Medical Device Service Contract Comparative Analysis

Hamid Hatami[1], Joël Brose[2]

[1] *Ottawa-Carleton Institute for Biomedical Engineering (OCIBME), Ottawa, Canada, hhata090@uottawa.ca*
[2]*Supervisor; Department of Biomedical Engineering, The Ottawa Hospital, Ottawa, Canada, jbrose@toh.ca*

Abstract— **This study evaluates service contracts for medical equipment maintenance, focusing on the Total Cost of Ownership (TCO) as a key factor in decision-making for healthcare facilities. Through a comparative analysis of Full-Service, Shared Service, and Parts-Only contracts, this research examines their financial and operational impacts. A tool was developed to standardize data collection, normalize costs, and enable value-based comparisons. The findings emphasize the significance of internal resource capabilities, OEM support, and contract scalability in selecting optimal service models. Recommendations include adopting failure codes for work orders, standardizing maintenance data, capturing comprehensive contract criteria, implementing periodic contract evaluations, and establishing a national hospital network for sharing maintenance experiences. These strategies aim to improve the efficiency of service contract management and optimize TCO in maintaining medical equipment.**

Keywords— **Total Cost of Ownership, Service Contracts, Return on Investment, Medical Equipment Maintenance**

I. Introduction

After 10 years of being in service, medical equipment typically reaches the end of its lifecycle, requiring hospitals to consider and assess replacements based on clinical needs and technological advancements. This procedure includes selecting a suitable service and support model for maintaining devices like MRI machines, CT scanners, and ultrasound systems. Service contracts, often established with OEMs or ISOs, provide structured approaches to maintenance, ensuring safety, reliability, and compliance while transitioning hospitals from reactive to proactive maintenance strategies.

There are multiple contract types, the most common contracts include Parts-Only, Shared Service, and Full-Service agreements. Parts-Only contracts cover replacement parts, relying on in-house teams for labor. Shared Service models divide responsibilities between hospitals and the vendor, while Full-Service contracts offer comprehensive maintenance and reducing downtime.

Considering the significant financial and clinical implications, hospitals must evaluate contracts based on Total Cost of Ownership (TCO) and Return on Investment (ROI). TCO encompasses direct costs, like parts and labor, and indirect costs, such as downtime, to provide an extensive financial view. ROI measures the benefits relative to costs, highlighting long-term value. By aligning financial objectives with operational needs, hospitals can select contracts that optimize costs, enhance equipment performance, and improve patient outcomes.

II. Background

Hospitals face significant challenges in selecting service contracts for medical equipment especially Diagnostic imaging systems, due to both financial and operational considerations. Financially, the absence of structured evaluation processes often leads to overpaying for high-coverage contracts that exceed actual requirements. Conversely, choosing lower-coverage contracts can shift risks to the hospital, including unexpected repair costs, limited OEM support, and prolonged downtimes. Operationally, inadequate contracts may result in reduced uptime, compromised equipment reliability, and insufficient internal training, all of which hinder efficiency and patient care.

Existing literature highlights efforts to address these challenges. A study conducted in Czech healthcare facilities [1] demonstrated that operational and maintenance costs frequently exceed acquisition expenses, emphasizing the value of TCO in evaluating service contracts. However, its focus on specific devices, such as SPECT/CT scanners and ultrasounds, excluded fleet-based equipment and failed to analyze how contract types influence long-term costs.

Another framework introduced a risk-based decision-making[2] model for maintenance strategies, linking Total Biomedical Maintenance, Condition-Based Maintenance, and corrective approaches to equipment criticality. While this method provided insights into aligning maintenance strategies with operational needs, it lacked detailed cost comparisons of service contracts and their implications for TCO and ROI.

III. METHODOLOGY

This study employs a structured approach to evaluate service contracts for Diagnostic imaging systems by identifying cost components and developing a Total Cost of Ownership (TCO) tool. The methodology consists of three key components: service contract analysis, tool development, and cost evaluation.

