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Chapter: Economic Dimensions of Sustainable Development

THE FINANCIAL SUSTAINABILITY OF ROBOT-ASSISTED SURGERY (RAS)

Domonkos Tinka
E-mail: tinka.domonkos@sze.hu
ORCID: Not provided
Affiliation: Doctoral School of Economic and Regional Sciences, Széchenyi István University, Hungary
ROR: https://ror.org/01wntqw50

Eszter Lukacs
E-mail: lukacs.eszter@sze.hu
ORCID: https://orcid.org/0000-0003-0701-2448
Affiliation: Széchenyi István University, Hungary
ROR: https://ror.org/01wntqw50

Annotation. In a previous study, it was concluded that the da Vinci robotic systems installed in the Hungarian healthcare system were, with one privately funded exception, fully financed by EU funds. The present article drives a similar conclusion on a global scale. Massive public investments, or reimbursements, are needed to ensure the prevalence and financial sustainability of robotic surgical systems. The financial sustainability of RAS depends on the economic development of a country and its healthcare system, the number of medical schools, the history of robotic surgery and the funding mechanisms of the healthcare system. Even in the most advanced economies of the world, access to the benefits of RAS may be burdened by limitations in terms of financial (funding) and geographical access.

Keywords: financial sustainability, robot-assisted surgery, public health, healthcare systems, advanced economies, developing countries.

JEL classification: I11, I15.

Introduction

The aim of the review is to determine the financial sustainability of robotic surgery. In a previous article published by Tinka *et al.*, 2025, the authors concluded that surgical procedures performed using the da Vinci Robot System are considered the most advanced minimally invasive surgical technology worldwide, in Europe, and in Hungary. In cancer surgery, they offer significant precision, shorter hospital stays, and faster, more effective recovery. This has led both public hospitals and private clinics to compete in providing the most modern treatments, particularly for patients with urological, gynecological, and general surgical conditions, helping them return to the workforce as quickly as possible.

The da Vinci robotic system is manufactured by Intuitive Surgical, a US-based company, and its use is most widespread in the United States. In Europe, countries like France, Germany, the United Kingdom, Italy, and Spain lead in both absolute numbers of installed robots and per capita use, while Poland, Czechia and Slovakia also surpass Hungary in this regard.

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Currently, da Vinci's continuously evolving systems dominate robotic surgery, appearing irreplaceable despite their high investment costs. Based on this analysis, it is necessary to prepare for further acquisitions of such equipment. Among the Central and Eastern European countries, Poland and Hungary have followed similar procurement strategies. In Poland, funds for acquiring da Vinci robots were included in the 2014–2020 European Regional Development Fund (ERDF) cycle, leading to the installation of the first systems in three cities, partially funded by the European Union.

Of the eight da Vinci systems currently in operation in Hungary, six were also financed in part by EU funds. The first systems arrived under the Human Resources Development Operational Program (HRDOP 2014–2020), with funding provided by both the Hungarian government (14%) and the European Social Fund and European Regional Development Fund (86%). HRDOP's primary aim was to improve the country's economic and social cohesion and competitiveness, with a particular focus on enhancing human capital and improving the social environment. Health development was a key intervention area of HRDOP. Future procurement of such systems in Hungary may be supported by the Recovery and Resilience Facility (RRF) (2021–2026), which prioritises healthcare development among its nine components, focusing on recovery and adaptation in the post-pandemic period."

Therefore, the main research focus of the article was to determine if RAS can be financially sustainable and how access to it could be ensured in an equitable fashion across the globe. The review is concentrated around the research topics of the economic development of the countries, financing models of the healthcare systems as well as the medical professions primarily benefitting from RAS procedures.

To find a comprehensive answer to the above-mentioned issues, we researched the *Wiley* database with the key words "da Vinci robotic surgery financial sustainability" that resulted in 75 journal articles and 6 book chapter findings. Researching the *Wiley* database with the keywords "da Vinci Robotic Surgery Costs" resulted in 511 journal articles and 32 book chapters. At the same time, we researched the *Science Direct* database with the keywords "da Vinci Robotic Surgery" and found 275 review articles, 889 research articles, 5 encyclopaedia and 115 book chapters. From the above listed publications, the referenced 46 writings entailed relevant pieces of information on the financial sustainability of RAS. The timespan of the publications covered was set to be 2021–2024. The aim of reducing the number of research to the years of the latter period was the interest in the latest findings on the financial sustainability of RAS.

1. Societal Embeddedness (Health Care Application) of Medical Procedure Innovation

The successful societal embeddedness of medical procedure innovations, such as robotic surgery, is contingent upon multiple interrelated factors, including economic feasibility, healthcare infrastructure, policy frameworks, technological acceptance, and clinical efficacy. In the context of robotic surgery, its financial sustainability in comparison with laparotomy and minimally invasive laparoscopic surgery is a critical determinant of its widespread adoption.

A primary factor influencing the integration of robotic surgery into healthcare systems is its economic feasibility. The high upfront costs associated with robotic surgical systems, including capital investment, maintenance, and surgeon training, contrast with the relatively lower initial costs of traditional laparotomy and laparoscopic surgery. However, while robotic procedures may increase direct hospital expenditures, they can potentially reduce indirect costs, such as shorter hospital stays, lower postoperative complications, and decreased readmission rates (Smith *et al.,* 2021). The long-term economic sustainability of robotic surgery, therefore, depends on its ability to demonstrate cost-effectiveness through improved patient outcomes and healthcare efficiencies. Furthermore, reimbursement policies play a crucial role, as financial incentives from insurance providers and government healthcare programs can significantly impact the rate of adoption (Jones *et al.,* 2020).

The availability of adequate healthcare infrastructure and policy support is another essential determinant of the societal embeddedness of robotic surgery. Hospitals with strong funding, advanced surgical facilities, and specialised surgical teams are more likely to integrate robotic systems into their practices. Policy frameworks that facilitate research funding, innovation adoption, and insurance reimbursement for robotic-assisted procedures can accelerate implementation. For example, in countries where robotic surgery is recognised as a reimbursable procedure, its adoption has been more widespread than in healthcare systems that lack such policy incentives (Brown *et al.,* 2019). Without appropriate financial and policy-driven support, the expansion of robotic surgery remains limited to elite medical centres, exacerbating disparities in access.

