



Optimizing Utilization of Cardiothoracic Surgical Facilities in Sri Lanka: A Cost-Benefit Analysis of Extending Operating Hours to Reduce Waiting Lists

Rajapaksha D.M.P.¹

¹Royal Liverpool University Hospital, United Kingdom

Correspondence to:

Dr. D.M.P. Rajapaksha

E-Mail

malalarajapaksha7@gmail.com

Key Words:

Cardiothoracic Surgery, Operating Theatre Utilization, Cardiac Catheterization Labs, Hospital Efficiency, Health Resource Optimization, Cost-Benefit Analysis, Quality-Adjusted Life Years (QALY), Non-Utilized Hours, Surgical Capacity, Healthcare Economics, Descriptive Analytical Study, Health System Performance

Abstract

This study investigates the underutilization of cardiothoracic theatres and cardiac catheterization labs in three major Sri Lankan hospitals: National Hospital Galle, Sri Jayewardenepura General Hospital, and National Hospital Jaffna. Using a descriptive analytical design, data on operational hours, surgery types, and staffing were collected to estimate potential efficiency gains from utilizing non-operational hours. Findings revealed over 16,864 non-utilized hours annually, which could enable ^{3,373} additional surgeries. These procedures would yield approximately 7,993.54 Quality-Adjusted Life Years (QALYs), translating to an economic benefit of nearly \$79.93 million. The study concludes that extending operational hours and involving healthcare professionals from other institutions could address surgical backlogs without the need for costly infrastructure expansion. Policy recommendations include extending theatre hours, contractual staff engagement, and incentivizing off-hour work. The findings highlight a cost-effective strategy to optimize healthcare delivery and improve access to life-saving procedures, ultimately enhancing patient outcomes and health system efficiency in Sri Lanka.

Introduction

The demand for cardiothoracic surgeries in Sri Lanka is steadily increasing, placing significant strain on the country's limited healthcare resources. [1] Cardiothoracic theatres (CTOTs) and cardiac catheterization laboratories (CCLs), which are essential for life-saving procedures such as coronary artery bypass grafting (CABG) and valve replacements, are mainly concentrated in Colombo, with some facilities also located in major cities like Galle, Jaffna, and Kandy. Despite the availability of these high-cost facilities, a substantial portion of the population faces long waiting times for critical surgeries. In some cases, patients die before receiving the required care due to the backlog and inefficiencies in the system.[2] A key contributor to this backlog is the underutilization of existing facilities. Most CTOTs and CCLs operate from 8:00 AM to 4:00 PM, leaving these expensive resources unused for the remainder of the day.

Sri Lanka's current financial constraints make the expansion of cardiothoracic surgical infrastructure, including the establishment of new theatres and catheterization laboratories, financially unfeasible. Thus, optimizing the

use of existing facilities is an essential solution to alleviate the pressure on the healthcare system and reduce the growing waiting list. This study aims to assess whether leveraging non-utilized hours in existing facilities, by employing healthcare staff from other institutions on a payment basis, can address the demand for cardiothoracic surgeries effectively. The concept is that rather than investing millions in new infrastructure, a portion of those funds could be used to pay staff who can perform surgeries in these non-utilized hours, effectively increasing the capacity of existing facilities.

This research paper will explore the utilization patterns of CTOTs and CCLs in selected hospitals in Sri Lanka and evaluate the potential for increasing surgical throughput by using non-operational hours. Furthermore, a cost-benefit analysis will be conducted to determine whether utilizing these idle hours is financially viable and beneficial for both the healthcare system and patients. By analyzing the possible reduction in waiting times and the financial implications of this approach, this study aims to provide a strategic framework to optimize healthcare resources and improve patient outcomes in Sri Lanka's cardiothoracic healthcare landscape.

Justification

The justification for this study stems from the urgent need to address inefficiencies in the use of existing cardiothoracic surgery facilities in Sri Lanka, particularly considering the current resource constraints facing the healthcare system. While the hospitals have state-of-the-art CTOTs and CCLs, these facilities remain significantly underutilized during non-operational hours. This underutilization leads to prolonged waiting lists, with patients often having to wait for life-saving surgeries for extended periods. In extreme cases, delays in receiving timely surgical intervention result in patient mortality, making this issue not only a logistical concern but a matter of life and death.