Criteria	Description
Number of Systems	The total number of systems covered under the contract, influencing pricing and cost-sharing.
Term Length	The duration of the contract, which affects overall cost and flexibility.
Contract Cost	The direct cost of the Full-Service contract, covering labor, parts, and services.
Parts Not Included	Parts not covered under the contract, requiring separate purchase by the hospital.
Parts Included	Parts covered under the contract, reducing maintenance expenses.
Average Number of CM Calls	Frequency of unplanned corrective maintenance activities, crucial for cost estimation.
Average Response Time	Time taken by OEM technicians to respond to maintenance calls, affecting operational downtime.
OEM After-Hours CM Time	Availability and costs of maintenance services provided outside normal working hours.
OEM After-Hours Hourly Rate	Costs incurred for after-hours maintenance, varying between service providers.
Inflation	Expected inflation rate over the contract term, impacting future costs.
Others	Additional criteria specific to certain equipment or hospital requirements.
Discounts	Discounts offered for long-term contracts, bundled services, or promotions.
Life Cycle	The expected lifespan of the equipment, affecting long-term maintenance costs.
Software Updates	Inclusion of periodic updates to ensure security and functionality of equipment.
Software Upgrades	Major software changes or enhancements included in the service contract.
Hardware Upgrades	Hardware advancements covered under the contract to keep equipment up to date.
Downtime Cost	Costs incurred due to equipment being out of service, affecting hospital operations.
Downtime Discount	Discounts provided when equipment downtime exceeds a specified threshold.

Table 1-Full-Service Criteria

A. Contracts

The analysis focuses on three service contract types—Full-Service, Shared-Service, and Parts-Only—each with distinct features and cost implications.

For better understanding and clarity, all captured data points were grouped into six main categories: System Information, Maintenance, Contracts, OEM Support, Upgrades, and Variables. Each type of contract has its own unique terms and conditions, which result in different cost items for each contract. Some criteria are contract-specific, such as the OEM regular hourly rate for a parts-only contract, as this would be covered under both shared and full contracts. However, some cost items are common across all contract types, such as the overall contract cost.

1) Full-service *(Table 1)* contracts provide comprehensive coverage, including preventive and corrective maintenance, parts, labor, and some upgrades. These contracts offer predictable costs and reduce administrative overhead, as vendors manage all maintenance tasks. However, they often involve higher upfront costs, limited flexibility, and a risk of over-coverage for equipment with minimal maintenance needs.
2) Shared-service contracts *(Table 2)* are collaborative agreements where the hospital's biomedical team handles routine maintenance and first response to corrective maintenance, while vendors manage complex repairs and provide support. These contracts balance cost and risk, offering flexibility to adjust services based on internal capabilities. However, they require skilled in-house teams and may involve longer downtimes for escalated repairs.
3) Parts-only *(Table 3)* contracts focus on providing replacement parts, leaving labor and maintenance tasks to the hospital's biomedical team. These contracts are cost-effective for facilities with strong internal capabilities but can lead to delays and higher costs for frequent or complex repairs.

B. Tool Development and Testing

Based on the criteria outlined in Tables 1, 2, and 3, an internal model was developed to evaluate the Total Cost of Ownership (TCO) for different service contracts. Initially created in Excel, the tool provided a structured framework for capturing and analyzing data. However, recognizing the limitations of Excel in terms of accessibility, formula integrity, and user consistency, the model was redeveloped using HTML to enhance usability and ensure data reliability. Separate modules were designed for each contract type, allowing for tailored analysis of Full-Service, Shared-Service, and Parts-Only contracts.

