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An Analytical Study on the Determinants of Smart Digital Health Development in Singapore

Un estudio analítico sobre los determinantes del desarrollo de la salud digital inteligente en Singapur

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Resumen

This study endeavors to critically analyze the fundamental determinants driving the evolution of smart digital health on a global scale, with a particular emphasis on Singapore. Adopting a descriptive-analytical methodology, the research highlights the projected expansion of the digital healthcare market, with revenues expected to reach approximately $939.54 billion by 2032. These projections underscore the growing significance and pervasive integration of digital health solutions, particularly in the realms of fitness and well-being within Singapore. The nation's advanced healthcare infrastructure, reinforced by strong governmental support, has established it as a leading hub for innovation and investment in digital health technologies.

Palabras clave: health care, information technology, artificial intelligence, Digital health

Abstract

Este estudio examina los factores clave que impulsan la evolución de la salud digital inteligente a nivel global, con un enfoque en Singapur. A través de un enfoque descriptivo-analítico, se proyecta un crecimiento significativo del mercado, con ingresos estimados en 939,54 mil millones de dólares para 2032. La investigación resalta la creciente adopción de soluciones digitales en bienestar y actividad física, impulsada por la infraestructura sanitaria avanzada y el sólido respaldo gubernamental, posicionando a Singapur como un centro líder en innovación e inversión en salud digital.

Keywords: atención sanitaria, tecnología de la información, inteligencia artificial, salud digital

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Introduction

The challenges of remote healthcare delivery, particularly in the context of expanding access, efficiency, and quality of health services. It has increasingly been recognized as a strategic enabler for achieving sustainable development goals and advancing universal health coverage by supporting remote patient monitoring, home-based care, and digital medical consultations. The rapid evolution of healthcare systems requires professionals to adopt adaptive and technology-driven strategies capable of responding to the dynamic needs of service users. In this regard, digital health interventions contribute significantly to strengthening health systems, improving continuity of care, and enhancing patient-centered service delivery, especially for vulnerable populations and those with limited access to traditional healthcare facilities (Keesara et al., 2020; OECD, 2019; World Health Organization [WHO], 2025).

The strategic integration of data analytics and digital technologies has substantially enhanced the safety, efficiency, and quality of healthcare delivery by addressing previously unmet health needs and expanding access to medical services. Within the context of the ongoing digital revolution and the increasing incorporation of digital transformation into governmental health policies, smart digital health has emerged as a rapidly evolving and critical domain for strengthening healthcare systems. The widespread adoption of advanced technological applications has enabled the development of faster, more efficient, and cost-effective healthcare practices, thereby positioning digital health as a fundamental pillar in the modernization of global healthcare infrastructure. Furthermore, this transformation has stimulated the growth of digital health startups focused on developing health and wellness software solutions that optimize clinical workflows and enhance user experience for both healthcare providers and stakeholders (Iyawa et al., 2019; OECD, 2019; WHO, 2025).

Singapore's digital economy has demonstrated sustained and robust growth, supported by a long-term national vision and strong governmental commitment to fostering a competitive digital ecosystem and developing a highly skilled technology workforce. This strategic orientation extends across multiple sectors, with healthcare playing a particularly significant role in driving the emergence of smart digital health initiatives. Beyond its foundational impact, the transformation of digital healthcare in Singapore into an integrated smart health ecosystem has been shaped by several complementary factors, including coherent national digital health policies, advanced health data governance frameworks, extensive digital infrastructure, and strong public–private collaboration. Additionally, the integration of artificial intelligence, data analytics, and interoperable health information systems has enhanced system efficiency and service personalization. Collectively, these factors have positioned Singapore as a leading model for smart health development within digitally advanced economies (Ministry of Health Singapore, 2024; OECD, 2019; WHO, 2025).

The significance of this research lies in its objective to identify and analyze the key factors driving the development of smart digital health applications globally and within Singapore, a city recognized for its technological advancement and high quality of life. The study further examines the evolution of the smart healthcare market, providing insights into the strategic marketing of smart healthcare solutions in Algeria. As the global transition toward smart cities accelerates, leveraging the Internet of Things (IoT), big data, and interconnected intelligent systems, these transformations play a critical role in reinforcing economic, social, and environmental sustainability. While Algeria's adoption of digital transformation in healthcare remains comparatively delayed, the research aims to provide evidence-based recommendations to policymakers to facilitate the implementation of effective solutions and promote improvements in health system performance and societal well-being (Alami et al., 2017; Iyawa et al., 2019; OECD, 2019; WHO, 2025).