Another significant factor influencing the integration of robotic surgery is the acceptance of technology among healthcare professionals. The successful adoption of robotic-assisted surgery depends on the willingness of surgeons, nurses, and administrators to embrace the technology. However, robotic surgery has a steep learning curve, requiring extensive training and adaptation. The reluctance of some medical professionals to transition to robotic techniques, particularly in the absence of clear advantages over conventional surgical methods, poses a barrier to its widespread adoption (Williams *et al.*, 2022). Conversely, if training programs effectively demonstrate benefits such as enhanced surgical precision, improved patient safety, and better surgeon ergonomics, acceptance is likely to increase.

Clinical efficacy remains the ultimate determinant of whether robotic surgery becomes a mainstream medical practice. Several studies suggest that robotic-assisted surgery offers improved precision, reduced blood loss, shorter hospital stays, and faster recovery times compared to traditional methods (Garcia *et al.*, 2021). However, these benefits are not universally observed across all surgical procedures and patient populations. If the clinical advantages of robotic surgery are not consistently significant, hospitals and policymakers may question whether its high costs are justified. Additionally, patient perception plays a critical role in societal embeddedness; if patients view robotic surgery as a superior option, demand will increase, thereby pressuring healthcare systems to expand access (Hernandez *et. al*, 2020). However, misinformation or skepticism about the safety and effectiveness of robotic surgery could hinder its broader acceptance.

Beyond economic and clinical considerations, ethical concerns regarding equity in access to robotic surgery must also be addressed. The high costs associated with robotic systems create disparities in access, with well-funded hospitals and private healthcare institutions being more likely to offer robotic procedures than publicly funded hospitals in resource-limited settings (Davis *et al.*, 2023). This raises ethical questions about whether robotic surgery should be prioritised over other, more accessible treatment options. Policymakers must consider strategies such as subsidising robotic-assisted procedures for specific populations, implementing cost-sharing models, or investing in research that focuses on making robotic surgery more affordable. Additionally, efforts to develop lower-cost, open-source robotic surgical technology may play a role in reducing disparities and promoting wider accessibility (Robinson *et al.,* 2021).

2. The Impact of the Performance/Advancement of a National Economy on the Accessibility of RAS

The accessibility of RAS is deeply intertwined with the economic performance of a nation. As economies grow and develop, investments in healthcare infrastructure, medical innovation, and training programs increase, creating an environment where advanced surgical technologies can be integrated into standard medical practice.

Conversely, nations with weaker economies may struggle to justify the high costs of robotic surgery, leading to disparities in accessibility. The financial sustainability of robotic surgery remains a crucial determinant in its adoption, as decision-makers must weigh the benefits of improved patient outcomes against the substantial upfront and maintenance costs of these systems.

2.1 Economic Growth and Healthcare Investment

Economic growth plays a critical role in shaping healthcare expenditure and influencing how resources are allocated within a country's medical system. Wealthier nations generally allocate a greater proportion of their GDP to healthcare, allowing hospitals and medical institutions to invest in state-of-the-art equipment such as robotic surgical systems (Smith *et al.,* 2020). These investments not only improve surgical precision and patient outcomes but also support research and development, driving further technological advancements.

A strong economy also enables governments and private healthcare providers to establish well-structured reimbursement frameworks, which play a crucial role in making robotic surgery financially viable. In many high-income countries, robotic procedures are partially or fully covered by insurance providers, making them accessible to a larger patient population (Jones *et al.*, 2021). In contrast, lower-income nations often struggle with insufficient insurance coverage, leading to out-of-pocket expenses that place robotic surgery out of reach for the majority of the population.

2.2 Financial Sustainability and Cost-Benefit Considerations

One of the most significant barriers to the widespread adoption of robotic surgery is its financial sustainability. Robotic surgical systems, such as the da Vinci Surgical System, require a substantial initial investment, with acquisition costs ranging from $1.5 million to $2.5 million per unit, in addition to high maintenance fees and the recurring cost of disposable instruments (Brown *et al*., 2019). While robotic surgery offers clinical benefits, including greater surgical precision, shorter hospital stays, and reduced post-operative complications, the long-term cost-effectiveness of these procedures remains a topic of debate.

Hospitals in lower-income economies often prioritise cost-effective alternatives, such as laparoscopic or traditional open surgeries, which require less capital investment and fewer recurring expenses. As a result, the financial burden associated with robotic surgery remains a significant limiting factor in regions where healthcare budgets are constrained (Miller *et al.,* 2023). To address this issue, innovative financial models, such as leasing programs, government subsidies, and public-private partnerships, have emerged as potential solutions to distribute the financial risk and improve accessibility.

2.3 Technological Diffusion and Global Disparities

The adoption of robotic surgery is not uniform across different economic regions. High-income countries, particularly those with strong ties to medical technology manufacturers, have been at the forefront of integrating robotics into surgical practice. These nations often establish research collaborations with technology firms, enabling cost reductions through bulk purchasing agreements or government incentives (Lee *et al*., 2022). Additionally, wealthier countries benefit from established medical supply chains and technical support networks, which facilitate the maintenance and continuous operation of robotic systems.

In contrast, many middle- and low-income countries face significant challenges in acquiring and maintaining robotic surgical technology. The lack of trained personnel, limited access to technical support, and inconsistent funding streams make it difficult to sustain long-term robotic surgery programs (Davis *et al.,* 2020). Even in cases where robotic surgical systems are donated or procured through international aid, the high cost of maintenance and the need for specialised training often result in underutilisation or abandonment of the technology.

2.4 The Role of Medical Education and Training

Another key factor influencing the accessibility of robotic-assisted surgery is the availability of trained medical professionals. In developed economies, medical institutions invest heavily in structured training programs, offering simulation-based learning and hands-on experience for surgeons specialising in robotic procedures (Davis *et al.,* 2020). These training initiatives ensure that surgeons are proficient in using robotic systems, thereby maximising patient safety and procedural efficiency.

Conversely, in lower-income nations, the lack of formal training programs for robotic surgery poses a significant barrier to adoption. Many surgeons in these regions must seek training abroad, which can be costly and logistically challenging. Without proper training opportunities, even hospitals that acquire robotic systems may struggle to utilise them effectively, further limiting their accessibility. Some organisations have attempted to bridge this gap through remote training programs and international fellowships, but widespread implementation remains limited due to financial and infrastructural constraints (Brown *et al.,* 2019).

2.5 Regulatory and Policy Considerations

National economic performance also shapes healthcare policies and regulatory environments, which in turn affect the adoption of robotic surgery. In high-income countries, well-established regulatory frameworks streamline the approval process for new medical technologies, allowing for quicker integration into clinical practice. Additionally, government-backed initiatives often provide financial incentives for hospitals to adopt robotic surgical systems, further driving accessibility (Miller *et al.*, 2023).

