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Method

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A clinical service line investment recovery framework for medical equipment: method specification and a retrospective records-based feasibility application

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Abstract

Objectives: Hospitals may not preserve the assumptions approved for medical-equipment purchases alongside post-adoption financial and value outcomes. We specified a clinical service line (CSL) investment recovery framework and examined its initial feasibility using routine hospital records.

Methods: Targeted mapping of health technology assessment (HTA), lifecycle HTA, management accounting, and organizational learning concepts was followed by internal logic checks. A retrospective records-based application was conducted for one purposively selected 4 K arthroscopy camera-head investment at a Japanese acute-care hospital. Aggregate fixed-asset, lease, and claims records were analyzed descriptively without patient-level data or causal attribution.

Results: The framework links CSL definition, pre-adoption commitments, annualized investment burden (AIB), contribution margin (CM), evidence status, allocation, value guardrails, and feedback. The 72-month lease had a total value of JPY 4,728,240 and a minimum documented annual burden of JPY 788,040. Shoulder arthroscopy volume increased from 220 to 245 procedures (11.4 percent), and nominal procedure-fee revenue increased from JPY 102.8 million to JPY 114.9 million (11.8 percent) between 12-month periods. Planned values, variable costs, direct use logs, and prespecified quality or access indicators were unavailable; CM-based recovery metrics could not be calculated. The documented annual burden equaled JPY 31,522 per observed additional procedure, or 6.52 percent of the observed revenue increase under full attribution.

Conclusions: The framework operationalizes hospital-level post-adoption and lifecycle HTA as an auditable CSL process. The application demonstrated partial data availability and identified fields that must be preserved prospectively; it did not establish causality, actual recovery, acceptability, or decision impact.

Introduction

Hospitals purchase major medical equipment to expand clinical capability, shorten time to diagnosis or treatment, maintain emergency coverage, and support specialist services. At approval, clinical departments usually present clinical need and projected activity, while management reviews purchase or lease cost, maintenance, staffing, and reimbursement. After adoption, however, the original assumptions about cases, revenue, contribution margin (CM), quality, and recovery period may no longer be available in the same unit in which the investment was justified. The resulting gap is a hospital-internal health technology assessment (HTA) problem: how should an adoption hypothesis be preserved, tested, and returned to the next capital-allocation decision?

Department-level accounting is often too coarse for this task. A department is an administrative and personnel unit, whereas a patient pathway may cross imaging, operating rooms, wards, rehabilitation, and post-discharge services. Clinical service line (CSL) management offers a unit closer to a patient group and care pathway than a formal department (1). Value-based health care likewise emphasizes outcomes that matter to patients in relation to the resources required to achieve them (2). Financial recovery is therefore relevant to organizational sustainability, but it is not sufficient evidence that an investment generated value for patients, healthcare professionals, the organization, or the health system.

The internationally developed definition of HTA describes a multidisciplinary process that determines the value of a health technology at different points in its lifecycle to inform decision making (3). Lifecycle HTA (LC-HTA) extends this logic by connecting sequential assessment activities when evidence, the technology, or its context may change over time (4–6). Medical equipment is a natural application because utilization, staff learning, maintenance, reimbursement, and clinical pathways can change after purchase. A hospital-level method is needed to convert the assumptions approved at adoption into a planned post-adoption evidence record.

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Japan provides a useful implementation setting because universal health insurance, regulated fees, emergency-care obligations, regional planning, and public statistics shape hospital investment decisions (7). The procedural problem is nevertheless international. Public claims or equipment datasets may be available in some countries and absent in others, whereas most hospitals retain at least contracts, asset records, activity data, and accounting records. This study therefore had two objectives: to specify a CSL Investment Recovery Framework (CSL-IRF) as a hospital-level post-adoption component of LC-HTA, and to examine initial data and calculation feasibility through a retrospective application using routine aggregate hospital records.

