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Internet of Things (IoT) adoption in Healthcare Industry and bag of sound for the blindness a case study in Nishapur Hakim Hospital

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ABSTRACT

The smart bag for the blind is an extraordinary assistive technology that helps blind or visually impaired individuals gain more independence and access to their surroundings. Some smart bags can read texts from signs, books, or scanned documents and audibly convey them to the blind user. This feature makes accessing written information easier for blind individuals. These technologies are advancing and continuously improving and developing to provide a better experience for blind people. The text mining algorithm in the Ava smart bag for the blind includes a set of steps and natural language processing techniques. The text mining algorithm in the Ava smart bag for the blind, using advanced NLP and machine learning techniques, allows users to effectively interact with the texts present in their environment and benefit from written information. Speech language processing is one of the important aspects of the smart bag for the blind, enabling users to interact with the device and issue commands verbally. NLP allows the smart bag to understand user requests, such as asking for a specific location or obtaining information about an object.

Text-to-speech is a technique used to generate synthetic voice and read texts. Integrating speech language processing in the smart bag for the blind allows users to easily interact with the device and utilize its capabilities without the need for complex tactile or visual inputs.

The aim of our article is to examine the phenomenon of utilizing the Internet of Things and smart systems in the healthcare industry in a developing country to identify barriers and how this industry is striving to overcome these obstacles. For this research, we have chosen a qualitative research approach and a systematic mixed-methods strategy as our research strategy, which will help us reduce the findings of this phenomenon through an iterative process. The first part of the empirical findings was analyzed using thematic analysis tools that we employed for our data analysis. They were facilitated by experts who initiated a well-structured organizational framework through rigorous training for core staff and inspirational leadership to ease the implementation process.

The long-term application of the Internet of Things can provide numerous benefits for any organization. Our thesis examines the potential barriers to the application of the Internet of Things in the healthcare industry and the strategies adopted to overcome these challenges in the context of a developing country.

Introduction

The smart bag for the blind is an extraordinary assistive technology that helps blind or visually impaired individuals gain more independence and access to their surroundings. These bags are designed using advanced technologies, such as sensors, cameras, and artificial intelligence, to assist blind users in navigation, object recognition, and understanding their environment. Here are some features and benefits of smart bags for the blind:

Navigation and orientation: These bags are typically equipped with GPS navigation systems and motion sensors. They can provide blind users with routes, detect obstacles, and give warnings, helping them reach their desired destination. Some models can even suggest optimal routes based on obstacles and traffic conditions.

Object recognition: Cameras installed on the bag can identify objects and obstacles in the environment. These bags can inform blind users about what is nearby, such as a chair, door, or potential obstacles. This feature helps blind individuals interact more with their environment.

Text reading: Some smart bags can scan texts from signs, books, or scanned documents and read them aloud to the blind user. This capability makes access to written information easier for blind individuals.

Alerts and notifications: These bags can provide important alerts and notifications to blind users. For example, they can inform about changes in weather conditions, public transport announcements, or even recognize the faces of friends and acquaintances.

Access to mobile phones: Smart bags often connect with mobile phones, allowing blind users to access calls, messages, and mobile applications using voice commands or haptic feedback.

Independence and confidence: By providing real-time information and guidance, smart bags help blind individuals navigate various environments with greater confidence and carry out their daily activities. This can lead to increased independence and self-esteem.

These technologies are continuously advancing and improving to provide a better experience for blind individuals. Smart bags can significantly impact the lives of blind people and help them connect with the world around them.

The text mining algorithm in the Ava smart bag for the blind includes a set of steps and natural language processing (NLP) techniques. Here is an overview of the algorithm:

Text preprocessing:

- Text cleaning: Removing unnecessary characters, punctuation, and converting text to lowercase.
- Tokenization: Dividing the text into words or tokens.
- Stop word removal: Eliminating common and insignificant words (stop words) such as "and," "in," "with," etc.

Syntactic analysis:

- Part-of-speech tagging: Determining the grammatical role of each word (e.g., noun, verb, adjective).
- Sentence structure parsing: Understanding the syntactic structure of sentences to extract relationships between words.

Feature extraction:

- Named entity recognition: Extracting specific names such as names of places, people, organizations, etc.
- Object recognition: Identifying and classifying objects and concepts present in the text.
- Relationship extraction: Understanding relationships between words and phrases, e.g., "X is near Y."

Machine learning:

- Model training: Using labeled datasets to train machine learning models, such as classification or regression models.
- Text classification: Classifying texts based on topics, categories, or importance.

Text summarization:

- Key sentence extraction: Identifying important and key sentences that provide a summary of the text.
- Summary generation: Producing a short and useful summary of the original text.

Text-to-speech conversion:

- Text-to-speech: Using text-to-speech (TTS) techniques to convert extracted or summarized text into speech.
- Information presentation: Providing extracted or summarized information to the blind user through audio feedback.

The text mining algorithm in the Ava smart bag for the blind, using advanced NLP and machine learning techniques, allows users to effectively interact with texts in their environment and benefit from written information. This technology is continuously evolving to improve its accuracy and efficiency.

Speech Processing is one of the important aspects of smart bags for the visually impaired, allowing users to interact with the device and issue commands verbally. Here are some key stages in speech processing in these systems:

Speech Recognition: This stage involves converting the user's speech into text. Speech recognition algorithms analyze the input sounds and identify words and phrases. Machine learning techniques, especially deep neural network models, are very effective in this process.

Natural Language Processing: After converting speech to text, NLP algorithms help understand the meaning and intent of the user. This stage includes syntactic analysis, understanding the meanings of words and phrases, and interpreting user commands. NLP allows the smart bag to comprehend user requests, such as asking for a specific location or obtaining information about an object.

Command Extraction: In this stage, specific commands are extracted from the user's speech. For example, if the user says, "Tell me what time it is," the algorithms must identify the phrase "what time it is" as a command.

Executing Commands: After extracting the command, the smart bag executes it. For instance, if the command relates to time, the device can announce the current time verbally. Or if the user requests object identification, the smart bag can use a camera and computer vision algorithms to identify the desired object and announce its name.

Voice Feedback: The smart bag communicates with the user through voice feedback. This feedback can include announcing the time, reading text, or providing information about the surrounding environment. Text-to-Speech is a technique used to generate synthetic voice and read texts aloud.

Learning and Adapting: Speech processing systems can continuously learn and improve using machine learning, particularly deep learning. They can learn the user's speech patterns, the words and phrases used, and their preferences to personalize the interaction experience.

Integrating speech processing in smart bags for the visually impaired allows users to easily interact with the device and utilize its capabilities without the need for complex tactile or visual inputs. This technology significantly enhances the independence and accessibility of visually impaired individuals to information and their surroundings.

1- Problem Statement and Necessity of Research

The Internet of Things (IoT) is an emerging technology and a technological paradigm that is transforming the healthcare industry worldwide. The aim of our proposal is to investigate the phenomenon of IoT adoption in the healthcare industry of a developing country to identify the barriers and how this industry is striving to overcome these obstacles.

For this research, we have chosen a qualitative research approach and a systematic mixed-methods strategy as our research framework, which will help us reduce the findings of this phenomenon using a back-and-forth process. As part of the data collection process, semi-structured interviews were conducted with participants from the studied hospital.

The first part of the empirical findings was analyzed using thematic analysis tools that we

employed for our data analysis. This allowed us to interpret themes by returning to the collected data and previously published references. This research helped us identify some important factors affecting the adoption of IoT in hospitals, which were categorized into three distinct sections: technological, organizational, and environmental. The findings indicate that the barriers to IoT adoption in hospitals align with our experimental framework, referring to the theoretical framework in the literature. It was found that the barriers to IoT adoption primarily revolve around technology acceptance, complexity, organizational behavior, lack of expertise and infrastructure, absence of robust regulations and standards, and finally, security and privacy considerations. These were facilitated by experts who initiated a well-structured organizational framework through rigorous training for core staff and inspirational leadership to ease the implementation process.

In recent decades, the Internet of Things has inspired significant technological transformation in the healthcare industry. The long-term adoption of IoT can provide numerous benefits for any organization (Almeida et al., 2017). Many healthcare providers have faced difficulties in adopting this technology and have encountered multiple challenges from the moment of initiation to implementation (Lutra et al., 2018; Sharma & Tripathi, 2020; Zhou et al., 2020). Our thesis examines the potential barriers to IoT adoption in the healthcare industry and the strategies employed to overcome these challenges in the context of a developing country.

The Internet of Things (IoT) is the latest technology playing a vital role in digitizing the healthcare industry (Boys et al., 2018). Over the past two decades, IoT applications in healthcare have been growing worldwide, and the adoption of connected healthcare is expanding (Chan, 2015; Shah & Chirsu, 2018). For instance, many hospitals in developed countries have established patient tracking and management systems that help them reduce waiting times, treatment durations, and hospital processes such as patient admission and discharge (Alhoughil, 2018). In practice, optimizing the continuous customer experience and organizational flexibility and innovation are the main drivers and goals of digital technology adoption by healthcare providers (Hagerty, 2017; Henriette et al., 2015). Previous studies on IoT have shown that healthcare providers and companies have experienced significant increases in efficiency and profitability in their businesses through IoT adoption (Campbell & Gavad, 2019). Overall, IoT offers numerous benefits for companies and organizations in the healthcare industry in their work processes.

The Internet of Things is a network of physical devices and equipment with electronic items, software, sensors, and connectivity that enables these objects to collect and exchange data (Dimitrov, 2016). In other words, the concept of the Internet of Things generally refers to the communication, interaction, and sharing of structured data among connected devices and systems via the internet, aimed at increasing efficiency in a specific situation (Burgess, 2020). The best example of IoT in relation to artificial intelligence can be explained in the fields of manufacturing and automotive companies. Smart sensors and equipment scattered in production sectors continuously collect data alongside artificial intelligence to expand applications (Islam et al., 2015). These benefits can include preventive maintenance, increased productivity, and risk management. In healthcare, an example is scheduling medical examinations and receiving testing devices for patients through smartphone applications and devices without contacting the hospital or physical presence. IoT-based healthcare equipment enables early detection of potential deterioration and alerts patients and professionals so that patients can be treated without delay (Stowe et al., 2020; Ivanchik et al., 2020).

The healthcare industry has proven to be one of the sectors that has undergone significant transformation as a result of the application of digital technology at various levels of processes, products, and services (Kumar et al., 2020; Visconti & Mori, 2020). The Internet of Things can be considered a revolutionary digital tool for the healthcare industry, as it has the capability to transform traditional paper-based healthcare services into real-time patient data and remote patient monitoring. This phenomenon is referred to as digitization, which has dominated the healthcare industry over the past two decades as healthcare providers necessarily focus on the application of digital information to create simpler and more efficient methods (Kraus et al., 2021). Digitization

refers to the conversion of a specific product or service from its analog form to a digital and electronic form. Electronic Medical Records (EMRs) and real-time wearable tracking devices are examples of digitization in the healthcare industry. This transformation in healthcare is a joint result of the application of technology and rapid technological innovation to better perform work activities and explore opportunities in the healthcare industry (Gabayov et al., 2018). From an organizational and managerial perspective, the application of digital technologies (such as the Internet of Things) plays a significant role in the transformation of healthcare and its delivery methods. It is also expected to have significant impacts in the future.

