🏆 *reviewed paper*

The Role of Smart Cities on Smart Healthcare Management

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1 ABSTRACT

This qualitative study examines the role of Smart Cities in smart healthcare management. Interviews with eight practitioners in the field were conducted and analyzed using qualitative content analysis. The findings highlight the significant contributions of Smart Cities in healthcare, such as improved data collection, analysis, and communication between providers and patients. Challenges include the integration of healthcare technologies within Smart City infrastructures and addressing privacy and security concerns. The research underscores the importance of robust digital infrastructures and collaborative efforts between public and private sectors to support the implementation of smart healthcare services in Smart Cities. Recommendations include enhancing adaptability to new technologies and improving communication between healthcare providers and patients.

Keywords: practitioners, Smart City, qualitative research, healthcare, management

2 INTRODUCTION

The rapid urban population growth, projected to reach 60% by 2030, presents significant challenges such as waste management, air pollution, and resource shortages (Pierce & Anderson, 2017). The healthcare industry also faces constraints in delivering patient-centered care due to limited resources. Smart healthcare management solutions have emerged as potential remedies, saving costs and improving patient access. Stakeholders recognize the benefits of smart healthcare systems (Sligo et al., 2017; Renukappa et al., 2022). The shift towards proactive health management is driven by an aging population and the rise of chronic illnesses (Touti & Tabish, 2017).

Smart cities rely on advanced technologies to streamline municipal operations, with various components contributing to their concept (Hancke et al., 2012; Khan, Algarni, and Quasim, 2021). The Internet of Things (IoT) enables innovative healthcare applications (Budida et al., 2017).

This research project aims to explore the role of smart cities in healthcare and address obstacles to their implementation (Mbunge et al., 2021). The paper's structure includes sections on relevant research, methodology, analysis, findings, and conclusions. The literature search involved using specific keywords in search engines and databases to gather relevant studies.

3 LITERATURE REVIEW

3.1 Smart City

The present research examines the state of smart cities and smart healthcare management. The literature search involved two stages. Initially, a comprehensive internet search was conducted using public search engines. In the second stage, keywords such as smart city, smart healthcare, digital healthcare, e-healthcare, and technological adaptation were used to search Google Scholar and ScienceDirect. Various AND/OR operators were used to ensure an adequate collection of studies.

Smart cities have gained significant attention due to the increasing global urbanization. This urbanization process brings forth economic, social, and demographic changes. Advances in hardware and software design have led to a revolution in information and communication technology (ICT), offering opportunities to address urbanization-related challenges. A smart city aims to improve the quality of life by utilizing ICT and other means, ensuring effective urban operations and services while considering economic, social, and environmental aspects (Mohanty, Choppali & Kougianos, 2016).

The growing population and rising living standards highlight the need for smart cities. It is predicted that by 2050, 70% of the world's population will live in cities, which currently consume 75% of resources, produce 80% of greenhouse gases, and threaten the ecosystem (Mohanty, Choppali & Kougianos, 2016). Smart cities

ISBN 978-3-9504945-2-5. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, H. R. KAUFMANN – Ljubljana, Slovenia

offer a natural approach to tackle the challenges associated with rapid urbanization and population expansion (Khan, Algarni & Quasim, 2021).

These cities leverage cutting-edge technologies to enhance living standards while addressing climate change concerns. Smart cities combine democratic governance, efficient resource management, ubiquitous computing, artificial intelligence, and the Internet of Things (IoT) to generate ambient intelligence. They collect and analyze urban big data to support decision-making, leveraging technologies like AI and machine learning (Xu & Geng, 2019). Technology acceptance plays a crucial role in smart city development, with two approaches: technology-driven method (TDM) and human-driven technique (HDM) (An, Kim & Kim, 2020).

Smart cities exhibit diverse characteristics and consist of nine components: infrastructure, networks, transportation, energy, healthcare, technology, government, education, and citizens. These cities aim to achieve sustainability, quality of life, urbanization, and intelligence, addressing societal, economic, environmental, and governance aspects (Mohanty, Choppali & Kougianos, 2016). Various definitions of smart cities exist, with Holland's definition emphasizing investments in human and social capital, sustainable economic development, and wise resource management through participatory governance (El Hilali& Azougagh, 2021). Common components proposed by Pardo and Nam are widely acknowledged as critical to the success of smart city initiatives (Pardo & Taewoo, 2011 in El Hilali& Azougagh, 2021).

