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Internet of Things (IoT) adoption in Indian Healthcare Industry-A case study from a hospital.

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Arjun Thyagaraj, Krishnakumar Narayanan

HALMSTAD UNIVERSITY

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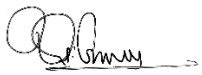

Krishnakumar Narayanan

ABSTRACT

Purpose:

Internet of Things (IoT) is an emerging technology and is a technological paradigm that is revolutionizing the healthcare industry all over the world. The purpose of our thesis is to investigate the phenomenon of IoT adoption in the healthcare industry in the context of a developing country to find out the barriers and how the industry is trying to overcome them. As the second highest population with a landmark of topping the table of developing country list, India has significant potential to bring interest in the IoT adoption in healthcare. Our unit of analysis is a hospital in India.

Method:

To reach our research, we have chosen a qualitative research approach and systematic combining method as our research strategy, which will facilitate us to narrow down the findings of the phenomenon by using a back and forth process. Semi-structured interviews have been conducted with participants of the case hospital as part of the data collection process.

Finding and Analysis:

The first part of the empirical finding is analyzed by the thematic analysis tool, which we have used for the data analysis. This enabled us to interpret the themes in our own way going back to data collected and previous literature references. The study helped us identify some of the main factors affecting IoT adoption in the hospital, categorized under three different sections: technological, organizational, and environmental. The findings indicate that IoT adoption barriers in hospital are categorized as per our tentative framework with theoretical frame reference in the literature review part. Adoption challenges were found mainly centred on technological acceptance, complexity, organizational behaviour, lack of expertise and infrastructure, lack of stringent regulations and standard and finally, the security and privacy concerns. They have initiated a well organizational structure with experts, providing rigorous training for key staff and visionary leadership to facilitate the adoption process.

Keywords: Internet of Things; Technology Adoption; Healthcare Providers; Innovation.

List of Abbreviations:

IOT	Internet of Things
AI	Artificial Intelligence
EMRS	Electronic Medical Record System
IT	Information Technology
TRA	Theory of Reasoned Action
TAM	Technology Acceptance Model
TPB	Theory of Planned Behavior
DOI	Diffusion of Innovation
UTAUT	United Theory of Acceptance and Use of Technology
TOE	Technology Organization Environment Framework
BI	Behavioral Intension
RF	Radio Frequency Module
RPMS	Remote Patient Monitoring System
ICU	Intensive Care Unit
CCU	Critical Care Unit
OP	Operation Room
ETR	Emergency Treatment Room
ECG	Electrocardiogram
TA	Thematic Analysis
IMO	Indian Medical Association
EHR	Electronic Health Record

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1. INTRODUCTION

Over the past few decades, the Internet of Things (IoT) has inspired considerable fascination and technological transformation within the healthcare industry. Adopting IoT may provide a wide variety of benefits for any organization in the long run (Almeida et al., 2017). Many healthcare providers have a hard time with the process of adopting such technology and facing numerous challenges from the moment of initiation until implementation (Luthra et al., 2018; Sharmaa & Tripathi, 2020; Zou et al., 2020). Our thesis explores the possible barriers of IoT adoption in the healthcare industry and the strategies they have taken to overcome in the context of a developing country.

1.1 Background

Internet of Things (IoT) is the most emerging technology that plays a vital role in the digitalization of the healthcare industry (Boyes et al., 2018). In the last two decades, healthcare IoT cases are picking up momentum globally, and the acceptance of connected healthcare is accelerating (Chan, 2015; Shah & Chircu, 2018). To exemplify, many hospitals in developed countries have introduced patient tracking and management system, which helps them to reduce waiting for time, treatment progress and efficient hospital processes such as patient acceptance and discharge (AlHogail, 2018). In practice, end-to-end customer experience optimization, operational flexibility and innovation are the key drivers and goals for adopting digital technologies by healthcare providers(Haggerty, 2017; Henriette et al., 2015). Previous studies on the Internet of Things have demonstrated that healthcare providers and companies experienced a significant increase in the efficiency and profitability of their business through the adoption of IoT (Kamble & Gawade, 2019). In general, IoT will bring out enormous benefits in the business processes for companies and organizations within the healthcare industry.

IoT is a network of physical devices and other items embedded with electronics, software, sensors, and network connectivity, enabling these objects to collect and exchange data (Dimitrov, 2016). In another way, the concept of IoT generally refers to the connection, interaction and sharing of contextualized data between connected devices and systems using the internet with the aim of increasing efficiency in a given situation (Burgess, 2020). The best illustration of IoT in connection with artificial intelligence (AI) could be explained within manufacturing floors and automated factories. Sensors and intelligent devices distributed across these manufacturing floors, combined with AI will constantly collect data to drive the application (Islam et al., 2015). The benefits could be predictive maintenance, increased productivity, and risk management. In healthcare, it can be exemplified by scheduling medical appointments and receiving tentative advice for patients

through smartphone applications and devices without calling a hospital or by avoiding a physical presence. IoT based healthcare devices will provide early detection of potential exacerbation and inform patients as well as professionals such that patients can be treated promptly (Aceto et al., 2020; Ivančić et al., 2020).

Healthcare industry proves to be one of the significantly revolutionized sector by the impact of leveraging digitalization across different levels of the process, products and services (Kumar et al., 2020; Visconti & Morea, 2020). IoT can be referred to as a revolutionary digital tool for the healthcare industry as it has the potential to transform traditional paper-based healthcare service into real-time patient data and remote patient monitoring. This phenomenon is known as digitalization, and has gained prominence in the past two decades in the healthcare industry, as healthcare providers vitally focusing on using digitalized information to make conventional ways of working simpler with more efficient (Kraus et al., 2021). Digitalization refers to the conversion of a specific product or service –from analogue format to digital format. Electronic medical record system (EMRs) and real-time tracking wearable devices are some examples of digitalization in the healthcare industry. This transformation in healthcare is a combined effect of technology adoption and rapid innovation of technology to outperform business activities and exploring the opportunities within the healthcare industry (Gebayew et al., 2018). From an organizational and managerial perspective, the adoption of digital technologies (such as IoT) had played a key role in the evolution of healthcare and the way it has been delivered. Furthermore, it is expected to promote dramatic influences in future as well.

With the sustainable growth and increment in technology across the globe, it is imperative for hospitals to adopt IoT to provide a better service facility. The competence and existence of an organization are directly proportional to how fast the organization is adopting technologies within the changing environment (Almeida et al., 2017; Sivathanu, 2018). Technology adoption refers to the acceptance, integration, and use of new technology by an organization, individuals, public and private entities or any interested actors in the society (Ghobakhloo & Ching, 2019; Straub, 2009). It may involve, among other aspects, managerial processes and organizational dynamics of how firms respond to digital technology changes in order to achieve a competitive advantage (Christensen & Rosenbloom, 1995).

Many companies from various areas such as logistics, manufacturing, transportation, and energy sectors have already initiated their activities towards IoT adoption. In another way, firms invest in IoT adoption not only for their own purpose, but also for offering better services to other companies and individuals in the field (Almeida et al., 2017). The world's most popular manufacturer of electric vehicles, Tesla, is gearing up to reinvent lean manufacturing by the application of IoT. Connected power infrastructures by GE Energy and ABB are examples abound in developed countries. The impact of IoT adoption has been profound and is expected to be even more profound in future (Kamble & Gawade, 2019) as it is a part of survival for the companies to

develop sustainable competitive advantage and to fulfill the increasing demand and expectation of consumers. Some of the possible challenges which decide the pace of IoT adoption and technology acceptance within the healthcare industry is different across the world as it is influenced by national and organizational culture, organizational structure, changes in business models, societal environment and acceptance, financial investments and growing market demand (Ghobakhloo & Ching, 2019).

1.2 Problem Discussion and Research Gap

Considering the boundless possibilities of IoT, innovation and technology will rapidly change the way that healthcare providers adopt IoT to develop a sustainable competitive advantage, which in turn will drastically reshape the care delivery system in the short and long run(Kraus et al., 2021). This ongoing process of technology adoption within IoT infrastructure takes place in a context of people, firms, governmental policies, consumer expectation, regions and nations (AlHogail, 2018; Straub, 2009). A country's ability to achieve and sustain long term economic growth is determined by its ability to increase productivity through the pace of new technology adoption, together with human and physical capital. In a developing country, people face a lot of problems to have access to new technologies such as IoT in terms of poverty, lack of internet speed, low levels of expertise and lack of overall infrastructure (Lather, 2018; Sukkird & Shirahada, 2015).

Zayyad & Toycan (2018), through their exploratory research, states that factors like perceived usefulness, belief, wiliness, and attitude of healthcare professionals have a significant influence on the technology adoption process in developing countries across Africa. Whereas, Khan et al (2019) stated that the concept of gender, trust and privacy plays a vital role in the technology adoption process in developing countries in Asia. Developing countries are still struggling to adopt new technologies due to lack of proper infrastructure, cost, time and benefit analysis and skills workforce and national policies (Anwar & Shamim, 2011). According to Molla & Licker (2005), understanding the concept of technology adoption in developing countries essentially requires different approaches as businesses are facing a number of challenges that emphasize the relevance of technological, financial and legal infrastructure constraints. In contrast, developed countries have adapted new health technologies such as IoT in the healthcare sector to a great extent. Developed countries like Canada, UK, France and Sweden have adopted IoT applications in human environments, for efficient healthcare delivery, to improve the quality of human life and to focus on Sustainable Development Goals (SDG) (Arowoiya et al., 2020; Curtius, 2018; Mero et al., 2020).

