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College Administration

Project Management



IoT in Healthcare Sector in UAE

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:Academic year

2024

Chapter 1: Introduction

Healthcare systems are changing as new technologies become part of daily operations in the health sector. The Internet of Things (IoT) also plays a pivotal role in the United Arab Emirates (UAE). As the government of the UAE is committed to employing advanced healthcare systems, promote innovation in their healthcare system (Alhajaj and Moonesar, 2023). In order to achieve this goal, IoT is seen as a crucial factor to fuel modernization in the healthcare sector. Moreover, IoT not only provides facilities related to interconnected devices and systems. They can extract, analyse, and share real-time data, harnessing patient care and optimizing overall healthcare operations in the healthcare sector. As a country known for rapid integration of advanced technologies, the UAE is looking to make IoT part of healthcare systems to cater to high healthcare demands, ranging from patient monitoring to smart hospital infrastructure.

In the last couple of years, UAE has invested a large chunk of their budget in healthcare. For instance, the UAE government has allocated \$1.33 billion for their health sector in 2023 (UAE Ministry of Finance, 2024). This shows the government's sheer commitment to provide high-quality medical services to its citizens. There is an appropriate amount of budget allocated to implement digital health solutions, such as the application of IoT, as part of UAE Vision 2021 and the National Innovation Strategy (UAE Cabinet, 2021). It is estimated that healthcare will grow at a compound annual rate of more than 20% at the end of 2024, indicating the UAE as a major country in the Middle East (Cognitive Market, 2024). Moreover, UAE's ICT infrastructure and 5G connectivity have boosted IoT deployment in healthcare, providing assistance to different applications. This includes telemedicine, wearable healthcare devices, and forecasting analytics.

As UAE government is focused on innovation in healthcare, key for smart healthcare initiatives such as Dubai Health Authority and smart health programs. This program is aiming to not only promote IoT-backed solutions (Zgallai et al., 2022). This may include real-time health data tracking, remote monitoring of patients, and offering timely care. For instance, smart sensors and wearable devices have provided traction about monitoring chronic diseases. In this way, doctors and paramedic staff can collect particular data and provide them with personalized care. As per the report, more than 55% of UAE residents' willingness

to use wearable technology for health monitoring shows how prepared people and healthcare professionals are to integrate IoT into everyday medical procedures (Alhajaj and Moonesar, 2023).

In addition, IoT application in the healthcare system of the UAE is expected to optimize resource allocation and minimize operational costs as well. Therefore, connection of systems and devices, IoT allows forecasting to maintain medical equipment and refine hospital logistics (Sallabi et al., 2018). This includes management of inventory and tracking of assets. Like, Sheikh Khalifa Medical City in Abu Dhabi has employed IoT-based devices to track their assets, contributing to reducing the time required to locate mandatory medical equipment (UAE Ministry of Finance, 2024). IoT is positioned to have a greater effect on how hospitals are provided in the United Arab Emirates as time goes by because of its capacity to improve patient satisfaction and manage healthcare operations. This research study will explore various aspects of IoT to reshape healthcare in the UAE, catering to its challenges and benefits, and potential to transform healthcare services in the country.

Problem Study

Apart from swift implementation of IoT in the healthcare system in the UAE, various challenges remain to increase patient care and overall operational efficiency. Challenges like data privacy and cybersecurity among developers create problems regulating smooth integration of IoT (Xanthidis et al., 2020). Moreover, lack of standard framework, the effectiveness of IoT apps for watching over patients and data-driven decision-making is limited by healthcare providers' inability to securely transmit data across platforms.

Moreover, these challenges lead to a high cost of IoT maintenance and a shortage of skilled professionals to manage problems (Zgallai et al., 2022). Therefore, catering to these challenges can only ensure that IoT solutions can improve access and efficiency as well.

Background of Study

In the last few years, the internet of things has gained place in the healthcare sector worldwide. As IoT can provide seamless data sharing, remote monitoring, and forecasting analytics to improve healthcare efficiency, after connection with IoT devices such as

wearable medical equipment, this can provide continuous patient monitoring, early diagnosis, and accuracy of treatment as well (Cognitive Market, 2024). On an international level, the IoT market in the healthcare market is expanding, fuelled by the rising demand for digital healthcare solutions and the country's increasing budget for advanced healthcare systems.