Conceptual position within HTA

National or payer-level HTA does not directly answer hospital-specific questions about local capacity, shared equipment, staffing constraints, referral geography, and competition for capital across clinical programs. Hospital-based health technology assessment (HB-HTA) and mini-HTA support local adoption decisions by combining general evidence with hospital context and implementation requirements (8–11). The CSL-IRF is not a substitute for these approaches. It adds a post-adoption layer that retains the approved CSL hypothesis and returns AIB, CM, allocation, value indicators, and evidence status to reassessment and renewal decisions. This responds to the continuing difficulty of measuring the effects and repercussions of local HTA when follow-up and comparable baselines are inconsistently documented (12).

The framework is complementary to LC-HTA rather than equivalent to it. LC-HTA connects assessment activities across time and requires the decision problem, activity sequence, and optimization criteria to be specified prospectively (4–6). Within that broader process, the CSL-IRF operationalizes one hospital-level sequence: approval, evidence-field preservation, post-adoption measurement, reassessment, and feedback to the next investment. Coverage with evidence development contributes the logic of conditional use with planned evidence generation (13;14), while health technology reassessment and disinvestment support renewal, replacement, scale-down, or withdrawal decisions for technologies already in use (15;16). Value-based procurement adds lifecycle cost, maintenance, training, utilization, and outcomes to the purchasing decision (17;18).

Implementation also depends on leadership, data infrastructure, multidisciplinary participation, and integration with existing hospital decision processes, which remain recognized barriers in HB-HTA (19). The CSL-IRF addresses a related information-asymmetry problem. Executives are accountable for capital allocation and organizational sustainability, whereas clinical applicants hold more detailed knowledge of need, demand, and workflow. Agency theory explains the risk of forecasts that will not later be reviewed in the same responsibility unit (20;21). Organizational learning requires results to be compared with the assumptions that produced action, so that the rules themselves can be revised (22).

Management accounting, capital budgeting, and time-driven activity-based costing provide tools for responsibility units, annual burden, margin, and progressively finer cost attribution (23–26). The balanced scorecard supports joint financial and nonfinancial monitoring but does not by itself preserve an equipment-specific investment hypothesis, allocation responsibility, and evidence status (27). The CSL-IRF is therefore intended as a learning and accountability system, not a punitive scorecard.

Methods

Framework development and source mapping

Framework development followed four steps: problem specification; targeted mapping of source domains that contributed a design requirement; construction of indicators, allocation rules, evidence-status labels, value guardrails, and governance triggers; and internal logic testing. The source domains were CSL management and value-based health care; HTA, HB-HTA, mini-HTA, and LC-HTA; coverage with evidence development, reassessment, disinvestment, and value-based procurement; management accounting and capital budgeting; time-driven activity-based costing; agency theory; organizational learning; and external health-system statistics. A targeted update of the current HTA definition and LC-HTA literature was completed on 20 August 2026. This was not a systematic or scoping review, and the mapping should be interpreted as a transparent design rationale rather than an exhaustive evidence synthesis. Search concepts, mapping boundaries, and component-level traceability are provided in Supplementary File 1.

Framework specification and internal checks

The artifact was specified around a fixed CSL definition; pre-adoption activity, revenue, variable-cost, value, and allocation hypotheses; post-adoption measurement using the same definitions; and governance action. Internal checks examined double counting between depreciation and lease payments, confusion between total and incremental CM, counterfactual status, shared-asset allocation, quality or access deterioration despite favorable finance, and sensitivity to burden, demand, and margin assumptions. Synthetic calculations were retained as boundary tests and moved to Supplementary File 1; they were not treated as empirical validation.

Retrospective records-based feasibility application

A retrospective application was conducted at one acute-care hospital within Fukujukai Medical Corporation. Three non-retired medical-equipment assets suggested by the study team were purposively screened from the asset list available in February 2026 because they appeared mappable to a CSL. This was an exploratory sample rather than a census of investments. A leased 4 K arthroscopy camera head linked to shoulder arthroscopy was selected because the asset and lease record and corresponding procedure activity could be identified for 12 months before and after its August 2025 introduction.