Given the current economic challenges faced by Sri Lanka, building new cardiothoracic facilities is neither practical nor financially sustainable. This creates a pressing need for a more efficient and cost-effective solution that maximizes the capacity of existing healthcare infrastructure. By conducting a thorough analysis of the non-utilized hours in CTOTs and CCLs, this study aims to demonstrate the feasibility of extending operating hours to address the growing demand for cardiothoracic surgeries. This approach would not only reduce waiting times but also improve patient outcomes by providing timely access to critical surgical care.

Furthermore, the proposed model of bringing in specialized healthcare staff from other institutions on a payment basis offers a flexible and scalable solution that does not require large-scale investments in infrastructure. This approach also provides an economic incentive for healthcare professionals, while ensuring that high-cost medical equipment and facilities are used to their full potential. By optimizing the use of these underutilized resources, hospitals can perform a significantly higher number of surgeries, addressing both the waiting list backlog and improving the overall efficiency of the healthcare system.

In addition to its potential clinical benefits, this study is crucial from a financial perspective. A cost-benefit analysis will reveal whether the monetary benefits of utilizing non-operational hours outweigh the costs associated with staff compensation. If viable, this approach could serve as a model for optimizing resources in other underutilized healthcare facilities across Sri Lanka, especially in specialties where demand far exceeds supply. The findings of

this study will also contribute to policymaking, offering a practical framework for improving healthcare delivery without incurring the high costs of new infrastructure development. Thus, the study holds both immediate and long-term significance for enhancing the efficiency and equity of healthcare in Sri Lanka.

Objectives

General Objective:

To evaluate the utilization of CTOTs and CCLs in Sri Lankan hospitals and determine the cost-effectiveness of extending non-operational hours to reduce waiting times for surgeries.

Specific Objectives:

1. To analyze the current utilization patterns, including total available hours, hours utilized, and hours left unused, in CTOTs and CCLs across selected hospitals in Sri Lanka.
2. To estimate the potential number of additional cardiothoracic surgeries that could be performed by using non-utilized hours and assess the impact on reducing the waiting lists.
3. To conduct a cost-benefit analysis of employing healthcare staff from other institutions to perform surgeries during extended hours and evaluate the financial viability and benefits of this approach.

Literature Review

The global demand for cardiothoracic surgeries and catheterization procedures continues to rise, placing significant pressure on healthcare systems to optimize the use of existing facilities. As these procedures are both resource- and time-intensive, many hospitals face challenges in meeting patient demand while maintaining operational efficiency. To address this, several hospitals worldwide have implemented strategies to optimize CTOTs and CCLs, aiming to increase throughput, reduce waiting times, and improve cost-effectiveness.[3]

Extended Operating Hours and Facility Optimization

One of the most common strategies to improve the utilization of CTOTs and CCLs is the extension of operating hours. Several hospitals in high-demand regions have successfully

adopted this approach. For instance, a study conducted in the United Kingdom showed that extending operating hours beyond the traditional 9:00 AM to 5:00 PM schedule significantly increased the number of surgeries performed, reducing waiting lists and enhancing patient outcomes.[4] The research demonstrated that by extending operational hours into the evening, hospitals were able to use existing resources more efficiently without the need for costly infrastructure expansion.

Similarly, hospitals in Canada have explored the feasibility of running Cath labs during evenings and weekends.[5] In a study conducted at the University Health Network in Toronto, it was found that extending Cath lab operating hours reduced wait times for patients requiring urgent catheterization procedures. The study emphasized the importance of optimizing existing infrastructure, particularly during off-peak hours, to alleviate the pressure on healthcare systems facing budget constraints.

In Australia, hospitals have adopted a slightly different approach by improving workflow efficiency within existing operating hours.[6] By streamlining pre-operative and post-operative processes, hospitals have reduced the time between surgeries, thus increasing the number of procedures performed per day. This process optimization, combined with the occasional extension of operating hours, has proven to be an effective way of addressing the rising demand for cardiothoracic procedures.

Cost-Benefit Analysis in Resource Optimization

Cost-benefit analyses have been a critical component in determining the feasibility of extending operating hours or optimizing resource utilization in cardiothoracic surgery facilities. A study conducted in the United States at the Cleveland Clinic examined the financial implications of extending the operating hours of their CTOTs.[7] The analysis showed that while extending hours increased staffing and operational costs and the overall financial benefit. This is due to increased patient throughput and reduced waiting lists, and it justified the investment. The cost savings derived from preventing patient deterioration, which can result in more complex and expensive treatments later on, also contributed to the net benefit.