The effect of IoT in healthcare in the UAE is also incorporated in UAE Vision 2021, showing the commitment of the government to increase digital innovation in the healthcare system (UAE Cabinet, 2021). As the government is pouring money into the extensive ICT infrastructure and utilization of 5G, positing the country as a leader in the Middle East in IoT-backed healthcare systems. Institutions like Dubai Health Authority and Sheikh Khalifa Medical City are stark examples of IoT-based systems employed in patient care.

Objectives of Study

This research study is looking to attain various objectives from this study. Following are the objectives of this research study:

1. Explore impacts of IoT regarding healthcare efficacy and patient care results in the UAE.
2. Assessment of the adoption level of IoT technologies in healthcare providers.
3. Highlighting key factors and challenges related to IoT implementation in the healthcare sector.

In addition, this research study is aiming to analyse the efficacy of IoT employment in improving patient monitoring, resource allocation, and data management in the UAE healthcare sector. The evaluation of these factors in this research study will provide insights and recommendations to optimize IoT interaction in the UAE healthcare system.

Research Questions

How are IoT-backed healthcare technologies being implemented in patient care and healthcare efficiency in the UAE?

What are key challenges and hurdles to implementing IoT in the UAE healthcare sector, and how can these issues be added to boost up healthcare transformation?

Chapter 2: Literature Review

Introduction to IoT in Healthcare

The research study conducted by El Khatib (2023) explained that IoT is seen as a network of interconnected devices, providing facts to collate, share, and analyse real-time data to optimize different applications. For the healthcare sector, IoT plays a crucial role to transform and create positive differences in medical operations, foster remote patient monitoring, help in the diagnostic process, and harness personalized treatment plans as well. Moreover, with the use of connected devices such as medical imaging tools, wearable sensors, and mobile healthcare applications, paramedics or doctors can have key insights about patient history, thus elevating the standard of treatment. IoT applications have transformed handling resources and keeping track of patients, improving the effectiveness, accessibility, and patient-centeredness of healthcare.

Sallabi et al. (2018) has carried out described that on an international level, IoT is seen as a key technology employed in healthcare due to its capability to provide smooth care delivery without costing much. It is estimated that healthcare is projected to increase at a combined annual rate of more than 20%, near to touch \$534 billion at the end of 2025 (Cognitive Market, 2024). As more sophisticated advancements have been employed in wearable healthcare devices and hospital management systems, each can take advantage of IoT to cater to rising demands for smooth healthcare services. Different countries like China, the United Kingdom, and the United States are using IoT in their healthcare systems to track patients, chronic diseases, and data-driven clinical decisions.

In the last few years, the UAE has made remarkable success in the implementation of IoT in healthcare, using advanced digital technologies. The UAE government has invested a large amount of money in transforming the healthcare system, making it part of its Vision 2021 and 2030 (UAE Cabinet, 2021). As per the UAE Telecommunications and Digital Government Regulatory Authority (TDRA), the UAE has the highest interconnected penetration rates of its 99% population in the Middle East (TDRA, 2023). Because 5G technology provides quicker data transfer and greater connection for healthcare uses like telemedicine and smart inspection, its ubiquitous distribution also makes it easier for IoT adoption.

The UAE government has taken key initiatives to promote IoT in the healthcare sector in the UAE. The institutes, like Smart Health by DHA, aim to integrate IoT in public health services to offer smooth, data-backed health solutions (UAE Cabinet, 2021). The Ministry of Health and Prevention of the UAE has launched various pilot projects to use IoT in remote monitoring patients with chronic diseases, utilizing healthcare professionals to provide timely care (SEHA, 2024). By cultivating an ecosystem that supports digital innovation, the UAE not only improves the standard of healthcare but nevertheless aligns its healthcare system with global digital norms.

IoT-Enabled Healthcare Benefits

The integration of IoT in healthcare has provided transformative advantages in the healthcare sector, such as personalized treatment and diagnostics. One of the key impacts of IoT applications is real-world health monitoring. This provides a facility for healthcare to track patient's current health conditions and remotely monitor them as well. IoT-backed devices like wearable heart monitors and blood pressure cuffs help in the extraction of personal data. This data is used by healthcare professionals timely (Alhajaj and Moonesar, 2023). The real-world scenario provides a timely intervention, preventing more complications in high-risk patients. On an international level, this has been crucial to managing chronic diseases like diabetes and cardiovascular disease. This enables health provider's better disease control (Zgallai et al., 2022). The potential of IoT to improve medical treatment and encourage preventative healthcare is shown by the early adoption of wearable technology by UAE hospitals in Dubai and Abu Dhabi, which monitor patients with chronic diseases and provide prompt, data-driven care.

