THE EUROPEAN SOCIETY OF MEDICINE
Medical Research Archives, Volume 14 Issue 6

RESEARCH ARTICLE

Financial Viability of Robotic Surgery Programs Across Health Systems: Implementation Gaps in Low- and Middle-Income Countries

Slimane Kerroumi[1], Chihab Ouanezar[1], Adel Djilali Lansari[1], Abedennour Bennekrouf[1], Abdelhalim Merrouche[1], Meshari Atif Alqurashi[2], Noor Nedal Alessa[2], Ahmed Abdulrahman Alharbi[2], Khaled Mohamed Mohammed[3], Mostafa Mohamed Ibrahim[4], Mustafa Jamal Yousfi[1]

[1]Department of Urology, University Hospital Center, Faculty of Medicine, University Oran 1, Oran, Algeria
[2]Department of Urology, King Faisal Hospital, Makkah, Saudi Arabia
[3]Department of Urology, Mansoura Specialized Hospital, Mansoura, Egypt
[4]Department of Urology, Ahmad Maher Teaching Hospital, Cairo, Egypt

OPEN ACCESS

PUBLISHED
30 June 2026

CITATION
Kerroumi, S., Ouanezar, C., et al., 2026. Financial Viability of Robotic Surgery Programs Across Health Systems: Implementation Gaps in Low- and Middle-Income Countries. Medical Research Archives, [online] 14(6).

ISSN
2375-1924

ABSTRACT

Introduction: Robotic surgery has expanded rapidly worldwide, but its financial viability remains highly dependent on the structure of each health system, reimbursement mechanisms, surgical volume, procurement strategy, and institutional capacity. Access remains particularly limited in low- and middle-income countries, where public budgets, insurance coverage, maintenance capacity, and procedural volume are often constrained.

Objective: This narrative review aimed to compare the global implementation of robotic surgery programs and their financial sustainability models across different health systems, and to identify the main barriers and implementation gaps in low- and middle-income countries.

Methods: A structured narrative review was conducted using PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar for English-language articles, reviews, economic evaluations, and health-system reports published between January 2015 and May 2026. The search combined terms related to robotic surgery, cost-effectiveness, financial viability, reimbursement, cost recovery, surgical volume, health systems, and low-resource settings. Twenty-four key sources were selected for thematic synthesis according to relevance to economic, organizational, reimbursement, and implementation issues.

Thematic synthesis: The financial viability of robotic surgery is determined by acquisition cost, maintenance contracts, limited-use instruments, operating room efficiency, case volume, reimbursement model, and multi-specialty utilization. High-income countries may benefit from stronger reimbursement systems, centralized planning, higher surgical volume, and institutional capacity to absorb early investment. In contrast, low- and middle-income countries face limited public budgets, weak reimbursement pathways, high out-of-pocket expenditure, maintenance barriers, dependence on external technical support, and low procedural volume, all of which increase per-case cost and threaten sustainability.

Conclusion: Robotic surgery programs in low- and middle-income countries require cautious, planned, and context-specific implementation. Sustainable models should rely on high-volume referral hubs, multi-specialty use, negotiated procurement, adapted reimbursement, local training, biomedical support, and periodic cost-effectiveness evaluation.

Keywords: robotic surgery; financial viability; cost-effectiveness; reimbursement; healthcare systems; low- and middle-income countries.

Introduction

Robot-assisted surgery has become an important component of minimally invasive surgery. Its technical advantages include three-dimensional vision, wristed instruments, tremor filtration, improved dexterity, and better surgeon ergonomics. These features are particularly useful in complex pelvic, oncologic, and reconstructive procedures that require precise dissection and suturing. However, although robotic surgery may reduce blood loss, length of stay, and perioperative morbidity in selected procedures, these clinical advantages do not automatically translate into cost-effectiveness or financial sustainability.[1,2]

The economic burden of robotic surgery extends well beyond the purchase price of the platform. Total cost of ownership includes acquisition, depreciation, installation, service contracts, instruments, sterile drapes, disposable accessories, training, proctoring, operating room adaptation, and downtime related to maintenance or technical support.[1,3]