With sustainable growth and technological advancement worldwide, the application of the Internet of Things to provide better services for hospitals is essential. The capability and existence of an organization are directly related to the speed of adopting new technologies in its changing environment (Almeida et al., 2017; Siwatano, 2018). The application of technology refers to the acceptance, integration, and utilization of new technology by organizations, individuals, public and private entities, or any interested actors in society (Qobakhlu & Ching, 2019; Strab, 2009). This can include managerial processes and organizational dynamics regarding how companies respond to technological changes to achieve competitive advantage (Christensen & Rosenbloom, 1995).

Many companies in various fields such as logistics, manufacturing, transportation, and energy have begun their activities towards the application of the Internet of Things. In other words, companies invest in the application of the Internet of Things not only for their own goals but also to provide better services for other companies and individuals in their field. Tesla, the most famous electric vehicle manufacturer in the world, has accelerated its reinvestment in production by utilizing the Internet of Things. Connected power infrastructures through GE Energy and ABB are abundant examples in developed countries. The impact of the application of the Internet of Things has been significant and is expected to increase in the future (Campbell & Gavad, 2019) as this is part of the survival for developing sustainable competitive advantage and meeting the growing demands and expectations of customers. Some of the main challenges in the path of applying the Internet of Things and technology adoption in the healthcare industry vary across different regions of the world, as they are influenced by national and organizational culture, organizational structure, changes in business models, social environment and social acceptance, financial investments, and growing market demand (Qobakhlu & Ching, 2019).

Considering the numerous capabilities of the Internet of Things, innovation and technology will rapidly change how healthcare providers apply the Internet of Things to develop sustainable competitive advantage, which will significantly reshape the healthcare delivery system in both the short and long term (Kraus et al., 2021). This ongoing process of technology application in the Internet of Things infrastructure occurs among individuals, companies, government policies, customer expectations, regions, and nations (Alhoughil, 2018; Strab, 2009). A country's ability to achieve and maintain long-term economic growth is determined by its capacity to increase productivity through the adoption of new technologies alongside human and physical capital. In a developing country, due to poverty, slow internet speed, low levels of expertise, and lack of overall infrastructure, people face challenges in accessing new technologies such as the Internet of Things (Lazhar, 2018; Sukird & Sharada, 2015).

Zayad and Twikan (2018) stated through their explanatory study that factors such as perceived effectiveness, belief, willingness, and attitude of healthcare professionals have a significant impact on the technology adoption process in developing countries in Africa. Meanwhile, Khan et al. (2019)

indicated that concepts of gender, trust, and privacy play a vital role in the technology adoption process in developing countries in Asia. Developing countries still face challenges in adopting new technologies due to inadequate infrastructure, costs, time, benefit analysis, skilled labor, and national policies (Anwar & Shamim, 2011). According to Mola and Leaker (2005), understanding the concept of technology adoption in developing countries essentially requires different approaches, as businesses face challenges that highlight the importance of limitations in technological, financial, and legal infrastructure. In contrast, developed countries have largely adopted new health technologies such as the Internet of Things in the healthcare sector. Developed countries like Canada, the UK, France, and Sweden have utilized the Internet of Things in human environments to provide efficient healthcare, improve the quality of human life, and focus on sustainable development goals (Arovia et al., 2020; Curtis, 2018; Maro et al., 2020).

Iran, considering the capabilities of the Internet of Things for transforming the healthcare industry, will soon become one of the fastest-growing outcome-driven markets in the world (Dosh, 2020; Olayan et al., 2019). In our view, Iran is the most significant case for demonstrating a developing country to examine this phenomenon, as it faces two major challenges: 1) population growth and 2) increasing customer expectations, which are barriers to technology development in the country. First, the growing population poses challenges for the adoption of new technology in healthcare, as it requires heavy investment, understanding customer needs, and awareness levels, which are also deterrents (Jamil et al., 2020; Mola and Leiker, 2005). Other barriers to technology adoption in a developing country include weak governance and lack of human capital, inappropriate government interventions in the market, such as excessive labor regulations, political influence, poorly defined bankruptcy policies, and social inequalities (Bergoeing et al., 2015; Mighty et al., 2020).

Although the Internet of Things offers many opportunities in the healthcare sector, numerous barriers slow down the adoption of this technology (Herzlinger, 2006; Visconti and Mori, 2020). Some factors relate to weak technology infrastructure, lack of structured regulations, absence of suitable technology management resources, local political interventions, a growing population, awareness, and financial aspects (Later, 2018; Narvan et al., 2019). The increasing population and rising customer expectations will make the development of IoT-based smart healthcare infrastructure essential, as the Internet of Things requires the integration of Information Technology (IT) and Operational Technology (OT) into a smart platform.

Hospitals are one of the most complex sectors in the upstream healthcare supply chain, as the process of technology adoption must be carried out by various actors and processes within the organization (Glover et al., 2020). As Herzlinger (2006) and Glover et al. (2020) stated, the involvement of various stakeholders such as doctors, medical specialists, insurance providers, patient-facing staff, senior management, and external entities complicates the implementation process in healthcare. Beyond this, budget structures, government policies, and the accountability of healthcare innovators further complicate the initiative and adoption of technology in healthcare (Jamil et al., 2020). The process of technology adoption in hospitals will simplify operations, understanding patient needs, building loyalty and trust, and providing a better customer experience (Boer et al., 2020; Kiratsis et al., 2012; R et al., 2020). The difficulty in measuring the impact of innovative technology on patients, the financial mechanisms in hospitals, the lack of structured oversight at every stage of technology adoption, and the involvement of various factors in the entire process make a hospital (as a case study) more complex (Metallo et al., 2018; Narvan et al., 2019). Additionally, traditional decision-making methods for adopting new technologies based on a stable and predictable system in healthcare are also unsuitable due to the complex nature of healthcare service delivery (Kozimski, 2016). The structure, culture, and nature of the organizational structure also play a significant role in adopting new technologies in hospitals, but the adoption process may

vary depending on the type of technology in question (Glyjins and Dawkins, 1994). This inspired us to select and examine the phenomenon of IoT adoption with a hospital case in our thesis.

In the process of technology adoption in any organization, barriers and mechanisms to overcome those barriers are intertwined. Healthcare organizations in developing countries are developing mechanisms to overcome barriers either through explicit planning in the pre-adoption stage or by learning from mistakes (Lida et al., 2018). Based on a long-term view towards technology acceptance in a rapidly changing environment, technology has fundamentally changed the way healthcare organizations think, plan, and operate in practice and policy-making (Zakaria and Moud Youssef, 2016). Some previous publications on technology adoption, through various studies, have provided insights into the differences between small and medium-sized enterprises in their approach to innovation, building customer trust, and how to appropriately adapt communications or organizational interventions to overcome various barriers to technological changes to encourage the adoption process (Aronson et al., 2019; Atzum, 2014; Chouki et al., 2020; Kiratsis et al., 2012; Zaidali et al., 2019). Specifically, developing mechanisms to anticipate and conceal challenges is a crucial step for successful adoption and implementation of new technology, requiring both "top-down" and "bottom-up" approaches within the organizational structure (Kozimski, 2016; Love et al., 2021). Therefore, the mechanisms that healthcare organizations adopt to overcome the barriers to IoT adoption should be considered to gain a complete picture of the IoT adoption process.

Healthcare providers are currently encouraged to implement Internet of Things (IoT) applications to enhance and improve their customers' experiences, knowing the increasing benefits and advantages of IoT (Metallo et al., 2018). In hospitals, while the opportunities for IoT applications are continuously increasing, research on which IoT services are in demand and what barriers exist to implementing solutions to overcome these barriers is still ongoing (Kang et al., a2019). Previous publications have clarified the impacts and benefits of IoT on healthcare providers, organizations, customer behavior, and its role in creating numerous opportunities for future business advancements (Buis et al., 2018). Most studies examining the implementation of IoT in developing countries have described the barriers from a traditional developed company perspective (Alehoghil, 2018; Lutra et al., 2018). In contrast, previous studies lacked empirical evidence regarding the barriers to IoT implementation in hospitals (Kang et al., b2019; Zakaria and Moud Youssef, 2016). Although some previous studies provided important insights into the implementation of technology in healthcare (Davood and Mary, 2019; Love et al., 2021; Martinez-Carro et al., 2018), they did not examine the barriers to technology implementation in hospitals from an organizational perspective. Furthermore, while some studies offered valuable insights into the barriers to technology implementation in healthcare organizations (Martinez-Carro et al., 2018; Sharma and Tripathi, 2020; Siwatano, 2018), most research did not explain mechanisms to overcome these barriers .

There are some integrated barriers [within the organization] for conceptualizing IoT in hospitals in developing countries that likely limit the implementation of technology in hospitals or slow down the implementation process. Some hospitals develop mechanisms to overcome these barriers to IoT implementation that continue from pre-implementation to execution. Considering the potential growing benefits and importance of IoT in healthcare, the barriers hindering hospitals from implementing IoT and even slowing down the process in developing countries like Iran need to be further examined. Therefore, the aim of this thesis is to investigate the current scenario in one of the hospitals in the city of Nishapur and interpret the hidden challenges in the path of hospitals using technology to understand the concept and take necessary steps to overcome these barriers.

-2Review of Literature (Review of Past Domestic and Foreign Research with References)

This section outlines the reference framework for this research, presenting relevant publications and key concepts regarding the application of technology in healthcare and the Internet of Things. The publications serve as a foundation for existing knowledge and previous studies on this topic by various researchers. We have utilized the theories from these publications to construct our research and identify barriers and solutions for the framework of applying the Internet of Things to address the research questions .

A list of selected articles for the literature review from various journals is provided in Table 1, categorized based on the type of research/sample that clarifies the nature of case studies, the country to identify differences between developing and developed countries, the identified barriers in the research study, the mechanisms as potential solutions, and recommendations from previous implementations and significant insights based on the author's analysis. These articles are then used to create dialogues among the authors and analyze the frameworks/models they have developed. An experimental theoretical framework based on a framework (Hamid et al., 2012) has been formulated for analyzing these articles and will later be employed in the development of the interview protocol for this case study dissertation. The literature review is then presented in the analysis section to compare the identified solutions from the primary data with the thematic analysis and publication-based data. This part is a crucial section of our case study, as a better literature review provides us with better knowledge to compare theoretical knowledge with the reality of practical implementation .