To address the research problem, this study adopts an analytical approach to examine and interpret data, statistics, and key indicators obtained from previous scholarly studies, research, and specialized statistical databases. The collected information has been systematically categorized into three principal

thematic sections, culminating in a concluding segment that synthesizes the key findings and presents a set of critical recommendations based on the study's results.

Basic components of a smart digital health system

Digital health

The term *digital health* refers to the use of information and communication technologies in healthcare and health management. It can be applied across multiple domains of medicine and public health, including the management of patient and population health data through electronic health records, the provision of telehealth services, and the delivery of health information via mobile technologies (mHealth) (Olu et al., 2019). Other applications include the use of connected medical devices within the Internet of Things (IoT) ecosystem, as well as wearable technologies that monitor, analyze, and transmit vital signs to personal or centralized repositories (Olu et al., 2019). In this sense, digital health represents the integration of the digital revolution into the healthcare sector through technological innovation and cultural transformation, encompassing an interdisciplinary field that combines technology, medicine, and research to design and apply digital solutions for health promotion (Tan et al., 2023).

Digital health also encompasses a range of services and technologies that enable patients to access healthcare support without physically visiting hospitals or clinics (Rowlands, 2019). It involves the collection, sharing, and analysis of health data through digital ICT systems to enhance patient services and healthcare delivery (Zainal et al., 2023). Moreover, digital health integrates information technology, big data, and artificial intelligence to support clinical decision-making and improve patient outcomes, including applications such as electronic patient records, remote medical monitoring, connected devices, and digital rehabilitation tools (Apablaza & Cano, 2022).

The World Health Organization defines digital health as the field of knowledge and practice associated with the development and use of digital technologies to improve health (WHO, 2025). Empirical evidence suggests that digital health programs can enhance the quality of care, reduce financial burdens, and improve patients' quality of life (Hu et al., 2026). Telehealth, as a growing component of digital health, enables healthcare professionals to monitor patients remotely outside traditional hospital settings, offering advantages such as real-time disease detection, prevention of disease deterioration, and reductions in hospital admissions (Malasinghe et al., 2019).

The application of digital technologies in healthcare also offers significant benefits, including improved access to health services—particularly in remote or underserved areas—and enhanced safety and quality of healthcare products and services (Olu et al., 2019). These technologies contribute to better access to health information for both healthcare workers and communities, improving workforce productivity and increasing the utilization of health services. Furthermore, digital health solutions can enhance efficiency, reduce service delivery costs, support real-time public health decision-making, and strengthen health system performance monitoring (Olu et al., 2019). Additional benefits include identifying and addressing social, cultural, physical, and financial barriers to equitable healthcare access, as well as improving the efficiency of digitized health insurance systems. Nevertheless, the use of remote patient monitoring requires careful consideration, particularly regarding data security and patient privacy, which remain critical areas for ongoing research (Abdel, 2024).

