MARKET COMPETITIVENESS AND DEVELOPMENT OF DIGITAL INNOVATIONS IN HEALTHCARE INDUSTRY.

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Abstract

The healthcare industry is undergoing a profound transformation driven by rapid digital innovation. While historical technological shifts have systematically improved people's living standards and health indicators around the world, advanced digital technologies are rethinking clinical possibilities, from supportive imaging to the treatment of previously incurable diseases.This article provides an assessment of the development and impact of digital innovations in healthcare, focusing on two transformative technologies: augmented reality (AR) and neural implants. Using a high-quality, evidence-based system, this study analyzes the clinical applications and market trajectories of AR and neural implants. The data was collected from industry research databases and clinical trial results documented by institutions such as Johns Hopkins University, Stanford Medical University, and Lawrence Livermore National Laboratory. Structured stakeholder analysis was applied to assess the multidimensional impact of these innovations on patients and healthcare professionals in four main areas: psychological, economic, cultural, and ethical. The results obtained indicate that both technologies significantly improve clinical accuracy and expand therapeutic possibilities. AR reduces the surgical error rate by up to 21% and improves the training of medical personnel, supported by a projected cumulative annual growth rate (CAGR) of 25% by 2027. At the same time, neural implants, with a market value projected to reach $6.14 billion by 2032, effectively restore lost sensory, motor, and communication functions. For stakeholders, both technologies optimize clinical outcomes, reduce the cost of long-term hospitalization, and foster a culture of continuous innovation. However, they simultaneously pose serious challenges, including difficult conditions for training clinicians, high implementation costs that threaten equal access, a potential reduction in the quality of responsive patient care, and serious risks associated with the confidentiality of biometric and neural data.

1. Introduction

The amenities we enjoy today are created thanks to people who took on the drudgery of day—to—day work-chopping trees, building houses, delivering letters over long distances, manually copying thousands of books-and turned it into machine work. Humanity has gone through successive waves of innovation to reach our current standard of living, while becoming much healthier and richer. The average person with modest means today has better access to education, healthcare, and safety than even the rich people of past centuries, largely due to the increasing influence of technological progress.

Innovation not only makes everyday life easier, but also saves lives. This article examines two digital innovations in healthcare — augmented reality (AR) and neural implants — and analyzes how each affects key stakeholder groups. For each technology, the article examines its clinical application, market trajectory, and impact on patients and healthcare professionals in psychological, economic, cultural, and ethical aspects.

The document is structured as follows. Section 2 describes the two technologies and the applied analytical framework. Section 3 presents the results of the analysis covering the application areas and the impact of each innovation on stakeholders. Section 4 discusses the general conclusions and implications. There are links at the end.

2. Methods

This article uses a qualitative, evidence-based approach to analysis. Two digital healthcare technologies — augmented reality and neural implants — were selected based on their demonstrated clinical applications, available market data, and significant documented impact on stakeholder groups.

For each technology, the analysis is carried out in two stages. First, the technology is described and its main areas of application in healthcare are determined based on an analysis of publicly available clinical case reports, institutional announcements, and industry publications. Secondly, a structured stakeholder analysis is applied, covering two main groups of stakeholders — patients and healthcare professionals - on four aspects of impact: psychological, economic, cultural and ethical.

The stakeholder analysis system is based on documented practical examples, market research data, as well as expert or institutional sources that all companies refer to. Market size and growth data are taken from industry research databases. Data on clinical cases are taken from official announcements of Johns Hopkins University, Stanford Medical University, Livermore National Laboratory. Lawrence and Children's Hospital of Los Angeles.

3. Results.

Augmented reality in healthcare. Review and clinical application. Augmented reality is a digital technology that creates a visualization of objects superimposed on reality. Unlike virtual reality (VR), which immerses users in a completely different environment, augmented reality brings digital elements to the real world. In healthcare, augmented reality is used for operations, medical imaging, patient education, diagnostic support, pain management, and immersive learning.

On June 8, 2020, the first widely recognized and documented AR spinal surgery was performed at Johns Hopkins University under the direction of Timothy Witham. The surgeons used a headset with a transparent eye display that allows them to see the patient's internal anatomy based on CT scan results superimposed on the surgical field. According to Witham, using augmented reality in the operating room is like having a GPS navigator in front of your eyes naturally, without having to look at a separate screen (Hopkins Medicine, 2021). Harvard Business Review reports that AR in surgical care reduces the risk of errors by 21% (HBR, 2018).

Augmented reality is also widely used in physical therapy and behavioral treatment, where it enhances patient engagement and treatment outcomes. It improves doctor-patient interaction by allowing clinicians to explain complex medical data through visual effects, increasing patient commitment. Los Angeles Children's Hospital partnered with Meta to create AR and VR simulations for teaching trauma to children using Oculus, allowing medical professionals to practice emergency scenarios in a safe environment (MedResponsive, 2025).