In contrast, nations with weaker economies often face regulatory challenges that delay the adoption of robotic-assisted surgeries. Inconsistent policies, bureaucratic inefficiencies, and a lack of clear guidelines on reimbursement for robotic procedures can create significant barriers to implementation (Smith *et al.,* 2020). Furthermore, economic instability can lead to budgetary constraints, forcing governments to prioritise basic healthcare services over high-cost surgical innovations.

2.6 Bridging the Gap: Financial Strategies for Improved Accessibility

Given the financial constraints associated with robotic surgery, various models have been proposed to enhance its accessibility. Leasing programs, for example, allow hospitals to acquire robotic systems without the burden of large upfront costs, making the technology more affordable in resource-limited settings (Lee *et al.,* 2022). Public-private partnerships have also emerged as a viable strategy, where government funding is supplemented by private-sector investment to improve healthcare infrastructure.

Additionally, some countries have introduced outcome-based reimbursement models, where healthcare providers receive financial incentives based on patient recovery outcomes rather than the specific procedures performed. This model encourages hospitals to adopt advanced technologies, such as robotic surgery, when they can demonstrate long-term cost savings and improved patient care (Jones *et al.,* 2021).

2.7 The Accessibility of RAS in Developed (Advanced) Economies

The accessibility of robot-assisted surgery (RAS) varies significantly among developed economies such as the United States, Canada, Australia, Japan, and European Union (EU) Member States. This variation is largely influenced by financial, infrastructural, and regulatory factors, all of which play a crucial role in determining the financial sustainability of robotic surgery in comparison to laparotomy and minimally invasive laparoscopic surgery.

One of the primary constraints affecting the accessibility of RAS is the financial burden associated with its implementation. The high initial investment required for robotic surgical systems, such as the da Vinci system, presents a significant barrier even in well-funded healthcare systems. The United States has the highest adoption rate, largely due to the ability of private healthcare institutions to offset costs through higher procedural reimbursement rates (Smith *et al.,* 2022). In contrast, Canada and most European countries, where healthcare systems operate under centralised public models, exhibit slower adoption due to stringent cost-effectiveness evaluations and budget constraints (Jones *et al.*, 2021).

Reimbursement policies further influence the availability of RAS. In the United States, private insurance companies often cover robotic procedures, enhancing their accessibility to insured patients. However, Medicare and Medicaid reimbursements do not always fully cover RAS costs, which can create disparities in access based on socioeconomic status (Miller *et al.,* 2023). In contrast, European countries such as Germany, France, and the United Kingdom assess the cost-effectiveness of robotic surgery before integrating it into national reimbursement plans, often leading to delays in adoption (Williams *et al.,* 2020). Japan, which has a universal healthcare system, has selectively expanded reimbursement coverage for specific robotic procedures, allowing gradual integration (Tanaka, 2021).

Beyond financial considerations, geographic and institutional disparities further affect accessibility. In urban centers with high surgical volumes, hospitals are more likely to invest in robotic systems. However, in rural areas, financial limitations and a lack of specialised personnel hinder availability (Lee *et al.,* 2022). This issue is particularly pronounced in countries such as Australia and Canada, where healthcare facilities are more dispersed, creating logistical challenges in accessing robotic surgery (Harris *et al.,* 2023). By contrast, Japan and densely populated regions of the EU experience fewer geographic limitations in the distribution of robotic systems.

Regulatory approval processes also impact market penetration and accessibility. The United States, through the Food and Drug Administration (FDA), has been relatively fast in approving new robotic surgical systems, contributing to their widespread use (Johnson, 2021). In the EU, the regulatory framework emphasises cost-benefit analysis, often delaying the approval and adoption of new technologies (Martinez *et al.,* 2023). Japan has pursued a strategic approach, approving RAS for specific procedures to ensure cost-effectiveness, while Canada and Australia have taken a more cautious stance, focusing on phased implementation (Kimura, 2022).

Even when robotic systems are available, accessibility is influenced by the availability of trained surgeons. In the United States and parts of Europe, extensive training programs have facilitated the integration of RAS into surgical practice (Anderson *et al.,* 2023). However, in countries such as Canada and Australia, limited training opportunities outside major urban centres create further barriers to widespread adoption (Singh *et al.,* 2020).

2.8 RAS in Middle- and Low-Income Economies

The integration of RAS into healthcare systems in middle-income and low-income countries (LMICs) presents both an opportunity to improve surgical outcomes and a challenge due to the high costs and infrastructure requirements associated with the technology. Several studies highlight key considerations for LMICs seeking to adopt robotic surgery sustainably, including alternative robotic platforms, cost-conscious approaches, and innovative financing models.

One of the primary challenges in adopting robotic surgery in LMICs is the high upfront investment required for equipment procurement, training, and maintenance. The da Vinci system, which dominates the global market for robotic-assisted surgery, remains costly, limiting accessibility for many hospitals in LMICs. However, alternative robotic platforms, such as the Senhance surgical system, have emerged as cost-effective solutions. Studies comparing Senhance to the da Vinci system in procedures such as benign hysterectomy suggest that the former offers significantly lower instrument costs while maintaining comparable surgical efficiency and case times (Coussons *et al.,* 2021). This suggests that hospitals in LMICs could benefit from exploring alternative systems that provide similar advantages in minimally invasive surgery without the prohibitive costs.

Another crucial factor in financial sustainability is the implementation of cost-conscious surgical strategies. Research has demonstrated that reducing the number of robotic instruments used per procedure can significantly decrease overall expenses without affecting surgical outcomes (Martins *et al.,* 2021; Cengiz *et al.,* 2021). Additionally, optimising operating room (OR) time and streamlining workflows can further enhance cost efficiency. Enhanced recovery after surgery (ERAS) protocols have also been shown to improve financial sustainability by reducing postoperative hospital stays, thereby lowering inpatient care costs (Baker *et al.,* 2023; Hill *et al.,* 2023). For example, robotic-assisted prostatectomy with an ERAS program has enabled same-day discharge for selected patients, significantly cutting down hospitalisation costs and freeing up resources for other patients in need (Hill *et al.,* 2023).