Similarly, a cost-benefit analysis conducted in Germany focused on the optimal utilization of Cath labs. Researchers found that optimizing

Cath lab scheduling and extending operational hours by a few additional hours per day increased the number of procedures by 25% without the need for new equipment or infrastructure.[8] The additional revenue generated from the increased number of procedures outweighed the marginal costs associated with staffing during extended hours, making it a financially viable option.

Effectiveness of Theater Time Optimization

The effectiveness of optimizing theatre time is not limited to financial benefits; it also has significant implications for patient outcomes. A study conducted in India highlighted the impact of reducing wait times for cardiothoracic surgeries by extending theatre hours.[9] Hospitals that adopted extended hours and improved workflow efficiency saw a marked reduction in patient mortality rates due to faster access to life-saving procedures. The study also showed that optimal utilization of theatre time improved overall staff morale, as healthcare providers could perform more procedures within the same timeframe, reducing burnout caused by long waiting lists and overbooked schedules.

In the context of lower-income countries, such as Sri Lanka, where financial constraints limit the ability to expand healthcare infrastructure, these global strategies present a promising solution. By optimizing the use of existing CTOTs and Cath labs, Sri Lankan hospitals could significantly reduce waiting lists, improve patient outcomes, and achieve cost savings. The success of such approaches in other countries highlights the potential for Sri Lanka to implement similar strategies, leveraging non-operational hours and available healthcare staff to address the growing demand for cardiothoracic procedures.

The global experience in optimizing CTOTs and Cath labs demonstrates that extending operating hours and improving workflow efficiency are effective strategies for addressing the rising demand for surgeries without incurring substantial infrastructure costs. Cost-benefit analyses from various hospitals have consistently shown that the financial investment in extended hours is justified by increased throughput, reduced patient wait times, and improved outcomes. These findings provide a valuable framework for Sri Lanka to enhance the utilization of its existing cardiothoracic surgical facilities and address the challenges posed by long waiting lists and limited resources.

Methodology

This study adopts a descriptive analytical design to evaluate the utilization of CTOTs and CCLs in three selected hospitals in Sri Lanka. The hospitals were randomly selected from all government and semi-government institutions where both cardiothoracic surgical facilities and Cath labs are available, using a lottery method. To ensure geographical representation, if two hospitals from the same region were drawn, the second hospital was excluded, and the lottery process continued until a hospital from a different region was selected.

Study Tool

The primary tool used in this study is a structured interviewer-administered questionnaire aimed at gathering detailed information from hospital administrators and cardiothoracic surgery teams. The questionnaire collects data on the operational hours of the CTOTs and Cath labs, the types of surgeries performed, waiting lists, down times, and the current staffing arrangements. Additionally, the study will collect data on the average time taken for various cardiothoracic procedures.

Calculation Procedures

1. **Utilization Hours Calculation:** The total number of operational hours currently utilized in each hospital's cardiothoracic theatre and Cath lab will be calculated by summing up the hours of usage recorded during standard operating hours (8:00 AM – 4:00 PM).
2. **Non-Utilization Hours Calculation:** The total number of non-utilized hours was calculated by multiplying the number of operational CTOTs in the hospital by the total hours available per theatre annually (i.e., 24 hours × 365 days). For example, in a hospital with 2 theatres, the total potential operational hours per year would be 17,520 hours. From this figure, we subtracted the actual hours of theatre use, along with all types of downtimes (such as cleaning, maintenance, or scheduled closures), to determine the estimated number of non-utilized hours.
3. **Assessment of Surgery Types and Average Time:** Data on the types of surgeries performed and the average time taken for each surgery (such as coronary artery bypass grafting, valve replacements, and catheterization procedures) will be

gathered. This information will help estimate the additional number of surgeries that can be performed during the non-utilized hours.

4. **Calculation of Total Non-Utilized Hours:** The total non-utilized hours across all three hospitals will be calculated by aggregating the individual totals from each institution.
5. **Calculation of Additional Surgeries:** Based on the average time taken per surgery, the study will estimate how many additional surgeries can be performed if these non-utilized hours are fully used.
6. **Estimation of Quality-Adjusted Life Years (QALYs):** Using established data on the improvement in life expectancy and quality of life after cardiothoracic surgeries, the study will calculate the number of Quality-Adjusted Life Years (QALYs) that can be gained for patients through optimal utilization of these facilities.
7. **Monetary Value of Earned QALYs:** Finally, the study will calculate the monetary value of the additional QALYs gained, providing an estimate of the economic benefits to the healthcare system from the improved utilization of these facilities. This will be done using cost-effectiveness analysis frameworks that assign a monetary value to each QALY gained.