We have categorized the literature review into four parts to better understand each aspect :

.1Application of Technology in Healthcare

.2UTAUT Model in Healthcare

.3T-O-E Framework in Healthcare

Internet of Things

Table 1. Demonstration study of technology application

Important points/conclusions	Known mechanisms for utilizing technology	Known barriers to the implementation of technology	Model/Theoretical Framework	Country	Type of study and sample	Authors, year, and journal
This study demonstrates the importance of loading high-level factors in the study of deployment decisions in a heavily organizational pressure environment.	•Accessibility •Data aggregation •Experiments •Human resources	Technical factors: •System quality •Observed accessibility Environmental factors: •Competitive pressure •Government regulations Organizational factors: •Internal data management •Budget cuts	Organizational/Technological/Environmental Framework	United States of America	Survey of 547 doctors	Schwartz and Schwartz (2014) Journal of Organizational Computing and Electronic Commerce
Analysis of survey data on impermeable barriers in a manufacturing company that prevents the adoption of preventive technology.	•Resource allocation •Skilled workforce •Technical staff	•Related to cost •Related to the institution •Related to the workforce •Related to information	Multicriteria Framework	Canada	Survey of Innovation and Advanced Technology (SIAT) statistics from 1993	J. Baldwin, Z. Lin / Policy Research, 31(2002)
Due to the centrally planned economy and inflexible hierarchical system, larger organizations are more affected by the adoption of new technology than smaller companies.	•Ecosystem protection •Management •Organizational characteristics	•Structural barrier •Regulatory barrier •Cultural barrier •Land barrier	Linear Structural Relationship Model	China	A multiple case study of industrial companies in China	Y. Liu / Energy Policy, 67 (2014) 421-412

This analysis shows the willingness to adopt technology from an operational perspective.	N/A	•Risks •Competition •Technological capability	Conceptual Model	Greece	Qualitative comparative analysis on 528 managers	N. Papas and colleagues / Journal of Business Research(2021)
A key aspect of technology adoption is the implementation strategy, which is based on technical, economic, organizational, and human factors.	•Personal relationship •Complementary skills •Implementation strategy	•Project barriers •Technical barriers •Organizational barriers •Behavioral barriers	Combination of Rogers' Implementation Process and Conceptual Framework	Canada	Examination of the process used by hospitals for the adoption and implementation of PACS technology	Peer/International Journal of Medical Information 76 (2007) 23-22
The aim of the study is to examine the theoretical model of the Unified Theory of Acceptance and Use of Technology (UTAUT) and to identify the key role of Internet of Things (IoT) adoption in healthcare.	• Trust • New knowledge	•Behavioral expectation •Performance expectation •Effort expectation •Social impact •Facilitating conditions	Conceptual Framework Model	France	Based on structural equation modeling conducted on 267 users	W.B. Arfi and colleagues / Technical forecasting and social changes 167 (2021) 120688
The findings of the research have serious implications for policymakers and practitioners to develop mechanisms to enhance the application of e-government, thereby making urban governance more efficient and transparent.	N/A	•Attitude •Behavioral intentions •Scientific awareness	Conceptual Theoretical Framework	India	Survey conducted in 4 cities in India: Ahmedabad, Surat, Vadodara, and Rajkot	M. Samuel and colleagues / Urban Management Journal 9 (2020) 417-408
It highlights the importance of using electronic health records in long-term care facilities.	•Training	•Cost • Cultural change	N/A	United States of America	Interviews with healthcare stakeholders: nurses, management, and executives of companies	Cherry and colleagues / Journal of Health Care Quality, Volume 30 (2008) p. 37
Both theories are essential tools for adoption and have applications across various cultural, geographical, and other contexts.	N/A	• External stimulus • Cognitive response • Intention • Behavior	Technology Acceptance Model (TAM) and Theory of Planned Behavior (TPB)	United States of America	Systematic review of frameworks for technology adoption and their applications	Kool and Eidgah / Journal of Technology and Innovation Management, 2017, Volume 12, Issue 4
Organizational change processes and systems are the main factors in the adoption of IoT in a company.	•Personal effort •Accessibility	•Organizational aspect •Technical aspect	N/A	Netherlands	Comprehensive review of publications for the expected benefits and risks of the Internet of Things	P. Broosh and colleagues / International Journal of Information Management 51 (2020) 101952
The study of adoption is viewed as a chain of stages from initiation to decision-making to implementation.	N/A	Organizational level •Organizational •Environmental •Management Individual level •User acceptance	Diffusion of Innovations Theory (DOI), Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM)	United Kingdom	Review of theories	M. A. Hamid and colleagues / Journal of Engineering and Technology Management 29 (2012) 390-358
The study shows that barriers to adoption and penetration in developing countries are very challenging.	•Privacy •Limited access capability	•Cost •Security •Infrastructure •Weak Internet	N/A	India	Survey of publications and expert opinions	Sunil Luthra et al. / Journal of Computer Science 125 (2018) 739-733

Planning and implementation in the adoption of open-source projects in a research environment.	N/A	•Attitude •Awareness •Effort •Performance	Research Model Based on UTAUT	Africa	Survey of 544 respondents through stratified sampling	W. Dole et al. / International Journal of Information Management 27 (2011) 45-32
The conclusions are useful for researchers, regulators, and theoretically for IoT marketers.	• Imaginary • Interest	•Financial costs •Behavioral intentions	Conceptual Model: Extended UTAUT	France	Based on structural equation modeling conducted on 268 French users	W. B. Arfi et al. / Technology Forecasting and Social Change 63 (2021) 120437
UTAUT is a powerful tool for organizational management to assess the need for new technology.	N/A	• Performance expectation • Effort expectation • Social impact • Facilitating conditions	UTAUT	United States of America	Based on data from four organizations over a six-month period and three measurement points	Venkatesh et al. / MIS Quarterly 27 (3) 42 (2003)
All areas of TOE have a significant positive impact on technology adoption.	•Data management •Accessibility	•Security •Privacy •Infrastructure	TOE Framework	India	Regression analysis of data from IT units of various hospitals	S. Bouyan et al. / Journal of Engineering and Applied Sciences 13 (6): 1441-1436 (2018)
The user's perspective on acceptance was based on the identified factors below.	•Knowledge •Customer satisfaction	•Utility •Ease of use •Cost •Behavioral intention	TAM	Italy	Systematic review of 32 academic articles	Alkawasi et al. / International Journal of Engineering and Technology (2017)

1.2The application of technology

"Everything is in flux "

Heraclitus (Greek philosopher)

The above quote refers to the idea that everything is subject to change and adaptation over time, whether we like it or not. Application is seen as a gradual, continuous, and incremental change in response to environmental conditions (Jennings and Simon, 1994; Tushman and Romanelli, 1985). Researchers and specialists have been eager to explore the technical aspects of change and understand its impacts on organizations (Kimberly and Evanisko, 1981). As a result, the term technical application describes the organizational process of a company adapting to advanced technology .

The view that "potential adopters want to know how much a new idea is better than the current idea" is a modified quote from Rogers' theory (1962) from the early 1970s. Several theories have been proposed by various authors to explain the concept of technology application and innovation. Besides that, Rogers (1962) explained the most famous model for the diffusion of innovation. The concept of technology application is defined as a phased process in which a decision is made through the application of a specific technology and includes various activities, including decision-making by technical/specialized staff in the internal and external environment of an organization (Almeida et al., 2017; Batra and Pal, 2015; Rogers, 2010). According to Hamid et al. (2012), the actual application of technology and innovation in an organization can begin with a response to a change in environmental conditions or at a point where innovation becomes a necessity for the organization's routine .

The application of technology is explained by various theories such as the Theory of Reasoned Action (TRA), the Theory of Planned Behavior (TPB), the Diffusion of Innovations (DOI), and many other theories. These theories understand the need for technological change over time (Öner Güçin and Sterlberg, 2015). An individual acceptance theory is presented in Table 2 to understand the various theories and their main constructs that will be useful for building our theoretical framework. TRA is one of the earliest theories to explain work behavior, an individual's positive or

negative feelings, and the perception of others regarding performing a task (Ajzen and Fishbein, 1977). TAM measures the belief in performance enhancement through the use of a specific system (Davis, 1989). MM indicates an individual's action to achieve a valuable outcome such as payment, promotion, or reward (Davis et al., 1992). TPB is an extended version of TRA that simplifies an individual's understanding of performing a specific task. C-TAM-TPB is a combined model in which an individual's attitude, controlled behavior, and efficiency are studied. MPCU reports the level of individual belief in using a relatively difficult technology. IDT explains innovations that are better known than previous practices and are compatible with existing values. SCT understands the consequences of behavior concerning performance, individual expectations, and the judgments of others .

The healthcare industry is one of the essential pillars of society that ensures safety and improves the quality of care. The healthcare system is driven by rapid changes and requires adaptation to new technologies over time. The internal environment, such as the information system in a hospital, focuses on quality and practical tools to achieve good outcomes. Additionally, the hospital information system plays a vital role in ensuring the provision of quality healthcare services. Regarding the diffusion of medical innovations, specific criteria such as social-normative challenges, networking, professional or individual authority, medical expertise, knowledge, and scientific evidence are essential for success. In improving the quality of this process in hospitals, the system must provide accurate, complete, and timely information to be effective and efficient in medical decision-making .

This process is not as straightforward as it may seem from the outside; in this section, the involvement of managerial perspectives in this application will be studied and will be used in subsequent analyses for individual behavioral purposes. According to Rava (2005), information systems and IT services require hospital staff to have good communication and project planning skills. This helps service staff assess the technical and organizational context for technology application. Management must determine whether the application is beneficial to the user and whether it requires significant effort or additional training for staff to acquire knowledge. Management should assess the level of new technology application, as this is essential for understanding the timeline for the continuous updating of new technology in the hospital (Theo et al., 2008).

Table 2. The Index of Individual Acceptance Theory and Its Main Structures

main structures	description	Individual Acceptance Theory
•Attitude •Individual norm	The most fundamental and effective theories of human behavior. User studies of TRA have been consistent with individual acceptance of technology.	Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1977)
•Utility •Ease of use •Individual norm	TAM was used to predict the acceptance of information technology and its experimental application on jobs.	Technology Acceptance Model (TAM) (Davis, 1989)
•Intrinsic motivation •Extrinsic motivation	Psychological research to confirm the motivational theory on behavior.	Motivational Model (MM) (Davis et al., 1992)
•Attitude •Individual norm •Behavioral control	A developed TRA theory by adding a behavioral control structure to understand the determining factor of intention and behavior.	Theory of Planned Behavior (TPB) (Ajzen and Fishbein, 1977)
•Attitude •Individual norm •Behavioral	This model combines TAM and TPB to present a	C-TAM-TPB (Combined TAM and TPB) (Taylor and

control •Utility	combined model of perceived effectiveness.	Todd, 1995)
•Complexity •Long-term consequences •Social factors •Facilitating conditions	This model proposes a competing perspective for TRA and TPB. The nature of the model is to predict individual behavior rather than intention and will.	MPCU (Model of PC Utilization) (Thompson et al., 1991)
•Relative advantage •Adaptability •Voluntariness	This model is based on sociology and is used in the study of various innovations for organizational tools.	Innovation Diffusion Theory (IDT) (Tornatzky et al., 1990)
•Performance •Sense of efficacy •Anxiety	SCT is the most powerful theory of human behavior and is specifically used to study the performance and ability to use information technology ..	Social Cognitive Theory (SCT) (Bandura, 1986)

2.2The UTAUT model in healthcare

Research on the acceptance of information technology (IT) has led to many competing models, each with different sets of determining factors. Therefore, the Unified Theory of Acceptance and Use of Technology (UTAUT) was developed using eight models of technology adoption and use: TRA, TAM, MM, TPB, C-TAM-TPB, MPCU, IDT, and SCT (Venkatesh et al., 2003). It has been shown that UTAUT performs better than the eight individual models and has been validated with organizational analysis (Venkatesh et al., 2003). UTAUT plays a role in better understanding the acceptance behavior and application of new technologies in an organization, which has motivated our comprehensive case study. The UTAUT method has the following advantages: 1) the ability to analyze data with different sizes, 2) the execution of subgroup analysis, and 3) the analysis of complex structural models with multiple constructs.