Criteria	Description
Number of Systems	The total number of systems covered under the contract, influencing pricing and cost-sharing.
Term Length	The duration of the contract, which affects overall cost and flexibility.
Contract Cost	The direct cost of the Shared-Service contract, covering labor, parts, and services.
Parts Not Included	Parts not covered under the contract, requiring separate purchase by the hospital.
Parts Included	Parts covered under the contract, reducing maintenance expenses.
OEM After-Hours CM Time	Availability and costs of maintenance services provided outside normal working hours.
OEM After-Hours Hourly Rate	Costs incurred for after-hours maintenance, varying between service providers.
Inflation	Expected inflation rate over the contract term, impacting future costs.
Others	Additional criteria specific to certain equipment or hospital requirements.
Discounts	Discounts offered for long-term contracts, bundled services, or promotions.
Life Cycle	The expected lifespan of the equipment, affecting long-term maintenance costs.
Software Updates	Inclusion of periodic updates to ensure security and functionality of equipment.
Software Upgrades	Major software changes or enhancements included in the service contract.
Hardware Upgrades	Hardware advancements covered under the contract to keep equipment up to date.
Biomed technologist Hourly Rate	The average hourly rate for a senior biomedical technologist involved in maintenance activities.
Average PM Time	The average time required to complete a preventive maintenance (PM) task for the equipment.
Training Cost	The cost incurred for training biomedical technicians, including course fees and other related expenses.
Number of Training	The total number of biomed technologists planned to undergo training.
License Fee	The annual fee paid to the OEM for renewing the license that authorizes technologists to work on and repair specific devices.
Phone Support	Costs associated with telephonic troubleshooting or guidance provided by the vendor.
Travel and Lodging	Expenses related to travel, accommodation, and meals for technologists during training.
Phantom and Tools	Costs of specialized tools or phantom devices required for calibration, testing, or maintenance.

Table 2-Shared-Service Criteria

To validate the proposed model, an Image-Guided Therapy System was selected as a test case. We divided Criteria into two group, Fixed and Variables. Fixed criteria represent parameters that remain constant, such as the contract cost, which is unaffected by operational factors like downtime or repair needs. Variable criteria, on the other hand, encompass elements that fluctuate, potentially increasing associated risks.

Criteria	Description
Number of Systems	The total number of systems covered under the contract, influencing pricing and cost-sharing.
Term Length	The duration of the contract, which affects overall cost and flexibility.
Contract Cost	The direct cost of the Shared-Service contract and parts.
Parts Not Included	Parts not covered under the contract, requiring separate purchase by the hospital.
Parts Included	Parts covered under the contract, reducing maintenance expenses.
OEM After-Hours CM Time	Availability and costs of maintenance services provided outside normal working hours.
OEM After-Hours Hourly Rate	Costs incurred for after-hours maintenance, varying between service providers.
Inflation	Expected inflation rate over the contract term, impacting future costs.
Others	Additional criteria specific to certain equipment or hospital requirements.
Discounts	Discounts offered for long-term contracts, bundled services, or promotions.
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Phone Support	Costs associated with telephonic troubleshooting or guidance provided by the vendor.
Travel and Lodging	Expenses related to travel, accommodation, and meals for technologists during training.
Phantom and Tools	Costs of specialized tools or phantom devices required for calibration, testing, or maintenance.
Number of OEM Regular visits	The total number of regular visits made by the OEM for maintenance or service.
OEM Regular CM time	The average amount of corrective maintenance (CM) time spent by the OEM during regular visits.
OEM Regular hourly rate	The hourly rate charged by the OEM for 9-5 corrective maintenance (CM) services.
Open Box Fee	The charge applied by the OEM when returning an unused, opened part, covering handling and restocking.

Table 3- Parts-only Criteria

1) Fixed and Variable Criteria: The testing phase identified four key variable criteria: internal corrective maintenance (CM) time, OEM CM time, number of systems, and number of technologist training. While OEM after-hours CM time was initially included, in this hospital setting, OEM after hours CM time is limited to emergencies only and has found not to be relevant in the calculation given the low values. This exclusion led to the assumption of a fixed annual number of hours for this criterion, ensuring that the model aligned with realistic operational conditions.

Criteria	Full-service	Shared-Service	Parts only
Life Cycle	10	10	10
Number of Systems	1	1	1
Biomed Technologist Average Hourly rate	N/A	55	55
Average PM time	N/A	21	21
Average CM time	N/A	50	50
Training cost	N/A	19500$	19500$
Travel and lodging	N/A	4000$	4000$
Number of Training	N/A	1	1
Phantom and tools	N/A	-	-
OEM Regular CM time	N/A	N/A	5
Number of OEM Regular visits	N/A	N/A	4
OEM Regular hourly rate	N/A	N/A	460
OEM after hours CM time	10	10	10
OEM after hours hourly rate	600	600	800
Phone support	N/A	N/A	Included
Contract Cost	58k$	33k$	15k$
Term length	5	5	5
License fee	N/A	N/A	Included
Parts included	-	-	-
Parts Not included	-	-	-
Software updates	-	-	-
Software upgrades	-	-	-
Hardware upgrades	24k$	24k$	24k$
Open Box Fee	N/A	N/A	
Inflation	-	-	-
Discounts	-	-	-
Down time cost	-	-	-
Down time discount	-	-	N/A
Others	-	-	-
Total Cost of Ownership Per Year	66k$	47k$	40k$

Table 4-Contract costs based on an internal formula.