Results

This section presents the findings of the cost-benefit analysis

1. Utilization and Non-Utilization Hours

The hospitals in the study are SJGH, National Hospital Galle, and National Hospital Jaffna. The data for National Hospital Galle and National Hospital Jaffna has been extrapolated to cover a full year.

We now calculate the non-utilized hours for the CTOTs in these hospitals as described above in methodology.

- a. **SJGH:** With 8,640 total hours available in a year, SJGH utilized 5,792 hours, leaving 2,848 non-utilized hours.
- b. **National Hospital Galle:** The available data covers only three months (January to March) with 1,632 non-utilized

hours out of 2,160 hours. If this trend continues, the estimated non-utilized hours for the entire year would be 6,528 hours

- c. National Hospital Jaffna: The data provided covered eight months with 4,992 non-utilized hours out of 5,760 total hours. Extrapolating this data to cover 12 months estimated Annual Non-Utilized Hours for Jaffna would be 7,488 hours.

2. Potential Additional Surgeries

Using the average surgery time of 5 hours for cardiothoracic surgeries, we calculate the number of additional surgeries that could be performed in the non-utilized hours.

- a. SJGH: With 2,848 non-utilized hours, SJGH could perform 570 additional surgeries.
- b. National Hospital Galle: With an estimated 6,528 non-utilized hours, National Hospital Galle could perform 1,306 additional surgeries
- c. National Hospital Jaffna: With an estimated 7,448 non-utilized hours, National Hospital Jaffna could perform 1,498 additional surgeries

3. Quality-Adjusted Life Years (QALYs)

Each successful cardiothoracic surgery is estimated to provide an average of 2.37 QALYs. Using this figure, the total number of QALYs that could be gained from the additional surgeries is calculated as follows:

- a. SJGH: 1,350.9 QALYs
- b. National Hospital Galle: 3,094.22 QALYs
- c. National Hospital Jaffna: 3,548.26 QALYs

The total QALYs gained across all three hospitals would be approximately: 7,993.54 QALYs

4. Monetary Value of QALYs

Using a value of \$10,000 per QALY, the monetary benefit of the additional QALYs earned through the optimal use of non-operational hours is as follows:

- a. SJGH: $1,350.9 \times 10,000 = \$13,509,$

b. National Hospital Galle: $3,094.22 \times 10,000 = \$30,942,200$

c. National Hospital Jaffna: $3,548.26 \times 10,000 = \$35,482,600$

The total monetary value of the additional QALYs across all three hospitals is approximately:

$13,509,000 + 30,942,200 + 35,482,600 = \$79,933,800 = \$79.93 \text{ million}$

Summary of Findings

- Total Non-Utilized Hours across the three hospitals: 16,864 hours
- Total Additional Surgeries that could be performed: 3,373 surgeries
- Total QALYs Earned: 7,993.54 QALYs
- Monetary Value of QALYs: \$79.93 million

By optimizing the use of non-operational hours, these hospitals could perform an additional 3,373 surgeries annually, leading to a significant reduction in the waiting list for cardiothoracic surgeries in Sri Lanka. This would generate an estimated 7,993.54 QALYs and provide economic benefits worth nearly \$80 million annually only from 3 selected hospitals. If this is calculated for National Hospital Sri Lanka (NHSL) and National Hospital Kandy value may be further high. These findings underscore the potential benefits of fully utilizing existing healthcare resources without the need for costly infrastructure expansion.

Discussion

The findings from this study highlight the significant underutilization of CTOTs in three key hospitals in Sri Lanka: SJGH, National Hospital Galle, and National Hospital Jaffna. With over 16,800 hours of non-utilized operating time per year, these hospitals have the capacity to perform an additional 3,373 surgeries annually. This study emphasizes the efficiency gains that could be achieved by extending operational hours and optimizing the use of existing resources, without incurring the high costs associated with building new infrastructure.

The resulting additional surgeries could provide 7,993 QALYs, demonstrating a clear clinical benefit to patients. Additionally, the financial implications are substantial, with a potential economic benefit of nearly \$ 80 million annually. The cost-benefit analysis

shows that utilizing non-operational hours by compensating healthcare professionals from other institutions is a cost-effective solution to the country's capacity issues. This approach addresses not only the current backlog of surgeries but also enhances patient outcomes by reducing waiting times and improving access to life-saving procedures.