In order to improve patient care, IoT has helped in increasing operational efficiency in healthcare facilities, enabling health providers to track and predictive maintenance systems to streamline resources and help in minimizing the costs to maintain healthcare-related tools and machines. However, through the monitoring and utilization of medical equipment in a real-world scenario, IoT can forecast when devices will need maintenance, minimize downtime, and provide availability to key equipment. For instance, Sheikh Khalifa Medical City in Abu Dhabi uses IoT-based asset tracking devices to manage medical routes, reducing the time needed to locate equipment in departments of hospitals (SEHA, 2024). Moreover, IoT can offer comprehensive data about inventory levels, offering efficient management of stock and reordering of key supplies. This degree of operational effectiveness is essential for

hospitals looking to maximize resources while upholding high patient care standards, particularly in a rapidly expanding medical industry like the UAE's.

Key leverage taken by healthcare from IoT is its ability to minimize overall costs in the healthcare sector. IoT-based remote monitoring and diagnostics can reduce the frequency of emergency visits and readmissions by citizens, which are seen as costly services. UAE's Ministry of Finance (2024) has provided key insight that remote monitoring can save up to 30% costs related to hospital readmission by alerting healthcare providers to potential healthcare challenges before they become severe. In the backdrop of the UAE, healthcare expenditure is on the rise, and IoT can only provide innovative solutions to support cost-effective healthcare delivery by the government.

Key IoT Applications in UAE Healthcare

The remote patient monitoring is seen as a critical application of IoT technology in the UAE. This played a crucial role in managing chronic disease. As the UAE has one of the highest numbers of people who are suffering from diabetes and cardiovascular disease in the world, around 17% of the adult population is living with diabetes (Al-Rawashdeh et al., 2022). This alarming state highlighted the need for effective management strategies to prevent complications related to these conditions. In an IoT-based monitoring system, healthcare providers can be able to track patients' vital signs. This includes blood glucose levels, heartbeat, and blood pressure from their homes. The patient health database can give medical professionals important information to identify illness trends, make wise judgments, and develop more effective treatment strategies. Additionally, by reducing hospital visits and stays, this preventive measure eases the strain on healthcare resources and advances the UAE's public health objectives.

The epidemic, when individuals were unable to attend hospitals because of viral transmission, led to the rise of telemedicine services. According to Khatib et al.'s research report from 2021, IoT technologies are crucial in delivering health information and consultations right to their doorway. Dubai Health Authority is a bright example in the UAE, where telemedicine practices were exercised during pandemic, where thousands of citizens of the UAE had leveraged from the facilities backed by IoT in the shape of telemedicine. The importance of telemedicine is also highlighted in the research study of Odeh et al. (2019), in which usage of IoT-backed applications has provided facilities to patients to access

healthcare providers and consult with them about their problems in real-time scenarios. Another research study has indicated that IoT-based technologies also reduced the chances of transmission of diseases further, as patients can now avail themselves of healthcare online by their phone. Therefore, the chances of human contact have been minimized, as virtual care is becoming a more viable option for healthcare providers as well as patients to avail of as compared to traditional visits (Shwedeh et al., 2023). The usefulness and portability of medical services for thousands of people across the country would surely benefit from IoT integration.

The technology is being evolved with the passage of time, and IoT-backed systems are rapidly making their space in healthcare facilities in the UAE. For instance, the concept of smart hospitals is being used to offer better healthcare faculties, making it easy for hospital staff to manage daily operations without making too much effort as compared to conventional methods of running hospitals (Odeh et al., 2019). In this backdrop, hospitals in the UAE are also adopting an IoT-based monitoring system for monitoring patients to attain real-time data regarding the current conditions of patients and record data about the current health condition of patients. In this aspect, different features like environmental control are playing a crucial role in providing a conducive environment where patients can easily heal (Al-Rawashdeh et al., 2022). In addition, various IoT-backed services and security measures are being used to track and trace property, provide safety measures for patients, and maintain data integrity. These developments demonstrate the UAE's dedication to incorporating state-of-the-art technology into healthcare, which promotes a more effective, patient-centered method of delivering medical treatment.

