardized clinical pathways, and workflow redesign. These interventions are essential to enhance operational efficiency, improve cost recovery, and maintain service quality and patient safety in resource-constrained hospital settings.

Keywords: Activity-based costing, Cost containment, Health service management, Hospital efficiency, Lean management, Soft tissue tumor surgery.

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1. Introduction

Hospitals are increasingly challenged to deliver high-quality healthcare services while maintaining financial sustainability, particularly under prospective payment mechanisms such as Diagnosis-Related Groups (DRGs). In Indonesia, the implementation of the INA-CBGs reimbursement system has fundamentally reshaped hospital financing structures by introducing fixed tariffs for defined clinical episodes. While this system aims to improve efficiency and cost control at the macro level, numerous studies have documented persistent discrepancies between INA-CBGs reimbursement rates and the actual costs incurred by hospitals, especially for complex and resource-intensive surgical procedures [1, 2]. These discrepancies exert significant financial pressure on hospitals and underscore the urgent need for effective cost containment strategies that do not compromise service quality or patient safety.

Soft tissue tumor (STT) management represents a particularly high-resource clinical service due to its dependence on multidisciplinary clinical teams, advanced diagnostic modalities, intensive operating room utilization, and comprehensive postoperative care. Surgical oncology services, including STT procedures, are characterized by high clinical variability and unpredictable resource consumption. Previous studies have consistently reported that oncology-related surgical services frequently experience negative operating margins when reimbursement tariffs fail to adequately reflect real operational costs [3-5]. If inefficiencies in service delivery remain unaddressed, such financial imbalances may pose serious risks to hospital sustainability, especially in referral and tertiary care settings.

Conventional cost-control strategies in hospitals have predominantly emphasized input reduction, such as restricting consumable use, limiting staffing levels, or postponing equipment investment. Although these approaches may yield short-term savings, they often risk undermining care quality, workforce morale, and patient safety. Recent evidence increasingly supports a paradigm shift toward process-oriented cost containment strategies that focus on improving efficiency, reducing waste, and optimizing resource utilization across care pathways [6]. Within this context, lean management, originally developed in the manufacturing sector, has gained substantial attention in healthcare as a systematic approach to enhance service flow and operational performance without compromising clinical outcomes [7].

Lean management in healthcare emphasizes the identification and elimination of non–value-added activities from the patient's perspective. Empirical studies have shown that excessive waiting times, redundant processes, unnecessary motion, and poor coordination among healthcare professionals are major contributors to inefficiency and cost escalation, particularly in operating room services [8, 9]. Surgical services are especially vulnerable to such inefficiencies due to their complex workflows, high interdependence among professional roles, and reliance on precise scheduling and coordination. Consequently, lean-based interventions offer significant potential to improve both operational performance and financial outcomes in surgical settings.

In parallel, Activity-Based Costing (ABC) has emerged as a robust and transparent costing methodology capable of capturing the true cost of healthcare services by allocating resources based on actual activities performed rather than broad averages. Compared with traditional costing methods, ABC provides more accurate unit cost estimates, facilitates identification of cost drivers, and supports evidence-based managerial decision-making [10-12]. Importantly, integrating ABC with lean management allows hospitals to directly link financial information with process improvement initiatives, thereby strengthening the analytical foundation for cost containment strategies.

Despite growing international evidence supporting lean and ABC integration, their application within Indonesian hospital settings remains limited, particularly in the context of oncologic surgical services. Existing studies have predominantly focused on general surgical units, outpatient services, or administrative processes, leaving a critical evidence gap related to soft tissue tumor management under the INA-CBGs reimbursement system [13, 14]. This gap is especially relevant given the increasing demand for oncology services and the financial vulnerability of hospitals operating under fixed prospective payment schemes.

Moreover, hospital managers require context-specific cost containment strategies that are aligned with national reimbursement mechanisms, organizational culture, and workforce dynamics. Lean interventions that are implemented without adequate adaptation to local operational realities often fail to achieve sustained improvements and may encounter

resistance from clinical staff [15]. Therefore, an in-depth analysis that integrates financial, operational, and human resource perspectives is essential to ensure both feasibility and long-term impact.