Considering the possibilities of IoT to transform the healthcare industry by the near future, India will be one of the huge result-oriented fastest growing market globally (Dash, 2020; Olayan et al.,

2019a). We argue, India is the most relevant case to represent developing country context to investigate the phenomenon as the country is facing two biggest problems: a) increasing population and b) rising expectation of consumers, which are marking a boundary for entire technological developments in the country. Firstly, increasing population is problematic for relatively new technology adoption in healthcare as it requires huge investments, understanding consumer's requirement and level of awareness is a hindrance (Jmaiel et al., 2020; Molla & Licker, 2005). Some other impediments to technology adoption in a developing country are poor governance and lack of human capital, the government's distorting interventions in the market, such as excessive labor regulations, political influence, poorly defined bankruptcy policies and social inequalities (Bergoeing et al., 2015; Maiti et al., 2020). Government of India has taken the initiative toward the digitalization of healthcare sector. The initiatives undertaken by the Indian Government towards digitalization, will boost the adoption and implementation of IoT driven healthcare infrastructure by 2024. According to the annual financial reports from Government authorities in India, IoT investment in India was estimated at around USD 5 billion in 2019 and is expected to triple by end of 2021 (to reach USD 15 billion) (Chatterjee & Kar, 2018; Hosseini, 2019). A staggering population is exacerbating the innovation and technology adoption problems at an organizational and individual level (Acharya & Pathak, 2019). So, the aim of our thesis is to understand the IoT adoption within the healthcare sector in the context of developing country with a representative study from India. In the healthcare sector, there are thousands of hospitals within the country which ranges from the primary care centre, specialty, super & multi-specialty hospitals. Out of this, we could classify them into a different type of healthcare providers like profit, non-profit, regional, military, and medical colleges spread from village to big metro cities in India. At a closer look, most of the hospitals in India, especially public hospitals, and health facilities, evade the adoption of new technologies and prefer using traditional approaches and systems. This affects a patient's availability of record and dampens the quality of health service (Batra & Pall, 2015).

Although IoT in the healthcare sector offers ample opportunities, significant barriers are slowing down the adoption of this technology (Herzlinger, 2006; Visconti & Morea, 2020). Some of the factors are related to inferior technology infrastructure, lack of structured regulations and adequate technology management resources, local political interventions, growing population and awareness and financial aspects (Lather, 2018; Narwane et al., 2019). The increasing population and rising consumer expectation will decide the IoT enabled smart healthcare infrastructure developments since IoT require an integration of information technology (IT) and operational technology (OT) with an intelligent platform. India, one of the largest emerging economies in the world, with a remarkable pace of technology developments in the past and the undeniable slow progress in IoT adoption(Maiti et al., 2020), represents a relevant case to investigate the rate of IoT based technology adoption with a unified analysis of hospital. Overall, India can be characterized as an extreme context (Palinkas et al., 2015a; Robinson, 2014), to investigate the phenomenon as it is showing some specific characteristics towards the technology adoption

process due to the implicit policies, governmental obligations and political influences (Chatterjee & Kar, 2018; Lather, 2018; Samuel et al., 2020).

Hospitals are one of the most complicated sectors in upstream of healthcare providers as the process of technology adoption has to go through different actors and processes within the organization (Glover et al., 2020). As stated by Herzlinger (2006) and Glover et al (2020), the involvement of different stakeholders like doctors, medical specialists, insurance providers, frontline staffs, high-level management and external bodies makes the adoption process so complicated in healthcare. Apart from this, the funding structure, government policies and accountability of healthcare innovators make the innovation and adoption of technology making more complex in healthcare (Jmaiel et al., 2020). The process of technology adoption in hospitals will streamline operations, understand what the patient requires, build loyalty and trust and offer a better user experience (Buer et al., 2020; Kyratsis et al., 2012; R. et al., 2020). The difficulty of measuring the impact of innovative technology for patients, financing mechanism in the hospitals, lack of structured supervision in each stage of technology adoption and involvement of different actors throughout the process makes a hospital more complicated (Metallo et al., 2018; Narwane et al., 2019). Moreover, tradition decision making approaches to new technology adoption based on stable and predictable system are inappropriate in healthcare because of the complex nature of healthcare delivery (Kuziemsky, 2016). Organizational structure, culture, nature of structure also plays a vital role in different hospitals for adopting new technologies, but the adoption process may vary depending on the type of technology considered (Gelijins & Dawkins, 1994). This has inspired us to choose and investigate the phenomenon of IoT adoption with a case of hospital in our thesis.

Barriers and mechanisms to overcome those barriers are intertwined in any organization when it comes to the technology adoption process. Healthcare organizations are developing mechanisms to overcome barriers either by explicit planning in the pre-adoption stage itself or by learning from mistakes (Lydia et al., 2018). Building on a long vision to adapt with rapidly changing environment, technology has totally changed the way healthcare organizations think, plan and operate, both in practices and policies(Zakaria & Mohd Yusof, 2016). Some previous literatures in technology adoption, through their different studies, has provided some peek insights into how SMEs differ in terms of their attitudes towards innovation, building up consumer trust and how organizations could tailor their communications or interventions to overcome different barriers to technological changes to encourage adoption process (Aronson et al., 2019; Atzmon, 2014; Chouki et al., 2020; Kyratsis et al., 2012; Zeadally et al., 2019). In particular, developing mechanisms to the foreseen and hidden challenges are crucial steps for the successful adoption and implementation of new technology, which require both ‘top-down’ and ‘bottom-up’ approaches in an organizational structure (Kuziemsky, 2016; Low et al., 2021). Hence it is important to pinpoint the mechanisms that the healthcare organization is taking forward to overcome the barriers to IoT adoption so as to bring out a complete picture of the IoT adoption process.

Given the growing benefits and advantages of IoT, healthcare providers are now prompted to adopt IoT applications to improve and enhance the experience of their customers and clients (Metallo et al., 2018). In hospitals, while the opportunities of IoT applications are continuously increasing, research on what IoT services are actually in demand and what the barriers for adoption and solutions to overcome the barriers are not thoroughly investigated (Kang et al., 2019a). Prior literature has shed light on the effects and benefits of IoT on healthcare providers, organizations, consumer behavior, and its contribution to creating tremendous opportunities for further business developments (Boyes et al., 2018). Most of the studies that address IoT adoption in developing countries, were developed in traditional companies and described the barriers from a single level perspective (AlHogail, 2018; Luthra et al., 2018). In contrast, previous studies lack empirical evidence on barriers of IoT adoption in hospitals (Kang et al., 2019b; Zakaria & Mohd Yusof, 2016). Although some of the previous studies provided relevant insights into technology adoption in healthcare (Dauwed & Meri, 2019; Low et al., 2021; Martínez-Caro et al., 2018), they did not address the barriers to technology adoption in hospitals from an organizational perspective. Additionally, although some studies provided valuable insights on the barriers to technology adoption in healthcare organizations (Martínez-Caro et al., 2018; Sharmaa & Tripathi, 2020; Sivathanu, 2018) most of the studies did not explain the mechanisms to overcome the barriers too.

There are some integrated barriers to conceptualize IoT in hospitals in developing countries which presumably, either limiting the hospitals to adopt technology or slowing down the adoption process. Some hospitals are developing some mechanisms to overcome such barriers for IoT adoption, starting from pre-adoption until implementation. Considering the possibilities of growing benefits and significance of IoT in healthcare, the barriers that prevent the hospitals from adopting IoT and even slowing down the adoption process in developing countries such as India, should be further investigated. Hence, this thesis aims to analyze the present scenario within the Indian context and interpret the hidden challenges in a way that hospitals could make use of it to understand the concept and to take necessary steps ahead to overcome those barriers.

1.3 Purpose and Research Question

The purpose of this master thesis is to understand the present scenario of Internet of Things (IoT) adoption in the Indian healthcare industry, thereby explore and underline the barriers for IoT adoption and the mechanisms they develop to overcome these barriers in hospitals.

With reference to the subject and information provided in the above section, we derive the following research question:

-What are the barriers for IoT adoption in hospitals in developing countries and how do they overcome these barriers?

Our master thesis on IoT adoption in hospitals could be beneficial for researchers and practitioners to travel through a journey of technology adoption and to understand and compare sub-sequential transformation of the healthcare industry embedded in an IoT infrastructure. Apart from this, our contribution within IoT could also be overlooked by healthcare providers in developing countries to create sustainable competitive advantage by the adoption of technological advancements within the industry setting.

1.4 Delimitation

This section's aim is to point the research choices and to define the set of boundaries for this study. One of the authors has a background in healthcare development projects across India and the Middle East other one has experience in software development projects in India. Hence, the author's experience, and interest in the field of innovation and management led to the investigation of possible combinations of these fields.

The focus of the research will be in the developing countries and more specifically in the Indian healthcare sector, which right now is booming in terms of IoT adoption in hospitals across the country (Mital et al., 2018; Olayan et al., 2019b; R. et al., 2020). The healthcare industry is in a transitional phase in IoT adoption and implementation in India compared with many developed countries like UK, Canada, USA, and Germany.

In our thesis, we have collected data by interviewing the participants from one case hospital located in Bangalore, India (South India). There any many hospitals located in every town, villages and cities across the country. This investigation on barriers to IoT adoption could be different in other hospitals depends on size, geographical influence and local government policies.

1.5 Thesis Layout

Introduction
In this chapter, a summary of all the chapters of the thesis is presented. There is a brief explanation of all the relevant topic for the case study. This provides an overview and makes it convenient for the reader.

Literature review
In this chapter, theories related to the process of technology adoption and the internet of things has been described with a focus towards the hospital domain. A representative chart has been created for easier study of various articles. Based on the study, a tentative theoretical framework is utilized for further research analysis.

Methodology
In this section, the approach and the strategy implemented in the case study. Information about the company, professional background and theoretical sampling has been presented.