Fig. 1: Smart City Core Dimension. Source: (El Hilali& Azougagh, 2021)

Technology plays a crucial role in smart cities, serving as the foundation for rethinking various aspects. Smart cities leverage technologies such as the Internet of Things (IoT), Internet of Drones (IoD), and Internet of Vehicles (IoV) to develop sustainable urban environments. These technologies generate data that is analyzed to gain insights for enhancing the efficiency and effectiveness of smart societies and cities (Heidari, Navimipour & Unal, 2022).

While technology is important, it alone cannot create a smart city. The involvement of human resources is essential. Smart residents play a significant role in driving the smart city through their data, education, and creativity. Residents are at the core of city issues, and their input is crucial for finding solutions (El Hil, Ali& Azougagh, 2021)

Collaboration is a vital aspect of smart city governance. Smart governance, also known as smart collaboration, involves the interaction of all stakeholders, including the public sector (local government), private sector (industries), university (researchers and experts), and citizens, to design and implement smart city projects (El Hilali& Azougagh, 2021). People-centric smart city development requires governments to consider the perspectives and preferences of the residents when providing smart city services. Unfortunately, in many top-down implementations of smart city programs, the genuine needs of people are often overlooked (Wu, 2020; Ji et al., 2021).

To avoid investing in smart city projects that do not meet citizens' needs and expectations, city administrators must understand the preferences of local citizens for smart city services. This understanding can help inform decision-making on investment priorities and resource allocation for services that citizens genuinely need (Ji et al., 2021). Data warehouse technology is a critical component of smart city services, but issues such as data protection, privacy, and regulations need careful consideration (Lytras, Visvizi & Sarirete, 2019).

3.2 Smart Healthcare

In the context of smart healthcare, digital sensors, nanotechnology, fog computing, cloud computing, and telemedicine are examples of innovations that utilize the Internet of Things to generate and share data among stakeholders. These advancements in information management enable better data collection and create a foundation for "smart" healthcare platforms (Chakraborty et al., 2022). However, security and privacy in

smart healthcare systems must be addressed to prevent unwanted attacks and threats. Information security and privacy are crucial to protect against privacy violations and their potential impacts on individuals' lives (Chakraborty et al., 2022).

The healthcare industry faces various challenges due to rapid population growth, limited resources, and outdated healthcare systems. Traditional healthcare often struggles to meet the needs of the growing population, resulting in overburdened hospitals and occasional errors in treatment. In many rural areas, accessing adequate medical care remains an unattainable goal. To address these challenges, intelligent healthcare, enabled by modern technologies, has emerged as a solution (Mohanty, Choppali & Kougianos, 2016).

Smart healthcare is a system that actively accesses information, connects various stakeholders involved in healthcare, manages the needs of the medical ecosystem, and responds to those needs. It encompasses technologies such as wearables, the Internet of Things (IoT), and mobile internet, facilitating communication among all parties involved, ensuring appropriate care for patients, enabling informed decision-making, and optimizing resource utilization (Tian et al., 2019).

The year 2020, particularly with the COVID-19 pandemic, has accelerated the shift towards virtual healthcare encounters and the adoption of digital health technologies. These include shared electronic health records (EHR), remote visits, telehealth, wearable tech, and digital medicines powered by machine learning and artificial intelligence (Bergier et al., 2021). However, the digitalization of healthcare also presents significant challenges for patients, professionals, and healthcare systems.

Smart or modern technology-enabled healthcare allows people to receive medical assistance and services anytime and anywhere through digital devices such as laptops, tablets, or smartphones. The smart delivery management system enables services like emergency care, diagnostics, and monitoring. However, implementing smart healthcare solutions can be challenging, leading to a discrepancy between anticipated benefits and actual results. Factors such as resistance from healthcare practitioners, practical challenges, data security, and system vulnerabilities pose hurdles to successful adoption (Quasim et al., 2021; Renukappa et al., 2022).