Against this background, the present study aims to analyze the unit cost and Cost Recovery Rate (CRR) of soft tissue tumor surgical services and to formulate cost containment strategies using a lean management approach. By combining Activity-Based Costing with detailed process analysis, this study seeks to generate practical and policy-relevant insights to support hospital efficiency, improve financial sustainability, and enhance the alignment between clinical service delivery and the INA-CBGs reimbursement framework within the Indonesian healthcare system.

2. Materials and Methods

2.1. Study Design

This study employed a mixed-methods approach using an explanatory sequential design. The quantitative phase was conducted first to calculate unit costs and financial performance indicators of soft tissue tumor (STT) surgical services, followed by a qualitative phase aimed at exploring process inefficiencies and identifying improvement strategies using lean management principles. This design enabled integration of financial and operational perspectives to support evidence-based cost containment strategies.

2.2. Study Setting

The study was conducted at Hospital "X," a tertiary referral hospital in Makassar, Indonesia, which provides specialized surgical oncology services and operates under the national health insurance reimbursement system (INA-CBGs). The hospital's operating room (OR) serves multidisciplinary teams, including surgeons, anesthesiologists, nurses, pharmacists, and supporting staff.

2.3. Study Population and Data Sources

Quantitative data were obtained from hospital financial records, medical records, operating room logs, and administrative databases for patients undergoing soft tissue tumor surgery during the study period. Cost components included direct medical costs (personnel, consumables, medications, and medical devices) and indirect costs (overhead, utilities, and equipment depreciation). Qualitative data were collected from purposively selected key informants involved in STT service delivery, including surgeons, anesthesiologists, operating room nurses, hospital managers, and support staff.

2.4. Cost Analysis

Unit cost calculation was performed using Activity-Based Costing (ABC). All clinical and non-clinical activities related to STT surgical care were identified and grouped into activity cost pools. Resource consumption was assigned to each activity using appropriate cost drivers. The Cost Recovery Rate (CRR) was calculated by dividing the INA-CBGs reimbursement tariff by the unit cost of the STT procedure. A CRR value below 1 indicated financial loss.

2.5. Lean Management Analysis

Lean management analysis involved direct observation of service flow from patient admission to postoperative care. Activities were classified as value-added (VA) or non–value-added (NVA). Types of waste were identified according to lean principles, including waiting, motion, overprocessing, transportation, inventory, defects, and underutilization of human resources. Time-motion analysis was used to measure service delays, particularly waiting time in the operating room process.

2.6. Data Analysis

Quantitative data were analyzed descriptively to determine unit costs, cost structure, and CRR values. Qualitative data were analyzed thematically to identify dominant inefficiencies and formulate lean-based improvement strategies. Integration of findings was conducted during the interpretation phase to ensure consistency between cost analysis and process improvement recommendations.

2.7. Ethical Considerations

This study was reviewed and approved by the Ethics Committee of the Faculty of Public Health, Hasanuddin University (Approval No. 1488/UN4.14.1/TP.01.02/2025). Written informed consent was obtained from all participants before data collection. For participants who were unable to provide consent directly, consent was obtained from their legal guardians or family representatives

3. Results

Table 1.
Direct Medical Cost Components of Soft Tissue Tumor Procedures.

Cost Component	Description
Medical personnel	Surgeon, anesthesiologist, and nursing services
Procedures and diagnostics	Surgical procedures and supporting medical services
Drugs and consumables	Anesthetic drugs, antibiotics, and disposable medical supplies
Indirect costs (overhead)	Utilities, maintenance, and administrative services

Table 1 presents the composition of direct medical costs for soft tissue tumor (STT) procedures. Procedural and diagnostic services constitute the largest proportion of total costs, followed by medical personnel and consumables. This distribution highlights the importance of operational efficiency and resource utilization in controlling overall service costs.

Table 2.
Overhead Cost Allocation per STT Procedure.

Indicator	Value
Overhead cost per procedure (IDR)	2,995,207

As shown in Table 2 the overhead cost allocated to each STT procedure was IDR 2,995,207. This substantial indirect cost reflects suboptimal service utilization and inefficiencies within the operational process, indicating opportunities for cost containment through improved workflow management.

Table 3.
Unit Cost Comparison Using Activity-Based Costing.