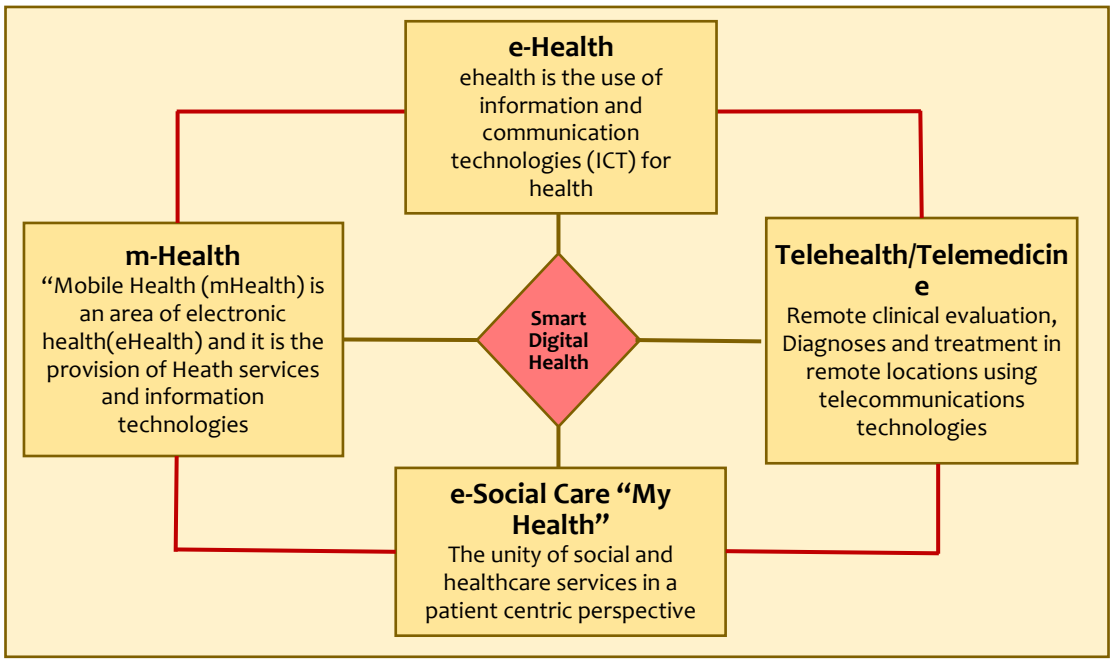
Smart digital health

Smart digital health is defined as a set of healthcare solutions that facilitate communication among healthcare professionals and between healthcare professionals and patients or clients, in addition to enabling patients to engage in self-care. These solutions support health prevention and treatment at home to reduce hospitalization, and when necessary, they can also facilitate home-based treatment

(Furlepa et al., 2022). Accordingly, smart digital health can be viewed as a framework for addressing healthcare challenges through remote services enabled by technology. Figure 1 illustrates the range of technologies within the smart health domain that support the delivery of patient-centered healthcare services. In this framework, information is shared and utilized across stakeholders and sectors, emphasizing that smart digital solutions extend beyond technology alone and require organizational change. For this reason, technical solutions in this domain are collectively referred to as smart digital health, as they enable patients and ecosystem stakeholders to share relevant data (Nordic Innovation, 2018).

Figure 1.

Data and information sharing across solutions and sectors



Source: Nordic Innovation. (2018). A Nordic story about smart digital health.

Connected Health

Connected health is defined as a socio-technical model for managing and delivering healthcare through the use of technology to enable remote healthcare services. It also serves as an umbrella term encompassing various forms of remote healthcare, including telemedicine, mobile health, digital health, and e-health services (Nordic Innovation, 2018). Mobile health (mHealth) refers to the delivery of healthcare services via mobile devices through dedicated applications. These services include patient management functions such as appointment bookings, reminders, discharges (MacKinnon & Brittain, 2020), and referrals, delivered through multiple channels including the internet and mobile devices. mHealth also integrates data from wearable devices, particularly those related to fitness and health monitoring. Several successful applications in the Nordic region demonstrate innovative approaches to patient monitoring (Chauhan et al., 2025), including the Coalalife application in Sweden for cardiovascular data collection, the Kaiku Health application in Finland for smart patient monitoring (Wettstein et al., 2024), and the Docrates Cancer Center in Finland, which provides specialized oncology services.

Telehealth or telemedicine

Telemedicine, also referred to as telehealth or e-health, enables healthcare professionals to evaluate, diagnose, and treat patients in remote locations using communication technologies. This approach allows patients in geographically isolated areas to access medical expertise efficiently without the need for travel (Vudathaneni et al., 2024). Telehealth solutions improve patient satisfaction while reducing the demand for hospital resources such as staff, beds, and equipment (Haleem et al., 2021). Examples of successful applications include the OpenTeleHealth platform in Denmark for remote patient monitoring, the Kanta system in Finland for patient data management in telehealth, and the Kvikna application in Iceland for information management.

Electronic social care

Electronic social care integrates social services with healthcare by providing reliable information related to patient well-being and enabling its continued use over time. Innovative models such as population health management have emerged through the integration of social and healthcare data into unified data warehouses (Knezevic et al., 2025), where digital analytics and artificial intelligence can be applied. Examples of successful applications include the use of Coalalife in Sweden to provide aggregated data to general practitioners, RoomMate in Norway for secure image information sharing (Nwokedi et al., 2024), and Stiki Solutions in Iceland for securing healthcare system data (Nordic Innovation, 2018).