Another research study conducted by Khatib et al. (2021) has provided key insight about the adoption of wearable health technology. More than 60% of individuals in the UAE have expressed their satisfaction over the utilization of wearable devices for healthcare. These devices may include fitness trackers, health monitoring bands, and smartwatches, enabling citizens to not only track their daily physical activity such as sleep patterns, heart rate, and other health indicators. The utilization of these smart technologies may empower individuals to take charge about health by offering insights about daily activities and eco-health activities. Moreover, the data collection from wearables can also be used regarding healthcare providers, designing opportunities for more personalized care. Wearable technology's

increasing popularity is consistent with the UAE's Vision 2021, which prioritizes health and wellbeing for the country's future (SEHA, 2024).

One of the notable aspects of IoT in healthcare is its capability to extract large amounts of data for analysis to increase decision-making processes. In the backdrop of the UAE, healthcare providers can take full-scale advantage of IoT data analytics to design predictive models that can highlight trends and health-related risks about population (Al-Rawashdeh et al., 2022). For example, analysing data from monitoring devices, healthcare systems can forecast severity in chronic diseases, allowing insight about pre-emptive measures that should be taken. The backed approach not only harnesses individual patient care but also designs health strategies by enabling targeting interventions about populations that are at-risk (Alhajaj and Moonesar, 2023). Incorporating information analytics into UAE healthcare institutions represents a dramatic change to a proactive, preventative monitoring paradigm that puts community health improvement first.

The utilization of data analytics about UAE healthcare facilities has highlighted changes toward active, preventive measures to take care of population by providing IoT-backed solutions (Shwede et al., 2023). In this regard, artificial intelligence will help in preventing issues in the patient data. It may indicate the beginning of illnesses, allowing medical professionals to take prompt action before illness strikes.

Impact of IoT on Patient Outcomes and Quality of Care

The entry of sophisticated IoT-based devices in the healthcare industry has offered remarkable results when it comes to patient health care. There are various studies that have shown these technologies have provided ease and lessened the stress level of patients traveling long distances to consult their required health providers. As per the research study carried out by Yesmin et al. (2022), they have highlighted that patients with chronic diseases have observed less time spent in hospitals as they are being facilitated by IoT technologies such as telemedicine. These systems have offered real-time data to doctors, giving them enough time to make adjustments in treatment plans depending on the health history of the patient. In the UAE, initiatives like remote patient monitoring about diabetes management have provided positive results; healthcare providers reported improved glycemic control and minimized emergent intervention (Bhatt and Chakraborty, 2023). In addition to improving

health outcomes, this proactive strategy gives healthcare institutions the ability to better manage their resources.

Kelly et al., (2020) has explained in its research study that IoT technology has remarkably increased patient engagement and self-management, especially when it is real patients with chronic diseases. By using IoT devices, patients are now more capable of monitoring health indicators actively and offering feedback to their healthcare provider. In this way, they feel a sense of empowerment over one's health and encourage patients to participate in treatment plans. In the backdrop of the UAE, research studies have highlighted various benefits of IoT-oriented, educated programs to use mobile applications and connect with devices to offer patients personalized health information (Yesmin et al., 2022). For instance, in Dubai, it showed that diabetes patients are using IoT-based devices to monitor their health condition and receive educational support as well to increase a high level of engagement related to care. IoT fosters greater adherence to medical regimens and lifestyle changes by making health information more readily accessible and actionable, resulting in improved patient outcomes.

Research studies have also discussed the impact of IoT related to quality of care indicators, which is increasingly evident in different healthcare setups. Several essential criteria, such as emergency visits, the rate of hospital readmission, and patient satisfaction, contribute to healthcare quality. Additionally, IoT-supported apps have helped to advance these fields (Vatin et al., 2024). Other studies found that hospitals have used IoT-powered remote monitoring systems to reduce readmission rates through timely intervention for improved illness management. The Ministry of Health and Prevention of the UAE has also provided an interesting study about visits of patients with chronic diseases to hospitals. It is indicated in their report that patients who are using the facility of remote monitoring are less likely to visit the hospital as compared to others who are not using IoT-based applications. It is also indicated in this research study that patients show a high level of satisfaction as they feel more connected and heard by health providers on IoT applications. Moreover, patients become less disconnected from their doctors and nurses once they can access current information and assistance, resulting in higher satisfaction.

IoT was also essential in reducing healthcare expenses and making the most use of existing assets in order to raise the degree of patient participation. IoT technology has helped healthcare institutions and consumers save money by preventing problems and reducing the incidence of emergencies (Bhatt and Chakraborty, 2023). A research study has shown that

remote monitoring can save healthcare systems up to more than \$30 billion per year, reducing readmission and hospitalization rates (Yesmin et al., 2022). In the UAE, where healthcare expenses are rising, integrating IoT technology is consistent with the government's objective of establishing a greater effectiveness healthcare system.