Cost Indicator	Amount (IDR)
Unit cost (ABC method)	9,045,213
Hospital tariff	15,737,000
INA-CBGs tariff	4,248,900

Table 3 demonstrates that the unit cost of STT procedures calculated using the Activity-Based Costing method exceeded the INA-CBGs reimbursement tariff but remained below the hospital's internal tariff. This mismatch contributes to financial imbalance in service delivery.

Table 4.
Cost Gap per STT Procedure.

Indicator	Amount (IDR)
Unit cost	9,045,213
INA-CBGs reimbursement	4,248,900
Negative cost difference	4,796,313

Table 4 highlights a negative cost difference of IDR 4,796,313 per procedure, indicating that STT services operate at a financial loss under the current reimbursement scheme. This finding underscores the necessity for systematic cost containment strategies.

Table 5.
Cost Recovery Rate (CRR) of Surgical Services.

Indicator	Value
Total revenue (IDR)	1,026,161,333
Total cost (IDR)	2,134,670,268
Cost Recovery Rate (%)	48

The Cost Recovery Rate (CRR) of 48%, Table 5 indicates that less than half of the total service costs were covered by revenue. This low CRR reflects financial inefficiency and threatens the sustainability of surgical services if left unaddressed.

Table 6.
Lean Analysis: Identified Waste in STT Service Process.

Type of waste	Key findings
Waiting	Delays due to physician and team availability
Motion	Inefficient movement of staff and patients
Process	Lack of standardized clinical pathways

Lean analysis Table 6 identified waiting as the dominant form of waste, with an average service waiting time of 243 minutes. Ineffective scheduling and the absence of standardized clinical pathways were the main contributors to inefficiency, resulting in increased operational costs and reduced service utilization.

4. Discussion

This study provides robust empirical evidence of financial inefficiencies in soft tissue tumor (STT) surgical services and underscores the strategic value of integrating Activity-Based Costing (ABC) with lean management principles to develop effective cost containment strategies in hospital settings [16, 17]. The findings reveal a substantial mismatch between actual unit costs and INA-CBGs reimbursement rates, resulting in persistent negative margins that pose significant threats to the financial sustainability of STT surgical services, particularly in referral hospitals managing complex cases.

The calculated unit cost of IDR 9,045,213 exceeded the INA-CBGs tariff by more than twofold, highlighting a structural reimbursement gap. This finding is consistent with recent studies indicating that diagnosis-related group (DRG) based payment systems frequently underestimate the true cost of surgical services, especially those involving high clinical variability, extended operating time, multidisciplinary teams, and intensive resource utilization [18-20]. In tertiary care hospitals, STT surgeries often involve advanced diagnostics, specialized surgical expertise, and prolonged perioperative management, all of which contribute to higher costs that are insufficiently captured by bundled payment schemes. Without internal efficiency improvements, such reimbursement mismatches can lead to chronic financial losses and undermine service continuity.

The Cost Recovery Rate (CRR) of 48% further confirms the severity of the financial imbalance, indicating that less than half of total service costs were recovered through reimbursement [21]. Comparable CRR values have been reported in low- and middle-income countries where hospitals operate under fixed tariffs amid rising labor, equipment, and consumable costs [22, 23]. Low CRR levels are frequently associated with suboptimal process flows, underutilization of operating room capacity, prolonged length of stay, and disproportionately high indirect costs. In this study, indirect costs, including staff idle time, facility overhead, and administrative delays, constituted a substantial portion of total costs, reinforcing the need for process-oriented cost containment rather than isolated cost-cutting measures.

Lean analysis revealed waiting as the dominant form of waste, with an average preoperative waiting time of 243 minutes. Excessive waiting has been consistently identified in the literature as a major contributor to inefficiency in operating room services, increasing overhead costs, reducing staff productivity, and negatively affecting patient experience [19, 24, 25]. Prolonged waiting times often reflect systemic issues such as poor scheduling coordination, variability in surgeon and anesthesiologist availability, delayed patient preparation, and lack of standardized operating procedures. In STT management, where surgical complexity necessitates precise coordination, such inefficiencies are amplified and translate directly into increased costs.