AR helps in diagnosis by using 3D visualizations such as MRI and computed tomography superimposed on the patient's body, which improves diagnostic accuracy. Google's AR microscope highlights cancer cells, and apps like AccuVein help nurses find veins (Mobidev, 2025). In the field of medical education, augmented reality — in particular, Microsoft HoloLens — helped professors at Queen Mary University of London teach anatomy classes during the COVID-19 pandemic, when students did not have access to ward rounds (FutureVisual, n.d.).

Regarding market growth: according to Global Market Insights, the augmented reality healthcare market was estimated at 850 in 2020 millions of dollars, and the cumulative annual growth rate (CAGR) is projected to be 25% from 2021 to 2027 (GMInsights, n.d.).

Stakeholder Analysis — Augmented Reality

Psychological impact. For patients, AR provides a better understanding of procedures through visual explanations of health conditions and treatment plans. This increases patient awareness, reduces anxiety, and improves treatment adherence. AR can also turn rehabilitation into a playful experience, boosting mood and motivation, especially in children. For doctors, AR increases professional confidence by helping

them make accurate decisions and reducing cognitive stress and mental fatigue. However, less technically savvy and older doctors may face increased stress related to learning.

The economic effect. AR improves the accuracy of surgical intervention, reducing undesirable outcomes and shortening the operation time. AR patient education - for example, teaching patients with diabetes to lead a healthy lifestyle — reduces the number of emergency interventions. AR-provided telemedicine is cheaper than face-to-face consultations, and home rehabilitation reduces costs even further. The costs associated with human error are also being reduced. For doctors, AR allows them to handle more cases per unit of time, increasing earnings and career competitiveness, although the cost of initial training is a negative factor. The future of some specialties may become uncertain.

Cultural influence. For migrant patients experiencing language barriers, the ability of AR to store large amounts of data and adapt content to different languages and cultural contexts increases the effectiveness of treatment. AR mental health apps help lonely patients cope with depression and other conditions. For professionals, AR facilitates teamwork through real-time data exchange and creates a culture of continuous innovation and learning across all medical institutions.

Ethical aspects. AR improves informed consent by helping patients better understand risks and procedures. However, AR collects sensitive biometric and medical data; poor encryption raises legitimate concerns about data privacy. The high cost of AR technology creates the risk of unequal access — hospitals that lack resources cannot implement it, which violates the principles of equitable medical care. For doctors, augmented reality supports competence through tools such as holoanatomy, but it can also lead to over-reliance on technology, loss of independent clinical skills, and reduced empathic interaction with patients.

Neural Implants in Healthcare. Neural implants, also known as brain implants or neuroprostheses, are devices placed in the brain to monitor, stimulate, or modulate neural activity. They consist of sensors, microchips, a power source, and software, and function by recording biological signals and converting them into digital data. Neural implants are used for deep brain stimulation in Parkinson's disease and epilepsy, cochlear implants in hearing loss, retinal implants to restore vision, and for paralyzed patients to control prosthetics or communicate.Cochlear implants and visual prostheses restore hearing or vision by stimulating sensory pathways; cochlear.com More than 700,000 implantable devices are reported to have been provided to patients worldwide. On March 29, 2022, Stanford Medicine installed two intracortical brain-computer interface (iBCI) sensors in two areas of the brain involved in speech production, combined with decoding software that translates brain activity accompanying speech

attempts into words on a screen (Stanford Medicine, 2023). Lawrence Livermore National Laboratory (LLNL) thin-film electrodes monitor hippocampal activity in patients with epilepsy, reducing symptoms in 60-80% of patients and improving seizure prognosis (LLNL, 2024). Experimental implants are also aimed at improving cognitive functions and memory in patients with Alzheimer's disease.

In addition to direct clinical applications, neural implants generate unprecedented sets of neural data that contribute to the development of neurology and may contribute to further breakthroughs in AI-based healthcare.

Regarding market size and growth: The global neural implant market was estimated at US$2.37 billion in 2024 and is projected to reach US$6.14 billion by 2032, with an average annual growth of 12.65% between 2025 and 2032 (DataBridge, n.d.).

Stakeholder Analysis — Neural implantsPsychological impact. For patients, neural implants are a major source of hope, restoring abilities such as vision, hearing, and communication that were lost due to illness. This restores a sense of control over life and reduces the feeling of isolation that has been documented in patients with sensory or communication impairments. For doctors, implants increase professional confidence by improving patient outcomes, although the technological demands placed on these devices create new sources of stress, especially for doctors who do not have experience working with cutting-edge technologies.

Economic consequences. By restoring hearing, vision, communication and other functions, neural implants increase patients' chances of finding employment. For example, patients who have cochlear implants can return to work. Implants such as DBS reduce the need for inpatient treatment for patients with epilepsy, reducing the cost of hospitalization. Negative economic factors include high initial costs and limited geographical accessibility, which can lead to increased transportation costs. For doctors, neural implants increase work efficiency and real wages, and the growing market creates new career opportunities; however, the initial cost of training is significant, and some specialties face interruptions related to automation.