To ensure the effective implementation of smart healthcare initiatives within healthcare provider organizations, it is important to understand and assess potential barriers. This can be done by identifying dilemmas and implementing proactive strategies to address them, thereby increasing the likelihood of successful adoption (Renukappa et al., 2022)

Smart healthcare relies on technologies like biotechnology, IoT, cloud computing, big data, 5G, microelectronics, and AI (Pan, 2019; Tian et al., 2019). These technologies enable disease monitoring, research, diagnosis, treatment, and patient management. Wearable devices, virtual assistants, information platforms, surgical robots, mixed reality, RFID, mobile platforms, big data, and machine learning all contribute to improving healthcare (Pan, 2019; Tian et al., 2019). Smart healthcare has the potential to reduce costs, enhance resource utilization, foster collaboration, accelerate telemedicine, and provide personalized medical services (Farahani, 2018; Tian et al., 2019).

Understanding the effective elements of IoT adoption in healthcare is crucial for maximizing its potential (Al-Rawshdeh et al., 2022). The concept of technology transfer, which examines users' adoption behavior in a connected context, is relevant in smart healthcare (Song et al., 2009; Pan et al., 2019). The Technology Acceptance Model (TAM) is often used to study users' intentions to adopt digital technologies in healthcare. TAM suggests that users' attitudes, influenced by perceived utility and ease of use, drive their intentions to use technology (Davis, 1989; Mangi et al., 2021).Factors such as gender, age, and experience have been found to influence user behavior and can modify the relationships between the components of TAM. For instance, in the healthcare context, research has shown that doctors are less likely than nurses to record incidents using an online information system (Chang and Hsu, 2012; Kingston et al., 2004). Another important factor influencing the acceptability of new technology is convenience, which comprises time and location utilities. Users are more likely to accept and adopt technology if it is easy to use and simplifies their lives (Kim, Mirusmonov & Lee, 2010; Lu et al., 2021).

Digital infrastructure refers to the technological foundation that enables the collection, storage, transmission, and analysis of healthcare data. It encompasses both public and private components, which play distinct roles in supporting the delivery of healthcare services (Buetow and Niederhuber, 2009).

ISBN 978-3-9504945-2-5. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, H. R. KAUFMANN – Ljubljana, Slovenia

Public digital infrastructure in smart healthcare involves technology and systems established and maintained by government or public entities. Examples include Health Information Exchanges (HIEs) that facilitate secure data exchange among healthcare providers, government-managed health databases for public health monitoring, and national health information networks that support interoperability between different healthcare systems (Sahay, T Sundararaman and Braa, 2017).

Private digital infrastructure in smart healthcare is implemented and managed by private healthcare organizations. Examples include Electronic Health Records (EHRs) that provide comprehensive patient health information within a healthcare organization, telehealth and remote monitoring systems for virtual care and remote patient monitoring, and patient portals/mobile apps for patient engagement and self-management (Ben Ahmed et al., 2021).

Novelty is another key factor in the adoption of smart healthcare devices. High levels of novelty indicate high innovativeness and commercial differentiation. These devices are associated with radical innovations, which can positively impact organizational outcomes and meet consumer demands. From an individual perspective, new smart healthcare devices with new services enhance customer attraction and better address their needs (Amara et al., 2008; Lu et al., 2021).

In the context of smart healthcare adoption, practitioners play a crucial role. However, previous research has indicated that practitioners face challenges in adjusting to new technologies and may not be fully enthusiastic about participating in digitalization efforts. Understanding practitioners' perceptions and uncovering the reasons behind their hesitancy is essential to promote successful adoption of digital technologies in healthcare (Pan et al., 2019).

Research Objective	Research Questions	Interview Questions	Sources
To investigate the smart city role in Smart Healthcare Management	RQ1: How does Smart Healthcare technologies ease the work for Health professionals and practitioners?	Q1-Do you think using innovative Technology in the Medical field such as IOT, AI… is Important? If yes Why and If No why Not? Q2-Why do you Trust on smart Technology or Why NOT? Q3- How do you think novel Technology would increase the patient's satisfaction?	Titan et al., 2019 Mohanty, Choppali and Kougianos, 2016). Al-Rawshdeh et al,2022 Renukappa et al., 2022
	RQ2: How do smart cities influence the perception of practitioners towards smart Health care?	Q1-Do you perceive SHCS as useful for the realization of the human needs of your patients? If yes why? If No why Not? Q2-Do you perceive working with smart Healthcare services to be easy or difficult? Please explain Q3-How do you find the role of smart cities in protecting the data in smart health care services? Q4- what additional success factor could you see for adaption of practitioners to the Technology? Q5- what kind of barriers or challenges do you see in adaption to the new technology?	Mangi et al., 2021 Tian et al, 2019 Ji et al., 2021 Lytras, Visvizi and Sarirete, 2019
	RQ3: How can smart cities motivate practitioners to accept and adopt the SHC technology?	Q1- Which beneficial influences of SHC technologies for practitioners and Healthcare organizations do you see? Q2- Which potentially negative aspects for practitioners do you see? Q3- How smart cities could increase the motivation of practitioners in using SHCS? (Educating? Workshop?)	Lu et al., 2021

Table 1: Research Table.