Different components of digital health

The COVID-19 pandemic has accelerated the development of digital health, transforming healthcare delivery through online symptom screening, patient-facing tools, remote patient monitoring, and telehealth services. This transformation has created significant opportunities in the healthcare market, with venture capital funding in digital health more than doubling compared to 2019 (Omboni et al., 2022), largely due to the increased adoption of consumer-oriented digital health technologies (Khan & Duncan, 2025). Key components of digital health include the management of large and complex datasets through advanced analytics, the use of cloud computing for scalable healthcare infrastructure, patient-centered healthcare delivery models such as connected health (Peek et al., 2023; Cotton & Patel, 2019), the application of e-health systems across healthcare functions, active patient engagement through e-patients, and the use of gamification technologies in health and fitness applications (WHO, 2025):

- The use of electronic processes and information technology (ICT) across the full range of functions, affecting health and care, in other words, the use of e-health which symbolizes the field of medical informatics, which uses the Internet and related technologies to organize and distribute health services and information.
- E-Patients: Patients who participate fully electronically in their health and care are referred to as e-Patients, and they know everything there is to know about their health and health care, and may be involved in their own health and care, as well as the health and care of the people they care for.
- Using game application technology : incorporating game-like elements has become a familiar and effective strategy in health and fitness applications. It boosts user engagement and encourages individuals to exercise more regularly while making lasting, positive adjustments to their daily habits—ultimately leading to meaningful improvements in their overall health.

The global digital health market is driven by increasing demand for mobile health applications, remote patient monitoring services, and the widespread adoption of smartphones and health-related applications worldwide (Pandey, 2025). These trends have contributed to the integration of artificial intelligence, mobile platforms, and automated electronic health records, supporting the development of smart healthcare systems that enhance service quality and promote sustainable development (Ghadi et

al., 2025). However, concerns related to cybersecurity and financial constraints continue to pose challenges to market growth (Alzghaibi, 2025).

Levels of health care development

Digital health is described as the integration of electronic information and communication technologies into healthcare processes to improve overall health and well-being. The rapid adoption of emerging technologies such as wearable devices, mHealth applications, ingestible sensors (Bahadori et al., 2025), and artificial intelligence has provided strong momentum for the growth of the smart digital health market (Ronquillo et al., 2025).