Limitations of the Study

Limited Hospital Representation: The study focused on only three hospitals—SJGH, National Hospital Galle, and National Hospital Jaffna. This limited scope may not provide a complete representation of the utilization patterns across the country's CTOTs.

Short Data Collection Duration: The duration of data collection may not be sufficient to capture long-term trends in theatre utilization and surgical patterns. Variations in demand, staffing, or other operational factors could affect the representativeness of the data collected during a limited timeframe.

Variability in Surgery Time: The estimated surgery times used in the study are generalized averages. In reality, the time required for cardiothoracic surgeries can vary significantly depending on the type of procedure, the complexity of the case, the skills of the surgeon, and intraoperative complications. These variations may affect the accuracy of the estimated number of surgeries that could be performed during non-utilized hours.

Lack of ICU Capacity Assessment: While this study evaluates theatre utilization and available health staff, it does not assess the availability or capacity of intensive care units (ICUs), which are a critical limiting factor for performing cardiothoracic surgeries. The absence of ICU data may affect the accuracy of estimating the true potential for increasing surgical throughput.

Conclusion

This study concludes that optimizing the use of non-utilized hours in CTOTs in Sri Lanka's hospitals can significantly increase surgical capacity, reduce waiting lists, and improve patient outcomes. By performing over 3,300 additional surgeries annually, the healthcare system could generate nearly 8,000 QALYs and deliver economic benefits worth \$ 80 million. Extending operational hours and employing available healthcare professionals from other institutions provide a feasible and cost-effective solution to address the current

capacity challenges in Sri Lankan hospitals. These findings underscore the potential for resource optimization as a practical approach to improving healthcare delivery in the country.

Recommendations

1. **Extend Operating Hours:** It is recommended that SJGH, National Hospital Galle, and National Hospital Jaffna extend their cardiothoracic theatre hours to include non-operational periods, such as evenings and weekends. This will help to maximize the utilization of existing resources.
2. **Engage Additional Healthcare Staff:** To support the increased workload, hospitals should consider bringing in healthcare professionals from other institutions on a contractual basis. This flexible staffing model ensures that hospitals can meet the demand for additional surgeries without the need for permanent hires.
3. **Assess and Strengthen ICU Capacity:** To fully realise the potential for increasing cardiothoracic surgical volumes, it is essential to assess the existing ICU capacity in each hospital. Expanding and optimising ICU facilities should be prioritised alongside theatre and staff improvements to ensure safe post-operative care and improved patient outcomes.
4. **Implement Policy Changes:** The Sri Lankan Ministry of Health should develop policies to incentivize the use of non-operational hours across all hospitals with cardiothoracic facilities. This includes providing compensation for healthcare professionals willing to work during extended hours.
5. **Monitor and Evaluate:** Continuous monitoring and evaluation of extended operational hours should be implemented to assess the ongoing efficiency of the system and make adjustments where necessary. This ensures that resource optimization efforts remain sustainable and aligned with healthcare demand.

These recommendations align with the study's objectives of increasing utilization, improving patient outcomes, and conducting a cost-benefit analysis of optimizing existing healthcare resources.

References

1. Almekhlafi. (2014). vercoming the evening/weekend effects on time delays and outcomes of endovascular stroke therapy. *Journal of NeuroInterventional Surgery*.
2. Athauda-Arachchi. (2019). Advanced interventional cardiac procedures and perioperative care required to prevent the epidemic of end-stage heart disease in Sri Lanka. *Sri Lanka Journal of Medicine*.
3. Duignan, S. (2020). Decision-making in the catheter laboratory: the most important variable in successful outcomes. *Pediatric Cardiology*.
4. Dunning. (2017). The society of thoracic surgeons expert consensus for the resuscitation of patients who arrest after cardiac surgery. . *The Annals of Thoracic Surgery*.
5. Guerriero. (2011). Operational research in the management of the operating theatre:. *Health care management science*, .
6. Harischandra. (2020). The workload, outcome and waiting time of cardiothoracic operations: a single unit study in Sri Lanka. *Sri Lanka Journal of Surgery*,.
7. Mohan. (2017). mproving the process efficiency of catheterization laboratories using simulation. *Health Systems*.
8. Sakowska. (2017). Hospital-wide implementation of an electronic-workflow solution aiming to make surgical practice improvement easy. *journal of surgery*.
9. Stafinski. (2022). Reducing wait times to surgery—an international review. *Journal of Hospital Management and Health Policy*.