Available sources were the asset and lease record and aggregate claims-based procedure statistics. The pre-implementation period was 1 August 2024, through 31 July 2025, and the post-implementation period was 1 August 2025, through 31 July 2026. The same reimbursed procedure items were used in both periods; automobile-liability and workers' compensation cases were excluded. Revenue represented nominal procedure-fee revenue only, not total episode or service-line revenue. A reimbursement revision occurred during the post-implementation period; revenue was therefore treated as a secondary descriptive measure. No patient identifiers, patient-level records, or clinical outcomes were accessed.

The application first assessed whether each minimum framework field could be retrieved: original application and planned values, contract and annual burden, activity and revenue, variable cost, committed and actual-use allocation, and value indicators. Available values were summarized descriptively. Because variable costs and original planned CM were unavailable, actual CM, contribution

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margin ratio (CMR), investment burden coverage ratio (IBCR), and ex-post performance ratio (EPR) were not estimated. Instead, the minimum required CM per observed additional procedure and an attribution-margin threshold were calculated. No statistical test or causal before-and-after claim was made.

Results

Framework architecture

The CSL-IRF links a pre-adoption decision record to post-adoption measurement and the next investment decision (Figure 1). Intended users include hospital executives, clinical and CSL leaders, finance and fixed-asset staff, management-planning units, clinical engineering, operating-room or imaging managers, and quality teams. Minimum internal inputs are the investment application, CSL definition, asset or lease record, activity data, revenue and variable-cost data, an allocation rule, and prespecified value indicators. External claims, registry, equipment-capacity, or regional data are optional contextual inputs rather than mandatory components or automatic thresholds.

At application, the hospital records the target CSL and patient group, expected cases, revenue, variable cost, planned CM, AIB, review timing, value indicators, and ex-ante allocation weights. After adoption, the same definitions are used for observed activity, revenue, variable cost, CM, AIB, allocation, and value status. At reassessment, deviations are classified as demand or referral shortfall, staffing or slot constraint, reimbursement or material-cost change, allocation mismatch, or a value-related restriction. The finding is then linked to continuation, remediation, reallocation, scale-down, replacement, or renewal.

Financial and value-governance indicators

For CSL s, AIB is defined as the annualized accounting burden allocated from equipment or contract e. It includes depreciation D_e, maintenance M_e, lease cost L_e, update or upgrade cost U_e, and annualized installation or training cost F_e, with CSL allocation weight $w_{e,s}$. Thus, CSL-specific AIB is $\mathrm{AIB}_s = \sum_e w_{e,s}(D_e + M_e + L_e + U_e + F_e)$.

AIB is an accounting view of annual burden rather than cash flow. Depreciation and lease cost are mutually exclusive for the same component, and mixed arrangements must be itemized. When new dedicated fixed operating costs are required, they should be recorded separately or added to an expanded recovery denominator.

CSL-specific CM is revenue R_s minus variable cost VC_s, or $\mathrm{CM}_s = R_s - \mathrm{VC}_s$. Variable cost includes materials, drugs, outsourced tests, consumables, and other costs that vary with cases; depreciation and fixed staff cost are not included in this definition. For a new expansion investment, the preferred numerator is incremental CM, defined as post-investment CM minus the counterfactual CM that would have occurred without the investment: $\Delta\mathrm{CM}_{s,t} = \mathrm{CM}_{\mathrm{post},s,t} - \mathrm{CM}_{\mathrm{counterfactual},s,t}$.

Counterfactual CM cannot be generated by framework logic alone. A credible strategy may use a prespecified pre-period trend, matched comparator, interrupted time series, or capacity-adjusted baseline. Tier 1 denotes a defensible incremental-CM analysis. Tier 2 denotes planned-versus-observed commitment tracking and must not be interpreted causally. If even the original plan is unavailable, the application is classified as a data-feasibility assessment rather than a completed Tier 2 review.