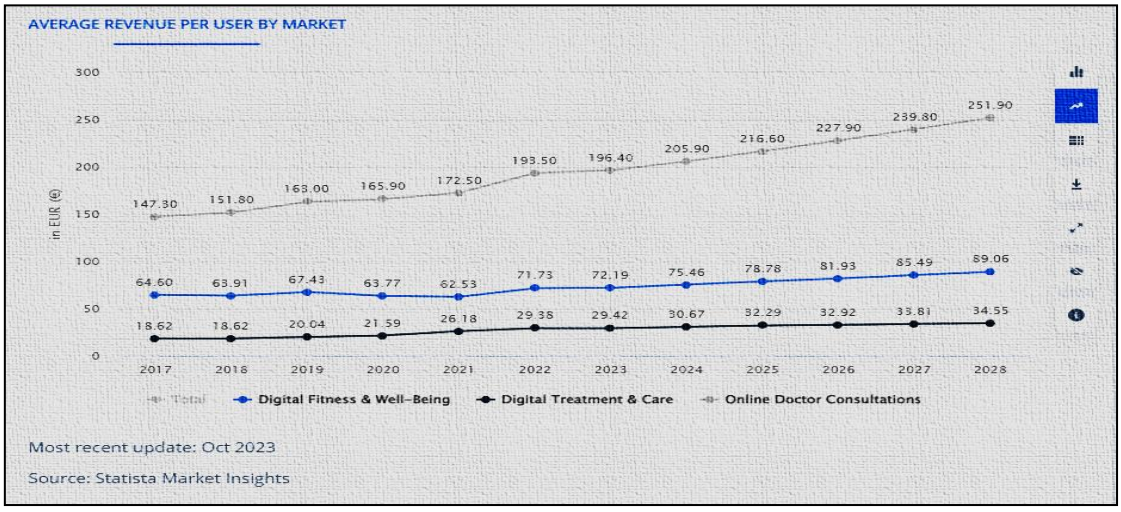
At the global level

Digitization has significantly transformed the global healthcare industry, resulting in increased adoption of mobile health services, driven primarily by widespread smartphone usage and the impact of the COVID-19 pandemic (Rawal, 2025). Consequently, demand for smart healthcare products has expanded, with the fitness and digital well-being sector capturing the largest market share and generating revenues of €85.53 billion in 2024 (MarketsandMarkets, 2025). The global digital healthcare market is projected to reach €177.10 billion by the end of 2024, with a compound annual growth rate of 9.23% between 2024 and 2028, leading to a projected market size of €252.10 billion by 2028 and an average revenue per user of €54.88 (Grand View Research, n.d; Statista, 2025a).

Digital health encompasses the digital transformation of healthcare systems through the integration of software, hardware, and services. Key technologies include mHealth applications, wearable devices, electronic health records, electronic medical records, telemedicine, telehealth, and personalized medicine (MarketsandMarkets, n.d; Pandey, 2025). Demographic changes, disease prevalence, rising healthcare costs, and inequalities in access to care have increased the need for technological innovation, while epidemics and pandemics have further highlighted the importance of digital health solutions. These factors are expected to continue driving market growth, with digital health revenues projected to reach €252.05 billion by 2028 (WHO, 2021; Grand View Research, n.d.).

Figure 2

Average digital healthcare market revenue per user



Source: *From Statista. (2023, October).* Average revenue per user (ARPU) in digital health markets worldwide from 2017 to 2028, by segment [Chart]. https://www.statista.com/outlook/hmo/digital-health/digital-fitness-well-being/worldwide. Reprinted with permission.

The digital health market, encompassing multiple intersections between healthcare and digital technologies, has experienced substantial growth, creating significant opportunities for businesses worldwide. Market data indicate that the average revenue per user reaches €205.90 for telemedicine consultations, €75.46 for fitness and physical and digital health services, and €30.29 for digital treatment and care solutions. These figures highlight the differentiated economic performance across digital health segments and reflect the increasing demand for technology-enabled healthcare services. Digital solutions have played a pivotal role in reshaping electronic health by enhancing the value delivered to traditional healthcare systems. Consequently, redefining the structure and functional scope of digital health has become essential to ensure its effective integration and activation for end users. Overall, the continued expansion of digital health is closely linked to a range of external technological, economic, and social factors that collectively influence its growth dynamics (Navallo et al., 2024; Rawal, 2025).

The digital health market has witnessed significant global growth driven by increased adoption of digital technologies, heightened health awareness among consumers, and rising healthcare expenditures in exchange for the convenience offered by online health services (IMARC Group, n.d.). One of the most influential factors has been the impact of the COVID-19 crisis, which contributed to an estimated growth increase of 2.3%, in addition to several market-specific drivers (Statista, 2025a).

Customer choices and preferences. Consumers increasingly seek digital fitness and well-being solutions to monitor and improve their health, driving demand for wearable devices and health-tracking applications (Chandrasekaran et al., 2025). Online medical consultations have also gained popularity among individuals seeking timely and accessible professional advice (Tila, 2025).

Changes in market trends. A growing global trend involves the use of health and fitness applications to track daily activities and monitor health indicators. Digital treatment platforms are also attracting increasing interest by enabling patients to access personalized treatment plans and medication management services online (Curry, 2026).

Local contextual conditions. Country-specific conditions play a crucial role in shaping digital health market development. The widespread adoption of smartphones, combined with governmental support for digital healthcare initiatives (Ahmed et al., 2025), has accelerated the expansion of telehealth platforms, particularly in regions with limited access to traditional healthcare facilities (Sylla et al., 2025).

Macroeconomic factors. Market growth is further influenced by macroeconomic variables such as technological advancement, regulatory support, and investment in healthcare infrastructure (Rabbani et al., 2025). Additionally, the global increase in chronic diseases and aging populations has amplified demand for digital healthcare solutions.