Cultural impact. Increased use of neural implants promotes social inclusion by allowing people with disabilities to speak up and increase empathy and respect in society. For medical professionals, the widespread introduction of implants promotes a culture of innovation and development. However, there may be a generational gap between older doctors and patients who are not used to new technologies and younger ones who are more enthusiastic about their implementation. The work environment may become more competitive, which will lead to an increase in demand for specialists with dual specialization (medicine and technology).

Ethical aspects. Neural implants increase safety and allow for more informed

patient consent due to the detailed data provided. However, collecting neural data poses a serious privacy risk if encryption is insufficient. Cognitive implants can influence the decision-making process or even the patient's personality, raising concerns about patient autonomy. Equal access is a major concern — high costs and limited availability mean that many patients cannot receive treatment even with viable technology. For doctors, implants increase the responsibility for data confidentiality and require careful monitoring of the device's output, as clinicians may be held accountable for machine-caused errors.

4. Discussion

Both augmented reality and neural implants demonstrate a significant and growing impact on the healthcare industry. Each technology expands clinical possibilities: AR enhances the accuracy, effectiveness, and educational aspect of existing procedures, while neural implants help with conditions including severe hearing loss, paralysis, and epilepsy that were previously incurable or poorly treatable.

An analysis of stakeholders shows that there is a common pattern in both technologies. Patients benefit from improved health outcomes, greater independence, and more informed participation in the medical care process. Healthcare professionals benefit from increased accuracy, professional development, and efficiency, but face new demands in terms of technological literacy, investment in training, and ethical responsibility.

Both technologies have common problems. The cost of implementation, both at the institutional and individual levels, can lead to inequalities in access, which run counter to the fundamental principles of equitable health care. Data privacy is a critical issue for both AR and neural implants, given the confidential nature of biometric and neural data. The risk of excessive dependence on technology, accompanied by a decrease in independent clinical application skills and a decrease in empathic interaction with people, is a cross-cutting problem.

Further developments in both areas are needed. For AR, the most effective next step would be to increase affordability and expand access to medical facilities with limited resources. For neural implants, the priority areas are solving the problems of residual accuracy, expanding geographical accessibility, and creating a reliable legal and ethical framework for managing neural data.

Overall, both AR and neural implants are highly significant innovations that are likely to further strengthen their positions in healthcare over the coming decade. Their potential will be realized most effectively when technical achievements are supported by appropriate ethical, legal and regulatory frameworks governing their implementation.

References

1. Hopkins Medicine (2021) Johns Hopkins performs its first augmented reality surgeries in patients. Available at: https://www.hopkinsmedicine.org/news/articles/2021/02/johns-hopkins-performs-its-first-augmented-reality-surgeries-in-patients (Accessed: 13 May 2025).
2. ResearchAndMarkets.com (2022) Global $9.79 Bn AR-VR in Healthcare Market to 2027. Available at: https://www.businesswire.com/news/home/20220719005693/en/ (Accessed: 13 May 2025).
3. MedResponsive (2025) Augmented Reality — The Next Frontier in the Healthcare Industry. Available at: https://www.medresponsive.com/blog/augmented-reality-next-frontier-healthcare-industry/ (Accessed: 15 May 2025).
4. Mobidev (2025) Augmented and Virtual Reality in Healthcare: Use Cases, Challenges, and Opportunities. Available at: https://mobidev.biz/blog/augmented-and-virtual-reality-in-healthcare-use-cases-challenges-opportunities (Accessed: 13 May 2025).
5. HBR (2018) How Augmented Reality Will Make Surgery Safer. Harvard Business Review. Available at: https://hbr.org/2018/03/how-augmented-reality-will-make-surgery-safer (Accessed: 15 May 2025).
6. GMInsights (n.d.) Augmented Reality Market Size and Industry Analysis. Available at: https://www.gminsights.com/industry-analysis/augmented-reality-ar-market (Accessed: 15 May 2025).
7. FutureVisual (n.d.) Benefits of Augmented Reality in Healthcare. Available at: https://www.futurevisual.com/blog/benefits-augmented-reality-healthcare/ (Accessed: 15 May 2025).
8. DataBridge (n.d.) Global Neural Implants Market Size, Share, and Trends Analysis Report — Forecast to 2032. Available at: https://www.databridgemarketresearch.com/reports/global-neural-implants-market (Accessed: 15 May 2025).
9. Cochlear.com (n.d.) When your loved one gets a hearing win, so do you. Available at: https://www.cochlear.com/us/en/campaign/our-hearing-wins (Accessed: 16 May 2025).
10. Stanford Medicine (2023) Brain implants, software guide speech-disabled person's intended words to computer screen. Available at: https://med.stanford.edu/news/all-news/2023/08/brain-implant-speech-als.html (Accessed: 16 May 2025).
11. LLNL (2024) Big Ideas Lab Highlights Potential for Medical and Research Breakthroughs Using Neural Implants. Lawrence Livermore National Laboratory. Available at: https://www.llnl.gov/news/big-ideas-lab-highlights-potential-medical-and-research-breakthroughs-using-neural-implants (Accessed: 16 May 2025).