The CMR is $\mathrm{CMR}_s = \mathrm{CM}_s / R_s$. Required additional revenue to cover the annualized burden is $R_{\mathrm{req},s} = \mathrm{AIB}_s / \mathrm{CMR}_s$. If case-level CM is $\mathrm{CM}_{\mathrm{case},s}$, the break-even volume is $Q_{\mathrm{BE},s} = \mathrm{AIB}_s / \mathrm{CM}_{\mathrm{case},s}$. For expansion investments, $\mathrm{IBCR}^{\mathrm{inc}}_{s,t} = \Delta\mathrm{CM}_{s,t} / \mathrm{AIB}_{s,t}$. For replacement or continuity investments, total CSL CM may be used as a supplementary numerator, $\mathrm{IBCR}^{\mathrm{total}}_{s,t} = \mathrm{CM}_{s,t} / \mathrm{AIB}_{s,t}$. An IBCR below 1.0 means that CM has not covered the annualized accounting burden during that period; it does not automatically mean that cash flow is negative because AIB contains depreciation.

Margin of safety (MOS) compares observed volume with break-even volume as $\mathrm{MOS}_{s,t} = \left(Q_{\mathrm{obs},s,t} - Q_{\mathrm{BE},s,t}\right) / Q_{\mathrm{obs},s,t}$. The EPR

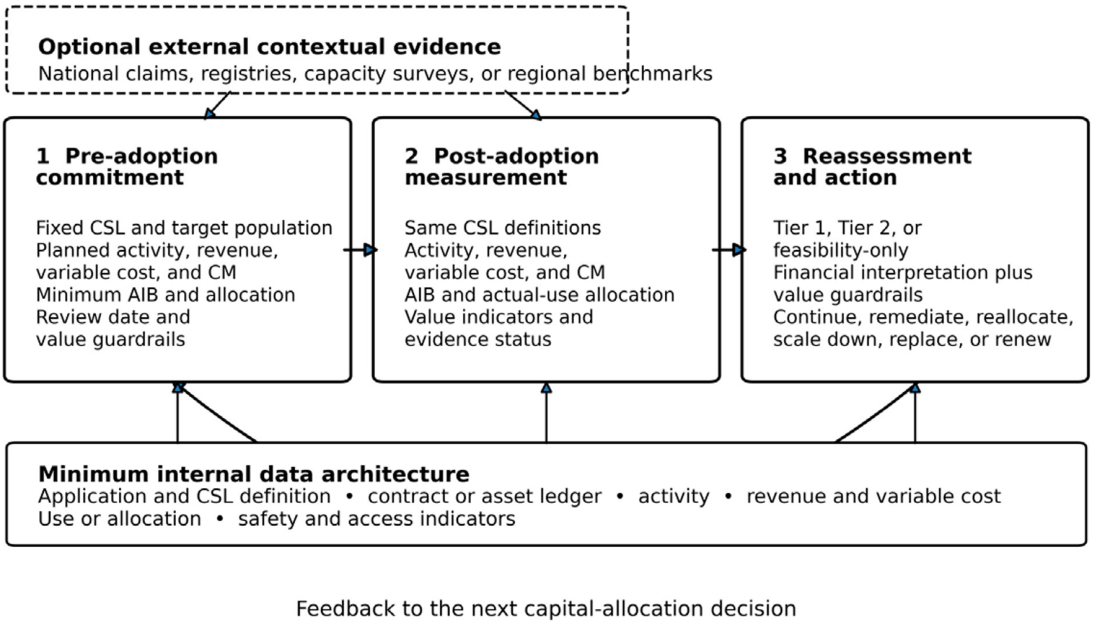


Figure 1. Clinical service line investment recovery framework architecture. The clinical service line investment recovery framework (CSL-IRF) links a fixed pre-adoption clinical service line (CSL) hypothesis to post-adoption measurement, reassessment, governance action, and feedback to the next capital decision. Optional external evidence can refine assumptions but does not replace minimum hospital records. AIB, annualized investment burden; CM, contribution margin.