A healthcare system built on a fully digital ecosystem can generate multiple societal benefits. Empirical studies demonstrate the value of digital tools in disease surveillance, screening programs, awareness campaigns (Erku et al., 2023), behavioral health interventions delivered through social media, and digital health literacy. Evidence increasingly confirms that digital healthcare solutions support prevention strategies, reduce healthcare demand, and contribute to healthier societies by integrating medical and behavioral knowledge (Qiu et al., 2025).

At the Singapore level

Singapore provides comprehensive healthcare coverage through multiple layers of care. Among ASEAN countries, it records the highest per capita healthcare expenditure, which is expected to increase faster than GDP due to population aging and demographic shifts (Navallo et al., 2024; Gill et al., 2024). According to recent statistics:

- Singapore ranked first among 104 countries in the *Health Component* of the Legatum Prosperity Index 2023, reflecting population health status and access to services.

- Singapore General Hospital ranked ninth globally in the 2023 *World Hospital Rankings* conducted by Newsweek and Statista.
- National healthcare expenditure is projected to reach US$43 billion by 2030.
- Healthcare spending is expected to represent 5.9% of GDP, potentially rising to 9.0% by the end of the decade.

According to an analysis of the top 50 HealthTech companies in Southeast Asia for 2023–2024, Singapore accounted for 66% of leading firms, while Malaysia's share increased from 2% in 2021 to 6% in 2023 (Mendoza, 2025).

In 2021, Singapore's imports of medical equipment declined by 5.0% year-on-year, with U.S. suppliers holding a 24% market share and more than 70% of imports re-exported (U.S. Department of Commerce, International Trade Administration, 2025). From 2023 onward, imports and domestic production are expected to rise due to economic recovery, demographic aging, chronic disease prevalence, technological innovation, and increased health awareness (Nexdigm, 2024). These trends are also accelerating a shift from hospital-centric care toward outpatient and community-based models, creating strategic opportunities for remote care and patient monitoring initiatives (Theseira, 2025).

Singapore's national healthcare spending is projected to reach S$59 billion by 2030, supported by targeted investments in healthcare infrastructure, subsidies, and digital health innovation Priority areas include telemedicine, remote care, artificial intelligence, cybersecurity for electronic health records, data sharing, preventive care, and personal health management (Ministry of Health Singapore, 2022).

Levels of adoption of smart healthcare solutions

The healthcare ecosystem has undergone a paradigm shift in service delivery and consumption, increasing demand for decentralized, cost-effective, and high-quality care models. Digital health supports key objectives such as prevention-oriented care, improved access, cost reduction, quality enhancement, and efficient resource utilization. Mobile applications, wearable devices, and ingestible sensors have become essential tools for diagnosis and patient monitoring (Pandey, 2025).

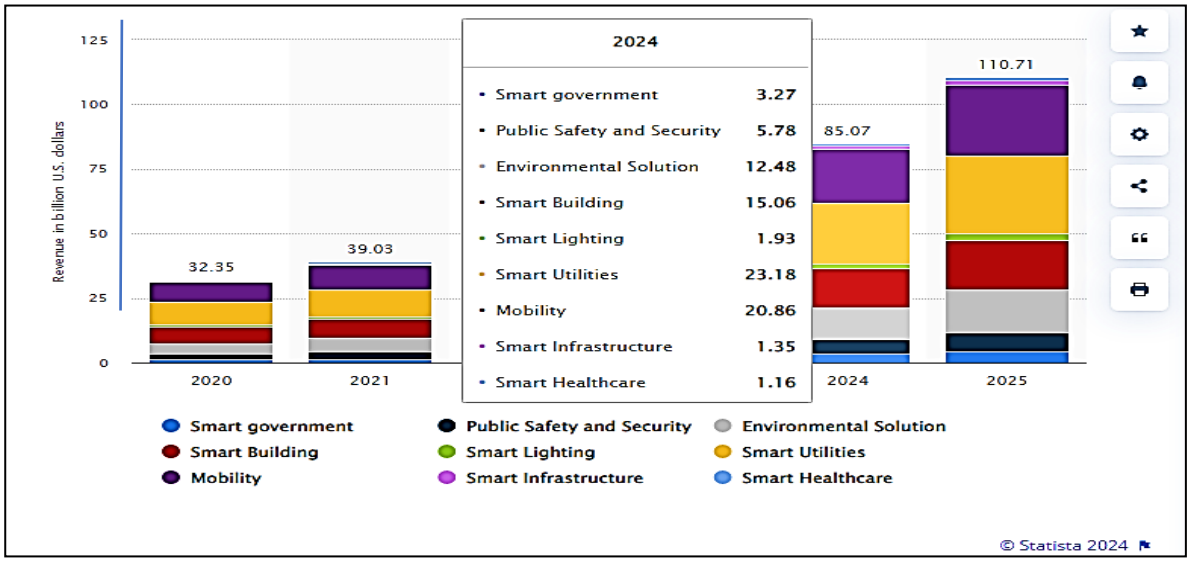
The adoption of telemedicine and smart medical devices has expanded significantly. The value of IoT in healthcare is projected to exceed US$534 billion by 2025, while wearable device adoption reached approximately 515 million units by the end of 2022. Artificial intelligence applications in healthcare are expected to generate annual savings of up to US$150 billion by 2026, with big data analytics reducing treatment costs by approximately 25% (Deb, 2025).