To mitigate financial barriers, some LMIC healthcare systems have explored outsourcing robotic surgeries to private hospitals. This public-private partnership model enables government-funded hospitals to provide robotic-assisted procedures without bearing the full cost of acquiring and maintaining robotic systems. A cost analysis of such a model in Australia found that outsourcing robotic-assisted procedures allowed public hospitals to access cutting-edge technology while avoiding substantial capital investments (Young *et al.,* 2021). This approach could serve as a viable strategy for LMICs where direct investment in robotic platforms remains unfeasible. Additionally, strategic collaborations between governments, medical institutions, and technology providers could facilitate leasing programs or shared robotic surgery centers, reducing the financial burden on individual hospitals.

A significant challenge in implementing robotic surgery in LMICs is the need for a trained workforce. Unlike traditional open or laparoscopic surgery, robotic-assisted procedures require specialised training for surgeons, OR staff, and anesthesiologists. Establishing comprehensive training programs and simulation-based learning can help ensure that surgical teams acquire the necessary skills before performing live procedures. Research highlights the importance of structured robotic surgery training pathways, particularly in LMICs, where access to high-cost training programs in developed countries may not be feasible (McKay *et al.*, 2024). Investing in local training centres, supported by tele-mentoring and virtual simulations, could bridge the skills gap and facilitate the widespread adoption of robotic-assisted surgery in resource-limited settings.

Integrating robotic surgery into existing LMIC healthcare frameworks also requires strategic planning regarding procedure selection and patient prioritisation. Given the high costs associated with robotic-assisted surgery, hospitals in LMICs should initially focus on high-volume procedures where robotic technology offers the greatest advantages, such as hysterectomy, prostatectomy, and colorectal surgery (Dumont *et al.,* 2021; Chumnanvej *et al.,* 2023). Prioritising these procedures can maximise the return on investment by ensuring that robotic platforms are utilised efficiently and that patients who stand to benefit the most receive treatment.

Moreover, technological advancements in robotic surgery, such as single-port robotic-assisted surgery, could further enhance feasibility in LMICs. Single-port systems require fewer incisions, potentially reducing OR time, shortening recovery periods, and lowering the overall cost per procedure (Heo *et al.,* 2024). The application of single-port robotic systems in urology, general surgery, and hepatobiliary surgery has demonstrated promising results, with comparable clinical outcomes to multi-port approaches but with improved cost efficiency and better cosmetic results for patients (Heo *et al.,* 2024; Mellado *et al.,* 2024).

The potential benefits of robotic surgery in LMICs extend beyond financial considerations. Improved surgical precision, reduced intraoperative blood loss, and lower complication rates contribute to better patient outcomes, which is particularly critical in regions where access to postoperative care is limited (Park *et al.,* 2024; Mellado *et al.,* 2024). Furthermore, robotic surgery allows for minimally invasive treatment of complex conditions, such as gallbladder cancer and spinal surgery, which were previously challenging to perform in many LMICs due to technological and expertise constraints (Chumnanvej *et al.,* 2023; Mellado *et al.,* 2024).

Table 1. Integration of RAS into Healthcare Systems

Conducive conditions	**Non-conducive conditions**
economic growth of a country	weak economies
growing healthcare/GDP ratio	low healthcare/GDP ratio
well-structured healthcare reimbursement frameworks	insufficient insurance coverage, out-of-pocket healthcare expenses
clinical benefits: greater surgical precision, shorter hospital stays, thus lower costs, reduced post-operative complications	substantial initial investment, high maintenance fees, recurring cost of disposable instruments
innovative financial models (leasing programs, government subsidies, public-private partnerships)	cost-effective alternatives (laparoscopic or traditional open surgeries)
prevalence of and cooperation with medical research and technology manufacturers, technical support	lack of trained personnel, limited access to technical support
bulk purchasing agreements or government incentives	inconsistent funding streams
medical technology supply chains	(even if funded by aid) high cost of maintenance and the need for specialised training results in underutilisation or abandonment of the technology
structured medical training programs, simulation-based learning, surgeons specialising in robotic procedures	costly and logistically challenging training abroad programmes
well-establised regulatory frameworks	regulatory challenges, inconsistent policies, bureaucratic inefficiencies, a lack of clear guidelines on reimbursement
government-backed initiatives providing financial incentives for hospitals to adopt robotic surgical systems	budgetary constraints forcing governments to prioritise basic healthcare services over high-cost surgical innovations
private healthcare institutions (outsourcing RAS to private hospitals)	centralised public healthcare models
urban centers with high surgical volumes	rural areas, geographical disparities, logistical challenges

Source: Tinka D., Lukács E. (self edited, 2025).

3. Financing Models for Robotic Surgery Systems Worldwide

The adoption and expansion of robotic surgery systems have been driven by a variety of financing models, reflecting differences in healthcare infrastructure, economic policies, and institutional capabilities. These models include public-private partnerships, government funding, direct hospital investment, private healthcare financing, leasing, philanthropic donations, and considerations of financial sustainability.

One increasingly popular approach is public-private partnerships (PPPs), which allow public hospitals to access robotic surgical systems without bearing the full cost of purchase and maintenance. For instance, the Lyell McEwin Hospital in Australia has partnered with private healthcare providers to utilise da Vinci Xi surgical systems within private hospitals, effectively minimising capital expenditure while still providing access to advanced surgical techniques (Young *et al.,* 2021). Such partnerships reduce the immediate financial burden on the public sector while allowing high-complexity procedures to be performed in select cases. The high cost of these systems, estimated at AU$4 million per unit, remains a challenge that hospitals seek to mitigate through collaborative funding models (Young *et al.,* 2021).

Government and state funding also play a role in financing robotic surgery systems, particularly in countries with strong public healthcare infrastructures. The UK's National Health Service (NHS) has begun incorporating more cost-efficient robotic systems, such as the Versius® platform, to provide an alternative to the expensive Da Vinci® system (NHS Digital, 2023). In Australia, discussions on Medicare subsidies for robotic surgery continue, although funding remains contingent on demonstrating financial and clinical benefits over traditional methods (Australian Government, 2022).

In some cases, hospitals invest in robotic surgery systems through internal budgeting, treating these purchases as long-term capital expenditures. A single Da Vinci Xi system costs approximately AU$3.7 million, with an additional AU$200,000 required annually for maintenance (Young *et al.,* 2021). In France, hospitals amortise these costs over seven years to justify the investment, although cost-effectiveness analyses remain inconclusive regarding financial sustainability (Paul-Dehlinger *et al.,* 2024).

Private healthcare and insurance providers also play a significant role in financing robotic surgery. Many private hospitals invest in robotic systems independently, funding them through higher surgical fees that are often reimbursed by private insurance companies. This model has driven significant adoption in the United States, where private healthcare dominates (Intuitive Surgical, 2023). The ability to charge higher fees for robotic surgeries makes them financially viable for private institutions, particularly in high-income countries (Young *et al*., 2021).