Empirical Data and Analysis
Semi structure open interview has been conducted with different participants of the case hospital, and a summary of the interview has been written. In the analysis and finding section, we have mentioned the method of collecting data. Thematic analysis is used for the data analysis process. The findings have been formulated in a table form.

Analysis
The findings from the interview have been used for developing dimensions and codes, and we developed an overall theoretical framework accordingly.

Conclusion
The last section of the thesis is described with a conclusion followed by the project, practical implications, and future research scope.

2. THEORETICAL FRAME OF REFERENCE

This chapter describes the frame of reference for this study, presenting the related literature and core concepts on technology adoption in healthcare and IoT. The literature serves as a base on the existing knowledge and previous studies of the topic by various researchers. We have used the theories from the literature to further build on our research and identify the barriers and solution to the IoT adoption framework to answer our research questions.

A list of chosen articles for literature review from various journals have been presented below in Table 1 and further classified based on ***The Type of study/ sample*** revealing the nature of the case study, ***Country*** to identify the difference between developed and developing countries, ***Barrier factors*** identified in their research study, ***Mechanism*** factors are the possible solution or recommendation from previous implementation and ***Key insights*** based on the author's analysis. These articles are then used in creating interactive author dialogues and analyzing their framework /models to build on. A tentative theoretical framework has been formulated based on a framework(Hameed et al., 2012) to carry out the analysis from these articles and will be furthermore used in developing our interview protocol for this thesis case study. The Literature review is then recalled in the analysis section to compare the identified solution from primary data of the thematic analysis and literature-based data. This section is a crucial part of our case study, as a better literature study gives us a better knowledge to compare the theoretical knowledge and practical implementation realism.

We have classified the literature review into four subchapters to understand better each aspect:

I. Technology Adoption in Healthcare
II. UTAUT Model in Healthcare
III. T-O-E Framework in Healthcare
IV. IoT (Internet of Things)

Table 1: Representative study of technology adoption

Author(s), year, and journal	Type of study and sample	Country	Theoretical Model / Framework	Identified barriers for technology adoption	Identified mechanisms for technology adoption	Key insights/conclusions
Schwarz and Schwarz (2014) Journal of Organizational and End User Computing	Survey with 547 physicians	USA	Technology-Organization-Environment Framework	Technological factors: - Systems quality - Perceived availability Environmental factors: - Competitive pressure - Perceived government regulation Organizational factors: - Internal data management - Financial slack	- Availability -Data Integration -Trials -human resources	The study demonstrates the importance of incorporating macro level factors when studying the adoption decision in a context with heavy institutional pressure.
J. Baldwin, Z. Lin / Research Policy 31 (2002)	Survey of Innovation and Advanced Technology (SIAT) of 1993 Statistics	Canada	Multivariate Framework	- Cost-related - Institution-related - labor-related - Organization-related - Informational- related	-Resources Allocation -Skilled Labours -Technicians	The analysis of the survey data examines the impenetrable barriers in manufacturing firm that prevent technology adoption.
Y. Liu / Energy Policy 67 (2014) 412–421	A multiple-case study of Chinese industrial firms	China	Linear Structural Relations Model	- Structural Barrier - Regulatory Barrier - Cultural Barrier - Contextual Barrier	-Ecosystem Protection -Management -Organizational Characteristics	Larger organizations are most affected than smaller firms in adoption of new technology because of the planning-oriented economy and inflexible hierarchical system.
N. Pappas et al/ Journal of Business Research (2021)	Qualitative comparative analysis on 528 managers	Greece	Conceptual Model	- Risks - Competition - Technology Competence	N/A	The analysis shows the willingness to adapt from an operational perspective.
Pare / International Journal of Medical information 76 (2007) 22-23	Examining the process used by hospital to adopt and implement PACS technology.	Canada	Combination of: Rodger's adoption process and Conceptual framework	- Project Barriers - Technological Barriers - Organizational Barriers - Behavioural Barriers	-Self-interest -complementary skills -implementation strategy	Crucial part in adoption of technology is implementation strategy, which is based on technical, economical, organizational, and human factors.

W.B. Arfi et al / Technological Forecasting & Social Change 167 (2021) 120688	Based on structural equation modelling conducted on 267french users.	France	Conceptual Framework Model	- Behavioural Expectancy - Performance Expectancy - Effort Expectancy - Social Influence - Facilitating Conditions	-Trust -New knowledge	The study aims to examine the united theory of acceptance and use of technology (UTAUT) model and highlight the key role of risk- trust relationship for Internet of Things (IOT) adoption in healthcare.
M. Samuel, et al / Journal of Urban Management 9 (2020) 408–417	Survey conducted in 4 Indian cities: Ahmedabad, Surat, Vadodara, and Rajkot	India	Conceptual Theoretical Framework	- Attitude - Behavioural Intensions - Knowledge Awareness	N/A	The study findings have immense relevance for policy makers and implementers to strategize mechanisms of increasing the usage of e governance thereby making urban governance efficient and transparent
Cherry et al / Journal for Healthcare Quality, Vol.30 (2008), pg.37	Interview with healthcare actors: Nurses, Administration and Corporate Executives	USA	N/A	- Cost - Cultural Change	- Training	Highlights the importance of Electronic Health Records adoption in Long-Term care facilities.
Koul & Eydgahi / Journal of Technology Management & Innovation, 2017. Volume 12, Issue 4	A systematic review of technology adoption frameworks and their applications	USA	Technology Acceptance Model (TAM) and Theory of Planned Behaviour (TPB)	- External Stimulus - Cognitive Response - Intension - Behaviour	N/A	Both the theories fundamental mean for adoption, with applications across multiple culture, geographies, and different contexts.
P. Brous, et al / International Journal of Information Management 51 (2020) 101952	Comprehensive literature study of the expected benefits and risks of IoT	Netherlands	N/A	- Organizational Aspect - Technological Aspect	- Self Effort - Accessibility	Organizational change, Processes and Systems are the key factors for IoT adoption in a firm.
M.A. Hameed et al. / Journal of Engineering and Technology Management 29 (2012) 358–390	Examining the theories	UK	Diffusion of Innovation (DOI) theory, Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM)	<u>Organizational Level:</u> - Organizational - Environmental - Management <u>Individual Level:</u> - User Acceptance	N/A	Study of adoption as a sequence of stages, from initialisation to decision to implementation.

Sunil Luthra et al. / Procedia Computer Science 125 (2018) 733–739	Literature survey and experts' opinion	India	N/A	- Cost - Security - Infrastructure - Poor Internet	- Privacy -Limited Accessibility	Study shows the adoption barrier and diffusion is very challenging in the developing country.
W, Dulle et al. /International Journal of Information Management 27 (2011) 32–45	Survey of 544 respondents through stratified sampling	Africa	Research Model based on UTAUT	- Attitude - Awareness - Effort - Performance	N/A	Planning and implementation in adoption of open access projects in research environment.
W.B. Arfi et al / Technological Forecasting & Social Change 63 (2021) 120437	Based on structural equation modelling conducted on 268french users.	France	Conceptual Model: Extended UTAUT	- Financial Cost - Behaviour Intentions	-Visionary -Interest	The conclusions are applicable to IoT researchers, regulators, and, theoretically, marketers.
Venkatesh et al./ MIS Quarterly Vol. 27 No. 3, pp. 42 (2003)	Based on data from four organization over a six-month period with three point of measurement.	USA	UTAUT	- Performance Expectancy - Effort Expectancy - Social Influence - Facilitating conditions	N/A	UTAUT is a powerful tool for the organizational management to assess the need for new technology.
S.Bhuyan et al./ Journal of Engineering and Applied Science 13(6): 1436-1441 (2018)	Regression analysis from IT department data of different hospitals.	India	TOE Framework	- Security - Privacy - Infrastructure	- Data Management - Accessibility	All the Context of TOE has a significant positive impact on Adoption of technology
Alkawsi et al./ International Journal of Engineering & Technology (2017)	Systematic review of 32 academic journal articles.	Italy	TAM	- Usefulness - Ease of use - Cost - Behavioural Intension	- Knowledge -Customer Satisfaction	User perspective of acceptance was based on the following identified factors.

2.1 Technology Adoption

"All things are flowing."

- Heraclitus (Greek philosopher)

The above quote refers to that everything is subjected to adoption over time, whether desired or not. Adoption is defined as the gradual, continued and incremental change in response to environmental conditions (Jennings & Seaman, 1994; Tushman & Romanelli, 1985). Researcher and practitioners were keen to explore the technical aspect of change and understand its effects on the organization (Kimberly & Evanisko, 1981). Consequently, the term technological adoption describes the organizational process of modifying a firm to utilize advanced technology.

"Potential adopters want to know the degree to which a new idea is better than an existing one" is the modified quote from the theory by (Rogers, 1962) from the early 1970s. A few theories have been explained by different authors for the concept of technology and innovation adoption. Out of which, Roger (1962) has explained the most popular model for diffusion of innovation. The concept of technology adoption is defined as a stage at which a decision is made through adopting a particular technology and involves various activities, including managerial and professional/ technical staff decision making in both the internal and external environment of an organization (Almeida et al., 2017; Batra & Pall, 2015; Rogers, 2010). According to Hameed et al (2012), actual technology and innovation adoption in an organization can be initiated by either a response to a change in the environmental conditions or at some point when innovation becomes a requirement for their organizational routine.