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compares observed cumulative CM with the planned CM hypothesis stored at approval: $\mathrm{EPR}_{s,t} = \frac{\sum_{\tau=1}^{t} \mathrm{CM}_{\mathrm{obs},s,\tau}}{\sum_{\tau=1}^{t} \mathrm{CM}_{\mathrm{plan},s,\tau}}$. Here, $\mathrm{CM}_{\mathrm{plan}}$ is the planned contribution-margin hypothesis; it is distinct from committed allocation weight. The cumulative gap is $G_{s,t} = \sum_{\tau=1}^{t} \left(\mathrm{CM}_{\mathrm{obs},s,\tau} - \mathrm{CM}_{\mathrm{plan},s,\tau}\right)$.

Shared assets create a second allocation problem. If only observed use is used to allocate AIB, a CSL that requested the equipment but did not use it can lose all responsibility for the original investment hypothesis. The CSL-IRF therefore stores ex-ante committed allocation separately from ex-post actual-use allocation. Committed AIB is $\mathrm{AIB}_{s}^{\mathrm{commit}} = \sum_{e} w_{e,s}^{\mathrm{commit}} (D_e + M_e + L_e + U_e + F_e)$. Actual-use AIB is $\mathrm{AIB}_{s,t}^{\mathrm{actual}} = \sum_{e} w_{e,s,t}^{\mathrm{actual}} (D_e + M_e + L_e + U_e + F_e)$. Table 1 summarizes the financial indicators.

Financial recovery is necessary for sustainability but is not sufficient evidence of value realization. The framework therefore retains separate value domains for patients, healthcare professionals, the organization, and the health system or society (Table 2). Safety and access indicators act as veto gates: favorable financial results cannot support expansion or renewal while a prespecified guardrail is breached. Workforce capability, public service, equity, and environmental sustainability are reported alongside financial recovery rather than collapsed into an unvalidated composite score.

Decision-making and reassessment process

The review sequence begins with evidence status. If a credible counterfactual was prespecified, incremental CM and incremental IBCR may be interpreted under Tier 1 assumptions. If only planned and observed values are available, Tier 2 supports accountability but not causal inference. If planned fields, costs, allocation, or value indicators are missing, the first output is a data-availability map showing which decisions cannot yet be supported. Governance action follows cause classification rather than a single threshold. Illustrative triggers and synthetic boundary tests are provided in Supplementary File 1 and require local calibration.

Retrospective records-based feasibility application

Of the three purposively screened assets, one could be linked to both an asset and lease record and comparable pre- and post-implementation procedure statistics. The selected 4 K arthroscopy camera head had a 72-month lease, a total contract value of JPY 4,728,240, and a documented annual lease component of JPY 788,040. Separate maintenance, update, installation, and training costs were not identifiable, so JPY 788,040 was treated as the minimum documented AIB rather than a complete AIB estimate.

Shoulder arthroscopy activity increased from 220 procedures in the pre-period to 245 in the post-period, a difference of 25 procedures or 11.4 percent. Nominal procedure-fee revenue increased from JPY 102,782,400 to JPY 114,863,400, a difference of JPY 12,081,000 or 11.8 percent. Mean procedure-fee revenue per procedure changed only from JPY 467,193 to JPY 468,830, an increase of 0.35 percent. Figure 2 shows the descriptive period comparison.

The original investment application, planned activity, planned CM, committed allocation, service-line variable costs, direct equipment-use logs, and prespecified quality or access indicators were not available in the records assembled for this application. A claims-based volume proxy suggested that shoulder procedures comprised 245 of 255 potentially related arthroscopy procedures, but it did not establish actual equipment use and was retained only as a supplementary sensitivity input. Consequently, actual CM, CMR, IBCR, EPR, and value-gate status were not calculated.

Let a denote the proportion of the observed procedure-fee revenue increase attributable to the equipment, m the CMR on that attributable revenue, ΔR the observed revenue increase, and $A_{\min}$ the minimum documented annualized investment burden (AIB). Break-even requires $a m \Delta R \geq A_{\min}$.