The worldwide diffusion of robotic surgery remains uneven. Robotic platforms are concentrated mainly in high-income countries, particularly the United States, Europe, Japan, South Korea, and parts of the Gulf region, where infrastructure, surgical volume, training pathways, and reimbursement mechanisms are more favorable. In market-driven systems, adoption may be influenced by hospital competition, patient demand, and institutional positioning. In publicly funded systems, investment decisions are more commonly judged through cost-effectiveness, budget impact, productivity, and opportunity cost.[4,5,6]

Several economic evaluations have shown that robotic surgery can be financially acceptable in selected high-volume settings, particularly when reductions in complications, readmissions, length of stay, or productivity gains offset higher intraoperative costs. Nevertheless, the evidence is procedure-specific and health-system-dependent, with variable findings across prostatectomy, cystectomy, gynecologic surgery, and broader surgical programs.[7,8,9,10,11,12,13]

The implementation gap is most evident in low- and middle-income countries. In these settings, robotic surgery is frequently concentrated in private or elite tertiary centers, raising concerns about equity, public-sector affordability, and long-term sustainability.[22,23,24]

This narrative review aims to compare the financial viability of robotic surgery programs across different healthcare systems and to identify key implementation gaps, barriers, and strategic options for sustainable adoption in low- and middle-income countries.

Methods

This article was designed as a structured narrative review. The objective was to synthesize current evidence on the economic, organizational, and policy determinants of robotic surgery implementation across health systems, with a specific focus on low- and middle-income countries. This was not designed as a systematic review or meta-analysis; therefore, no pooled statistical analysis was performed. However, the search and selection process was described transparently to improve methodological clarity and reproducibility.

A literature search was conducted using PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar. The search covered publications from January 2015 to May 2026. Additional relevant evidence was identified through manual screening of reference lists, institutional reports, and health policy documents when these sources provided relevant information on reimbursement, procurement, cost recovery, or implementation barriers.

The search strategy combined terms related to robotic surgery, cost, financing, reimbursement, implementation, and resource-limited health systems. Search terms included: robotic surgery, robot-assisted surgery, cost-effectiveness, cost analysis, economic evaluation, financial viability, cost recovery, reimbursement, health systems, hospital implementation, surgical volume, low- and middle-income countries, and resource-limited settings.

Articles were considered relevant when they addressed at least one of the following domains: acquisition cost, maintenance cost, limited-use instruments, disposable consumables, operating room efficiency, cost per procedure, reimbursement model, cost-effectiveness, budget impact, productivity, multi-specialty utilization, training cost, implementation barriers, or sustainability in low-resource settings. Studies were excluded if they were purely technical, focused only on clinical outcomes without economic or implementation relevance, duplicated data from another report, or lacked extractable information relevant to the review objective.

Twenty-four key sources were selected for detailed thematic synthesis. Because the available evidence was heterogeneous in study design, procedure type, country, cost perspective, and reimbursement structure, findings were synthesized narratively and organized into thematic domains: total cost of ownership, reimbursement models, high-income country experience, implementation gaps in low- and middle-income countries, and strategic models for sustainable adoption.

Table 1. Summary of selected evidence included in the thematic synthesis

Author / Year	Setting	Study type	Main economic or implementation focus	Relevance
Childers 2018	United States	Cost estimation	Acquisition and operating costs	High relevance
Feldstein 2019	United States	Cost of ownership	Capital, maintenance, instruments	High relevance
Wright 2016	United States	National database study	Hospital competition and financial status	High relevance
Nabi 2020	United States	Cohort study	Out-of-pocket cost	High relevance
Yim 2023	United States	Narrative review	Hospital reimbursement	High relevance
Labban 2022	United Kingdom	Cost-effectiveness model	Incremental cost-effectiveness and quality-adjusted life-years	High relevance
Dixon 2023	United Kingdom	Economic evaluation alongside randomized trial	Cost-effectiveness of robotic cystectomy	High relevance
Machleid 2022	United Kingdom	Cost-utility model	Robotic cystectomy cost-utility	High relevance
Maynou 2024	United Kingdom	Econometric analysis	Productivity and efficiency	High relevance