To ease the financial burden of robotic surgery systems, leasing models are becoming an increasingly attractive option. Leasing allows hospitals to access robotic platforms without large upfront capital investments, making robotic surgery accessible even to institutions with constrained budgets. Intuitive Surgical, the manufacturer of the Da Vinci system, offers leasing programs that reduce the initial financial burden while allowing hospitals to gradually pay for their robotic systems over time (Intuitive Surgical, 2023). This model is particularly relevant for emerging markets where healthcare budgets may not support outright purchases.

Another source of funding for robotic surgery systems is philanthropic and endowment contributions. Some hospitals acquire these systems through private donations or research grants. For example, a Sydney hospital received a Da Vinci Xi system through a donation, illustrating how philanthropy can help offset high acquisition costs and expand access to robotic-assisted surgery (Young *et al.,* 2021).

Financial sustainability remains a critical concern for hospitals investing in robotic surgical systems. Studies indicate that robotic surgery can become cost-effective over time, particularly when high case volumes are achieved. Research in Australia suggests that if 50% of elective operations were robotic-assisted, the initial AU$4 million investment could be recovered within ten years (Young *et al.,* 2021). Increasing patient throughput and reducing hospital stays are key factors in improving financial viability. Moreover, robotic-assisted surgery has been shown to lower postoperative complications and readmission rates, further contributing to cost savings (Chumnanvej *et al.,* 2023).

Despite these advantages, challenges persist. The high capital investment required for robotic systems continues to be a major barrier to widespread adoption. However, market competition is expected to lower costs as patents expire and new robotic systems enter the market. Hospitals must justify their investments with cost-effectiveness analyses, demonstrating that robotic surgery improves patient outcomes, reduces hospital stays, and ultimately leads to financial savings (Paul-Dehlinger *et al.,* 2024).

3.1 Cost Differences between Laparotomy, Minimally Invasive Laparoscopy, and RAS

The cost differences between laparotomy, minimally invasive laparoscopy, and RAS are influenced by various factors, including procedural complexity, hospital infrastructure, surgeon experience, and regional healthcare policies. Generally, laparotomy, or open surgery, incurs the highest overall costs due to longer hospital stays, a higher incidence of postoperative complications, and extended patient recovery periods. For instance, a study analysing the costs of different hysterectomy approaches found that total abdominal hysterectomy (TAH) had significantly higher hospitalisation costs compared to minimally invasive techniques. The primary cost drivers were an extended hospital stay, averaging approximately four days longer than minimally invasive approaches, and an increased rate of postoperative complications that required additional medical intervention (Dumont *et al.,* 2021). These factors contribute to higher direct hospital costs, as well as indirect costs such as lost productivity for patients.

Minimally invasive laparoscopy has consistently been shown to be a more cost-effective alternative to both laparotomy and RAS. Laparoscopic techniques reduce hospital stays, lower the risk of postoperative infections, and minimise overall healthcare expenditures. A cost-effectiveness study of hysterectomy procedures found that laparoscopic hysterectomy (LH) had an average cost of €3,859 per patient, significantly lower than the €6,615 associated with robotic-assisted hysterectomy (Paul-Dehlinger *et al*., 2024). The reduced cost of laparoscopic procedures is largely attributed to lower instrument expenses, shorter operating room times, and faster patient recovery, which collectively result in lower hospitalisation and follow-up care costs. Similarly, studies on colorectal surgeries have reaffirmed that laparoscopy remains the most cost-effective surgical option, demonstrating comparable clinical outcomes while maintaining a lower financial burden than robotic-assisted approaches (Cengiz *et al.,* 2021).

In contrast, RAS presents a different cost structure, characterised by high initial investment costs associated with acquiring robotic systems, routine maintenance expenses, and the recurring need for specialised disposable instruments. These factors make robotic procedures more expensive on a per-case basis. For example, in the context of hysterectomy, the cost per robotic procedure was found to be €6,615, which is approximately €2,756 more than laparoscopic hysterectomy (Paul-Dehlinger *et al.,* 2024). Additionally, robotic surgery often involves higher operating room costs due to the time required for robotic system setup, instrument docking, and intraoperative troubleshooting. However, as hospitals gain more experience with robotic procedures, cost reductions become possible. A study on robotic colorectal surgery noted that, after surgeons overcame the learning curve, hospital costs became comparable to those of open surgery, suggesting that proficiency plays a crucial role in cost-efficiency (Cengiz *et al.,* 2021). Furthermore, institutions that perform a high volume of robotic surgeries tend to optimise resources, leading to a lower per-case financial burden and improved overall cost-effectiveness (Dumont *et al.,* 2021).

Despite its higher upfront costs, RAS has demonstrated potential economic benefits in specific scenarios. For example, robotic procedures are often associated with lower intraoperative blood loss, reduced postoperative pain, and a shorter length of hospital stay compared to open surgery, factors that can contribute to lower long-term healthcare costs. Moreover, some studies suggest that robotic surgery may lead to fewer readmissions and reduced rates of major postoperative complications, which can offset some of the initial financial investment (Paul-Dehlinger *et al.,* 2024). However, these advantages depend heavily on the procedural volume and institutional efficiency in managing robotic surgical programs.

3.2 Financial Sustainability/Return on Investment of RAS

The financial sustainability and return on investment (ROI) of robotic surgery are determined by multiple interdependent factors, ranging from the initial capital investment and ongoing operational costs to efficiency improvements, patient outcomes, and systemic healthcare considerations. One of the most significant economic challenges associated with robotic surgery is the high upfront cost required to acquire robotic systems such as the da Vinci Surgical System. These systems often cost several million dollars, posing a major financial hurdle for hospitals and healthcare institutions considering their adoption. In addition to the purchase price, ongoing expenses such as maintenance, servicing, and software updates contribute significantly to the total cost of ownership. The necessity of specialised disposable instruments, which are generally more expensive than those used in conventional laparoscopic procedures, further increases per-procedure costs and affects long-term financial sustainability (Martins *et al.,* 2021). Moreover, surgeon training presents another crucial cost factor, as proficiency in robotic-assisted surgery requires extensive education and practice, adding both financial and time-related burdens. Institutions investing in robotic surgery must weigh these factors carefully, as the financial feasibility of such an investment depends on achieving sufficient procedural volume and efficiency to offset these costs (McKay *et al.,* 2024).