Technology adoption is explained by many theories such as the Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), Diffusion of Innovation (DOI) Theory, and many more. These theories cognize the need for technological change over time (Oner Gucin & Sertel Berk, 2015). An individual acceptance theory has been presented below in table 2 to understand the different theories and their core construct that would be beneficial for constructing our tentative theoretical framework. **TRA** was one of the first theory to explain user behavior, an individual's positive or negative feeling and perception of others view about carrying out the task (Ajzen & Fishbein, 1977). **TAM** is the degree to which an individual believes in enhancing his performance using a particular system (Davis, 1989). **MM** signifies the user performing an action for a valued outcome such as pay, promotion or award (Davis et al., 1992). **TPB** is an extended version of TRA with individual perceived ease of carrying out the task. **C-TAM-TPB** is the hybrid model in which the attitude, controlled behavior, and usefulness of an individual is studied. **MPCU** is to account for an individual extent to believe in using a technology that is relatively difficult. **IDT** explains the innovation perceived as better than the predecessor and being consistent with existing values. **SCT** is to understand the consequences of behavior with respect to performance, personal expectations, and individual's judgement.

Healthcare industry is one of the important pillars of society, to ensure safety and improve the quality of care. The healthcare system is driven by radical changes, requiring adapting to modern technologies over time. The internal environment, such as the information system in a hospital, focuses on quality and practical tools to endorse good outcomes. Besides, the hospital information system also plays a vital role in providing quality healthcare services. In the case of medical innovation diffusion, there are certain criteria such as social-normative challenges, networking, professional or individual authority, medical experts, knowledge, and scientific evidence to succeed. In improving the quality of these process in the hospital, the system should provide accurate, complete, and timely information to be effective in medical decision making.

The process is not as straightforward/simple as it seems to external overlook; the involvement of the management perspective in the adoption will be studied in this section and used in our analysis further for individual behavioral intentions. According to Roa (2005) Information Systems and Information Technology Services require hospital staff to posse's good skill with communication and project planning. This will help the service staff to evaluate the technological and organisational context for the technology adoption. The management must decide if the adoption is user friendly and less effort to the employees or additional training must be given for existing employees to acquire the knowledge. The management must study the rate of adoption of new technology, as it is crucial for knowing the time frame in constant upgradation of new technology in the hospital (Teo et al., 2008).

Table 2: Representative of Individual Acceptance theory and core constructs

Individual Acceptance Theory	Description	Core Constructs
Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1977)	Most fundamental and influential theories of human behavior. Studies employing TRA have been consistent in individual acceptance of technology.	- Attitude - Subjective Norm
Technology Acceptance Model (TAM) (Davis, 1989)	TAM was used to predict information technology acceptance and intension usage on jobs.	- Usefulness - Ease of use - Subjective Norm
Motivational Model (MM) (Davis et al., 1992)	Psychological research to support motivational theory on behavior.	- Extrinsic Motivation - Intrinsic Motivation
Theory of Planned Behavior (TPB) (Ajzen & Fishbein, 1977)	An extended TRA theory by adding the construct of behavioral control to understand the determinant of intension and behavior.	- Attitude - Subjective Norm - Behavioral Control
Combined TAM and TPB (C-TAM-TPB) (S. Taylor & Todd, 1995)	This model combines both TAM and TPB to provide a hybrid model of perceived usefulness.	- Attitude - Subjective Norm - Behavioral Control - Usefulness
Model of PC Utilization (MPCU) (Thompson et al., 1991)	This model is a competing perspective to proposed TRA and TPB. The nature of the model is to predict individual usage rather than intention.	- Complexity - Long-term Consequences - Social factors - Facilitating Conditions
Innovation Diffusion Theory (IDT) (Tornatzky et al., 1990)	Model is based on sociology and is used in the study of various innovation to organizational tools.	- Relative advantage - Compatibility - Voluntariness
Social Cognitive Theory (SCT) (Bandura, 1986)	SCT is the most powerful theories of human behavior and specially used for the study of performance, and the ability to use of information technology.	- Performance - Self-efficacy - Anxiety

2.2 The UTAUT Model in Healthcare

Information technology (IT) acceptance research has yielded many competing models, each with different sets of acceptance determinants. Hence, The United Theory of Acceptance and Use of Technology (UTAUT) model was developed using the following eight technology adoption and usage models: TRA, TAM, MM, TPB, C-TAM-TPB, MPCU, IDT, and SCT (Venkatesh et al., 2003a). UTAUT was proved to outpace the other eight individual models and was confirmed with organizational analysis (Venkatesh et al., 2003a). UTAUT contributes to a better understanding of the behavior of acceptance and use of new technologies in an organization, which in turn has been motivated for our comprehensive case study. UTAUT method has the following advantages: (1) for the possibility to analyze data of different sizes, (2) conduct subgroup analysis, and (3) to analyze complex structural models with numerous constructs.

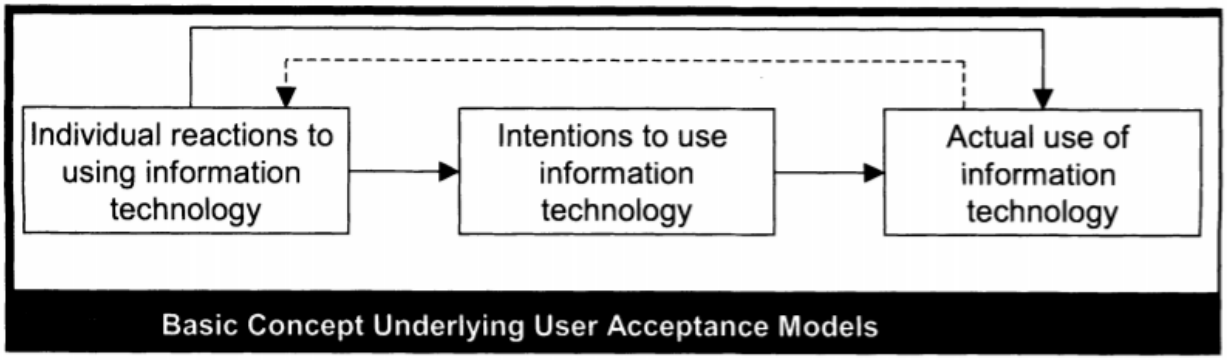

Figure 1: User Acceptance Model (Venkatesh et al., 2003a)

The above figure 1 presents the basic conceptual framework in understanding the research of user acceptance of Information technology (IT). The model hypothesis is significant to direct and indirect determinants to user intentions to accept and use of information into constructs. The direct determinants are of four constructs (performance expectancy, effort expectancy, social influence and facilitating conditions), and the indirect determinants consist of two constructs (attitude and self-efficacy). The strength of the relationship between direct and indirect determinant constructs are influenced by four moderating factors of the user i.e. (age, awareness, gender, and experience), that influences the Behavioral Intention (BI) in the technology acceptance and usage.

In figure 2 shows the formulated UTAUT model by Venkatesh (2003a), with all the constructs and moderators. In this section, we shall define all the determinants individually with respect to their moderating roles. **Performance expectation** relates to how people think emerging technologies can help them do their jobs better, and many researchers on technology adoption have acknowledged the importance of this dimension with the moderator as age and gender in forecasting behavioral intention (Venkatesh et al., 2003b; Louho & Kallioja, 2006). **Effort expectancy** is complexly associated with using a device, and it is said to have a substantial impact

on technology acceptance in the early stages but fades away after long and prolonged use. Age, experience, and gender were conceptualized to moderate the impact of effort expectancy on behavioral intentions (Venkatesh et al., 2003b). **Social influence** refers to how a person's decision to use the technology is influenced by his or her coworkers, another leading member of the organization. This consideration has been seen to have a substantial impact based on age, gender, voluntariness, and experience moderators (Venkatesh et al., 2003b; Schaper & Pervan, 2007a). **Facilitating conditions** is described as the degree to which an individual acknowledges that an organizational and technological framework exists to facilitate the use of a system. In this, the age and experience are the moderators in facilitating conditions (Schaper & Pervan, 2007b). **Attitude and Self-efficacy** are not directly influential on behavioral intension.