Table 1. Financial indicators for CSL-level investment monitoring

Indicator	Definition	Primary use	Interpretation boundary
AIB	Allocated annual depreciation or lease cost plus maintenance, updates, and annualized installation or training	Annual accounting burden of the investment	Not initial cash outflow; owned and leased components must not be double counted
CM	Revenue minus variable cost	Contribution before fixed burden	Requires a consistent service-line variable-cost definition
Incremental CM	Observed CM minus counterfactual CM	Preferred numerator for expansion investments	Requires a prespecified and defensible counterfactual (Tier 1)
CMR	CM divided by revenue	Links required revenue to AIB	Interpret only with the same revenue and variable-cost scope
IBCR	Eligible CM divided by AIB	Whether CM covers annual accounting burden	IBCR <1 does not by itself establish negative cash flow
EPR	Observed cumulative CM divided by planned cumulative CM	Commitment tracking against the approved plan	Not causal; cannot be calculated if planned CM was not preserved
Allocation	Committed allocation and actual-use allocation retained separately	Responsibility and realized use of shared assets	A proxy based on procedure share is not a direct equipment-use measure
Evidence status	Tier 1, Tier 2, or data-feasibility assessment	Prevents overinterpretation	The label is part of the result, not a quality score

Note: AIB, annualized investment burden; CM, contribution margin; CMR, contribution margin ratio; CSL, clinical service line; EPR, ex-post performance ratio; IBCR, investment burden coverage ratio.

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Table 2. Value domains retained alongside financial recovery

Value domain	Example indicators	Minimum evidence	Governance role
Patient clinical value	Safety events, technical success, patient-relevant outcomes	Prespecified clinical or safety source	Safety deterioration can veto expansion or renewal
Access and equity	Waiting time, cancellations, geographic or underserved-group access	Administrative or access measure using a stable definition	Access deterioration can trigger remediation despite favorable finance
Healthcare professionals	Workload, touch time, training, technical capability, retention	Staffing, workflow, or competency record	Supports workforce planning and identifies hidden operating burden
Organization	Capacity, emergency coverage, referrals, teaching, strategic capability	Operational or strategic indicator defined before adoption	Makes nonfinancial organizational value auditable
Health system, society, and CSR	Regional availability, public-service role, equity, transparent stewardship	Locally selected public-value indicator	Supports accountability without automatically monetizing public value
Environmental sustainability	Energy, consumables, waste, equipment life, maintenance or reuse	Prespecified environmental measure where feasible	Reported as a separate domain; no universal composite score is assumed

Note: CSR, corporate social responsibility; Candidate indicators should be selected before adoption and interpreted within the local decision context.