At the global level

The global smart healthcare market reached a value of US$184 billion in 2022 and is projected to grow to approximately US$541 billion by 2032, with a compound annual growth rate of 15.7% (Grand View Research, n.d.). Artificial intelligence-based diagnostics have achieved accuracy rates of up to 90% for certain medical conditions, telemedicine usage increased globally by 80% in the past year, and over 60% of hospitals worldwide have implemented IoT technologies (Elagina, 2025). Approximately 85% of healthcare institutions now use big data analytics for population health management, contributing to healthcare cost savings of up to 30% for providers and patients (Grand View Research, n.d.).

Figure 3

Smart city operating revenues worldwide 2020-2025, by industry



Source: Elagina, D. (2025). Projected revenue generated by startups in the global smart city market from 2020 to 2025, by industry (in billion U.S. dollars) [Chart]. https://www.statista.com/statistics/1231502/smart-city-startup-revenue-by-industry. Reprinted with permission.

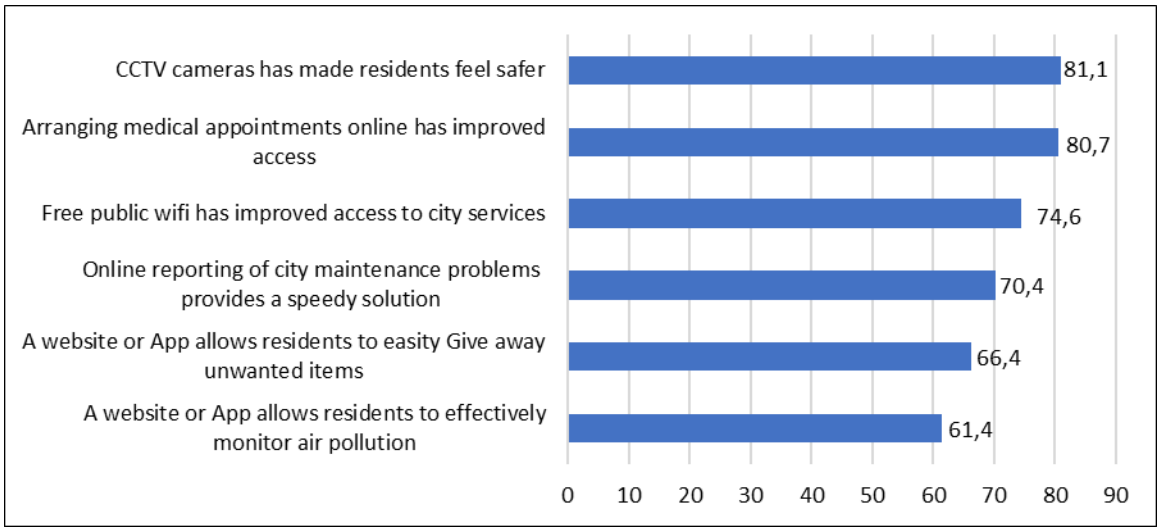
The projected global revenues of smart city utility technology startups were expected to reach US$10.75 billion in 2021, increasing to approximately US$30 billion by 2025. Within this context, the smart digital health sector reached revenues of approximately US$1.16 billion in early 2024 (Elagina, 2025).