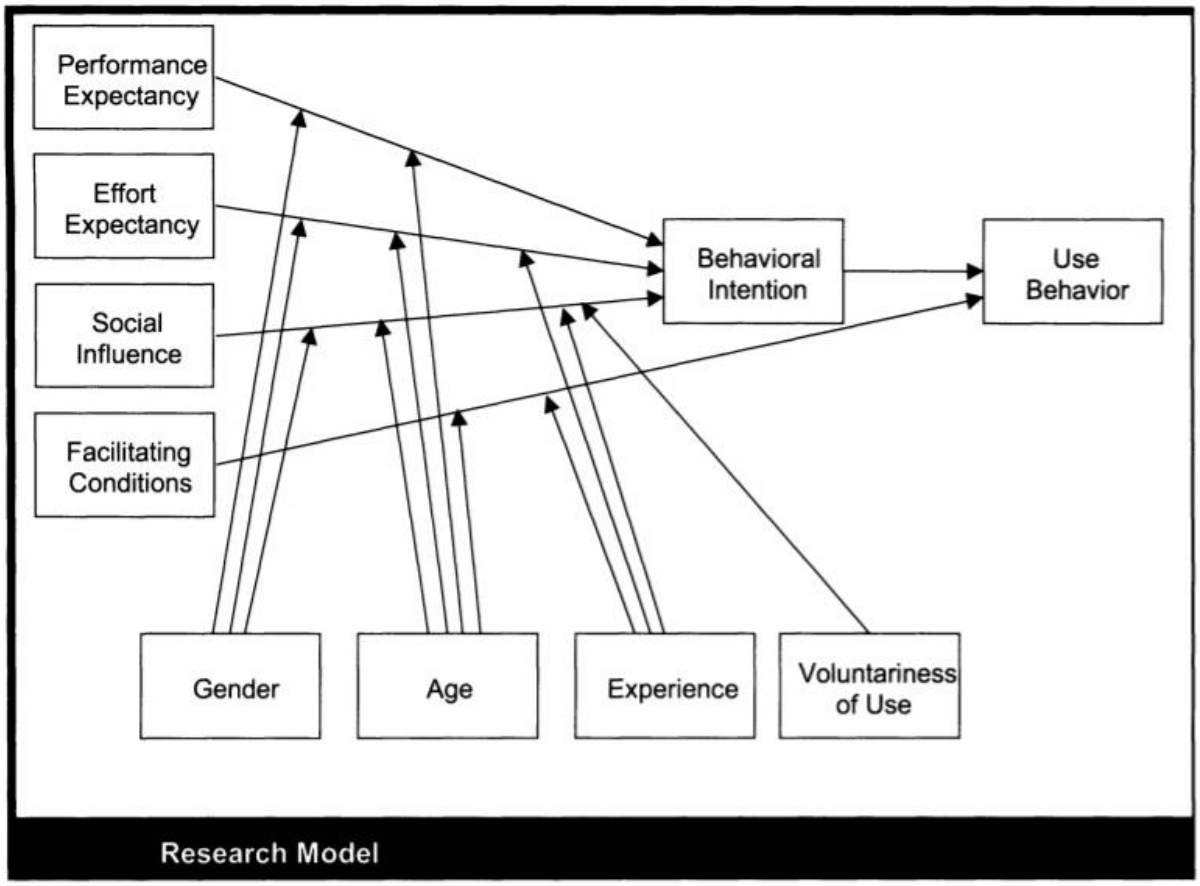

Figure 2: UTAUT Model (Venkatesh et al., 2003b)

Behavioral Intension is the underlying model theory for the positive influence on technology usage. UTAUT explains the variance in intention and ability to define the individual acceptance and usage decision in the organization. There are many prevailing explanatory models of individual acceptance, yet UTAUT is prodigious in unifying the theoretical perspectives into common literature and incorporates moderators to dynamical influence on user experience, demographic, and organizational context.

Healthcare is one of the least investigated fields by researchers with respect to the generational variable. The customer's age is the main behavioural ability to adopt technological adoption. The present study aims to bridge the gap by deepening knowledge about IoT acceptance based on different user behavioural factors (Ben Arfi et al., 2021). The UTAUT in figure 2 explains the adoption of diverse technology in healthcare by targeting a specific audience .i.e., professionals. Some variables are based on the level of knowledge about or previous experience with the technology of the user. For example, Medical equipment users are often handled by older adults; new device anxiety and resistance to change can determine the acceptance of new technology (Cimperman et al., 2016; Hoque & Sorwar, 2017). In some places, digital literacy or accessibility can impact the usage of healthcare technologies (Lee & Rho, 2013). IoT technology in healthcare is generally used by high-level professional supervision. These factors focus on the decision-making process for technology adoption. Finally, many kinds of literature studies prove that technology adoption of making things digital in healthcare requires personal data to be stored. Data disclosure is of privacy concern and raises service risks (Alaiad & Zhou, 2014). Hence, this individual aspect is connected to our study.

2.3 Technology Organization Environment (TOE) Framework in Healthcare

The development of innovation and adoption to users within the context of the firm was described in *The process of technological innovation* (Tornatzky et al., 1990). TOE was adapted for IT adoption studies, providing a useful analytical framework that can be used for the integration of an IT innovation (Oliveira & Fraga, 2011). Information technology has been studied under the individual level section for many decades with the primary goal of making it easier for organizations to derive value out of it by increasing their efficiency, such as UTAUT (Venkatesh et al., 2003a). TOE framework proposed by (Tornatzky et al., 1990) is used to examine the context of a physical decision involving an organizational level theory that explains the influence of firms process in three contexts: the organizational context, the technological context, and the environmental context. Below figure 3 represents the TOE framework; it shows how each context is directly related to each other.

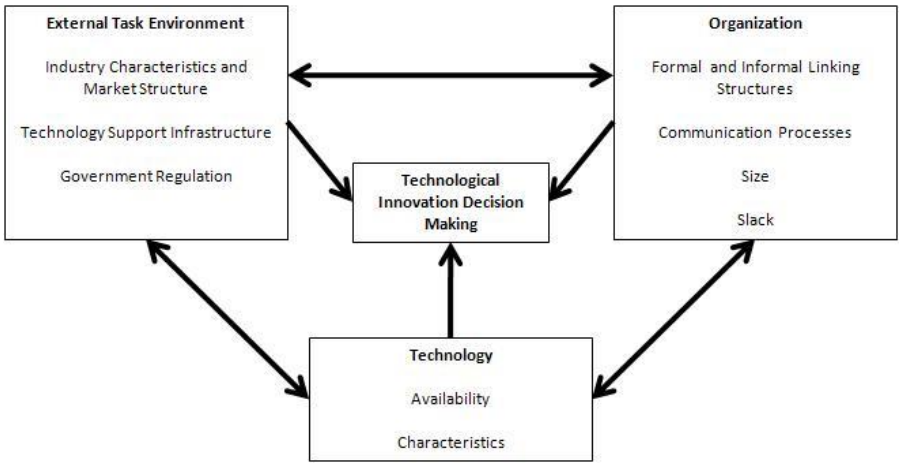

Figure 3: TOE Framework (Tornatzky et al., 1990)

We shall understand each of the contexts with respect to technology adoption in healthcare below:

The Technological context refers to both internal and external innovations that are important to the firm (Hedberg et al., 1976). Internal technologies are those that are currently in use by businesses. External technologies are those that are now available on the market but are not being used by the organization. According to the innovation concept (Rogers, 1962), an individual develops an attitude toward the invention, which leads to a decision on whether to embrace or reject it (Tornatzky & Klein, 1982). They selected relative advantage, compatibility, and complexity as innovation features that are important to attitude development based on a meta-analysis of the technical innovation literature on characteristics of innovation (Thong, 1999). The technological factors specify five attributes: relative advantage, compatibility, complexity, expense, and security. Relative advantage is defined as if the technology is perceived to be better than its previous version (Chong & Ooi, 2008). Compatibility is described as if the technology is compatible with the organization's existing IT systems as well as its healthcare process (Brown & Russell, 2007).

The organizational context refers to descriptive assessments of the organization, such as its scope, scale, and managerial structure. Davidson (1999) states that organizational characteristics such as centralization, formalization, integration, and scale impact the development of technology in hospitals. Top management interests in successfully using capital and providing a conducive work system for technological adoption. In terms of the effects on organization size in IT adoptions, research has shown contradictory conclusions. According to Brown and Russell (2007), larger firms frequently have more resources and are thus more inclined to invest in technology to increase company performance. However, other studies contend that small businesses are more likely to adopt IT technology because they are more flexible, nimble in decision making, and have fewer current legacy system compatibility difficulties (Gibbs & Kraemer, 2004).

The Environmental context is the area in which the company does business, and it is determined by the market itself, its rivals, the firm's ability to access services provided by others, and contacts with the government (Tornatzky et al., 1990). The competitive pressures on the healthcare business have compelled many businesses to embrace technology. The environmental context includes corporate competitiveness, vendor support, and government legislation. This dimension relates to the hospital administration's higher-level challenges. It depicts the healthcare industry's external elements play a vital role (Sulaiman, 2011). Healthcare firms will gain from improved inventory, supply chain visibility, accurate data collecting, and operational efficiency by embracing new innovative technologies (Yao et al., 2010). The healthcare industry is likely among the most strictly regulated. There are laws and legislation in place to govern the standards to be maintained in health care institutions (Cao et al., 2014).

2.4 Internet of Things

In this sub-chapter, we discuss the IoT influence over organizations, individuals, and ecosystem actors in general. In healthcare, A lack of timely and relevant medical information, along with challenges of caregiving process management, have been important hurdles to effective and efficient healthcare service delivery (Turcu, Turcu, & Cerlinca, 2013). As a result, technological improvements have long sought to resolve such challenges by providing ubiquitous, smart, interconnected, pervasive, and smart healthcare. This development of IoT benefits the personal and professional lives of its end users, but based on a structural modelling study it shows that organizational barriers for IoT adoption in the healthcare sector (Ben Arfi et al., 2021) and Behavioural intension is the significant moderator for customer intention to use the new technology. The IoT application has been able to help in the improvement of both software and hardware components to be safe, flexible, consistent, patient-centred, timely, and power-efficient (Bhattacharya et al., 2017; Gao & Bai, 2014; Martínez-Caro et al., 2018). Medical equipment's at home has become the "early-bird application of IoT" (Bhattacharya et al., 2017), and services using internet technology to connect devices has enabled eHealthcare. eHealthcare is of most relevant to economic and social impacts, for example, distant monitoring of patients with disability and recording physical activities such as calories, heart rate. The literature review on IoT adoption in healthcare has revealed the following conclusions: a) This is an emerging era and scope for many research gaps. b) Problem is always acknowledged from an organization perspective. c) Age factor is often missed while investigating IoT adoption in healthcare. d) modified UTAUT model with TOE framework is the best analysis for eHealthcare.

In our literature review on IoT articles, the Authors urge more emphasis on the adoption dimension regardless of any industries. The broad application of IoT service has made companies an important aspect to advance technology Boos et al. (2013). This requires intensive use of Information Technology (IT) to gain a competitive advantage in the market, which leads to a vital source of innovation. IT solutions have been developed to facilitate the reengineering of public healthcare systems (Maass & Eriksson, 2006). IoT has been widely used in the healthcare industry

for patient monitoring and providing better healthcare services. One of the challenging parts is of integrating into the workflow of physicians and nurses. IoT integration would make patients data such as summaries with initial history, follow-up, and progressive notes easier for the hospital attendants while diagnosing.