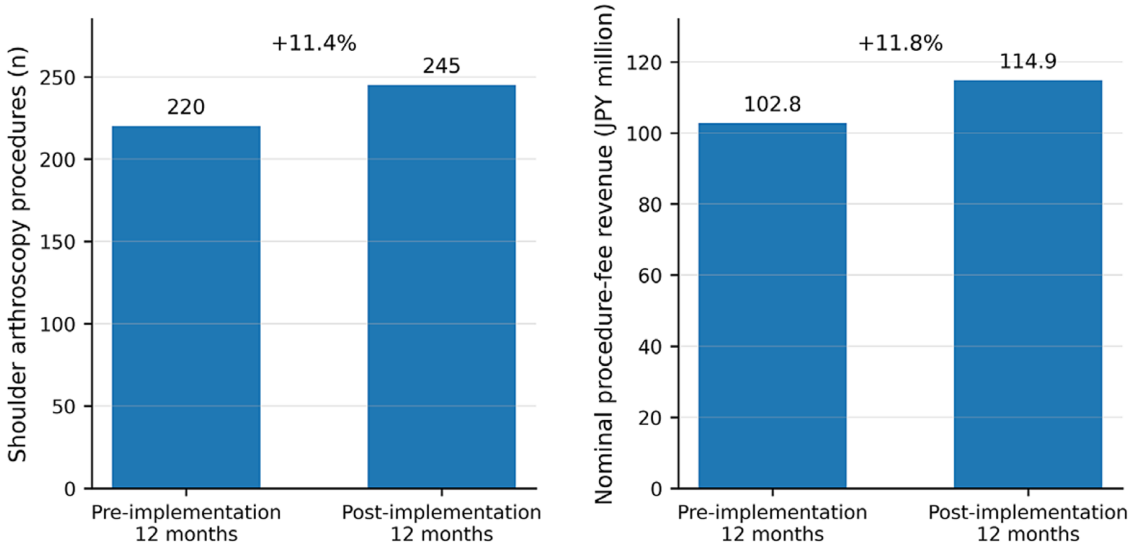


Figure 2. Descriptive retrospective application to the selected equipment investment. Shoulder arthroscopy procedure count and nominal procedure-fee revenue are shown for the 12 months before and after the August 2025 lease start. Revenue represents the selected reimbursed procedure items, not total episode or service-line revenue, and the post-implementation period included a reimbursement revision. Differences are descriptive and are not attributed causally to the equipment.

With $A_{\min}$ = JPY 788,040 and ΔR = JPY 12,081,000, the condition becomes $am \geq \frac{A_{\min}}{\Delta R} = 0.0652$ under the full documented annual lease burden.

Equivalently, if all twenty-five additional procedures were attributable to the equipment, the required CM was JPY 31,522 per additional procedure. These are recoverability thresholds, not evidence that the camera caused the observed increase or that the investment recovered its cost. Table 3 summarizes available fields, calculations, and unresolved outputs.

Discussion

The study combined method specification with a limited real-world application. Routine records were sufficient to identify the lease, a minimum annual burden, and comparable procedure activity, but they were insufficient to reconstruct the approved investment hypothesis, variable costs, actual-use allocation, or value guardrails. The framework could therefore generate a transparent recoverability threshold and a data-gap map, but not an actual CM-based recovery judgment. This result illustrates why post-adoption evaluation must begin at approval rather than be reconstructed only after performance becomes a concern.

The CSL-IRF fits within LC-HTA as a hospital-level post-adoption monitoring and reassessment module. LC-HTA emphasizes change over time and connected, prospectively sequenced assessment activities (4–6). The present application shows the practical consequence when that sequence is absent: contract and activity records remain, while the decision hypothesis and optimization criteria needed for reassessment cannot be recovered. The framework's contribution is therefore not to replace HB-HTA, mini-HTA, or LC-HTA, but to make their post-adoption evidence commitments operational within hospital accounting and governance.

Value generation extends beyond financial recovery. Patients may benefit through safety, outcomes, access, or shorter waits; professionals may gain or lose workload capacity and technical capability; organizations may strengthen emergency, referral, teaching, or regional functions; and health systems may gain equity or public-service value. A structured post-adoption record can also contribute to corporate

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Table 3. Retrospective field availability and feasible outputs for the selected investment

Framework field or output	Availability	Observed record or result	Analytical consequence
CSL, technology, and observation periods	Available	Asset/lease record and aggregate claims mapping	Single-investment application and comparable 12-month periods
Contract total and lease term	Available	JPY 4,728,240; 72 months	Contract burden documented
Minimum documented AIB	Available with limitation	JPY 788,040 per year	Minimum annual lease component; full AIB may be higher
Procedure activity	Available	220 before; 245 after	Descriptive difference: +25 procedures (+11.4%)
Nominal procedure-fee revenue	Available with limitation	JPY 102.8 million before; JPY 114.9 million after	Secondary descriptive difference; post-period included fee revision
Original planned values and committed allocation	Unavailable in records assembled	No planned activity, CM, review date, or allocation recovered	EPR and completed Tier 2 review not feasible
Variable costs and CM	Unavailable	Procedure-fee revenue only	Actual CM, CMR, and IBCR not feasible
Direct equipment-use log	Unavailable	245/255 procedure share retained only as sensitivity information	Actual-use allocation not established
Prespecified safety and access indicators	Unavailable	No value-gate fields recovered	Value-gate status not feasible
Recoverability threshold	Feasible	JPY 31,522 per observed additional procedure; attribution × CMR ≥6.52%	Threshold only; no causal or recovery claim

Note: AIB, annualized investment burden; CM, contribution margin; CMR, contribution margin ratio; CSL, clinical service line; EPR, ex-post performance ratio; IBCR, investment burden coverage ratio. Values are aggregate and non-person-level.

social responsibility by making these commitments and results auditable rather than leaving them as unsupported narratives. Environmental sustainability is an emerging HTA domain, but international practice remains heterogeneous and data intensive (28). The CSL-IRF therefore allows prespecified environmental measures, such as energy use, consumables, waste, or equipment life, to be reported as a separate value domain without claiming a universal method or converting them automatically into a financial score.