McCarthy 2023	England	Prospective economic evaluation	Robotic and laparoscopic gynecological surgery	Moderate relevance
Hyldgard 2017	Denmark	National cost analysis	System-level cost of prostatectomy	High relevance
Michels 2022	Netherlands	Economic evaluation	Robotic versus open cystectomy	High relevance
Specchia 2022	Italy	Comparative hospital analysis	Robotic, laparoscopic, and open surgery under regulated tariffs	Moderate relevance
Tedesco 2016	Italy	Cost-minimization analysis	Robotic versus laparoscopic and open surgery	Moderate relevance
Picozzi 2025	Italy	Cost-minimization and break-even analysis	Comparison of robotic platforms	High relevance
Ielpo 2022	Europe	Prospective study protocol	Cost-effectiveness of robotic versus laparoscopic surgery	Moderate relevance
Morii 2019	Japan	Comparative cost study	Open, laparoscopic, and robotic cystectomy	High relevance
Hong 2025	South Korea	Systematic review and meta-analysis	Cost and cost-effectiveness	High relevance
Peng 2023	Global	Bibliometric analysis	Health economics trends	Moderate relevance
Kawashima 2026	Japan	Threshold analysis	Contribution margin and material cost threshold	High relevance
Azhar 2019	Middle East	Regional review	Adoption and implementation	High relevance
Falola 2025	Africa	Review	Implementation barriers and recommendations	High relevance
Mehta 2022	Low- and middle-income countries	Narrative review	Challenges and opportunities	High relevance
Balakrishnan 2023	Low- and middle-income countries	Narrative review	Cancer surgery and affordability	High relevance

Thematic Synthesis and Critical Analysis

ECONOMIC STRUCTURE AND TOTAL COST OF OWNERSHIP

The cost structure of robotic surgery programs is driven by fixed, variable, and operational expenditures. Fixed costs include platform acquisition, depreciation or leasing fees, installation, operating room adaptation, and long-term service contracts. Variable costs include limited-use robotic instruments, sterile draping, disposable accessories, stapling systems, and procedure-specific consumables. Operational costs include training, proctoring, credentialing, simulation, operating room time, sterilization workflow, troubleshooting, software updates, and hardware upgrades.[1,2,3]

This structure explains why purchase price alone is an inadequate measure of affordability. A platform with a lower acquisition price may still be expensive if maintenance, consumables, service dependence, or instrument replacement costs are high. Conversely, a high acquisition price may be partially offset by high utilization, multi-specialty use, shorter length of stay, reduced readmissions, and increased operating room productivity. Economic evaluation should therefore focus on total cost of ownership and per-case cost rather than the purchase price alone.[1,3,15]

The emergence of competing robotic platforms may improve negotiating power for hospitals and health ministries. However, publicly available pricing remains limited because contracts depend on geography, procurement volume, leasing structure, service packages, instrument policies, and confidentiality agreements. This lack of transparency limits direct comparisons between platforms and makes local cost-effectiveness studies essential before adoption.[16,25]

Table 2: Comparative cost components of selected robotic surgery platforms based on publicly available information

Platform	Manufacturer / country	Acquisition cost	Maintenance cost	Instrument and disposable model
da Vinci system / da Vinci 5	Intuitive Surgical / United States	Approximately 1.5-2.5 million USD depending on model and contract	Commonly reported around 100,000-170,000 USD per year	Limited-use instruments and procedure-specific disposables
Hugo robotic-assisted surgery system	Medtronic / United States-Ireland	Not consistently publicly disclosed	Not consistently publicly disclosed	Mixed reusable and disposable components
Versius / Versius Plus	CMR Surgical / United Kingdom	Not consistently publicly disclosed	Not consistently publicly disclosed	Contract- and geography-dependent model
Senhance system	Asensus Surgical / Karl Storz / United States-Germany	Contract-dependent historical pricing	Not consistently publicly disclosed	Marketed with reusable instruments and lower per-procedure cost
Avatera system	Avatera Medical / Germany	Approximately 700,000-800,000 USD in some reports	Not consistently publicly disclosed	Single-use instruments and sterile components
SSI Mantra	SS Innovations / India-United States	Reported as substantially lower than dominant legacy systems	Lower maintenance and consumable costs have been reported	Platform-specific instruments
Toumai system	MicroPort MedBot / China	Reported average price around 1.77 million USD in 2025	Not consistently publicly disclosed	Platform-specific instruments and accessories