This study used a qualitative research approach with semi-structured interviews to explore roadblocks in smart healthcare adoption. Purposive and snowball sampling were employed to select participants. Interviews were conducted in English via video chat or phone from February 7th to 20th, 2023, with

durations of 20-35 minutes. Participants were practitioners in smart healthcare with knowledge of smart cities. The study aimed to understand their perceptions and challenges regarding digital technology adoption in healthcare.The collected material was analyzed using qualitative content analysis.(Kuckartz, 2018). This approach allows for rule-based analysis while preserving the originality of the data. A category system was developed, combining deductive and inductive approaches. Main categories were defined deductively, and subcategories were formed inductively based on the content. The coding process involved applying the category system to the entire material, facilitated by the use of MaxQDA analysis software.

Respondent	Job description	Interview Type	Interview length (Per minute)	date
R1	Pediatrician in Melbourne Royal children Hospital	Phone	25 Minuets	7/02/2023
R2	Dental Surgery Practitioner	Video chat	33 Minutes	9/02/2023
R3	Specialist in ophthalmology	Video chat	27 Minutes	9/02/20223
R4	General dentist at smart Dental clinic	phone	20 Minutes	12/02/2023
R5	General practitioner in Women's Mercy hospital	Video chat	30 Minutes	12/02/2023
R6	Medical Doctor and Director of Smart Moves Healthcare	Video chat	33 Minutes	13/02/2023
R7	Decision scientist in public Affair at Meta	Video chat	25 Minutes	19/02/2023
R8	Psychologist, researcher, Mental Health and well-being in modern working world	Video chat	35 Minutes	20/02/2023

Table 2: interview respondents.

4 PRESENTATION OF FINDINGS

This section presents the findings from the interviews, summarizing the extracted categories and providing supporting quotes from the interviewees.

4.1 Novel Technology

This main category explores the integration of smart healthcare with the technology-driven concept of a smart city, addressing the conflict between technology and resource utilization described in the literature review. The subcategories "inevitable role of innovative technology," "reliability," and "satisfaction" were created within this category.

4.1.1 Inevitable Role of Innovative Technology

The respondents unanimously identified the significant role of innovative technologies such as AI, IoT, robotics, precision medicine, 3-D printing, augmented reality/virtual reality, genomics, and telemedicine in healthcare delivery. For example, one respondent (R4) stated, "The entry of technology into the medical field is not only important but also necessary." Another respondent (R6) mentioned, "This kind of technology can help healthcare services recognize diseases with fewer failures compared to humans." Additionally, several respondents (R1, R6, R7, R8) highlighted the benefits of cost savings and efficiency. Furthermore, one respondent (R5) emphasized the critical role of technology in early illness detection, which can be a life-saving factor. The respondents also mentioned the use of technology in education to enhance learning quality and reduce the trial-and-error approach (R8).

4.1.2 Reliability

Based on the eight interviews, there is a low level of trust in innovative technology among treatment professionals. Only one respondent (R3) expressed unconditional trust, while others mentioned trusting smart technology for its efficiency (R7, R3). However, factors like lack of conclusive results, testing, assurance, technological limitations, and subject sensitivity make it difficult for practitioners to fully trust (R1, R2, R4, R5, R6, R7, R8). Respondents emphasized the need for experimental stages, patient safety, and human participation in data analysis (R6, R1, R5). Concerns about safety and security were raised,

ISBN 978-3-9504945-2-5. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, H. R. KAUFMANN – Ljubljana, Slovenia

contributing to mistrust among treatment personnel (R4, R5, R6, R7). One respondent stressed the importance of privacy in protecting patients' lives (R5).

4.1.3 Satisfaction

Patient satisfaction is crucial for evaluating care quality, and all eight respondents stressed the importance of smart healthcare technology in improving it. Time and cost savings were mentioned as significant benefits, particularly for the elderly and people with disabilities (R1, R7). Respondents also noted how revolutionary technology can enhance the patient experience, reducing discomfort and increasing satisfaction (R4, R6). The use of digital systems for data collection and storage was highlighted for improving efficiency and medical record safety (R7, R6). Furthermore, respondents recognized the impact of practitioners and treatment workers on patient care and satisfaction (R6).