At the Singapore level

The Singapore government's spending on health, estimated at approximately 2% of GDP, is among the lowest compared to other high-income countries. Nevertheless, Singapore maintains a high standard of health and healthcare outcomes. Life expectancy at birth reaches around 83 years, and the country records one of the lowest infant mortality rates globally (Report Ocean, 2025). In addition, the increasing importance and widespread adoption of government-approved digital fitness and wellbeing solutions, supported by a robust healthcare infrastructure and strong governmental backing, have positioned Singapore as a leading hub for innovation and investment in digital health. Accordingly, the digital health market in Singapore is expected to experience substantial growth (Statista, 2025b).

Revenues in the Singaporean digital health market are projected to reach approximately USD 790.10 million by the end of the current year, reflecting significant growth opportunities for the sector. The market is forecast to expand at a compound annual growth rate of 14.16% between 2024 and 2028, reaching an estimated market size of USD 1,342.00 million by 2028 (Taylor, 2025). Furthermore, the average revenue per user (ARPU) is expected to reach USD 142.30, with digital treatment and care accounting for the largest share of revenues, estimated at USD 438.50 million at the beginning of 2024 (Mendoza, 2025).

Figure 4
Health and safety index score in smart cities in Singapore



Source: From Institute for Management Development. (2024). IMD Smart City Index 2024. IMD World Competitiveness Center. https://www.coit.es/sites/default/files/imd_-smartcityindex-2024-full-report.pdf.

Healthcare in Singapore is primarily based on the principle of individual responsibility combined with affordable healthcare for all citizens. Government subsidies support investments in smart city infrastructure (Ministry of Health Singapore, 2024), including sensory camera surveillance systems (81.1%) and remote medical diagnostic systems (60.7%). In addition, individual private savings and a set of insurance schemes collectively known as the "3Ms" (Medisave, MediShield, and MediFund) play a central role in financing healthcare coverage for citizens. Moreover, the adoption of telemedicine and remote patient monitoring has contributed to a reduction of approximately 60% in hospital readmissions (Tan et al., 2023).

Conclusion

Smart healthcare, driven by rapid technological advancements and artificial intelligence, has profoundly transformed the healthcare industry by offering innovative solutions and improving patient outcomes. Recent statistics indicate a significant increase in the adoption of smart healthcare systems, particularly in telemedicine, wearable devices, and AI-based diagnostic tools, with telemedicine representing one of the fastest-growing segments in the smart healthcare market.

Following the outbreak of the COVID-19 pandemic, the adoption of telemedicine accelerated considerably, as healthcare professionals increasingly relied on virtual care delivery to maintain effective communication with patients under conditions of social distancing. These developments have not only enhanced the quality of patient care but have also improved resource allocation and reduced overall healthcare costs.

Globally, the smart healthcare market reached an estimated value of USD 184 billion in 2022 and is projected to grow to approximately USD 541 billion by 2032, at a compound annual growth rate of 15.7% (Pandey, 2025). The adoption of smart technologies has yielded notable outcomes, with artificial intelligence-based diagnostics achieving accuracy rates of up to 90% for certain medical conditions. Additionally, global telemedicine usage increased by nearly 80% in recent years, while more than 60% of hospitals worldwide have implemented Internet of Things (IoT) devices for diverse healthcare applications.

Furthermore, approximately 85% of healthcare institutions now employ big data analytics to support population health management, contributing to increased patient awareness. Nearly 70% of patients express willingness to use smart healthcare solutions to improve health management, resulting in healthcare cost savings of up to 30% for both patients and providers. Revenues generated by emerging companies in the smart healthcare sector reached approximately USD 1.16 billion by early 2024 (Elagina, 2025).

At the national level, Singapore has emerged as a leading center for innovation and investment in digital health. Life expectancy has reached approximately 83 years, infant mortality rates remain among the lowest worldwide, and hospital readmissions have declined by nearly 60%. These outcomes are attributed to the widespread adoption of government-approved digital fitness and wellness solutions, a strong healthcare infrastructure, and sustained government support, including investments in smart cities, surveillance systems, remote medical diagnostics, and comprehensive insurance schemes. National health expenditure in Singapore is projected to reach SGD 59 billion by 2030, with approximately SGD 5.6 billion allocated to address short- and long-term infrastructure challenges, healthcare costs, and population aging.

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