Note: Costs vary substantially by country, procurement model, leasing arrangement, service contract, instrument-use policy, and negotiated institutional agreement. Publicly reported values should therefore be interpreted as approximate ranges rather than fixed prices.[1,3,25]

Reimbursement and healthcare financing models

Reimbursement is a central determinant of robotic surgery viability. In private or mixed insurance-based systems, hospitals may attempt to offset robotic costs through procedure-based payments, private insurance reimbursement, patient demand, or increased market share. However, robotic technology is not always reimbursed as a separate premium, and hospitals may still absorb additional costs related to equipment, instruments, maintenance, and operating room time.[4,5,6]

In diagnosis-related group or fixed-payment systems, reimbursement is usually linked to the diagnosis or procedure rather than to the technology used. When no supplementary innovation tariff exists, the additional cost of robotic surgery is absorbed by the institution. Under these conditions, financial sustainability depends on case volume, tariff adequacy, multi-specialty use, efficient scheduling, reduced complications, shorter length of stay, and strict cost control.[6,12,13]

In publicly funded systems, the economic question is less about hospital profit and more about value for public expenditure. Robotic surgery must be evaluated against competing healthcare priorities, including workforce shortages, access to essential surgery, cancer pathways, and the opportunity cost of capital investment. This is particularly important in low- and middle-income countries, where budget constraints are more severe and unmet surgical needs remain substantial.[22,23,24]

High-income health systems

In the United States, robotic surgery is financed through a mixed system that includes private insurance, Medicare, hospital billing, and procedure-based reimbursement. This environment has supported rapid diffusion of robotic platforms and may reward hospitals that use robotics to strengthen market position and patient recruitment. High-volume centers can improve viability by distributing fixed costs across a large number of procedures. However, this model also creates variability in patient charges, out-of-pocket costs, and access.[4,5,6]

In the United Kingdom, robotic surgery is evaluated within a tax-funded National Health Service model. Investment decisions are primarily linked to cost-utility analysis, incremental cost-effectiveness ratios, quality-adjusted life-years, budget impact, productivity, and system-level value rather than direct hospital profitability.[7,8,9,10,11] The United Kingdom model offers a structured framework for value-based adoption, but it can restrict expansion when cost-effectiveness remains uncertain or capital budgets are limited. Robotic programs may become more defensible when they are centralized in high-volume centers and when clinical benefits translate into reduced length of stay, fewer complications, lower readmissions, and improved theatre productivity.[7,8,10]

In continental Europe, robotic surgery is generally financed through public or mixed healthcare systems, often using diagnosis-related groups or fixed procedural tariffs. The main strength of this model is the ability to regulate diffusion through regional planning and concentration of activity in high-volume centers. The main limitation is the mismatch between fixed reimbursement and variable robotic expenditure when no technology-specific payment is available.[12,13,14]

In Gulf countries, robotic surgery has often been supported by government-funded tertiary healthcare systems and expanding private-sector programs. The availability of capital investment can facilitate rapid acquisition and the creation of centers of excellence. However, limited published data on reimbursement, cost-effectiveness, training cost, and hospital-level financial outcomes make long-term viability difficult to assess. The main risks are low utilization, high maintenance cost, and shortage of locally trained robotic teams and biomedical engineers.[21]

Asian healthcare systems are heterogeneous. Japan and South Korea have national insurance structures, while other countries rely more heavily on mixed public-private financing and out-of-pocket payment. Regional development of lower-cost platforms may improve access, but sustainability still depends on reimbursement alignment, surgical volume, cost control, and evidence that higher technology costs are offset by measurable clinical or system-level benefits.[17,18,19,20]