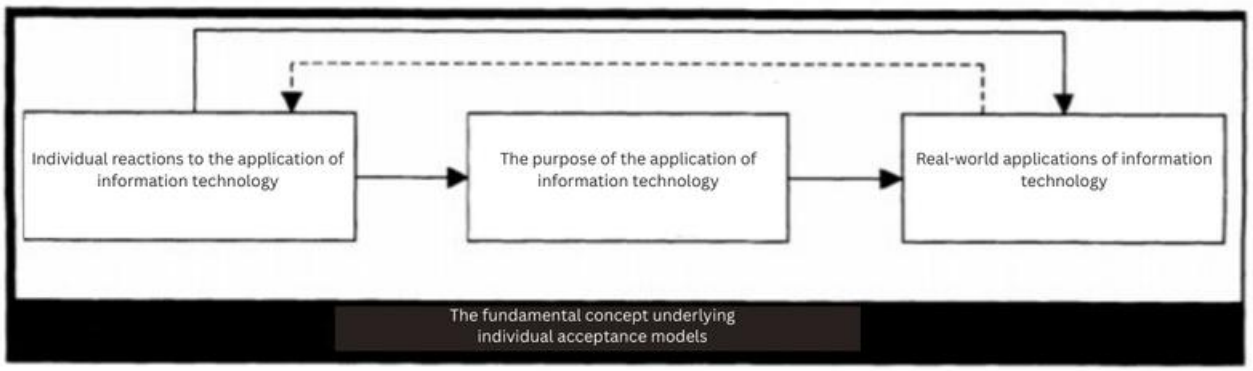
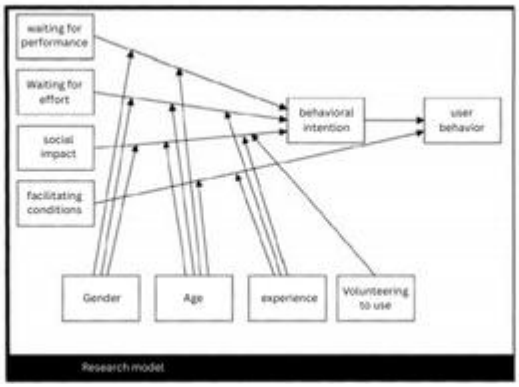


Figure 1. User Acceptance Model (Venkatesh et al., 2003)

Figure 1 displays the basic conceptual framework for understanding user acceptance of information technology. The model's assumptions regarding the direct and indirect determinants of user intentions to accept and use information are significant in the constructs. The direct determinants consist of four constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions), while the indirect determinants include two constructs (attitude and self-efficacy). The strength of the relationships among the constructs of direct and indirect determinants is influenced by four moderating factors: age, awareness, gender, and experience, which affect behavioral intention in the acceptance and application of technology.

Figure 2 illustrates the formulated UTAUT model and its constructs and moderators. In this section, we will define all the determinants separately, considering their moderating roles. Performance expectancy relates to individuals' thoughts about how emerging technologies can help them perform their tasks better, and many researchers have confirmed the importance of this dimension in

predicting behavioral intention with moderating factors such as age and gender (Venkatesh et al., 2003; Lohou and Kaliouja, 2006). Effort expectancy is complexly related to the use of a device and is said to have a significant impact on technology acceptance in the early stages, but its importance diminishes in long-term use. Age, experience, and gender have been conceptualized to moderate the effect of effort expectancy on behavioral intentions (Venkatesh et al., 2003). Social influence refers to how an individual's decision to use technology is affected by peers and other leading members of the organization. It has been observed that this consideration has a significant impact based on moderating factors such as age, gender, volunteering, and experience (Venkatesh et al., 2003; Shaper and Parwan, 2007). Facilitating conditions are described as the extent of individual approval of the existence of an organizational and technical framework to facilitate the use of a system. In this context, age and experience are the moderators in facilitating conditions (Shaper and Parwan, 2007). Attitude and self-efficacy do not directly influence behavioral intention.



.Figure 2. UTAUT model (Venkatesh et al., 2003)

The behavioral intention of the underlying model theory is to have a positive impact on the application of technology. UTAUT explains the variations in intention and ability to define individual acceptance and the decision to apply it in organizations. There are many common explanatory models for individual acceptance; however, UTAUT has an impressive performance in unifying theoretical perspectives in joint publications and employs moderators to influence the dynamics of user experience, statistical context, and organizational factors.

Healthcare is one of the least researched areas concerning generational variables. The age of the customer is a primary behavioral capability for the adoption of technology. The aim of this research is to fill the deepening scientific gap regarding the acceptance of the Internet of Things based on various user behavioral factors (Ben Arfi et al., 2021). UTAUT, in Figure 2, explains the application of various technologies in healthcare with the aim of targeting a specific audience, namely professionals. Some variables are based on the level of knowledge about technology or the user's previous experience with technology. For example, the use of medical equipment is often performed by older adults, and anxiety about new devices and resistance to change can determine the acceptance of new technology (Kiperman et al., 2016; Hook and Surwar, 2017). In some areas, digital literacy or accessibility can negatively impact the application of healthcare technologies (Li and Rou, 2013). The Internet of Things technology in healthcare is often used with high-level specialist monitoring. These factors focus on the decision-making process for the adoption of technology. Ultimately, many different types of studies demonstrate that the application of digital technology for objects in healthcare requires the storage of personal data. Data disclosure is a security consideration and increases service delivery risks (Elayad and Zhu, 2014). Therefore, this individual aspect is relevant to our study.

3.2. Organizational Environment Framework for Technology in Healthcare

The development of innovation and its application for users in the context of the company is described in the article on the process of technological innovation (Tornatzky et al., 1990). TOE has

been used for IT adoption studies, providing a useful theoretical framework applicable for aggregating an IT innovation (Oliveira and Fraga, 2011). Information technology has been studied in the sub-level sector for decades with the primary goal of facilitating value acquisition by organizations from this technology by increasing efficiency, as seen in UTAUT (Venkatesh et al., 2003). The TOE framework proposed by Tornatzky et al. (1990) is used to examine the context of a physical decision, including an organizational level perspective that explains the impact of companies' processes in three areas: organizational context, technological context, and environmental context. Figure 3 below presents the TOE framework; this figure shows that each type of context has a direct relationship with one another.

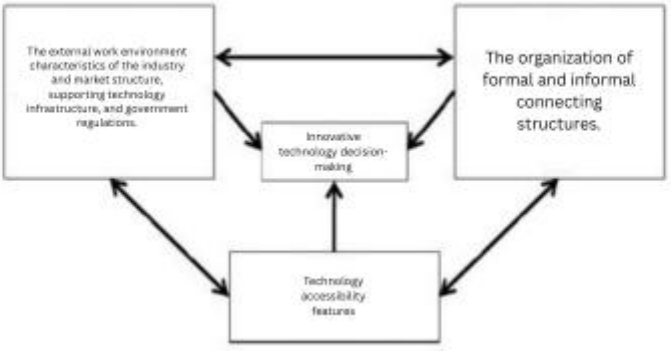


Figure 3. TOE Framework (Tornatzky et al., 1990)

We will understand each area in relation to the application of technology in healthcare:

The technology area refers to internal and external innovations that are important for the company (Herberg et al., 1976). Internal technologies are those currently being used by businesses. External technologies are those available in the market but not yet utilized by the organization. According to the concept of innovation (Rogers, 1962), an individual develops an attitude towards the creation of development that leads to a decision regarding its acceptance or rejection (Tornatzky and Klein, 1982). They selected competitive advantage, compatibility, and complexity as characteristics of innovation that are important for developing attitudes based on a meta-analysis of technical innovation publications regarding the characteristics of innovation (Tang, 1999). Technological factors identify four attitudes: relative advantage, compatibility, complexity, cost, and security. Relative advantage is defined as whether the new technology is perceived as better than the previous version (Chang and Ovi, 2008). Compatibility is defined as whether this technology is compatible with the organization's current IT systems and its healthcare processes (Brown and Russell, 2007).

The organizational area refers to descriptive evaluations such as scope, scale, and management structure. Davidson (1999) states that organizational characteristics such as centralization, formalization, integration, and scale affect the development of technology in hospitals. Senior management is interested in the successful use of capital and providing a conducive working system for technical application. Regarding the impacts of organizational size on IT adoption, research has shown contradictory results. According to Brown and Russell (2007), larger companies have more resources and are therefore more inclined to invest in technology to enhance company performance. However, other studies contradict this, suggesting that smaller businesses are more likely to adopt information technology because they are more flexible and agile in decision-making, and face fewer systemic adaptation difficulties due to less legacy burden (Gibbs and Kramer, 2004).

The environmental area is the domain in which the company operates and is determined by the market, competitors, the company's ability to evaluate services provided by others, and interactions with the government (Tornatzky et al., 1990). Competitive pressures on healthcare businesses have compelled many firms to adopt technology. The environmental area includes corporate competition, sales support, and government regulation. This dimension relates to higher-level challenges in

hospital management. This indicates that external components of the healthcare industry play an important role (Soleiman, 2011). Healthcare companies that adopt new technologies and innovations will benefit from better revenue, visibility of the supply chain, accurate data collection, and operational efficiency (Yao et al., 2010). The healthcare industry is likely one of the most regulated industries. There are laws and regulations governing standards compliance for healthcare institutions (Kao et al., 2014).

4.2Internet of Things

In this section, we discuss the impact of the Internet of Things on organizations, individuals, and the overall players in the ecosystem. In healthcare, the lack of timely and relevant information, along with the challenges of managing the care process, has been significant barriers that make the efficient and effective delivery of healthcare services difficult (Tursso, Tursso, and Serlinka, 2013). As a result, technical reforms have been sought to address these challenges by providing smart, comprehensive, relevant, and ubiquitous healthcare. The advancement of the Internet of Things benefits the personal and professional lives of end users; however, a structural modeling study shows that organizational barriers to the adoption of the Internet of Things in the healthcare sector (Ben Arfi Gag, 2021) and behavioral intention are important moderators for customers' willingness to use new technology. The application of the Internet of Things has been able to improve software and hardware components to be safe, flexible, adaptable, patient-centered, timely, and energy-efficient (Batacharia et al., 2017; Gao and Bai, 2014; Martinez-Carlo et al., 2018). Home medical equipment has become the primary application of the Internet of Things (Batacharia et al., 2017), and services using Internet technology have made electronic healthcare possible by connecting devices. Electronic healthcare is of utmost importance in terms of economic and social impacts, for example, remote monitoring of disabled patients and recording physical activities such as calories and heart rate. A review of publications on the application of the Internet of Things in healthcare has shown the following results: 1) This is a new era, and the scope for many research studies is open, 2) The issue is always confirmed from an organizational perspective. 3) The age factor is often overlooked in studies of the application of the Internet of Things in healthcare. 4) The optimized UTAUT model with the TOE framework is the best analysis for electronic healthcare.