Evaluation Parameters: *Table-4* summarizes the criteria and corresponding values used in the model testing for the three contract types.

C. Applications of the Model

The model offers two primary applications for hospitals and healthcare organizations:

1) Total Cost of Ownership (TCO) Calculation: The model enables the estimation of service costs and required budgets over the equipment's lifecycle. This provides decision-makers with a clear understanding of the financial implications of each contract type, facilitating accurate budget planning.
2) Value Comparison Among Contracts: By comparing the TCO across different service contracts, the model helps organizations align their contract selection with internal needs and desired service levels. This ensures a balance between operational efficiency and financial sustainability, supporting informed decision-making tailored to hospital-specific requirements.

IV. RESULTS

A. Effect of Individual Variable Changes on Total Cost of Ownership (TCO)

To evaluate the impact of individual variables on TCO, variables were adjusted independently while keeping all other criteria constant. This approach isolated the influence of each factor across the three contract types. *Table 5* summarizes the changes in TCO based on variations in OEM labor hours, the number of systems, training sessions, and corrective maintenance (CM) hours.

Variable Change		Contract Type		
		Full-Service	Shared-Service	Parts-Only
OEM Labour	20	63k	47k	40k
	35	63k	47k	48k
CM Hours	50	63k	47k	40k
	150	63k	53k	47k
#Systems	1	63k	47k	40k
	3	63k	46k	39k
#Training	1	63k	47k	40k
	3	63k	52k	45k

Table 5 - Effect of Individual Criteria (Contract cost in CAD$)

The analysis shows that increases in OEM labor hours under the Parts-Only contract can escalate costs to levels comparable to or exceeding those of the Shared-Service contract. This underscores the sensitivity of the Parts-Only contract to external labor inputs. Similarly, increasing the number of systems under contract demonstrates economies of scale, particularly for Parts-Only contracts, where the per-system cost is significantly reduced.

Increased number of Technologist trained, and internal CM hours also result in higher costs for both Parts-Only and Shared-Service contracts. However, despite these increases, the overall costs for these contracts remain lower than the Full-Service contract, which maintains a fixed-cost structure regardless of variable changes.

B. Impact of Collective Variable Changes on Total Cost of Ownership

Real-world scenarios often involve simultaneous changes in multiple variables due to dynamic operational needs and unexpected failures. To address this complexity, the combined effects of key variables were assessed. These included scenarios where both the number of systems and training sessions, internal and OEM labor hours, or all variables were adjusted collectively.

Variable Changes	Contract Type		
	Full-Service	Shared-Service	Parts-Only
#System & training	63k	47k	40k
	63k	47k	40k
OEM & Internal Labour	63k	47k	40k
	63k	53k	53k
All	63k	47k	40k
	63k	53k	53k

Table 6 - Effect of Collective Criteria (Contract cost in CAD$)

The results highlight the economies of scale achieved under Parts-Only and Shared-Service contracts when the number of systems and training sessions increase. Conversely, combined increases in internal and OEM labor hours result in substantial cost increases for these contracts, reflecting their reliance on labor inputs. The Full-Service contract remains unaffected by these changes due to its fixed-cost structure, making it less responsive to variable fluctuations but consistent in cost predictability.

C. Criteria Evaluation at Equal Cost

To facilitate value comparison among contract types, costs were normalized to the level of a Full-Service contract. This baseline allowed for a direct evaluation of the value and services provided under each contract type when operating at equivalent costs in 2 different scenarios to include scaling.