International transferability lies in the procedure and minimum data architecture rather than Japanese thresholds. Hospitals without national claims or equipment surveys can still begin with contracts, asset ledgers, activity counts, revenue, variable costs, use logs, and locally selected value indicators. External public data are an optional plausibility layer. The Japanese facility, cost, claims, and inpatient data sources retained in the supplement illustrate this optional layer rather than mandatory inputs (29–32). Reimbursement structure, accounting treatment, data ownership, and value priorities must be adapted locally, but the sequence remains portable: define the CSL, preserve planned values, state allocation and counterfactual assumptions, measure with the same definitions, apply value guardrails, and return the result to the next decision.

The feasibility application also changes the recommended implementation order. A minimal prospective record should first preserve the CSL definition, planned activity, planned revenue and variable cost, planned CM, documented AIB components, committed allocation, review date, and at least one safety and one access indicator. More complex costing or counterfactual methods can be added later. This staged approach reduces data burden while preventing the specific failure observed here, in which actual recovery metrics could not be reconstructed because the numerator, plan, and guardrails were never stored together.

Several limitations remain. The empirical component was a single, purposively selected case from one hospital and was not a census of investments. The before-and-after comparison was descriptive, included a reimbursement revision in the post-period, and did not control for staffing, referral, scheduling, or other concurrent changes. Procedure-fee revenue was not total service-line revenue, variable costs were unavailable, and the full AIB may exceed the documented annual lease component. No direct equipment-use log or patient outcome was used. The study did not evaluate face validity through an expert panel, user acceptability, threshold calibration, decision impact, or clinical and organizational outcomes. Finally, targeted conceptual mapping was not a systematic review. Multicenter retrospective and prospective studies should next test field completion, calculation reproducibility, counterfactual feasibility, burden, fairness, and whether the framework changes renewal or expansion decisions.

Conclusions

The CSL-IRF specifies an auditable hospital process that connects a CSL-level adoption hypothesis to annualized burden, margin, allocation, value guardrails, reassessment, and the next capital decision. Its initial real-world application showed that routine records can support part of the process, while missing planned values, variable costs, use logs, and value indicators prevent a complete recovery assessment. Prospective preservation of these fields is therefore a prerequisite for credible post-adoption and lifecycle HTA. The study does not establish that the selected investment caused higher activity or recovered its cost.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1017/S0266462326104358.

Data availability statement. The aggregate service-line summary, field-availability audit, threshold calculations, public-data extract, synthetic scenario inputs, and Python code used to generate the figures are provided in Supplementary File 2. Source contracts and internal administrative records are not publicly shared because they contain commercially and operationally sensitive information. No patient-level data were used.

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Author contribution. T.S. and N.K. contributed to the conception and design of the framework; T.S. contributed to source mapping, aggregate hospital-record extraction and verification, calculations, data curation, visualization, supplementary material preparation, and drafting; N.K. contributed to clinical and hospital-management interpretation, methodology refinement, supervision, and substantive editing. Both authors reviewed and approved the final revised version and agree to be accountable for all aspects of the work.

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Competing interests. The authors declare none.

Ethical standards. The retrospective feasibility application used only aggregate, non-person-level service-line activity, procedure-fee, asset, and lease data and involved no human participants, patient identifiers, clinical outcomes, individual-record linkage, or participant contact. Research ethics committee review and informed consent were therefore not applicable.

Use of artificial intelligence tools. OpenAI ChatGPT was used for English translation support and editorial drafting. The authors selected and verified the sources and hospital data, checked the calculations, revised the text, and take responsibility for the interpretation, references, figures, code, and final manuscript. Artificial intelligence tools were not treated as authors and did not generate or alter empirical hospital data.

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