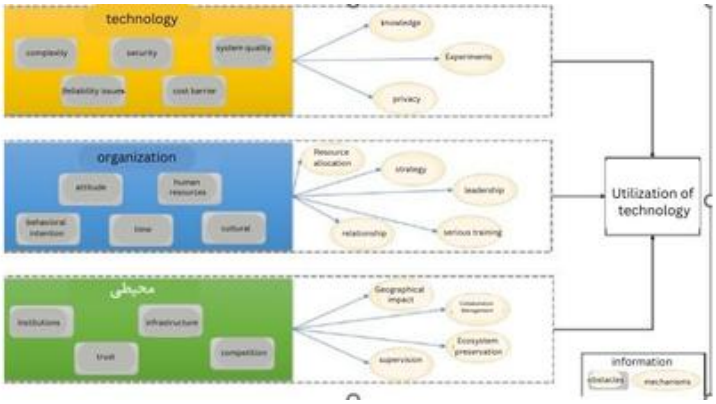
In our review of publications on the Internet of Things, authors place greater emphasis on the aspect of adoption, regardless of the industry type. The widespread application of Internet of Things services for companies has created an important aspect of advanced technology (Bos et al., 2013). This requires a focused application of information technology to gain a competitive advantage in the market, leading to a vital source of innovation. IT solutions have been developed to facilitate the re-engineering of public healthcare systems (Mas and Eriksson, 2006). The Internet of Things has been widely used in the healthcare industry for patient monitoring and providing better care services. One of the challenging aspects of integrating technology into the workflows of doctors and nurses is the integration of the Internet of Things, which simplifies patient data such as initial record summaries, patient follow-up after diagnosis, and progressive notes during diagnosis for hospital staff.

5.2. Theoretical Framework of the Experiment

The study of publications regarding the application of innovative service technology shows that most researchers do not have a defined approach and use the integration of multiple theories with a theoretical framework to understand the process of implementing innovation. The most commonly used theory, the DOI model, only represents individual behavior prior to implementation (Chowles et al., 2001; Mertens et al., 2001). Since DOI does not reflect behavior after implementation, the user acceptance model is combined with the TOE framework to serve as a basis and provides a holistic approach to the entire implementation process.

The theoretical framework will display various barriers and mechanisms based on the findings of previous studies concerning healthcare. Figure 4 is designed to directly understand the barriers,

descriptions, and mechanisms. We will understand all these variables for better communication in our case study; our interview protocol is based on this experimental framework.



b. Figure 4. Theoretical Framework for Technology Adoption
c. In Figure 4, the theoretical framework of TOE for aspects related to technology adoption with barriers is shown in the gray box and mechanisms in the yellow circle. Three aspects related to the thesis study are explained :
d. a. Technical Context
e. In the adoption of technology in healthcare, complexity with new equipment or services is inferred as the risk associated with understanding new technology for the organization (Batz et al., 1999). The quality of the system of life sensors or commonly used devices is defined with minimal error accuracy; sometimes new technologies are accompanied by unidentified errors. This complexity of system quality will present significant problems regardless of the industry (Larsen & McGuire, 1998). Issues of technology reliability state that data must be error-free and accurate. Data accuracy is essential because decisions are based on recorded data in the healthcare industry (Firoozi et al., 2018). Data security is a major challenge that includes privacy, trust, and legal issues that must be considered during the decision-making phase for adoption. Physical control and data manipulation relate to confidentiality (Alrajah et al., 2019). The cost of new technologies is initially much higher when they become available in the market, making the adoption decision a critical investment (Ben Arfi et al., 2021) .
f. To obtain a comprehensive definition of the advanced technology model for understanding applications and characteristics, acquiring knowledge is essential (Liu et al., 2017). According to Gadman (2019), timing plays a crucial role in impactful technology adoption, as some are more focused on practices, characteristics, and industrial changes from peers, software providers, and exhibitions that help in understanding. Sequences are built before public release to ensure their functionality and error-free operation while recording data as part of reliability assurance (Polmos et al., 2019) .
g. Privacy is another essential factor for technology adoption, meaning that a patient's personal information may contain sensitive subjects. Processing personal data such as health status, history, and access to this information is critical. Since data will be available on the database, access should be limited, and appropriate validation should be established (Suleiman & Magaira, 2014) .
h. h. Organizational Context
i. The attitude is an individual user's perspective towards technology, which depends on their decision to utilize the available technology (Hook and Sorwar, 2017). Here, the user is the individual decision-makers in the organizational context. The perceived usefulness of technology affects the behavioral intention to adopt new technology within the work structure (Chang and Tung, 2008). According to Graham (2019), timing plays a crucial role

in influencing technology adoption, as some learn more about methods, characteristics, and industrial changes from pairs, software providers, and exhibitions, which aids understanding. Therefore, time acts as a barrier, and adopting any technology takes time. Human resources discuss the skills of employees in working with advanced technical equipment, as operational errors can lead to reduced product yield (Alrajah et al., 2019). At the organizational level, culture shapes the technology selection path (Melitski et al., 2010). Organizational culture also discusses individual behavior, which is influenced by intrinsic and extrinsic motivations and can act as a barrier or a willingness to adopt technology (Davis et al., 1992).

j. Leadership, characterized by personal traits, is essential for analyzing a problem and reaching a smart solution to stimulate a specific way of thinking. Leadership relates to enthusiastic acceptance and pursuit for potential rewards (Shparz et al., 2005). Interest is a significant aspect in creating the possibility of trust and interaction among entities. Individual decisions may be heavily influenced by the level of interest. Interest has a positive impact on trust in adopting technology (Alhujail et al., 2018). At the organizational level, it is responsible for analyzing the current capabilities of the company and allocating resources accordingly to ensure a smoother adoption process (Alrabi et al., 2021). Strategy in integrating technology into the existing structure creates flexibility and agility in the workforce, and this is managed through various levels of approval before implementation (Chalmis and Parsana, 2013). For any new technology introduced in the organization, serious training must be provided so that the user is fully aware of the device/services. They must be able to work with the entities during events (Zakaria et al., 2010).

k. c. Environmental Context

l. The institution represents the legal, regulatory, and governmental policies that are continuously changing over time. The goal of policymakers to guide innovation through access to various decision-making systems with different perspectives on adopting options is negatively affected (Varabiova et al., 2017). Medical technologies establish various goals for healthcare facilities and attract the attention of different actors during the decision-making process for their adoption. Infrastructure for interoperability to work with any device from different suppliers is essential. Strong infrastructure is needed to support this, as suppliers have different configurations and installation methods that lead to connectivity and linking issues (Jaber et al., 2017). Better supply competition in a sector poses a threat to revenue generation. Therefore, it is recommended to have the latest beneficial market technology before competitors to create a competitive advantage. Trust in technology again reflects an individual perspective in the adoption process for the initial proposal and the company's ability to assess the impact on the environment (Alhujail and Alshahrani, 2019).

m. The geographical impact of technology is based on the organization's location, meaning that it is defined by the population, competition, and services in the area of interest. An urban area holds more significance than rural areas, as urban hospitals see a higher patient flow that requires more data analysis and processing alongside continuous monitoring (Sisibas and Yildirim, 2018). Managing the collaboration of technologies purchased from different suppliers for the organization and having good leadership among them is necessary for a more efficient supply chain and better learning (Nyami-Asiamah, 2020). The healthcare ecosystem is a suitable ecosystem with shared values of protected information, which requires stakeholders to create a knowledge network where all actors in the healthcare process, such as patients, are involved and benefit mutually (Choku, 2021). Monitoring refers to observing the proposed technology to understand its lifecycle and activities compared to the deprecated version (Bryan et al., 2014).

3-Research Objectives and Hypotheses

The aim of this proposal is to understand the current scenario of the application of the Internet of Things (IoT) in the healthcare industry in Iran and thereby examine and emphasize the barriers to the implementation of IoT and the mechanisms developed to overcome these barriers in hospitals .

Referring to the topic and information presented in the above section, we pose the following research question :

•What are the barriers to the implementation of IoT in hospitals in developing countries, and how do they act to overcome these barriers ?

Our master's thesis on the application of IoT in hospitals can be beneficial for researchers and professionals to track the adoption of technology and understand and compare the fundamental transformations in the healthcare industry intended in an IoT infrastructure. Apart from this, our findings on IoT can be utilized by healthcare providers in developing countries to create a sustainable competitive advantage by leveraging technological advancements in the industry .

4-Organizations, Centers, and Other Potential Beneficiaries of the Project's Outcomes (Specialized beneficiary organizations should also be mentioned) :

Certainly, hospitals can be the primary centers utilizing the results of this research project .

5- Definition of Specialized Terms (Theoretical and Practical Definitions of Terms in This Research Should Be Mentioned)

This has been fully explained in the above sections .

C- Information Related to the Implementation Method of the Project and Sample Selection (Research Method)

This chapter describes the methodology of this research. It presents the methodological options, strategies, and criteria chosen to ensure the quality of the research and reflects on the research process and methodological choices .

This research follows the methodological options proposed by (M. N. K. Sanders et al., 2009), which is illustrated in Figure 5, to provide an overview of how the research is conducted and data is collected. The term methodology refers to the approach we took to address the issue and seek answers. First, the research method is presented, followed by the research strategy we employed, the primary and secondary data collection processes, an explanation of a case study as a research method, interview sessions, and the collection of empirical data.

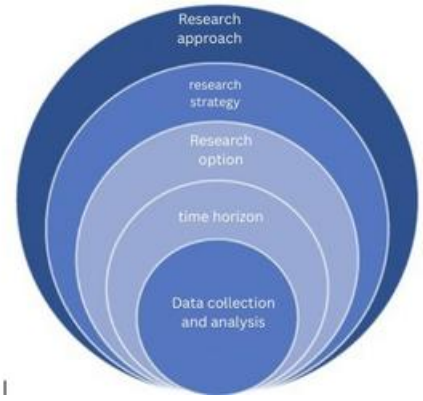


Figure 5. The developed onion model of research (M. N. K. Sanders et al., 2009)

To ensure the appropriateness of the methodological approach (Edmondson and McManus, 2007) and considering the nature of the research question, this study is based on a qualitative method (i.e., what are the barriers to the implementation of the Internet of Things in hospitals in developing countries, and how do they overcome these barriers?). Qualitative research is a suitable option for facilitating the exploration of phenomena in their context using various data sources, and it is recommended when a deep understanding of a specific phenomenon is necessary (Azongah Theophilus, 2018; Baxter and Jack, 2015; Kim et al., 2017). In contrast, quantitative research typically employs a deductive testing theory, while qualitative methods usually proceed with theory generation (Collins and Stakham, 2018; Creswell, 2009). We have developed theories based on various studies in technology implementation; therefore, the nature of the research question and topic inspired us to choose qualitative research. Qualitative research is a holistic approach that

involves discovery and is described as a descriptive exploratory model that occurs in a natural setting, allowing the researcher to develop specific details by engaging with real experiences (Creswell, 2007). This type of research is inherently descriptive and involves the collection and analysis of non-numerical data to understand concepts, opinions, and experiences through open interviews and focus groups (S. J. Taylor, 2016), while quantitative research uses highly structured methods such as questionnaires, surveys, and structured observations to collect numerical data.

Exploratory research is appropriate when the structure of the problem is difficult and when it is unclear which models to use and which characteristics are important (Tu, 2018). Exploratory research can be defined as the process of investigating a problem that has not been clearly studied or has not been fully examined in the past. Thus, this type of research is usually addressed with qualitative methods to gain a better understanding and picture of the existing issue, but in most cases, it does not lead to a conclusion (Jandagh and Matin, 2010; Tu, 2018). The use of an exploratory perspective provides high flexibility to the research process, even if the limited time of 5 months affects it. Since the goal of this thesis is to obtain rich data on a specific topic from individuals with similar work backgrounds (i.e., senior management or decision-makers in an organization), we use exploratory qualitative research in our study.

We argue that qualitative methods such as interviews can provide a deeper understanding of social phenomena compared to surveys. Some previous studies and publications in the field of technology implementation have used case study methods and interviews to examine and gain a clearer understanding of concepts. Hedman and Gimpel (2010), Mittel et al. (2018), and Nemoto et al. (2010) have used exploratory qualitative studies to investigate the concept of technology implementation, which has not been present in previous publications.