Despite these high costs, robotic surgery presents several potential avenues for cost savings. One of the most frequently cited benefits is the potential reduction in operating room time. In certain procedures, the improved dexterity and precision afforded by robotic systems can lead to increased efficiency, thereby reducing the duration of surgery and optimising resource utilisation. However, studies have shown mixed results in this regard, with some indicating longer operative times for robotic procedures, particularly during the initial adoption phase when the learning curve is steep (Sucandy *et al.,* 2024). Over time, as surgeons become more proficient, robotic surgery may demonstrate improved efficiency, but the impact on overall cost savings remains highly dependent on procedural type and institutional factors. Closely related to the number of medical schools offering robotic surgery training is the overall level of medical education and ongoing professional development available to surgeons. Studies have shown that surgeons who undergo specialised training in robotic surgery demonstrate shorter learning curves, improved efficiency, and reduced complication rates, all of which contribute to better financial outcomes (Bai *et al.,* 2022).

Hospitals that invest in continuous professional education for their surgical teams report significant improvements in robotic system utilisation. Training programs focused on improving robotic proficiency can reduce surgical errors, optimise resource utilisation, and enhance patient outcomes, ultimately leading to lower costs associated with postoperative complications and hospital readmissions (Young *et al.,* 2021). Moreover, structured training in robotic surgery enables surgical teams to perform complex procedures more effectively, increasing the cost-effectiveness of these systems over time.

Future advancements in robotic technology are expected to reduce costs, making these systems more accessible to a wider range of healthcare institutions. Additionally, improvements in automation and machine learning may further reduce operative times and complication rates, thereby enhancing cost-effectiveness (Paul-Dehlinger *et al.,* 2024). The implementation of tele-mentoring and remote training programs may also allow surgeons in resource-limited settings to develop expertise in robotic surgery without requiring extensive overseas training, further expanding access to these technologies.

Another significant economic advantage of robotic surgery lies in its effect on post-operative care. Multiple studies have highlighted the ability of robotic procedures to shorten hospital stays when compared to open surgery. This reduction in inpatient days translates to lower hospitalisation costs, freeing up hospital resources and improving overall patient throughput (Hill *et al.,* 2023). Additionally, robotic surgery is associated with reduced intraoperative blood loss due to its high precision, leading to lower transfusion rates and fewer post-operative complications. This translates into reduced reliance on blood products and shorter recovery times, both of which contribute to financial sustainability (Cengiz *et al.,* 2021).

In terms of patient outcomes, robotic surgery has been linked to lower complication rates compared to traditional open surgery. A reduction in complications, including surgical site infections, significantly lowers readmission rates, which is a major contributor to long-term healthcare costs (Caruso *et al.,* 2022). Moreover, the improved precision of robotic-assisted techniques minimises the likelihood of unplanned reoperations, further reducing healthcare expenditures. The cost-effectiveness of robotic surgery is often measured using quality-adjusted life years (QALYs), a metric that considers both the cost and the impact on patient health. Some studies indicate that, while robotic surgery is more expensive upfront, the improved patient outcomes and shorter recovery times may justify the additional expenditure in the long run (Bai *et al.,* 2022). However, this varies significantly depending on the specific procedure. For instance, robotic-assisted hysterectomy has been shown to be substantially more expensive than laparoscopic hysterectomy without providing significant clinical benefits that would justify the additional cost (Paul-Dehlinger *et al.,* 2024). On the other hand, robotic-assisted hepatectomy has demonstrated advantages in complex cases where enhanced precision, reduced blood loss, and improved outcomes outweigh the higher costs (Sucandy *et al*., 2024).

The financial viability of robotic surgery is also highly dependent on the type of procedure being performed. In spinal surgeries, for example, robotic assistance has been found to be cost-effective when used for procedures involving fewer than two levels of instrumentation, as it minimises revision surgery rates and improves surgical accuracy (Chumnanvej *et al.,* 2023). In contrast, in the field of gallbladder cancer surgery, the cost-effectiveness of robotic approaches remains uncertain due to the complexity of oncological outcomes and the added financial burden of robotic instrumentation (Mellado *et al.,* 2024). Similarly, robotic-assisted single-port pyeloplasty has demonstrated advantages such as lower blood loss, shorter operative times, and better cosmetic results. However, the overall cost of single-port robotic surgery remains higher than that of multi-port robotic surgery, raising questions about its economic sustainability in routine clinical practice (Heo *et al.,* 2024).

Beyond individual procedures, broader healthcare system factors play a crucial role in determining the financial sustainability of robotic surgery. Hospital volume is a major consideration, as institutions performing a high number of robotic surgeries are better positioned to justify the initial investment. A higher procedural volume allows hospitals to spread the fixed costs associated with robotic systems over a larger number of cases, thereby improving overall cost-effectiveness (Lee *et al.,* 2022). The cost-effectiveness of robotic surgery is also closely tied to the number of robotic systems a hospital or healthcare institution acquires. Large medical centres performing a high volume of robotic procedures benefit from economies of scale, where the initial capital investment in robotic technology is spread across numerous surgeries, thereby reducing the per-procedure cost (Paul-Dehlinger *et al.,* 2024).

Hospitals that invest in multiple robotic systems and maintain a steady surgical volume can significantly offset costs. A study on outsourcing robotic-assisted operations to private hospitals illustrated that increasing the volume of robotic procedures helped justify acquisition costs, particularly when robotic systems led to fewer open conversions and shorter hospital stays (Young *et al.,* 2021). The financial viability of robotic systems is therefore enhanced in institutions that integrate them into multiple surgical disciplines, such as urology, gynecology, general surgery, and orthopedics, maximising their utilisation. Conversely, in lower-income countries, the high cost of acquiring, maintaining, and operating robotic surgical systems presents a major barrier to adoption. A lack of financial resources limits the feasibility of robotic surgery, making it less cost-effective when compared to laparoscopic or open alternatives (Bai *et al.,* 2022). Moreover, lower surgical volumes in resource-limited settings can further reduce cost-effectiveness, as the high fixed costs of robotic systems cannot be adequately distributed across a large number of procedures.

Furthermore, reimbursement models significantly influence financial sustainability. In many healthcare systems, the extent to which robotic surgery is reimbursed by insurance providers and government programs determines whether hospitals can recover their investment. In countries where robotic surgery is not adequately reimbursed, the high costs may pose a financial burden on institutions and patients alike, potentially limiting its widespread adoption (Martins *et al.,* 2021).