4.2 Treatment staff perception

The perception of treatment staff regarding smart healthcare is influenced by smart cities, as indicated in the literature. This section focuses on the categories "human needs," "easiness and severity," "data protection/information privacy," "success factors and challenging aspects," and "adaptation motivation factors" to explore how smart cities impact the perspective of treatment staff.

4.2.1 Human needs

Patients' needs vary depending on the severity of their condition and their stage in the treatment process. The importance of addressing patients' psychological, physical, and social needs, and their interplay within larger systems such as family and society, is emphasized (R6). Five out of eight respondents agree that smart healthcare systems are effective in meeting patients' human needs (R1, R4, R6, R7, R8). Respondent 2 suggests that practitioners should provide necessary information and explain the benefits and ease of access to improve patients' understanding and positive perception of novel technologies and digitalized services. However, respondents also acknowledge that human contact cannot be replaced by smart technology (R3).

4.2.2 Easiness and severity

This section examines whether smart technology is easy for practitioners to use. All eight respondents agree that dealing with new technology can be initially difficult and challenging. However, with training, learning, and gaining expertise in innovative technology, practitioners can become more confident in using it. R6 mentions that teaching and learning new technology may be challenging at first, but it becomes easier over time. Respondents R5 and R8 highlight that persuading practitioners, especially younger ones, can be difficult due to concerns about privacy and security. Ethical and regulatory issues are also mentioned as factors that may hinder the adoption of innovative technology by practitioners (R8).

The findings indicate that while smart healthcare can meet patients' human needs and improve accessibility, there are challenges related to ease of use, privacy and security concerns, and regulatory and ethical considerations that need to be addressed to ensure the successful adoption and acceptance of smart technology by treatment staff.

4.2.3 Data Protection/Information Privacy:

Respondents emphasized the significance of data security and confidentiality in smart cities. They stressed the need for laws and regulations to protect data and information. The integration of multiple organizations in a smart city was seen as a way to enhance the healthcare system. Smart access controls, transparent regulations, and secure data platforms were identified as essential for preserving data, reducing costs, and engaging patients effectively.

4.2.4 Success Factors and Challenging Aspects:

Thorough training and understanding of new technology were seen as important for practitioners' trust and confidence. Easier communication, remote education, and therapy were mentioned as success factors. Cost, potential risks to practitioners, and the difficulty of learning new technology were identified as challenges.Sustainability was also highlighted as a factor for success

4.3 Adaption Motivation Factors:

To increase practitioners' motivation to adopt new technologies, smart cities should provide appropriate infrastructure and organize seminars and workshops to enhance knowledge and trust. The positive influences of new technology include reducing the risk of failure, improving access to reliable data, and increasing practitioners' knowledge. Negative aspects include data security concerns and communication breakdown. The following figure 3 depicts the main findings.