There has been an increasing focus in publications on the process of conducting one-on-one interviews as a primary research strategy in health and social research (Ryan et al., 2009). In our research, semi-structured interviews were conducted with professionals who have direct or indirect involvement in the decision-making process of technology implementation. These data are non-numerical. Therefore, exploratory qualitative research is a suitable option for a better understanding of the existing issue. As previously mentioned, our case also employs a holistic view that seeks to discover by engaging in real experiences, with the aim of developing a deep understanding of the social phenomenon by examining and interpreting the collected data (Ragab and Arisha, 2017). This research pays special attention to understanding how participants react to the process of implementing IoT-based technology in the healthcare industry and examining potential challenges in technology implementation.

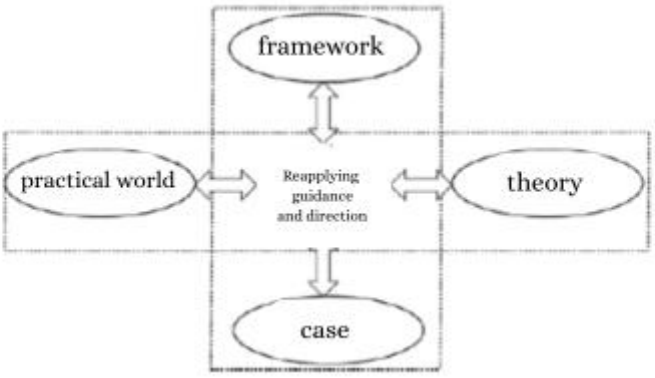
1.3Research Approach

According to M. N. K. Sanders and colleagues (2009), there are two types of approaches that can be used in a qualitative research method: deductive and inductive (Azungah Theophilus, 2018; M. N. K. Sanders et al., 2009). It has been stated that qualitative researchers can employ both inductive and deductive processes (Baxter and Jack, 2015; Bengtson, 2016). The deductive approach begins with a conceptual theory developed from existing publications in the same field within our theoretical framework, while the inductive approach describes the theory as the final outcome of the research (Bryman and Bell, 2011). Inductive reasoning is a process of testing a theory that starts with a proven theory or generalization made from existing publications and seeks to test the publication against collected data (Azungah Theophilus, 2018; Bryman and Bell, 2011).

The aim of this proposal is to examine the barriers faced by healthcare providers in implementing Internet of Things (IoT) technology in Iran. However, some potential general barriers in the digitalization of the healthcare industry and IoT facilities in healthcare have been examined by some researchers, and the challenges of implementing IoT technology have yet to be explored.

Essentially, a deductive approach will allow the researcher to examine and conclude based on empirical findings, while the inductive approach is used to investigate key components and parameters of technology implementation in previous research. The creativity of combining the two concepts to utilize the insights from them to identify the limitations of inductive and deductive approaches is essential (Aouzi and McDermott, 2017). However, we have chosen a combined process of inductive and deductive analysis to examine the barriers to IoT implementation in the healthcare context.

An integrated approach to examining the barriers to IoT implementation will be the most suitable for our case, as it will likely address the weaknesses related to both inductive and deductive approaches. This process of combining the two concepts is referred to as "systematic combination" or "abductive reasoning (best explanation inference)," which is described as a nonlinear process dependent on the path of the combined efforts with the ultimate goal of aligning theory and reality (Dubois and Gadde, 2002). This type of research process requires the researcher to continuously shift from one type of research activity to another and to move back and forth between empirical observations and theoretical insights (Dubois and Gadde, 2014). According to Gold et al. (2011), abductive reasoning seeks to infer the best explanation of the object of study with its supporting context. A representation of the systematic combination approach (Figure 6) was utilized in the technology application by Singh and Holmström (2015) in the analysis process, which helped to understand the best possible explanation of the issue. This example inspired us to choose the systematic combination method to examine the barriers to IoT implementation, which will assist us in interpreting raw data and enhance our understanding of both theoretical and empirical aspects**.**



.Figure 6. Systemic combination method (Dubiso Gad, 2014)

2.3Research Strategy and Research Option

This chapter discusses the overall strategy chosen for our research. A research strategy can be defined as "an action plan to achieve a specific goal" (Denscombe, 2010). Multiple research strategies can be used for a study. However, the best research strategy can be identified with three components: appropriate, feasible, and ethical (Denscombe, 2010). In our case, a research strategy is selected based on these three components, as shown in Table 3 below. According to M. N. K. Saunders and colleagues (2009), experiments, case studies, surveys, action research, proven theory, and practical description are different research strategies explained.

.Table 3. Research Strategy (Yin, 2009)

Focus on current events	Control over behavioral events	Research Question	Type of strategy

		Format	
Yes	No	Who, what, where, and how much	Navigation
Yes	No	How, why	Case study
Yes	Yes	How, why	Experiment

Our goal is to answer the following research questions: What are the barriers to the implementation of the Internet of Things in hospitals in developing countries, and how do they overcome these barriers? Several definitions and arguments have been presented by various authors regarding the case study. Eisenhardt (1989) states that a case study is a research strategy that focuses on understanding the dynamics present in a specific context. Case studies typically rely on qualitative information collected from interviews (Eisenhardt, 1989). Similarly, Creswell (2007) says that the case study method examines the real-life context of a bounded input or phenomenon through time and activity, gathering detailed information using various data collection methods over a stable period. According to Yin (2009), a case study is an empirical inquiry that investigates a contemporary phenomenon in depth within its real-life context, especially when the boundary between the phenomenon and context is not clearly defined (p. 18). Yin (2009) also states that although the case study is linear, it is an iterative process that can provide clear and specific outputs through the analysis and examination of the phenomenon. One advantage of the case study is that it can be beneficial in acquiring the enduring and emergent characteristics of life in a specific organization and can change with the flow and movement of organizational activities (i.e., potential changes in processes and services) (Noor, 2008).

In this thesis, the research question mentioned and the goal is to gain a better understanding of the phenomenon in real life constrained by the challenges ahead. Additionally, the aim of this thesis is to assist the healthcare industry by providing awareness in the implementation of the Internet of Things. Therefore, the choice of the case study method in this scenario is practical. To understand and examine the process of technology implementation in the healthcare industry, a specific case company has been selected, and this case study method allows us to understand the complex activities of real life, where various sources of evidence were collected through semi-structured interviews.

1.2.3. Case Selection: Hospital as a Healthcare Provider

Hospitals play a vital role in the daily lives of every individual in society. Hospitals are important due to their tools for providing care and aggregating services for the health system. Hospitals often provide a combination of practice, training, and learning for doctors, nurses, management staff, and other healthcare professionals, serving as a critical foundation for clinical approaches. Over the past two decades, hospitals worldwide have undergone extensive and significant technological transformations (Ben Arfi et al., 2021; Martínez-Carlo et al., 2018). As healthcare providers, hospitals must understand and keep up with technological changes and utilize those technologies to meet customer needs and expectations. Hospitals and the healthcare industry have significant potential for the intentional and intelligent implementation of advanced technologies and technical practices that can improve outcomes. To succeed, a well-designed action plan with resources is a vital component of any technological advancement in hospitals. The transformation of information technology is redesigning modern hospitals with promising technical, economic, and social prospects.

Today, due to the rapid growth of innovation and its implementation in medical technology and the reduction of health ignorance, patients are technically savvy; therefore, some of them will expect more advanced services from hospitals and healthcare providers. Additionally, in most developed countries, most hospitals are under government control (Fanali et al., 2020; Saltman et al., 2011; Ziad and Twiqan, 2018). This reduces competition; however, they are moving towards innovation for a better experience. In contrast, in developing countries like Iran, where private sectors are heavily involved in hospitals and the health supply industry, the implementation of technology plays a crucial role in determining the competitive advantage of organizations. Unfortunately, due to

numerous challenges in Iranian hospitals, acquiring and adapting to rapidly changing technology is a complex process.

For the research question created, our unit of analysis is the hospital. We have selected the hospital in question through purposive sampling based on a criterion selection strategy (Noor, 2008; Palinkas et al., 2015; Robinson, 2014). The hospital in question meets certain criteria for examining the phenomenon. To investigate the barriers to the implementation of the Internet of Things in a hospital, we need a specific hospital that has adopted a clear application centered around the Internet of Things. This hospital has experienced the overall process and has faced challenges at each stage of implementation, developing various mechanisms to overcome these barriers. Therefore, the hospital provides an effective research context and valuable insights into this phenomenon. We have chosen a medium-sized hospital for our interpretive case study, as there are many hospitals across the country that fall within the small to medium-sized institution range. Thus, selecting a unique hospital will allow our thesis to focus on a typical hospital that addresses concerns. Small and medium-sized hospitals are often more innovative and competitive due to their flexibility and ability to quickly and effectively integrate technology into their development activities (Pett and Wolf, 2009). Small and medium-sized enterprises with ambitious ideas often receive significant energy and productivity boosts in both traditional and new sectors (Ghahlo and Ching, 2019). More information on this will be provided in section 4.

3.3. Time Horizon

Saunders et al. (2009) explained that the time required to study a phenomenon is independent of the method chosen by the researcher. During the research execution, it is necessary for the researcher to be aware of the conditions and time frame available for the phenomenon being investigated. According to Saunders et al. (2009), the time horizon layer defines the necessary time frame for the research. This can be cross-sectional (a short-term study involving data collection over a specific period) or longitudinal (rapid data collection over a long period). This illustrates the difference between cross-sectional and longitudinal studies in the research process. Considering the nature of the research question (What are the barriers to the implementation of the Internet of Things in hospitals in developing countries, and how do they overcome these barriers?), a cross-sectional study is the most suitable option for examining the phenomenon of Internet of Things implementation in our hospital of interest, as our research aims to investigate the barriers to the implementation of the Internet of Things and the mechanisms developed to overcome these barriers in healthcare, with the unit of analysis being the hospital within a specific time frame.

4.3. Data Collection

This research is based on primary data collection through semi-structured interviews. The data collection and note-taking methods were carefully planned through contextual boundaries, creating protocols, and identifying key factors such as the type of data to be collected, collection methods, and the type of participants. Thus, the primary data collection is based on face-to-face semi-structured interviews and conversational communication. Semi-structured interviews create a guideline for defining the main topics to be covered but allow the researcher to be responsive and follow up on important issues that arise unexpectedly with the interviewee (Curtis, 2018). When the researcher wants to deeply explore the thoughts, beliefs, and feelings of the interviewee to examine personal interaction and gather rich data on a specific topic, semi-structured interviews are an effective method for collecting qualitative data (Baxter and Jack, 2015; Deyhan Kriwag, 2019; Ryan et al., 2009). Semi-structured interviews are interactive between the interviewee and the researcher and reflect a conversational exchange similar to what occurs in the real world (Denscombe, 2010; Kim et al., 2017). In our interviews, we did not want to follow a formal list of questions. Instead, we started with some open-ended questions that allowed us to open a discussion between the parties rather than just a question-and-answer format.