To mitigate these financial challenges, some hospitals have explored alternative models for incorporating robotic surgery into their offerings. One such approach is outsourcing robotic-assisted procedures to private hospitals, which enables public hospitals to provide robotic surgery without bearing the full cost of acquiring and maintaining robotic systems (Young *et al.,* 2021). This collaborative model can help reduce financial strain while ensuring patient access to advanced surgical techniques. Additionally, some institutions have sought to rationalise the use of robotic surgery by carefully selecting patients and procedures for which robotic assistance is most beneficial. By optimising patient selection, hospitals can ensure that robotic surgery is utilised in cases where it provides the greatest clinical and economic advantages (Baker *et al.,* 2023).

Ultimately, the financial sustainability and return on investment of robotic surgery depend on a combination of factors, including initial and ongoing costs, procedural efficiency, patient outcomes, hospital volume, and reimbursement policies. While robotic surgery offers clear benefits in terms of reducing hospital stays, minimising complications, and enhancing surgical precision, its cost-effectiveness is highly procedure-dependent. Hospitals and healthcare policymakers must carefully evaluate the economic trade-offs involved in adopting robotic surgery, taking into account both short-term costs and long-term benefits. As robotic technology continues to evolve, future advancements in efficiency, cost reduction, and accessibility may further improve its financial viability. Ongoing research and real-world cost analyses will be critical in shaping the future role of robotic-assisted surgery in healthcare (Sucandy *et al.,* 2024).

4. Medical Professions where RAS Brings Maximum Clinical Benefits and Minimal Costs

4.1 Financial Sustainability and Clinical Benefits of Robotic Surgery across Specialties

Robotic-assisted surgery (RAS) has transformed modern surgical practice, offering enhanced precision, reduced complication rates, and shorter hospital stays. Its application across medical specialties, including urology, gynecology, thoracic surgery, pediatric surgery, and oncology, has provided significant clinical benefits. However, concerns persist regarding the financial sustainability of robotic surgery, particularly in comparison to traditional open and minimally invasive laparoscopic techniques. While some procedures demonstrate cost-effectiveness due to improved patient outcomes, others remain financially burdensome, necessitating further analysis of long-term economic benefits.

4.2 Urology: Improved Outcomes, Cost-Effectiveness in Some Procedures

Urology remains one of the most studied fields for robotic surgery, with radical prostatectomy being a particularly well-established application. Robotic-assisted radical prostatectomy (RARP) has demonstrated superior functional outcomes compared to open and laparoscopic approaches, leading to faster recovery, reduced blood loss, lower complication rates, and improved post-operative continence and sexual function (Wang *et al.,* 2022). However, these benefits come at a significantly higher cost due to the high acquisition and maintenance expenses associated with robotic platforms.

A study comparing single-port (SP) and multi-port (MP) robotic-assisted pyeloplasty found that SP surgery provided superior cosmetic outcomes and resulted in lower blood loss (Heo *et al.,* 2024). However, the SP system was significantly more expensive than MP, raising concerns regarding cost-effectiveness. Despite these costs, studies suggest that in radical prostatectomy, robotic-assisted approaches can be more cost-efficient over time due to lower post-operative complication rates and quicker recovery (Hill *et al.,* 2023). Nevertheless, further comparative cost-effectiveness studies are required to justify its widespread adoption in urologic procedures such as pyeloplasty and nephrectomy.

4.3 Gynecology: Clinical Gains at a Higher Financial Cost

Robotic surgery in gynecology, particularly in hysterectomy, has increased in popularity due to its benefits in complex cases involving large uteri, endometriosis, and malignancies (Dumont *et. al.,* 2021). The minimally invasive nature of RAS reduces recovery times and leads to fewer complications when compared to traditional open hysterectomy.

However, a cost-effectiveness study of robotic-assisted hysterectomy for benign conditions revealed a substantial financial burden. The study compared robotic-assisted total hysterectomy (RATH) with laparoscopic hysterectomy (LH), showing that the average total cost per patient was significantly higher in RATH (€6,615) compared to LH (€3,859), with no statistically significant difference in complication rates (Paul-Dehlinger *et al.,* 2024). This finding suggests that while robotic surgery may offer technical advantages, it does not necessarily provide cost savings when treating benign gynecological conditions. The potential for cost reductions through increased robotic training, improved efficiency, and reduced disposable instrument costs remains an area of future investigation.

Another study on sacrocolpopexy, a procedure used for pelvic organ prolapse repair, found that robotic-assisted sacrocolpopexy had a higher cost compared to open surgery, despite comparable clinical outcomes. However, some studies suggest that the reduced length of hospital stay and lower long-term complications may offset these initial costs (Baker *et al.,* 2023). Further analysis is needed to determine whether robotic gynecological procedures justify the financial investment.

4.4 Thoracic Surgery: Higher Initial Costs, Potential for Long-Term Savings

RAS in thoracic procedures, such as lung resection and mediastinal tumor removal, has shown promise in improving surgical precision while reducing intraoperative risks. The minimally invasive nature of RAS results in decreased post-operative complications, lower blood loss, and shorter hospital stays compared to open thoracic surgery (Sucandy *et al.,* 2024). However, the financial implications remain a concern.

Despite the clinical benefits, robotic thoracic surgery is associated with high initial investment costs, making it financially challenging for many healthcare institutions. Some cost-effectiveness studies suggest that the reduction in post-operative complications and shorter hospital stays may lead to long-term cost savings, although more comprehensive economic analyses are needed to validate these findings. Additionally, increasing surgeon experience with robotic platforms and optimising surgical workflows may further enhance financial feasibility.

4.5 Pediatric Surgery: Expanding Use Despite Financial Barriers

Robotic surgery has shown growing potential in pediatric procedures, particularly for pyeloplasty, fundoplication, and complex urologic reconstructions. Studies indicate that robotic-assisted surgery in children leads to smaller incisions, lower post-operative pain, and shorter hospital stays compared to conventional approaches (Heo *et al.,* 2024). However, the high costs of robotic platforms limit their widespread adoption in pediatric surgical programs.

A major limitation in pediatric robotic surgery is the lack of appropriately sized robotic instruments, which further increases costs and complicates procedural execution. Some institutions have begun adapting adult robotic systems for pediatric use, although significant cost barriers remain. The long-term benefits of reducing hospital stays and complications may justify investment in robotic systems for pediatric surgery, but further research is needed to establish cost-effectiveness.

4.6 Oncology: Precision at a Price

RAS has gained traction in oncology due to its ability to enhance precision and minimise tumor manipulation, which is particularly valuable in cases of pancreatic, rectal, and gynecologic cancers. Studies suggest that robotic-assisted oncologic procedures lead to improved surgical outcomes, with lower rates of conversion to open surgery and reduced post-operative complications (McKay *et al.,* 2024).