2.5 Tentative Theoretical Framework

The literature study on technology adoption of innovative services reveals that most researchers do not have a defined approach and use the integration of several theories with a theoretical framework to understand the innovation adoption process. The most used theory DOI model reflects only the **individual behaviour** in pre-adoption (Chwelos et al., 2001; Mehrtens et al., 2001). As DOI does not reflect on the post-adoption behaviour, the user acceptance model with the TOE framework is incorporated to explain the different contexts of an innovation adoption process. Thus, DOI theory serves as the base and along with the TOE framework provides a holistic approach to the overall adoption process.

The theoretical framework will depict the various barriers and mechanisms with respect to healthcare based on findings of previous studies. The below figure 4 has been formulated to directly understand the barriers, descriptions, and mechanisms. We shall understand all these variables to relate our case study better and furthermore, our interview protocol is based on this tentative framework.

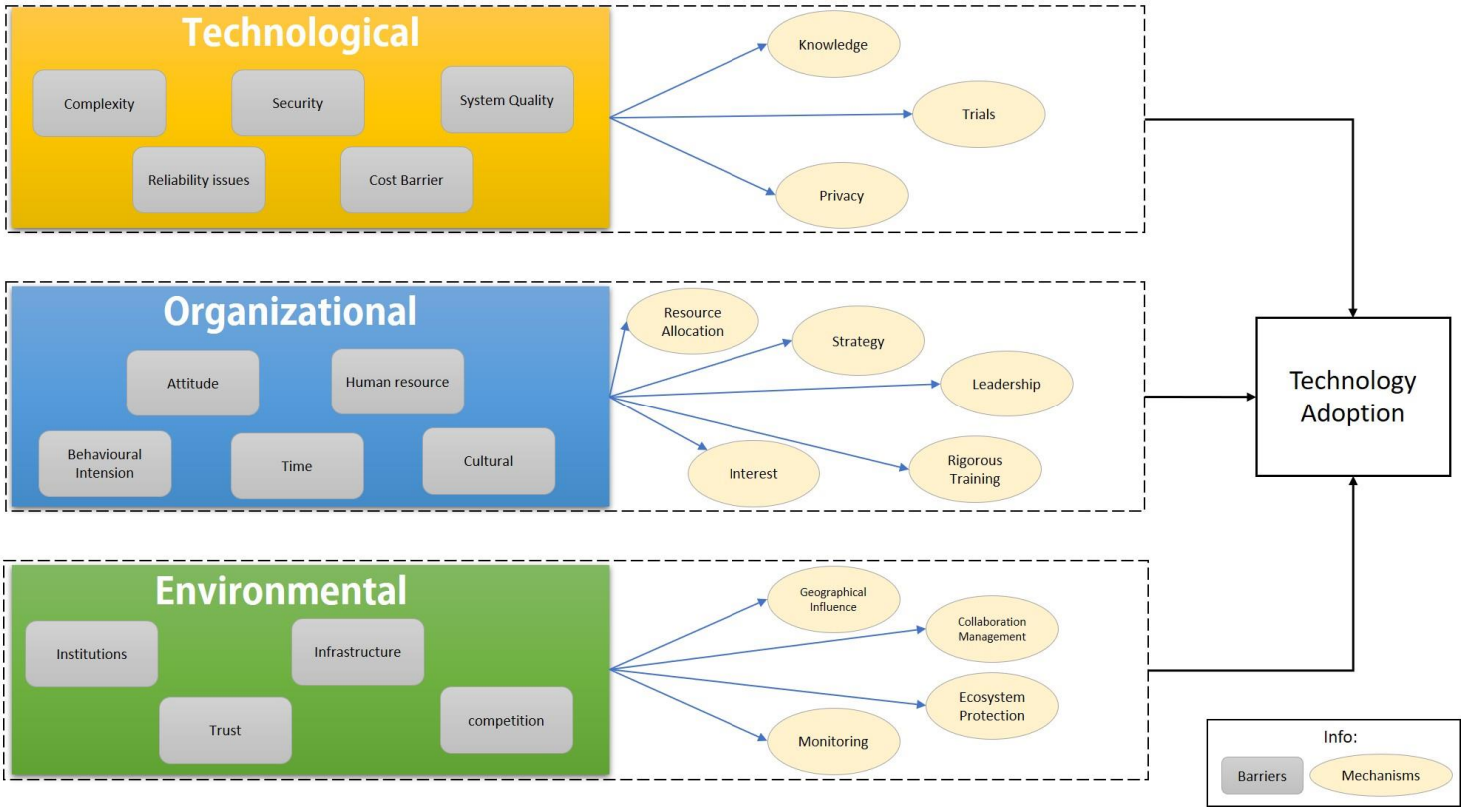

Figure 4: Technology Adoption Tentative Theoretical Framework

In the above figure 4, the tentative theoretical framework shows the TOE for technology adoption related aspects with barriers in grey box and mechanism in yellow circles, the three aspects are explained in relevance to our thesis study and in-detail explanation below:

a) **Technological context**

In a technology adoption of healthcare, **Complexity** with new equipment or service is inferred as the risk involved in understanding the new technology for the organization (Batz et al., 1999). **The system quality** defines the life of sensors or devices subjected to daily/ high usage rate with the least precision errors, sometimes new technologies come with unidentified mistakes. This complication of system quality will reflect insignificant problems regardless of any industry (Larsen & McGuire, 1998). **Reliability issues** of the technology describe that data should be error-free and accurate. Accuracy of the data is critical as decisions are based on recorded data in the healthcare industry (Firouzi et al., 2018). **Data security** is a significant challenge that includes privacy, trust, and legal issues that must be taken care of during the adoption decision phase. Both physical control and manipulation of data accounts to confidentiality (Alraja et al., 2019). **The cost** of new technologies is much higher initially when made available in the market, making the adoption decsion a crucial investment (Ben Arfi et al., 2021).

Knowledge acquisition is essential to get a comprehensive definition of the advancing technology paradigm to understand its usage and characteristics (Liu et al., 2017). According to Gadmdam (2019), timing plays a vital role in influencing technology adoption, as some learn more about better practices, features, and industry change from peers, software providers, and exhibition displays that help understand it. **Trails** are made prior offered to the public, to make sure of their functionality and error-free while recording data as a part of reliability (Polhemus et al., 2019).
Privacy is another essential factor for any technology adoption, i.e., a patient's personal information may contain sensitive matter. Processing personal data such as health status, history, and access to this information. Since, the data would be available in the database, the access should be limited and further adequate authentication (Sulaiman & Magaireah, 2014).

b) **Organizational context**

Attitude is an individual user perspective towards the technology, depends on his/her decision to adopt the available technology (Hoque & Sorwar, 2017), here the individual user of organization context are the decision-makers. The perceived utility of the technology influences **behavioural intention** to adopt a new technology into their work structure (Chang & Tung, 2008). According to Gaddam (2019), **timing** plays a vital role in influencing technology adoption, as some learn more about better practices, features, and industry change from peers, software providers, and exhibition displays that help understand it. Hence, time acts as a barrier and takes time in adopting

any technology adoption. **Human resources** speak of the employee's skill in handling high technical equipment because faulty operations and errors can lead to less efficiency of the product (Alraja et al., 2019). At an organizational level, the culture shapes the way or path to choose technology (Melitski et al., 2010). The organizational **culture** also speaks of the individual's behavior that is impacted by intrinsic and extrinsic motivations that can pose as a barrier or willingness to adopt technology (Davis et al., 1992).

Leadership is characterized by the personal attribute to analyze a problem and coming up with an intelligent solution to stimulate a way of thinking. Leadership is about enthusiastically accepting and pursuing it for contingent reward (Schepers et al., 2005). **Interest** is a critical aspect in enabling trust and interaction between things. Individuals' decisions may be influenced significantly by their level of interest. **Interest** has a positive influence on trust towards technology adoption (AlHogail, 2018). The organization level is responsible for analyzing the existing firm capability and **Allocating resources** according to provide a smoother adoption process (Alrahbi et al., 2021). **Strategy** in the integration of technology within the existing structure provides flexibility and agility within the workforce, and this is administered by many levels of approvals before the implementation (Chelmis & Prasanna, 2013). In case of any new technology introduced into the organization, **rigorous training** must be provided to make the user aware of the device/ service thoroughly. It should be capable of handling things during the mishaps (Zakaria et al., 2010).

c) **Environmental context**

Institution signifies the legal, law and governmental policy which keep changing over time. The goal of policymakers to guide innovation is hampered by the availability of numerous decision-making systems with varying perspectives on adoption choices (Varabyova et al., 2017). Medical technologies serve diverse purposes in health care facilities and grab the interest of diverse actors during the decision phase to embrace them. **Infrastructure** is vital for interoperability to work with any device that comes from various suppliers. A strong infrastructure is required to support it as suppliers have different configuration and installation methods which result in synaptic conflicts (Jabbar et al., 2017). **Competition** of better facility in similar sector poses a threat to revenue generation. Therefore it is recommended to have the latest helpful technology from the market before the competitors to create a competitive advantage. **Trust** in technology is again an individual perspective over the adoption process for initial offering and the firm ability to access impact on the environment (AlHogail & AlShahrani, 2019).

Geographic influence of the technology is based on the location of organization i.e., defined by the population, competitiveness, and services in the region matters. In an urban area is of mor

relevance than in rural areas, i.e., more patient flow is seen in urban hospitals that require more data to be analysed and processed along with constant monitoring (Cicibas & Yildirim, 2018). **Collaboration management** of the technologies bought from the different supplier to the organization and a good relationship must be maintained between the two for effective supply chain and better learning (Nyame-Asiamah, 2020). **Healthcare ecosystem** is the true ecosystem with protected information-sharing values that requires stakeholders to create a knowledge network in which all players of the healthcare process are involved, including patients, benefit from each other's opinion (Choukou, 2021). **Monitoring** refers to observing the offerings of the technology to understand the life cycle and its activities to the better extinct **(Bryan et al., 2014)**.