Deliberate selection is very important and must be justified in any scientific research. The aim of our study is to examine the issue from the perspective of multiple actors, as various factors play a role in the process of technology implementation in healthcare (Glover et al., 2020; Herzlinger, 2006). This led us to select individuals from different hierarchical levels within the hospital. We identified and selected individuals who are knowledgeable about the phenomenon either through expertise or experience (Palinkas et al., 2015). We initially developed the semi-structured interview questions based on expert individuals who could provide the most important direct information, sharing their experiences and decision-making processes that influence the implementation of Internet of Things technology in the hospital. We conducted interviews with a senior manager, a middle manager, and a nurse to understand how this technology has impacted them and what the requirements for technology implementation are at different stages. The different levels of staff within an organization help us to create a clear picture of the process.

Interviews are the cornerstone of scientific research and innovation, and they can be utilized by both experienced and novice researchers to collect data for projects (Lapboldreston, 2012). To gain a deep understanding and examine the barriers to the implementation of the Internet of Things in the industry, participants from various levels of the hospital hierarchy were considered to share their experiences, ideas, thoughts, and perceptions regarding the use of technology. Interpretations, symbols, and explanations about the concept were gathered to serve as the necessary data source for the research process. These descriptive data must be coded, analyzed, and validated using rigorous and systematic methods to yield results. Writing these data is an essential part of the research, where the collected data is transformed into written format.

1.4.3. Designing an Interview Protocol

The data collection tool is heavily influenced by the strategy chosen for conducting the research (M.N.K. Sanders et al., 2009). Therefore, the process of formulating important questions for semi-structured interviews is relatively complex and an inseparable part of a project. Our interview includes some open-ended questions to facilitate a formal introduction and to understand their general comprehension of technology use. This structure allows respondents to provide more detailed information about the specific case to the interviewer and enables the researcher to ask exploratory questions as follow-up tools (Ryan et al., 2009). Some common information that can assist in designing a relevant interview protocol can be found in publications, such as 1) preparing for the interview, 2) constructing efficient research questions, and 3) the actual execution of the interview (Kersoul, 2007, 2009). Kersoul (2007, 2009) states that the researcher should formulate questions in such a way that keeps the participant focused on answering the question. Additionally, the researcher should be prepared to pose follow-up questions to maintain the flow of attention to concerns. Starting the interview with a few easy questions to ease the interviewee and familiarize them with the interview topic is a good idea (Dionchiz and Wagon, 2019). We followed these teachings and guidelines in designing the interview questionnaire.

The aim of the research is to collect as much information as possible, experiences, and perceptions regarding the use of technology from various participants (senior management, middle level, and nurses) in the targeted hospital. This protocol is divided into four categories of questions: the first question is based on general or broad inquiries that address the participant's information, educational background, level of experience in the hospital, knowledge about the Internet of Things and technology use, and their daily work schedule. The second category of questions focuses on technical factors. This category includes questions related to technological barriers and the mechanisms employed to overcome those barriers. The third category includes questions related to organizational aspects. Thus, it refers to questions about barriers in the organizational context and the mechanisms developed to overcome those barriers. The last category includes questions related to environmental aspects and inquiries about overcoming environmental barriers and the strategies to address these barriers. General questions are designed in such a way that the participant must provide information related to each stage of the implementation process. With the design of the

interview protocol, organization and categorization are carried out based on our innovative theoretical framework. The interview protocol is presented in the appendix.

During this stage, we utilized a continuous back-and-forth process between the research questions and the framework of previous publications to develop a precise interview protocol. Brainstorming was the first step we employed to create an interview guide, meaning just a list of all topics and questions that come to mind when considering the research question. Once the initial list was completed, we used the back-and-forth movement between the research questions and the framework of publications to eliminate redundant and repetitive questions and topics. In this regard, questions are designed to focus on the organizational context, as this is the main part of our literature review. Agreement during the interview is also essential, allowing the respondent to provide an accurate account of their experiences regarding the research topic. Therefore, we aimed to raise potentially challenging questions at the end of the interview session to gain a deep understanding of the phenomenon after establishing agreement.

The interviews were conducted digitally, and data collection took place between April and May 2021. We conducted semi-structured interviews with various participants from the selected hospital. One is a representative of senior management, another is a middle-level specialist, and the last is a staff member in contact with patients. Table 4 provides details of the respondents and the interviews.

.Table 4. Descriptive information of the interviews and participants

Duration (minutes)	**Experience in the hospital**	Organizational Level	Role	**responder**
30	18	Senior Management/Decision Maker	President	R1
45	14	Middle Manager and Executive Board Member	Deputy Director	R2
30	9	Staff in Contact with Patients	Nurse	R3

The first interview was conducted with a senior management representative who is the head of the hospital. He, as one of the decision-makers of the hospital, possesses potential knowledge and experience in the hospital industry and is one of the founders of the selected hospital. He has good knowledge and experience in the Internet of Things in the healthcare industry. This interview lasted 30 minutes and helped us identify potential organizational barriers from a management perspective regarding technology, decision-making environment, budget, organizational culture, and external entities (local government laws and regulations).

The second interview was conducted with the hospital's executive director. He has worked in the hospital industry for over 14 years and is aware of the concepts and trends of the Internet of Things. He is a member of the hospital's board of directors and plays an important role in the organization's decision-making process. This interview lasted 45 minutes.

The last interview was with staff in contact with patients (R3) who are involved in the implementation and daily operation of the systems and procedures. These interviews provided us with inputs regarding the practical requirements for implementing the Internet of Things in the hospital.

All interviews were conducted digitally. Two interviews were conducted in English and one in the local language, which was later translated into English. We recorded each interview session with the permission of the respondents. This provided greater transparency in note-taking and data analysis, as we refer back to the recorded conversations and interpret the findings based on the research questions. Note-taking is the final stage of the interview session. Some information was

collected in the local language, as it was easier for the respondents to communicate. We then began collecting the data and the note-taking process.

2.4.3. Data Analysis

The goal of our thesis is to identify the barriers to the implementation of the Internet of Things in the healthcare industry, and therefore, we have chosen a systematic mixed-methods approach (abductive reasoning) as a research method to investigate the phenomenon. Thematic analysis (TA) should be considered a fundamental method in qualitative research, as qualitative methods are remarkably diverse, complex, and nuanced (Braun and Clarke, 2006). Thematic analysis is a method for identifying, analyzing, organizing, describing, and reporting themes found in a dataset (Braun and Clarke, 2006; Nowell et al., 2017). They stated that a serious thematic analysis can produce reliable and informative findings and results for examining a specific phenomenon. The process involves identifying themes through careful reading and re-reading of the data and is a form of pattern recognition with the data, where emerging themes are transformed into analytical categories (Fereday and Muir-Cochrane, 2006). Themes gain something important about the data in relation to the research question through the interview note-taking process and display a level of formatted response in the dataset. Even if they are not the most common themes in the dataset, they can collectively provide important components of the phenomenon under investigation.

Moreover, Nowell et al. (2017) claimed numerous advantages of thematic analysis. It allows researchers to see the data simply. Additionally, this method is useful for bringing together different understandings of participants, highlighting similarities and differences, and developing unexpected insights (Braun and Clarke, 2006; Nowell et al., 2017).

According to Braun and Clarke (2006), there are six stages in thematic analysis, and these stages overlap as presented below :

.1Familiarization with the data: We have recorded the interview session and transcribed its text. Then, we carefully reviewed and studied the collected data, summarized it, identified its key ideas, and noted them for each written text .

.2Generating initial codes: Coding refers to the process of labeling and organizing all relevant pieces of data in the dataset to answer the research question by identifying different themes and the relationships among them. Braun and Clarke (2006) state that a code is a letter or a brief phrase that encapsulates the reason why you think a part of the data is useful. Coding can be done manually or using software. According to Braun and Clarke (2013), these codes can be generated in two ways: data-driven or researcher-driven. During the translation and transcription, three initial codes were generated based on the direct information from the respondents. Notes were taken to track the summarized information .

.3Searching for themes: This stage builds a bridge between the data and the research question. Throughout this process, one must move back and forth between the data and the literature to create a list of potential second-order themes. If the researcher goes beyond the provided data and requires creative interpretation to generate codes, these codes are referred to as researcher-driven codes or latent themes (Braun and Clarke, 2013). Therefore, analyzing latent themes involves developing the themes themselves, which includes interpretive work, and the analysis produced is not only descriptive but also theoretical. We have followed the formulation of latent themes at this stage .

.4Reviewing themes: In this stage, we reviewed the second-order themes and ensured that they respond to the extraction of codes. Therefore, rereading all notes to determine whether the themes respond to the dataset is important .

.5Defining and naming themes: We re-examined, analyzed, and described the second-order

themes in relation to their capacity concerning the first-order codes and the research question .

.6Producing the report: The final stage involves selecting clear and appropriate examples of the extracts that best represent each selected theme/sub-theme. Ultimately, the articles were written with an analysis of the selected extracts, ensuring the connection between the research question and the publication sections .

Overall, thematic analysis typically helps the researcher to begin by writing and repeatedly reading the data, then to code, search, and review the themes in a back-and-forth manner. Then, definitions are provided, and finally, the themes are named with the researcher's interpretation with the aim of producing an analytical report. A well-executed analysis requires the researcher's interpretation, and thematic analysis will help provide a clear connection between the themes, with the goal of guiding the development of analytical claims .

.3.4.3Ethical Issue

Ensuring that the research aligns with ethical values and is conducted responsibly from the initial planning stages to publication is the responsibility and duty of the researcher. Therefore, one must be familiar with all ethical principles and values before conducting the study and address ethical issues (Eynik, 2020). In our thesis, some of these were carefully examined and considered from the design stage. We are responsible for ensuring compliance with 1) anonymity, 2) informed consent, and 3) confidentiality in reporting the results .

Saunders et al. (B. Saunders et al., 2015) stated that online pseudonyms and identifiable identities should be anonymized in conducting interviews with qualitative research respondents. Thus, in interviewing a selected group of participants, confidentiality and anonymity must be considered as ethical considerations for human participation. In this research, we do not disclose the names of the interviewees in the report of the collected empirical data, and this is maintained during the publication of the report .

The hospital that was part of the execution of this thesis was aware of our research topic. This process of consent is one of the main components of the ethical contract in a research study. Therefore, describing the topic and area of interest with all relevant information in the interview guide allows participants to decide whether to participate or not. They were given the option to decide whether to answer or not to some questions that could potentially harm their reputation or that of the hospital.

5.3Quality of Research

A significant criterion is that we must ensure the quality of the phenomenon under study. High-quality research, like our study, should have a clear and justified research question that indicates the research is timely, original, serious, and relevant. The quality of qualitative research necessitates a reflection of the chosen framework underlying the study. Therefore, we must build trust in our research to ensure the quality of qualitative research (Brieman and Bell, 2011). The criterion of trust in qualitative research is closely related to understanding a pattern from a specific field in which the research is conducted, and it is evaluated based on four factors: credibility, transferability, dependability, and conformability (Lincoln and Guba, 1985; Maru, 2005).

1.5.3. Credibility

Credibility is said to be akin to internal validity or the idea of internal consistency in quantitative research. Shenton (2004) states that this is one of the important criteria because it deals with the question, "How much do the findings align with reality?" Credibility pertains to the extent of the researcher's confidence in the accuracy of their study's findings. Credibility is achieved through prolonged engagement and interaction with participants, ongoing observation of the field, establishing authority for researchers, collecting appropriate reference materials, and peer

debriefing (Lincoln and Guba, 1985). Ani (2014) expresses that peer debriefing is one of the best methods that provides insight and guidance for researchers to improve the quality of research. Throughout the development of the thesis, we were regularly engaged in discussions with our supervisor to negotiate theories and methods used in the studies and to obtain appropriate feedback on research findings, as part of the peer debriefing process.