Implementation gaps in low- and middle-income countries

In low- and middle-income countries, the implementation of robotic surgery is constrained by limited public budgets, incomplete insurance coverage, high out-of-pocket expenditure, competing healthcare priorities, and limited biomedical infrastructure. Without specific reimbursement pathways, hospitals must absorb capital depreciation, maintenance contracts, limited-use instruments, consumables, training, and technical support.[22,23,24]

Low procedural volume further increases per-case cost and delays cost recovery. If robotic platforms are distributed across several low-volume hospitals, utilization remains insufficient to justify acquisition and maintenance expenses. This creates a risk of symbolic technology adoption without sustainable clinical integration. In such settings, the central problem is not simply whether a robotic platform can be purchased, but whether the health system can support safe, equitable, high-volume, and economically rational use over time.[22,23,24]

Equity is a major concern. When robotic surgery is available only in private hospitals or elite tertiary centers, access may depend on patient income rather than clinical indication. This can widen disparities and divert attention from basic surgical capacity, cancer pathways, anesthesia safety, operating room infrastructure, and workforce development. Therefore, adoption in low- and middle-income countries should be embedded within public-sector planning and should prioritize procedures with clear clinical value and sufficient volume.[22,23]

Strategic framework for sustainable adoption

A financially viable robotic surgery program in a low- or middle-income country should begin with a formal needs assessment. This assessment should evaluate surgical volume, priority indications, workforce capacity, training needs, operating room infrastructure, biomedical support, reimbursement options, patient affordability, and the expected break-even threshold.

Centralization is one of the most important strategies. Regional referral hubs can concentrate surgical volume, improve capital amortization, increase team experience, reduce duplication of expensive equipment, and support continuous training. Multi-specialty utilization is also essential. A platform used by urology, gynecology, digestive surgery, thoracic surgery, pediatric surgery, and other high-value specialties has a better chance of reducing the fixed cost per case.[1,3,15,16]

Procurement should be competitive and transparent. Ministries and hospitals should compare platforms not only by purchase price but also by maintenance cost, instrument lifespan, disposable cost, availability of technical support, service response time, upgrade policy, training package, and contract flexibility. Leasing, pay-per-use, capped maintenance, negotiated instrument cost, and regional purchasing agreements may reduce financial risk.[1,3,16,25]

Sustainable implementation also requires an adapted reimbursement model. Options include dedicated tariffs for selected robotic procedures, bundled payments, innovation funds, outcome-based reimbursement, or public-private partnerships. However, any reimbursement strategy should be linked to transparent cost monitoring, clinical audit, and periodic reassessment of cost-effectiveness.[6,7,8,9,13]

Finally, local capacity building is essential. Robotic programs require trained surgeons, anesthesiologists, nurses, technicians, sterilization teams, and biomedical engineers. Simulation, proctoring, certification, and national registries can reduce dependence on external experts and improve patient safety. Without this ecosystem, the robot remains an isolated purchase rather than a sustainable surgical program.[21,22,23]

Table 3. Strategic framework for financially viable robotic surgery programs in low- and middle-income countries

Strategic axis	Recommended action	Expected economic benefit
Needs assessment	Evaluate surgical volume, priority procedures, infrastructure, workforce, and local affordability before purchase	Avoids inappropriate investment and low-utilization platforms
Centralization	Develop regional robotic surgery hubs rather than distributing robots across many low-volume hospitals	Increases case volume and improves capital amortization
Multi-specialty use	Share the platform across urology, gynecology, digestive surgery, thoracic surgery, pediatric surgery, and other suitable specialties	Reduces fixed cost per procedure
Competitive procurement	Use transparent tenders and negotiate leasing, maintenance, instruments, training, and service response time	Reduces acquisition and recurrent costs
Adapted reimbursement	Create dedicated tariffs, bundled payments, innovation funds, or outcome-based reimbursement for selected indications	Aligns institutional incentives with sustainability
Training strategy	Build local simulation, proctoring, certification, and robotic team training programs	Reduces dependence on external experts and improves safety
Biomedical support	Develop local maintenance and biomedical engineering capacity	Limits downtime and costly external technical support
Local evidence generation	Create registries and perform local cost-effectiveness and budget-impact analyses	Supports evidence-based expansion
Equity protection	Integrate robotic surgery into public-sector planning rather than only private-sector expansion	Reduces inequity of access
Stepwise implementation	Start with high-volume, high-value procedures before expanding indications	Improves early cost recovery and safety