3. METHOD

This chapter describes the method adopted in this study. The chapter outlines the methodological choices, and strategies and criteria adopted to ensure the research quality. The chapter concludes with some reflections on the research process and methodological choices.

This study follows the methodological choices suggested by (M. N. K. Saunders et al., 2009), which is schematically illustrated below *figure 5*, in order to have an overview of how the research was conducted and data collection has been done. The term methodology refers to the way in which we approach a specific problem and seek answers for it. First, the research approach has been presented, followed by the research strategy we have taken, part of primary and secondary data collection process, explanation on case study as research method, interview session and empirical data collection.

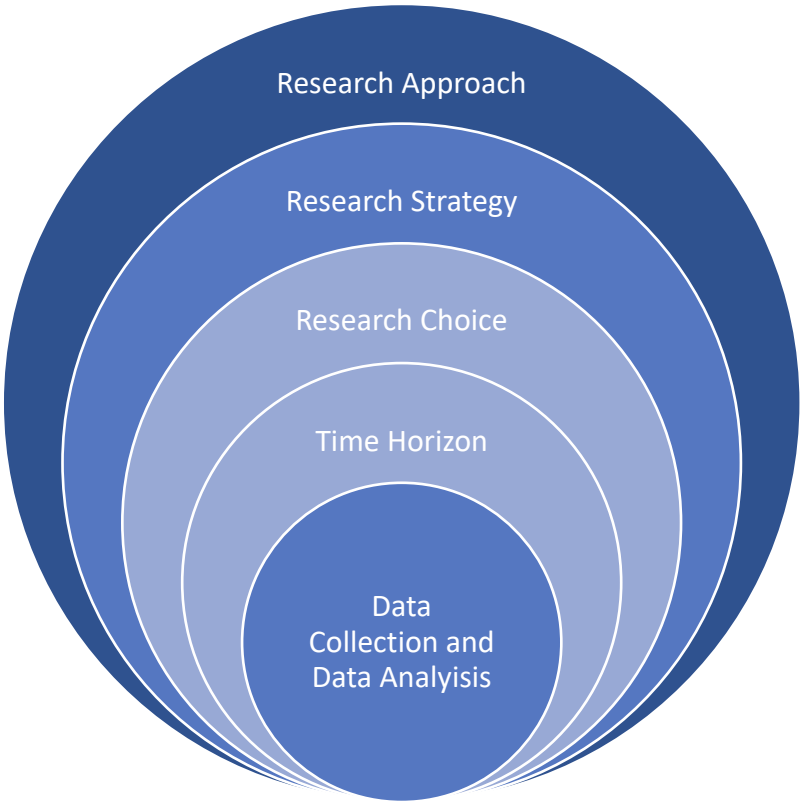

Figure 5: Developed Research Onion model (M. N. K. Saunders et al., 2009)

In order to ensure methodological fit (Edmondson & Mcmanus, 2007) and considering the nature of research question this study is based on a qualitative approach (i.e What are the barriers for IoT adoption in hospitals in developing countries, and how do they overcome these barriers?). Qualitative is the appropriate choice to facilitate exploration of the phenomenon within its context

using a variety of data resources and is recommended to use when an in-depth understanding of a specific phenomenon is required (Azungah Theophilus, 2018; Baxter & Jack, 2015; Kim et al., 2017). In another way, quantitative research usually takes on a theory testing deductive while qualitative approach is usually driven by generating theories (Collins & Stockton, 2018; Creswell, 2009). We have developed theories based on previous studies on technology adoption, hence the nature of the research question and subject inspired us to choose qualitative. Qualitative research is a holistic approach that involves the discovery and is described as an unfolding model that occurs in a natural setting that enables the researcher to develop a specific detail by constantly involving in the actual experiences (Creswell, 2007). This type of scientific research is descriptive in nature and involves collecting and analyzing non-numerical data to understand the concepts, opinions and experiences, by means of open ended interviews and focus groups (S. J. Taylor, 2016), whereas quantitative research used highly structured methods such as questionnaire, surveys and structured observations to collect numerical data format.

Exploratory research is appropriate when a problem is difficult to structure and when there is uncertainty regarding what models to be used and what characteristics are important (Tu, 2018). Exploratory research could be defined as a process of investigating a problem that not been studied very clearly or thoroughly investigated in the past. So this type of research usually addresses along with qualitative methods, to have a better understanding and picture of the existing problem, but wouldn't lead to a conclusion in most cases (Jandagh & Matin, 2010; Tu, 2018). Adopting the exploratory perspective, gave the research process a high level of flexibility even though the limited time of five months had its influences on the delimitation. Since the purpose of this thesis is to get rich data in a specific subject from expert people with the same background (ie; high level management or decision-making people in an organization), we conduct exploratory qualitative research in our study.

We argue that qualitative methods such as interviews can provide a deeper understanding of social phenomena than those compared to surveys. Some of the previous research and literature in the technology adoption field have used case study methods and one interview to investigate and understand the concepts more clearly. Hedman & Gimpel (2010), Mital et al (2018) and Nemoto et al (2010) have used a qualitative exploratory study to investigate on technology adoption concept, which is absent in the previous literature.

Increasing attention has been given in the literature to the process of conducting a one-to-one interview as a major research strategy in health and social research (Ryan et al., 2009). In our research, we conducted semi-structured interviews with professionals involved directly and indirectly in the decision-making process of technology adoption. This data is non-numerical. Hence qualitative exploratory research is the right choice to have a better understanding of the existing problem. As mentioned earlier, our case also adopts a holistic view that seeks discovery from involvement in the actual experiences and aims to provide an in-depth understanding of social

phenomena by exploring and interpreting collected data (Ragab & Arisha, 2017). In this study, the research has specific intention to understand how participants react towards the IoT based technology adoption process in the healthcare industry and to investigate the possible challenges on adopting the technology as well.

3.1 Research Approach

According to (M. N. K. Saunders et al., 2009), there are two types of approaches that can be used in a qualitative research method, Inductive and deductive (Azungah Theophilus, 2018; M. N. K. Saunders et al., 2009). It has been argued that the qualitative researcher can adopt both inductive and deductive processes (Baxter & Jack, 2015; Bengtsson, 2016). A deductive approach starts from a conceptual theory that has been developed from existing literature in the same context in our theoretical framework, whereas the inductive approach describes the theory as the final outcome of the research (Bryman & Bell, 2011). Deductive reasoning is a theory-testing process that commences with an established theory or generalization made from existing literature, and seeks to test the theory out of collected data(Hyde, 2000; M. N. K. Saunders et al., 2009). In contrast, inductive reasoning makes broad generalization from specific observation and is allowing to draw a theory conclusion from existing data (Azungah Theophilus, 2018; Bryman & Bell, 2011).

The aim of our thesis is to investigate the barriers that healthcare providers are facing towards the adoption of IoT based technology in the Indian context. However, some possible general barriers in the field of digitalization in the healthcare industry and possibilities of IoT in healthcare has been explored by some researchers, and the contribution to identifying the challenges of technology adoption in IoT is yet to investigate further. Basically, an inductive approach will enable the researcher to investigate and conclude with empirical findings, while a deductive approach is used to investigate the key elements and parameters of technology adoption in the previous research. Creativity of combining both concepts to make use of their blending in-sights is necessary to break out of the limitations of deduction and induction approaches (Awuzie & McDermott, 2017). Nevertheless, we have chosen a hybrid process of inductive and deductive analysis to investigate the barriers to IoT adoption in the Indian healthcare context.

We argue that an integrated approach will be most suitable to investigate barriers to IoT adoption in our case as it will possibly address the weaknesses associated with deductive and inductive approaches. This process of combining both concepts is called ‘systematic combining’ or ‘abductive reasoning’, which can be described as a non-linear path-dependent process of combining efforts with the ultimate objective of matching theory and reality (Dubois & Gadde, 2002). This type of research process requires the researcher to constantly going back and forth from one type of research activity to another and between empirical observations and theory (Dubois & Gadde, 2014). According to (Gold et al., 2011), abductive reasoning seeks to infer the

best explanation of the research subject within the context that is held. An illustration of the systematic combining approach (*figure 6)* on technology adoption by (Singh & Holmström, 2015) used back and forth on the analysis process, which helped them to understand the best possible explanation of the problem. This inspires us to choose a systematic combining approach to investigate the barriers to IoT adoption, which will help us to interpret the raw data and will improve our understanding of theoretical and empirical aspects.

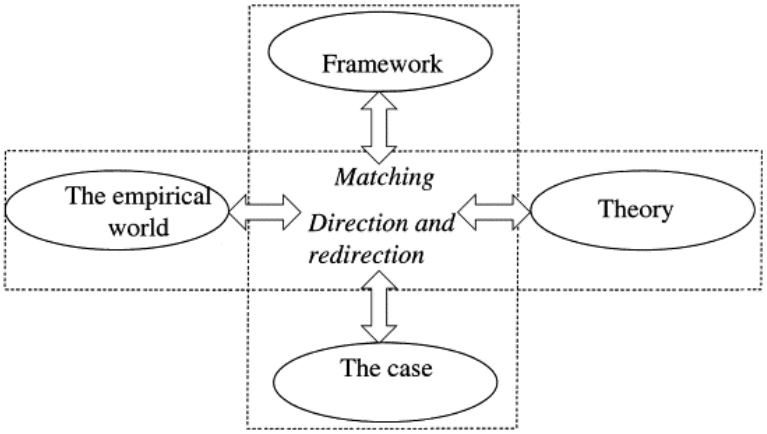

Figure 6: Systematic Combining Approach (Dubois & Gadde, 2002)

3.2 Research Strategy and Research Choice

This chapter is discussing the overall strategy we have chosen for the process. A research strategy could be defined as 'a plan of action to achieve a specific goal' (Denscombe, 2010). Several research strategies can be applied to one single research study. However, the best research strategy could be identified by three elements, suitable, feasible and ethical (Denscombe, 2010). In our case also, a research strategy is chosen as per table 3 below for the study based on these elements. According to (M. N. K. Saunders et al., 2009), experiment, case study, survey, action research, grounded theory and ethnography are the different research strategies explained.