Challenges and Barriers to IoT Adoption in UAE Healthcare

The incorporation of IoT technologies in healthcare has brought various advantages but also raised serious challenges related to data privacy and security. As a result, IoT devices will have the capacity to retrieve vast quantities of private health information, making healthcare institutions prime targets for assaults (Bhatt and Chakraborty, 2023). Compared to 2019, the UAE has seen a significant increase in cyberattacks roughly 250%, which presents a serious danger to the healthcare industry. Furthermore, data breaches undermine patient privacy and undermine public confidence in the medical field. (Al Badi et al., 2022). The potential for unauthorized accesses related to personal health-related information using used vulnerable IoT devices highlights the urgent need for strong cybersecurity protocols. Healthcare businesses in the UAE must take crucial actions to protect patient data and reduce the risks associated with IoT adoption, including establishing secure IoT frameworks, putting encryption mechanisms into place, and performing frequent security audits.

Alrahbi et al. (2022) indicated in the conducted investigation that one of the major difficulties associated to IoT employment in the UAE healthcare is the difficulty of interoperability. Additionally, a lot of healthcare institutions use IT systems that seamlessly interact with new IoT devices and associated apps. The lack of efficient interpersonal protocols across diverse devices may result in data silos in which vital health information is compromised, posing challenges to patient care. For instance, in the case of a hospital electronic health record system, it cannot effectively communicate with the IoT device used for remote monitoring of patients. As healthcare providers may lack access to real-time data, it is especially difficult to make informed decisions (Al Badi et al., 2022). To cope with these issues, there is a need to develop and apply standardized interoperability standards that not only ensure seamless communication but also in different healthcare systems without compromising the overall efficacy of IoT devices.

The implementation of IoT-based systems needs an appropriate amount of budget, which can be high, as the UAE government has allocated a large amount in its budget this year as well

regarding the healthcare system. However, still, there are some budget constraints that may make it challenging to manage, purchase, and incorporate IoT systems in the healthcare sector. As there is still need to make investment in managing, upgrading, and training staff as well so they can easily use IoT-based devices (Khan et al., 2022). The same issues are also being faced by the small healthcare organization, making it difficult to implement IoT-based systems, particularly when catering companies may shift cash for technological developments. To address this issue, the UAE government and other interested parties might seek out novel financing schemes, such as partnerships in public and private healthcare, to encourage the use of IoT in various areas of healthcare (Al Badi et al., 2022).

Future Opportunities and Directions for IoT in UAE Healthcare

Albreem et al., (2023) indicated in its research report that the future of IoT in the healthcare industry is bright, since UAE healthcare has seen considerable improvements by using artificial intelligence and big data analytics. Healthcare practitioners may highlight health patterns and estimate patient outcomes by fully leveraging AI-based insights. Qadri et al., (2020) has outlined how wearable technology can track important facets of real-time data for AI algorithms, facilitating the detection of problems by medical personnel and offering early warning indicators of patient illness concerns. This skill can help save healthcare expenditures, enhance handling of patients, and enable prompt response (Khan et al., 2022). Healthcare professionals in the United Arab Emirates will be better able to tailor treatment programs and allocate resources more effectively as a result of the growing adoption of these technologies.

The UAE must create strong laws that can establish technological standards before it can fully use IoT in healthcare. Since existing legislation must address several IoT-related issues, including data and patient data protection. Therefore, the adoption of comprehensive regulations must ensure that medical businesses respond to best-case studies that have used IoT technologies (Al Badi et al., 2022). These regulations can foster innovation by utilizing settings where common protocols facilitate seamless interaction between different IoT apps and IT systems. By fostering an environment of innovation and compliance, safeguarding patient data, and raising the bar for care, the UAE may become a leader in the modernization of healthcare.

With the growth of telemedicine services, the future of IoT in UAE healthcare appears bright. These shows have the potential to greatly increase individual's utilization of care, especially for those residing in underprivileged areas (Albreem et al., 2023). IoT can facilitate remote care in this sense, enabling patients to communicate with physicians via video calls and other virtual health platforms (Bhatt and Chakraborty, 2023). This is particularly true for the UAE, where people are living in different areas, impeding their swift access to healthcare services. For them, integration of IoT tools like connected monitoring tools and mobile health applications can be further increased, enabling healthcare professionals to monitor patient conditions daily to take informed decisions.

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