The aim of our research is to examine the barriers to the implementation of the Internet of Things in a hospital while maintaining the credibility of the collected data. We have chosen a semi-structured interview process as the method for data collection from several participants. Therefore, to avoid being misled and to prevent overly optimistic responses from participants, we designed a set of interview questions in such a way that respondents could arrive at answers based on their understanding.

2.5.3. Transferability

This term (which also refers to external validity or generalizability) can be related to the extent to which a reader is able to generalize the findings of a study to their specific context and the main issues that the researcher may claim for the general application of their theory (Lincoln and Guba, 1985). In most cases, researchers cannot prove that the results based on data interpretation are transferable; they can only demonstrate that it is likely to occur. The process through which definitions are derived should be as explicit and replicable as possible (Maru, 2005). Shenton (2004) states that transferability refers to the extent to which the results of qualitative research can be generalized or transferred to other contexts. Since our thesis is a case study, we collected a substantial amount of data to allow the reader of this research to determine whether these findings are transferable to their specific context. According to Robinson (2014), purposive sampling strategies, which are non-random methods, ensure the categorization of specific cases within a sampling space, and the researcher assumes that the logic of their strategy is based on prior theoretical understanding of the case study, and the selected individuals may have unique, significant, and different insights regarding the phenomenon under investigation. Therefore, we employed purposive sampling based on the nature of our research question to enhance the transferability of the research findings.

3.5.3. Dependability

Dependability refers to the stability of data over time and under different conditions. This relates to significant issues in such a way that the research conducted should remain unchanged over time with different researchers and analytical methods (Maru, 2005). It has been shown that this criterion is closely related to credibility and holds equal importance for qualitative research. Lincoln and Guba (1985) stated that establishing dependability ensures credibility. Similarly, many researchers believe that if credibility has been established, it is not necessary to demonstrate dependability separately. Sometimes, the credibility of data is assessed using data audits. A data audit can only be conducted if the dataset is rich and robust enough for an auditor to determine whether the research situation applies to their conditions (Crafting, 1991; Terharn and Riggs, 2015). This can be achieved by developing a detailed description of the study methods, creating an audit trail, and systematically repeating the data collection steps (Dance Comb, 2010; Patton, 1999). For audit trials, we regularly reported the initial data structure of this study to the observer. Additionally, all interviews were recorded throughout the data allocation process to ensure dependability.

4.5.3. Conformability

Brian and Bell (2011) stated that personal values and priorities of personnel regarding the reliability or conformability of research findings pose a threat. The term conformability (also referred to as objectivity) is based on the acknowledgment that research is never objective. The role of triangulation in enhancing this conformability should be emphasized in the context of researcher bias (Shenton, 2004). According to Guba (1981), the practice of reflexivity is a method for achieving conformability. This method is based on the view that there is integrity in the findings within the

data, and the researcher must maintain an appropriate relationship with the data, analytical processes, and findings so that the reader can validate the appropriateness of the findings (Crafting, 1991; Maru, 2005; Patton, 1999). In this research, conformability was ensured by providing valuable discussions to justify the methods employed based on previous studies with similar contexts or phenomena.

- Sampling method (the method of random allocation and standardization should be mentioned if necessary):

Semi-structured open interviews were conducted with various participants from the targeted hospital, and summaries of the interviews have been written. In the analysis and findings section, we have referred to the data collection method. The findings are organized in a table.

The findings from the interviews were used to develop dimensions and codes, and we developed a general theoretical framework based on them.

Limitations of the project and predictions for solving them (all existing limitations and their solutions should be mentioned):

The purpose of this section is to refer to research options and define a set of barriers for this industry. One of the authors has previous experience in healthcare development projects in Iran and the Middle East, while the other has experience in software development projects in Iran. Therefore, the authors' experience and their interest in the field of innovation and management led to the exploration of possible combinations in these areas.

The focus of this research will be on developing countries, especially on the healthcare sector in Iran, which is currently in the throes of implementing the Internet of Things in hospitals across the country (Mital et al., 2018; Olayan et al., 2019; R et al., 2020). The healthcare industry in Iran is at a transitional stage in the adoption and implementation of the Internet of Things compared to developed countries like the UK, Canada, the USA, and Germany.

In this article, we collected data through interviews with participants from a hospital located in Nishapur, known as Hakim Nishapur Hospital. There are hospitals in every city and village across the country. This study on the barriers to the adoption of the Internet of Things may vary in other hospitals depending on size, geographical impact, and local government policies.

Conclusion and future work

But what software or technologies do blind people use to have a more comfortable life? One of the active companies in this field is Google. Google, by providing the Lookout application, helps blind individuals to have a more enjoyable shopping experience and to be less affected by their visual impairment in the kitchen. Blind individuals can use the artificial intelligence embedded in this app to identify and purchase food items in supermarkets. They simply need to point their smartphone camera at a product, and the Lookout app, using technology similar to Google Lens, will read aloud the product name, contents, and even calorie count. In the latest update of this app, a computer-generated voice capability has been included, and as soon as a blind person touches a food package, the name of the food is announced. However, this app is still in its early stages and may have some errors in product identification, but in the near future, it could fully distinguish between a can of corn and a can of beans. The Android version of this app can currently identify up to 2 million popular products. Additionally, with the help of this app, a blind person can identify products in the kitchen cabinet, refrigerator, etc., using the barcode on the container, but it still cannot easily identify food items that are not in specific packaging, such as onions, tomatoes, etc. Despite this, Lookout performs better than iPhone apps like NaviLens and can boost the confidence of these individuals with its quick identification. Microsoft is also making suitable efforts in this area. The WeWALK cane, which is present in 37 global markets, has recently begun collaborating with Microsoft under the AI for Accessibility program to be equipped with Microsoft’s artificial intelligence. In this five-year program, $25 million is set to be invested to help app developers

provide smart applications that better meet the needs of blind individuals. The AI-equipped cane will hit the market in 2021, featuring sensors, a gyroscope, an accelerometer, and a compass, with data collected and analyzed by a smartphone.

Capabilities of apps

Applications can play a positive role in the lives of blind individuals. For example, Magnifying Glass with Light is a special application for visually impaired individuals that magnifies text or objects up to 10 times, allowing those with vision problems, but who are not completely blind, to utilize this feature and, for instance, read the menu in a restaurant and enjoy their outing.

Not only Android apps serve the blind, but Apple has also taken action in this area. The iPhone has a special feature called VoiceOver, which is essentially a screen reader. A blind person simply needs to activate it through the iPhone settings and then touch the text on the iPhone screen for it to be read aloud. Be My Eyes is another iPhone application that helps blind individuals get assistance from sighted volunteers who have previously participated in this initiative when needed.

A blind person calls this volunteer to help them read, for example, the label on a canned food item. So far, 3.5 million volunteers have registered for this initiative and have assisted over 200,000 blind individuals. Interestingly, these calls are answered within 45 seconds.

These busy startups have also entered the world of the blind to create a more enjoyable living space for them. One startup has designed a device called Hable One, which allows blind individuals to use their smartphones with Braille. "Stefan," the creator of this device, believes that smartphones have become an essential part of daily life and work, but the flat screens of smartphones make it difficult for blind people to use them. He initially designed this device for his blind grandfather and never imagined that he would actually enter the startup ecosystem with this idea. This six-button device is compatible with smartphones, allowing blind individuals to write text in Braille by connecting it to their smartphones. In fact, a blind person can write in Braille using this device and its app. This device also executes voice commands while the smartphone is in the blind person's bag or pocket. This device is currently available on the market, but the startup is also looking to provide better solutions.

Film enthusiasts have not been overlooked in this matter, as there are features that allow blind individuals to enjoy films. One of these features is audio description enabling technology, which is available on Netflix. This feature helps blind individuals by describing scenes in parts of the film that have no dialogue, ensuring they do not miss any part of the film. Another useful app is called Seeing AI. This free app was designed by a Microsoft employee who is blind. In fact, this app can function simultaneously as several applications. For example, it can count money, identify products using QR codes, read documents, and also describe the environment, people, and facial expressions to the blind person, helping them avoid obstacles.

A magical suitcase is another technology that can assist blind individuals. This robotic suitcase, which can be a good companion for blind travelers, is just a step away from the market and could herald good days for these individuals. Designed in collaboration with several Japanese companies and IBM, this suitcase can replace the white cane, guide dogs, and more due to its capabilities. Equipped with several cameras, sensors, and artificial intelligence, it can map the surroundings of a blind person in public places like airports and train stations, estimate the distance between the person and both fixed and moving obstacles, and guide them to the correct path to reach their airplane. A smartphone app connects to the suitcase, and using facial recognition technology, it can inform the blind person if they see someone familiar at the airport. If there is a location in the airport, store, or other places that the blind person has previously specified, it will remind them by vibrating the suitcase handle. Additionally, navigation and direction changes are also facilitated through these vibrations.

Some smart bags can read texts from signs, books, or scanned documents and audibly relay them to the blind user. These technologies are advancing and continuously improving to provide a better

experience for blind individuals. The text mining algorithm in the smart voice bag for the blind includes a series of steps and natural language processing techniques. NLP allows the smart bag to understand user requests, such as asking for a specific location or obtaining information about an object. Text-to-speech is a technique used to generate synthetic voice and read texts aloud.
Integrating speech language processing in the smart bag for the blind allows users to easily interact with the device and utilize its features without the need for complex touch or visual inputs. The aim of our article is to examine the phenomenon of employing the Internet of Things and smart systems in the healthcare industry in a developing country to identify barriers and how this industry is striving to overcome these obstacles.
These bags are designed using advanced technologies, such as sensors, cameras, and artificial intelligence, to assist blind users in navigation, object identification, and understanding their surrounding environment. Here are some features and benefits of smart bags for the blind: Navigation and orientation. These bags are typically equipped with GPS navigation systems and motion sensors. This feature helps blind individuals interact more with their environment. Reading text: some smart bags can read texts from signs, books, or scanned documents and audibly relay them to the blind user. For example, they can notify about changes in weather conditions, public transport announcements, or even recognize friends and acquaintances' faces.
Access to mobile phones: smart bags often connect to mobile phones, allowing blind users to access calls, messages, and mobile apps using voice commands or tactile feedback. Independence and confidence are enhanced by providing information and support.
... Smart bags can significantly impact the lives of blind individuals and help them connect with the world around them. The text mining algorithm in the Ava smart bag for the blind includes a set of steps and natural language processing (NLP) techniques....

...Text classification: Classifying texts based on topics, categories, or importance. Summarization: Extracting key sentences that provide a summary of the text. Summary generation: Producing a short and useful summary of the original text. Text-to-speech conversion: Using text-to-speech (TTS) techniques to convert extracted or summarized text into speech. Information presentation: Providing audio feedback of the extracted or summarized information to the blind user through audio feedback. The text mining algorithm in the Ava smart bag for the blind, using advanced NLP and machine learning techniques, allows users to effectively interact with texts in their environment and benefit from written information....
...This technology is continuously evolving to improve its accuracy and efficiency. Speech processing is one of the important aspects of the smart bag for the blind, allowing users to interact with the device and issue commands verbally....
...Here are some key steps in speech processing in these systems: Speech recognition. (Recognition)

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