Conclusion

Robotic surgery represents a major technological advance, but its financial viability depends on the structure and capacity of the health system in which it is implemented. Acquisition cost is only one part of a broader economic model that includes maintenance, instruments, operating room efficiency, reimbursement, training, biomedical support, surgical volume, and multi-specialty utilization.

In low- and middle-income countries, the main challenge is not only acquiring robotic platforms but sustaining them safely, equitably, and economically. A realistic strategy should rely on high-volume referral hubs, multi-specialty use, negotiated procurement, adapted reimbursement, local training, biomedical support, and periodic cost-effectiveness evaluation. Robotic surgery should therefore be introduced as a carefully planned institutional program rather than as a single technological purchase.

Conflicts of Interest Statement:

The author declare that there are no conflicts of interest.

Funding Statement:

There was no funding of this research.

Acknowledgements:

None.

References

1. Childers CP, Maggard-Gibbons M. Estimation of the acquisition and operating costs for robotic surgery. JAMA. 2018;320(8):835-836. doi:10.1001/jama.2018.9219
2. American College of Surgeons. Cost of robotic surgery remains complex equation. Bull Am Coll Surg. Published February 4, 2026.
3. Feldstein J, Schwander B, Roberts M, Coussons H. Cost of ownership assessment for a da Vinci robot based on US real-world data. Int J Med Robot. 2019;15(5):e2023. doi:10.1002/rcs.2023
4. Wright JD, Tergas AI, Hou JY, Burke WM, Chen L, Hu JC, et al. Effect of regional hospital competition and hospital financial status on the use of robotic-assisted surgery. JAMA Surg. 2016;151(7):612-620. doi:10.1001/jamasurg.2015.5508
5. Nabi J, Friedlander DF, Chen X, Cole AP, Hu JC, Kibel AS, et al. Assessment of out-of-pocket costs for robotic cancer surgery in US adults. JAMA Netw Open. 2020;3(1):e1919185. doi:10.1001/jamanetworkopen.2019.19185
6. Yim NH, McCarter J, Haykal T, Aral AM, Yu JZ, Reece E, Winocour S. Robotic surgery and hospital reimbursement. Semin Plast Surg. 2023;37(3):223-228. doi:10.1055/s-0043-1771234
7. Labban M, Dasgupta P, Song C, Becker R, Li Y, Kreaden US, et al. Cost-effectiveness of robotic-assisted radical prostatectomy for localized prostate cancer in the UK. JAMA Netw Open. 2022;5(4):e225740. doi:10.1001/jamanetworkopen.2022.5740
8. Dixon S, Hill H, Flight L, Khetrapal P, Ambler G, Williams NR, et al. Cost-effectiveness of robot-assisted radical cystectomy vs open radical cystectomy for patients with bladder cancer. JAMA Netw Open. 2023;6(6):e2317255. doi:10.1001/jamanetworkopen.2023.17255
9. Machleid F, Ho-Wrigley J, Chowdhury A, Paliah A, Poon HL, et al. Cost-utility analysis of robotic-assisted radical cystectomy for bladder cancer compared with open radical cystectomy in the United Kingdom. PLoS One. 2022;17(9):e0270368. doi:10.1371/journal.pone.0270368
10. Maynou L, McGuire A, Serra-Sastre V. Efficiency and productivity gains of robotic surgery: the case of the English National Health Service. Health Econ. 2024;33(8):1831-1856. doi:10.1002/hec.4838
11. McCarthy A, Samarakoon D, Gray J, McMeekin P, McCarthy S, Newton C, et al. Robotic and laparoscopic gynaecological surgery: a prospective multicentre observational cohort study and economic evaluation in England. BMJ Open. 2023;13(9):e073990. doi:10.1136/bmjopen-2023-073990
12. Hyldgard VB, Laursen KR, Poulsen J, Sogaard R. Robot-assisted surgery in a broader healthcare perspective: a difference-in-difference-based cost analysis of a national prostatectomy cohort. BMJ Open. 2017;7(7):e015580. doi:10.1136/bmjopen-2016-015580
13. Michels CTJ, Wijburg CJ, Hannink G, Witjes JA, Rovers MM, Grutters JPC. Robot-assisted versus open radical cystectomy in bladder cancer: an economic evaluation alongside a multicentre comparative effectiveness study. Eur Urol Focus. 2022;8(4):1041-1049.
14. Specchia ML, Arcuri G, Di Pilla A, La Gatta E, Osti T, Limongelli P, et al. The value of surgical admissions for malignant uterine cancer: a comparative analysis of robotic, laparoscopic, and laparotomy surgery in a university hospital. Front Public Health. 2022;10:920578. doi:10.3389/fpubh.2022.920578
15. Tedesco G, Faggiano FC, Leo E, Derrico P, Ritrovato M. A comparative cost analysis of robotic-assisted surgery versus laparoscopic surgery and open surgery: the necessity of investing knowledgeably. Surg Endosc. 2016;30(11):5044-5051. doi:10.1007/s00464-016-4852-7