	Scenario 1		
	Full-Service	Shared Service	Parts only
OEM labour	N/A	N/A	35
Internal Labour	N/A	280	250
#Systems	1	1	1
#Training	N/A	3	3
Contract Cost	63k	63k	63k

Table 7 - Scenario 1 for 1 System

	Scenario 2		
	Full-Service	Shared Service	Parts only
OEM labour	N/A	N/A	40
Internal Labour	N/A	330	300
#Systems	3	3	3
#Training	N/A	4	3
Contract Cost	63k	63k	63k

Table 8 – Scenario 2 for 3 systems

The analysis reveals distinct differences in the value provided by each contract type. Parts-Only contracts offer minimal OEM labor support, emphasizing reliance on internal resources, which may not suit organizations needing substantial external assistance. Shared-Service contracts provide significantly higher internal labor hours, demonstrating superior scalability and adaptability for facilities managing larger equipment fleets or increasing operational demands.

Additionally, Shared-Service contracts include provisions for additional training as system numbers grow, enhancing their value for organizations with evolving operational and training needs. In contrast, Full-Service contracts remain static, offering comprehensive but inflexible coverage.

V. Recommendation

This study proposes the following recommendations to improve the management and evaluation of service contracts for medical equipment:

1. Incorporate Failure Codes into Work Orders: Integrating failure codes into work orders would provide critical insights into equipment performance and maintenance trends. These insights can refine decision-making processes and enhance the evaluation of service contracts.
2. Standardize Data Collection and Entry Processes Ensuring uniformity in data collection and entry across all service contract assessments is essential for accuracy and consistency. Standardization would enable more reliable comparisons and support informed, data-driven decisions.
3. Capture Detailed Maintenance Criteria: Hospitals should collect comprehensive data on maintenance activities, including parts used, associated costs, and the frequency and duration of OEM visits. This detailed information is crucial for accurately calculating the Total Cost of Ownership (TCO) and evaluating contract performance.
4. Establish an Internal Re-Evaluation System: Implementing a system for periodic review and re-evaluation of service contracts would allow hospitals to assess their performance and adapt to changing operational requirements, ensuring the contracts remain aligned with organizational goals.
5. Develop a Nationwide Data-Sharing Network Creating a system for hospitals to share equipment maintenance histories and experiences would promote best practices and enhance decision-making. Such collaboration would reduce risks related to unforeseen equipment failures and maintenance challenges.

VI. Conclusion

This study utilized a Total Cost of Ownership (TCO) framework to evaluate the financial and operational implications of Full-Service, Shared Service, and Parts-Only contracts for medical equipment maintenance. The findings underscore the importance of aligning contract selection with organizational priorities, balancing cost efficiency, operational flexibility, and resource optimization to maintain high standards of patient care.

The comprehensive coverage and predictability of Full-Service contracts make them ideal for facilities with limited internal resources or those prioritizing risk-free operations. However, their high costs and inflexibility reduce their appeal for hospitals with robust in-house capabilities. Shared Service contracts offer a cost-efficient and scalable solution, combining internal resource utilization with external OEM support. This flexibility makes them particularly valuable for organizations aiming to optimize in-house expertise while managing complex maintenance needs. Parts-Only contracts, while initially cost-effective, rely heavily on internal capabilities and may lead to higher long-term costs under dynamic operational demands.

By analyzing variable changes and their collective impact on TCO, the study highlights the adaptability of Shared Service contracts in managing costs and scaling effectively.

VII. Future work

Future research should expand the analysis to include additional service contract types, including hybrid models and no-contract options. For institutions that believe they can manage equipment maintenance entirely in-house, or for specific equipment or fleets where this approach is viable, the financial and operational feasibility of forgoing formal contracts should be assessed. Additionally, master agreements, which offer pre-negotiated terms for multiple systems or facilities, should be examined for their potential to streamline procurement and reduce costs while maintaining flexibility.

The framework should also incorporate fleet-based equipment analysis, addressing the unique cost dynamics and operational challenges of maintaining groups of devices such as infusion pumps or ventilators. This extension would provide a more nuanced understanding of economies of scale and the implications of collective maintenance needs, particularly in larger healthcare systems.

Integrating risk analysis into the Total Cost of Ownership (TCO) framework is another critical area for development. Quantifying risks associated with equipment failure, fluctuating maintenance demands, and operational uncertainties would allow hospitals to evaluate trade-offs between cost, reliability, and risk more effectively. This comprehensive approach would provide actionable insights, enabling institutions to tailor their contract strategies—including no-contract options and master agreements—to align with their specific resources, priorities, and operational goals.

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