COST OPTIMIZATION OF DA VINCI SURGICAL PROCEDURES IN HUNGARY

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EXECUTIVE SUMMARY

This project examines the cost efficiency of robotic-assisted surgery using the Da Vinci Surgical System in Hungary, analyzing data from over 6,000 procedures performed since 2022. While robotic surgery offers clinical benefits such as enhanced precision and faster recovery, its higher instrument costs present economic challenges. The study aims to optimize instrument usage and benchmark cost performance across surgeons and institutions.

Using detailed, anonymized surgical instrument data, the project developed predictive models to estimate expected procedure costs and identify outliers with excessive expenses. Key findings highlight significant variability in instrument use and costs, revealing opportunities for standardization and cost savings without compromising clinical quality.

The resulting framework combines expert data processing with advanced analytics to provide actionable insights for healthcare providers. Although yet to be implemented broadly, this approach holds strong potential to support more cost-effective robotic surgery programs, ensuring long-term sustainability and wider access to advanced surgical care.

TABLE OF CONTENTS

BACKGROUND AND MOTIVATION

Robotic-assisted surgery, particularly with the Da Vinci Surgical System, is transforming surgical care across Europe by offering enhanced precision, reduced complications, and faster patient recovery times[1]. Since its introduction in Hungary in 2022, the technology has been increasingly adopted across various surgical disciplines. While the clinical benefits are well-documented, the relatively high cost of robotic surgery instruments and consumables compared to conventional laparoscopic techniques remains a significant challenge[2][3]. This project was motivated by the need to better understand and optimize these costs to ensure that robotic surgery remains both clinically effective and economically sustainable.

PROJECT OBJECTIVES

This study analysed detailed instrument usage data from more than 6,000 robotic surgeries performed across Hungarian hospitals. The core objectives were threefold: first, to identify the optimal combinations of surgical instruments for the most common procedures to minimize unnecessary usage; second, to benchmark cost performance across individual surgeons and healthcare institutions to highlight areas of efficiency and potential overspending; and third, to develop predictive models capable of forecasting procedure costs based on general procedural parameters, enabling early identification of outlier cases with excessive expenditures. Ultimately, the project aims to support healthcare decision-makers in implementing cost-saving strategies while maintaining or improving clinical outcomes

METHODOLOGY OVERVIEW

The project applied a rigorous, multi-step analytical approach. Initially, extensive cleaning and anonymization of the data ensured accuracy and privacy, while merging diverse sources allowed for precise case-level costing. Surgical procedures were then standardized and grouped to facilitate meaningful comparisons, with rare or atypical procedures excluded to maintain data robustness. Cost benchmarks were developed to classify procedures into optimal, average, and expensive categories, taking into account clinical appropriateness and reproducibility of cost patterns.

Advanced statistical and machine learning techniques were used to build predictive models that estimate expected procedure costs from features such as procedure type, surgeon, and system used. These models provide an objective baseline to identify unusually high-cost cases. To translate the findings into practical tools, the project delivered three key outputs: a Sales Report highlighting instrument use patterns and surgeon-level cost categories; an Executive Report offering institutional and individual cost performance summaries; and an Interactive Dashboard enabling stakeholders to explore cost trends and identify optimization opportunities dynamically.

KEY FINDINGS

The analysis revealed considerable variability in instrument usage and cost across procedures and surgeons. While some variability could be explained by differences in surgical complexity or the specific robotic system employed, the data also uncovered clear opportunities for cost savings through more standardized instrument selection and usage practices. Predictive modelling successfully identified cases with costs significantly above the expected range, providing actionable insights to guide clinical and administrative decision-making.

The project also demonstrated that data-driven approaches can effectively balance cost containment with clinical quality by focusing on instrument use optimization without compromising patient safety or surgical outcomes. These insights can serve as a model for hospitals aiming to improve the value of their robotic surgery programs.

LIMITATIONS

Despite its strengths, the project faced some limitations. The dataset did not include patient clinical outcomes, such as complication rates or long-term recovery metrics, which could enrich future analyses. Additionally, some procedure types lacked detailed categorization, potentially affecting the precision of cost assessments. Conversion cases, such as those where robotic surgery was switched mid-procedure to open surgery, could not be completely validated, although clustering algorithms were used to identify and manage potential outliers.

CONCLUSION AND IMPACT

This project presents a robust, scalable framework for analysing and optimizing the costs associated with robotic surgery. By combining expert clinical knowledge, detailed data preparation, and cutting-edge analytical methods, it offers valuable insights that healthcare providers can use to improve cost-efficiency without sacrificing quality of care. As robotic surgery continues to expand, these tools and findings will be essential for sustaining affordability and broad access.

The framework and tools developed through this project have strong potential for adoption by healthcare institutions aiming to integrate robotic surgery more cost-effectively. This initiative represents a significant step toward making advanced surgical technologies both clinically beneficial and economically viable in the long term.

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