16. Ielpo B, Podda M, Burdio F, Sanchez-Velazquez P, Guerrero MA, Nunez J, et al. Cost-effectiveness of robotic vs laparoscopic surgery for different surgical procedures: protocol for a prospective, multicentric study (ROBOCOSTES). Front Surg. 2022;9:866041. doi:10.3389/fsurg.2022.866041
17. Morii Y, Osawa T, Suzuki T, Shinohara N, et al. Cost comparison between open radical cystectomy, laparoscopic radical cystectomy, and robot-assisted radical cystectomy for patients with bladder cancer: a single-institution retrospective study. BMC Urol. 2019;19:110. doi:10.1186/s12894-019-0533-x
18. Hong YE, Shim H, Shin M. Costs and cost-effectiveness of robotic-assisted surgery in South Korea: a systematic review and meta-analysis. Front Public Health. 2025;13:1683482. doi:10.3389/fpubh.2025.1683482
19. Peng Y, Liu Y, Lai S, Li Y, Lin Z, Hao L, et al. Global trends and prospects in health economics of robotic surgery: a bibliometric analysis. Int J Surg. 2023;109(12):3911-3921. doi:10.1097/JS9.0000000000000720
20. Kawashima A, Hayashi T, Kawamura M, et al. Allowable robot-related material cost as a contribution margin threshold for financial sustainability of robot-assisted urologic surgery. J Robot Surg. 2026.
21. Azhar RA, Elkoushy MA, Aldousari S. Robot-assisted urological surgery in the Middle East: where are we and how far can we go? Arab J Urol. 2019;17(2):106-113. doi:10.1080/2090598X.2019.1601003
22. Falola AF, Singh S, Das U, Oluwagbemi A, Etta R, et al. Barriers and recommendations for the implementation of robot-assisted minimally invasive surgery in Africa. J Robot Surg. 2025;19:16. doi:10.1007/s11701-024-02163-7
23. Mehta A, Pandit M, Shukla S. Embracing robotic surgery in low- and middle-income countries. Indian J Surg Oncol. 2022;13(4):857-863. doi:10.1007/s13193-022-01654-1
24. Balakrishnan G, Krishnamurthy A. Robotic surgeries for cancer in low- and middle-income countries: hope or hype in surgical oncology? Int J Adv Med Health Res. 2023;10(2):64-70. doi:10.4103/ijamr.ijamr_245_23
25. Picozzi P, Nocco U, Labate C, Silvi F, Puleo G, et al. Comparative cost analysis of robotic surgical platforms: a cost-minimization and break-even analysis. Preprints. 2025.