For instance, RAS in pancreatic cancer resections has demonstrated reduced blood loss and shorter hospital stays compared to open pancreaticoduodenectomy, albeit at a higher cost. Similarly, robotic-assisted rectal cancer surgery has been associated with improved nerve preservation and lower rates of anastomotic leaks, making it a promising option for complex oncologic procedures.

In gallbladder cancer surgery, robotic approaches have been evaluated as an alternative to traditional open and laparoscopic methods. A systematic review found that robotic-assisted gallbladder cancer surgery provides comparable oncologic outcomes to open surgery, with potential advantages in precision and perioperative recovery (Mellado *et al.,* 2024). However, the financial viability of robotic cancer surgery remains a point of contention, as the increased cost of robotic systems must be weighed against the potential benefits of lower morbidity and reduced hospital stays.

Conclusions

A primary factor influencing the integration of robotic surgery into healthcare systems is its economic feasibility. The availability of adequate healthcare infrastructure and policy support is another essential determinant of the societal embeddedness of robotic surgery. Hospitals with strong funding, advanced surgical facilities, and specialised surgical teams are more likely to integrate robotic systems into their practices. RAS generally offers improved precision, reduced blood loss, shorter hospital stays, thus lower costs and faster recovery times compared to traditional methods. However, these benefits are not universally observed across all surgical procedures and patient populations. Beyond economic and clinical considerations, ethical concerns regarding equity in access to robotic surgery must also be addressed. The high costs associated with robotic systems create disparities in access, with well-funded hospitals and private healthcare institutions being more likely to offer robotic procedures than publicly funded hospitals in resource-limited settings. Policymakers must consider strategies such as subsidising robotic-assisted procedures for specific populations, implementing cost-sharing models. Additionally, efforts to develop lower-cost, open-source robotic surgical technology may play a role in reducing disparities and promoting wider accessibility.

The performance and advancement of a national economy play a pivotal role in determining the accessibility of robotic-assisted surgeries. Economic growth facilitates greater investments in healthcare infrastructure, training programmes, and medical technology, ultimately making robotic surgery more accessible. A strong economy also enables governments and private healthcare providers to establish well-structured reimbursement frameworks, which play a crucial role in making robotic surgery financially viable. However, financial sustainability remains a key consideration, as high costs continue to limit widespread adoption, particularly in lower-income nations. Increasing case volumes and innovative financial models, such as leasing programs, government subsidies, public-private partnerships, insurance reimbursement and philanthropic contributions, have emerged as potential solutions to distribute the financial risk and improve accessibility. While the latter innovative financial models, technological collaborations, and regulatory reforms can help bridge this gap, economic disparities continue to shape the global landscape of RAS.

As healthcare systems evolve, a nation’s economic strength will remain a crucial determinant of whether robotic surgery becomes a widely accessible option or remains a privilege reserved for wealthier populations. The successful adoption of robotic surgery in LMICs requires a multifaceted approach that balances cost-effectiveness, infrastructure readiness, and workforce development. By leveraging alternative robotic systems (e.g. Senhance), implementing cost-conscious surgical strategies, and exploring innovative financing models, LMICs can gradually and sustainably integrate robotic-assisted procedures into their healthcare systems.

Overall, laparotomy remains the most expensive approach due to longer recovery times and higher complication rates, making it less favourable in settings where minimally invasive options are available. Laparoscopy, on the other hand, continues to be the most cost-effective surgical option for most procedures, offering a balance between clinical outcomes and financial sustainability. While robotic-assisted surgery carries higher initial costs, it has the potential to become more economically viable as surgical teams gain experience and procedural volumes increase. The decision to adopt robotic surgery should therefore be carefully evaluated within each healthcare institution, taking into account factors such as case volume, surgeon expertise, and potential long-term cost savings. The presence of medical schools offering robotic surgery training and the overall level of medical education further enhance cost-effectiveness by reducing learning curves and improving procedural efficiency. As technology continues to advance and training programmes expand, robotic surgery is likely to become an increasingly viable and cost-effective option in modern healthcare.

Robotic surgery continues to revolutionise multiple surgical fields by enhancing precision, reducing recovery times, and improving overall patient outcomes. However, its financial sustainability remains a significant concern. While robotic-assisted radical prostatectomy, certain pediatric procedures, and complex oncologic surgeries may justify the high costs due to superior clinical results, procedures such as robotic hysterectomy and some urologic surgeries present questionable financial advantages.

The long-term viability of robotic surgery will likely depend on factors such as cost reductions in robotic platforms, improved training to enhance surgical efficiency, and further studies on cost-benefit analyses. As robotic systems become more widely adopted and technology advances, healthcare institutions must carefully assess which procedures justify the financial investment. Future research should focus on refining cost-effectiveness models and optimising resource allocation to ensure that robotic surgery remains a valuable and financially sustainable addition to modern surgical practice.

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ROBOTINĖS CHIRURGIJOS (RAS) FINANSINIS TVARUMAS

Domonkos Tinka, Eszter Lukács

Santrauka. Ankstesni tyrimai, atlikti šioje srityje, leidžia daryti išvadą, kad robotinė sistema „Da Vinci“, įdiegta Vengrijos sveikatos priežiūros sistemoje, buvo visiškai finansuojama ES lėšomis, išskyrus vieną atvejį, kuris finansuotas asmeninėmis lėšomis. Šiame straipsnyje daroma panaši išvada pasauliniu mastu. Siekiant užtikrinti plačią robotinių chirurginių sistemų taikymą ir finansinį gyvybingumą, būtinos didelės viešosios investicijos (arba kompensavimo schemos). RAS (angl. *Responsible Artificial Intelligence*) arba atsakingo dirbtinio intelekto ekonominį tvarumą lemia tokie veiksniai kaip šalies ekonominio išsivystymo lygis, sveikatos priežiūros sistemos struktūra, aukštųjų medicinos mokyklų skaičius, robotinės chirurgijos istorija šalyje ir sveikatos priežiūros finansavimo mechanizmai. Net ir labiausiai išsivysčiusiose pasaulio ekonomikose prieiga prie RAS privalumų gali būti dalinė dėl finansinių ir geografinių apribojimų.

Reikšminiai žodžiai: finansinis tvarumas; robotinė chirurgija; visuomenės sveikata; sveikatos priežiūros sistemos; išsivysčiusios ekonomikos šalys; besivystančios šalys.