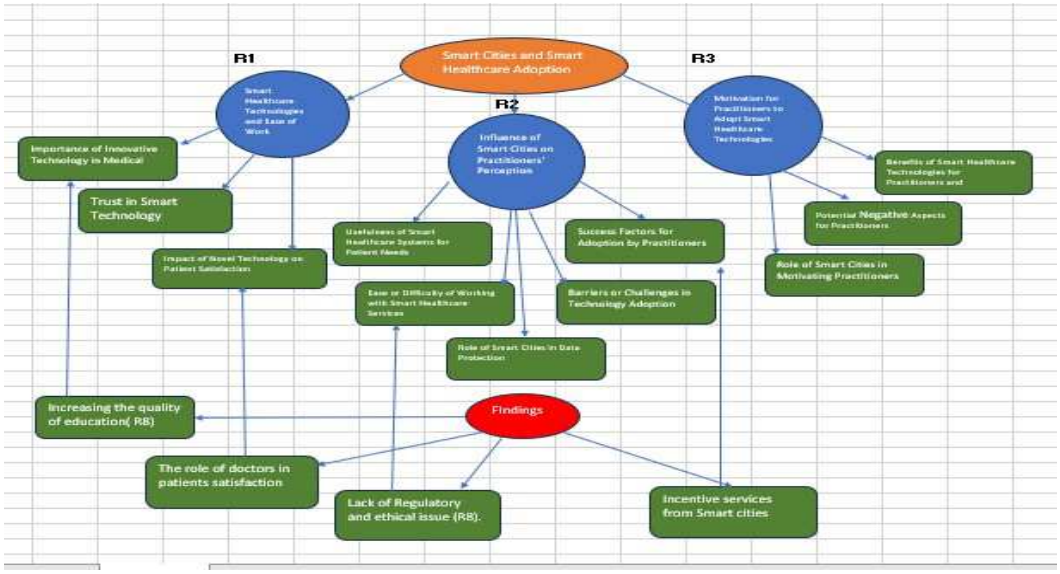

Fig. 2: Final conceptualization

5 DISCUSSION AND PRACTICAL IMPLEMENTATION:

The study highlights the significance of practitioners' perception and the role of technology in smart healthcare within smart cities (Heidari, Navimipour & Unal, 2022). While technology offers various benefits to practitioners, reservations exist regarding its limitations and the potential displacement of human roles in healthcare (R1, R2, R4, R5, R6, R7, R8). Balancing technological advancements with the essential role of human intervention is crucial. Patient satisfaction and positive experiences are also important outcomes, with patients benefiting from online services and improved treatment processes (R3). The attitude of users, influenced by anticipated benefits and ease of use, plays a significant role (Fletcher-Brown, 2020). Addressing data protection, information security concerns, and building trust are essential (R6, R8). Successful adoption requires training, improved communication, straightforward acquisition processes, post-sales support, and addressing cost-related challenges (R3, R8). The integration of technology in healthcare practices should consider practitioners' perception, human factors, patient-centric considerations, user attitudes, trust-building measures, data protection, and cost considerations (Heidari, Navimipour & Unal, 2022).

6 LIMITATION AND CONCLUSION

The study focuses on understanding how practitioners perceive smart healthcare technology within the context of smart cities. The findings emphasize the significant role of technology in advancing healthcare practices. It is evident that technology plays a crucial role in reducing human errors, aiding in various medical fields, enabling early disease diagnosis, and enhancing educational understanding. However, the study also reveals that practitioners have certain concerns and limited trust when it comes to adopting new technology. They perceive limitations and question the role of humans in smart healthcare. Factors such as user attitude, professional benefits, and ease of use influence practitioners' acceptance and adaptation to technology. On the other hand, patient experiences with smart healthcare technology are generally positive. The use of online services, diverse applications, and innovative gadgets can save time and money for patients. Patients with special needs also find smart healthcare technology to be satisfying, as it reduces discomfort and improves treatment experiences compared to traditional methods. The study highlights the importance of addressing human needs and providing patients with knowledge about revolutionary technologies to positively influence their expectations. The relationship between practitioners and patients is

ISBN 978-3-9504945-2-5. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, H. R. KAUFMANN – Ljubljana, Slovenia

considered a crucial aspect in shaping perceptions and acceptance of technology. Factors such as training, data protection, and ethical regulations are identified as key elements in building trust and confidence among practitioners. Pre-introduction training and continuous learning are identified as success factors in technology adoption. Additionally, smart cities need to invest in government regulations and ethical guidelines to ensure practitioners' confidence in data protection and information security. Cost-related challenges are recognized as barriers to technology adoption, especially in the early stages. There is also a fear among practitioners that technology might replace human involvement in healthcare processes. However, the study highlights the positive aspects, such as reduced failure rates among practitioners and improved access to integrated and accurate data, leading to time and cost savings.

In summary, the study emphasizes the central role of technology in advancing smart healthcare within smart cities. While practitioners have concerns and limited trust, patients' experiences with smart healthcare technology are positive. Addressing human needs, providing knowledge, ensuring data protection, and offering training opportunities are essential in bridging the perception gap and facilitating technology adoption in the healthcare industry.private and public infrastructure both play critical roles in the adaptation of practitioners to smart healthcare. Private sector investment drives innovation, provides training and support, and offers advanced technologies, while the public sector establishes policies, provides funding and incentives, develops infrastructure, and promotes research and knowledge dissemination. Together, these efforts create an environment conducive to practitioners' adoption and effective utilization of smart healthcare technologies.

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ISBN 978-3-9504945-2-5. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, H. R. KAUFMANN – Ljubljana, Slovenia