Recent studies emphasize that waiting waste in surgical pathways is not merely a time-related issue but a cost driver that escalates labor expenses, prolongs equipment usage, and reduces operating room turnover [26]. By identifying waiting as the primary non–value-added activity, this study provides actionable insights for hospital managers to prioritize interventions that yield both operational and financial benefits. Lean tools such as value stream mapping (VSM) enable visualization of bottlenecks across the perioperative continuum, facilitating targeted redesign of workflows to minimize idle time and improve process reliability.

The integration of lean management principles in this study highlights that effective cost containment should focus on waste elimination and value optimization rather than indiscriminate cost reduction [27]. Standardization through evidence-based clinical pathways, improved operating room scheduling, and enhanced coordination among multidisciplinary teams has been shown to reduce turnaround times, improve operating room utilization rates, and lower indirect costs without compromising clinical outcomes or patient safety [9, 28, 29]. In the context of STT surgery, standardized pathways can also reduce clinical variability, enhance predictability of resource use, and improve alignment between clinical practice and reimbursement mechanisms.

Importantly, this study reinforces the argument that financial sustainability in surgical services cannot be achieved solely through tariff adjustments or increased reimbursement rates. While payment reform is necessary at the policy level, hospitals must concurrently implement internal efficiency strategies to remain viable under existing payment systems [30]. Lean-based cost containment offers a pragmatic and scalable approach for hospital managers to address inefficiencies within their control, particularly in resource-constrained environments. By aligning clinical workflows with reimbursement structures, hospitals can mitigate financial losses while maintaining quality and safety standards.

The combined application of ABC and lean management represents a methodological strength of this study. ABC provides granular cost visibility at each activity level, enabling precise identification of cost drivers, while lean analysis contextualizes these costs within process flows to distinguish value-added from non–value-added activities [31]. This integrated framework allows hospitals to quantify financial gaps, prioritize improvement initiatives, and evaluate the economic impact of process redesign in a systematic manner. Recent literature increasingly supports such hybrid approaches as essential for managing complex surgical services under bundled payment systems [32].

Overall, the findings contribute to the growing body of evidence that lean-based cost containment, supported by accurate costing methods such as ABC, is critical for enhancing the financial and operational sustainability of hospital surgical services. For soft tissue tumor management, where clinical complexity and resource intensity are high, the adoption of lean principles offers a viable pathway to balance cost efficiency, service quality, and patient-centered care. Future studies should explore the longitudinal impact of lean interventions on cost recovery, clinical outcomes, and patient satisfaction, as well as their scalability across different surgical specialties and hospital settings.

5. Conclusion

This study demonstrates that soft tissue tumor surgical services operate under a substantial financial deficit resulting from a pronounced mismatch between actual unit costs and INA-CBGs reimbursement rates. The low Cost Recovery Rate clearly indicates that the current service delivery model is economically unsustainable in the absence of systematic efficiency improvements. These findings highlight the structural vulnerability of complex surgical services within prospective payment systems that do not fully account for clinical complexity and resource intensity.

The application of Activity-Based Costing provided granular insight into the true cost structure of soft tissue tumor management, enabling precise identification of major cost drivers across the care pathway. Concurrently, lean management analysis revealed waiting waste as the dominant source of inefficiency, particularly within preoperative and operating room

processes. This combination of financial and process-based analysis offers a comprehensive understanding of how operational inefficiencies translate into financial losses.

The implementation of lean-based strategies such as optimizing operating room scheduling, standardizing clinical pathways, and strengthening multidisciplinary coordination emerges as a practical and scalable approach to cost containment. Importantly, these interventions focus on waste elimination and value optimization rather than indiscriminate cost reduction, thereby preserving service quality, patient safety, and clinical outcomes. Such an approach aligns with the principles of value-based healthcare and supports sustainable performance improvement in surgical services.

Overall, the findings underscore the critical role of process-based efficiency improvements as a core strategy for achieving financial sustainability in hospital surgical services operating under constrained reimbursement systems. Policymakers and hospital managers are encouraged to integrate lean management principles into routine hospital operations and performance management frameworks. Doing so may enhance alignment between reimbursement mechanisms and service delivery realities, strengthen hospital resilience, and support the long-term sustainability of high-complexity surgical care within the Indonesian healthcare system.

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