Strategy type	Form of Research question	Requires control over behavioral events	Focus on contemporary events
Survey	Who, what, where, and how many	NO	YES
Case study	How, Why	NO	YES
Experiment	How, Why	YES	YES

Table 3: Research Strategy (Yin, 2009)

As our aim is to answer the below research questions; case study is the most appropriate strategy.

-What are the barriers for IoT adoption in hospitals in developing countries and how do they overcome these barriers?

A number of definitions and arguments have been provided by different authors in the case study context (Eisenhardt, 1989) states that case study is a research strategy that focuses on understanding the dynamics present within a single setting. Case studies typically rely on qualitative information gathered mainly from interviews (Eisenhardt, 1989). Similarly (Creswell, 2007) argues that the case study method explores a real-life context by a single entity or phenomenon bounded by time and activity, and collects detailed information by using a variety of data collection procedures during a sustained period of time. According to (Yin, 2009), the case study is an empirical enquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (p.18). Yin (2009) also states that even though a case study is linear, it is an iterative process that can deliver clear and specific output by analyzing and investigating the phenomenon. One advantage of a case study is that it can be useful in capturing the emergent and immanent properties of life in a particular organization and changes in movement and flow of organizational activities (i.e., potential changes in the processes and services) (Noor, 2008).

In this thesis, the previously mentioned research question and purpose are aimed at gaining a better understanding of the phenomenon in a real-life context bounded by various challenges faced. Moreover, the purpose of this thesis is to aid the Indian Healthcare industry by providing valuable insight into the adoption of IoT. Hence, choosing a case study approach is applicable in this scenario. To understand and examine the process of technology adoption in the Indian healthcare industry, a suitable case company has been selected, and this case study method enables us to understand the complex real-life activities in which multiple sources of evidence were collected by semi-structural interview.

3.2.1 Case Selection: Hospital as a Healthcare Provider

Hospitals play a vital role in everyone's daily life in a society. Hospital also matters to the health system by being instrumental for care delivery and integration of facility services. Hospitals often provide a setting for practising, training and education of doctors, nurses, administrative staffs, and other healthcare professionals and are a critical base for clinical research. Over the past two decades, hospitals have undergone massive and significant technological transformation across the world (Ben Arfi et al., 2021; Martínez-Caro et al., 2018). As a healthcare provider, hospitals should be able to understand and update on technological changes and to transform those technologies to meet customer demands and expectations. The hospitals and healthcare industry has a lot to gain by intentionally and intelligently adopting advanced technologies and technological practices that can improve outcomes. A well-designed plan of action with the resources in place to make it successful must be crucial components of any technological progress in hospitals. The IoT

revolution is redesigning modern hospitals with promising technological, economic, and social prospects.

Today, patients are technologically savvy due to the rapid growth of and pace of innovation and adoption in medical technology and the health disparity gap is shrinking. Because of this, some of them will expect advanced services from their healthcare providers and hospitals. In addition, in most developed countries, major hospitals are under the control of the government (Fanelli et al., 2020; Saltman et al., 2011; Zayyad & Toycan, 2018). This reduces the competition even though they drive towards innovation and a better patient experience. In contrast, in a developing country like India, where the private sectors are heavily involved in hospitals and the healthcare providing industry, technology adoption plays a pivotal role in determining the competitive advantage of the organization. Unfortunately, capturing and adapt the rapid changing technology is a complicated process when it comes to hospitals in India due to many possible challenges.

As per the generated research question, our unit of analysis is the hospital. We have selected the case hospital under purposive sampling, based on the criterion strategy (Noor, 2008; Palinkas et al., 2015b; Robinson, 2014). The case hospital meets some criteria to investigate the phenomenon. For exploring IoT adoption barriers in a hospital, we need a specific hospital that has adopted a particular IoT driven application. This hospital has experienced the overall process and undergone numerous challenges in each stage of the adoption process, and they developed different mechanisms to overcome the barriers as well. So, this hospital is providing fruitful research setting and peek insights about the phenomena as well. We have chosen a medium-sized hospital in our interpretive case study research as there are numerous hospitals across the country within lies within SMEs. So, choosing a unique SME hospital would enable our thesis to represent a typical one addressing the concerns. Small and medium-sized enterprise (SME) hospitals are more innovative and competitive in terms of adoption, due to their flexibility and their ability to quickly and efficiently integrate the technology into the firm's development activities (Pett & Wolff, 2009). With ambitious ideas and innovative solutions, SMEs are often attributed to injecting great energy and productivity into both traditional and new sectors (Ghobakhloo & Ching, 2019). More information about the case is presented in chapter 4.

3.3 Time Horizon

Saunders et al (2009) articulate that the time taken to research the phenomena is independent of which research methodology the researcher has chosen. When doing a research study, it is imperative that the researcher should be aware of the circumstances and time frame available for the phenomenon in which the researcher is investigating. According to Saunders et al (2009), the time horizon layer defines the time frame required for the research. It could be cross-sectional (short term study involving the collection of data within a specific period) or longitudinal

(collection of data repeatedly over a long period of time). This explains the differentiation between the cross-sectional and longitudinal studies in a research process. Considering the nature of the research question (What are the barriers for IoT adoption in hospitals in developing countries and how do they overcome these barriers?), the cross-sectional study is most suitable for investigating the phenomenon of IoT adoption in our specific case hospital since our purpose of the research is to investigate the barriers for IoT adoption and the mechanisms they develop to overcome these barriers in Indian healthcare, with a unit of analysis of hospital, in a specific time frame.

3.4 Data Collection

This study is based on primary data collection, based on semi-structured interviews. The data collection and transcribing procedure has been carefully planned through setting boundaries, establishing protocols, and identifying the key factors such as type of data that needs to be collected, collecting methods and type of participant. So, the primary data collection is based on semi-structured face to face interviews and conversational communication. Semi-structured interviews create a guideline for defining the key topics to be covered, but allow the researcher to be responsive and to relevant issues raised spontaneously by interviewers (Curtius, 2018). Semi-structured interviews are an effective method of qualitative data collection when the researcher wants to explore participant's thoughts, beliefs and feelings in-depth, to delve deeply into personal interaction and to collect rich data about a particular topic (Baxter & Jack, 2015; DeJonckheere & Vaughn, 2019; Ryan et al., 2009). Semi-structured interviews are interactive between the participant and the researcher and reflect conversational exchange similar to that in a real-world setting(Denscombe, 2010; Kim et al., 2017). In our semi-structured interview, we don't want to follow a formalized list of questions. Instead, we started off with some open-ended questions, which allowed us to open a discussion between both parties rather than straightforward questions and answer.

Informant selection is highly relevant and should be justified in any scientific research. Our study aims to investigate the problem from a multi-actor perspective because of the involvement of different actors in the technology adoption process in healthcare (Glover et al., 2020; Herzlinger, 2006). This has led us to select people from a different hierarchical level within the hospital. We identified and selected individuals that are especially knowledgeable about or experienced with phenomena (Palinkas et al., 2015b). We developed semi-structured interview questions primarily based on expert people who can provide the most relevant direct information, share their experiences and decision-making process to influence the technology adoption of IoT in hospitals. We conducted interviews with a high-level manager, middle-level manager and one nurse to understand how this technology has influenced them and the implications of technology adoption in different stages. Our aim is to collect rich information from different people involved in the technology adoption process, and we argue, interviewing different levels of employees in an organization will help us to generate a clear picture of the process.

Interviews are the cornerstone of innovation and scientific research and can be used by both experienced and novice researchers to gather data for projects (Bolderston, 2012). To have an in-depth understanding and to investigate the IoT adoption barriers within the industry, participants from the different hierarchical level considered to share their experiences, ideas, thoughts, and perceptions on technology adoption. Their interpretations, symbols and explanation about the concept are collected as a necessary data source for the research process. This descriptive data should then interpret using rigorous and systematic methods of coding, analysis and validation to find out the results. Transcribing those data is an essential part of the research in which we convert the collected data into a written format.

3.4.1 Designing an Interview Protocol

The data collection instrument is highly influenced by the strategy chosen to conduct the research (M. N. K. Saunders et al., 2009). So, the process of formulating relevant questions for a semi-structured interview is relatively complicated and an inevitable part of the project. Our interview contains some open-ended questions to facilitate an informal introduction and to understand their general perception about the technology adoption. This structure allows the participants to contribute as much detailed information about the specific case as the interviews move on to the tail-end, and it also allows the researcher to ask probing questions as a means of follow-up (Ryan et al., 2009). Some of the most common information which helps to design a relevant interview protocol, found within the literatures includes (a) the preparation for the interview (b) the constructing effective research questions and (c) the actual implementation of the interview (Creswell, 2007, 2009). Creswell (2007, 2009) also stated that the researcher must construct questions in such a manner to keep participants on focus and with their responses to the questions. In addition, researcher must be prepared with some follow-up questions or additional questions to get the right flow to address the concerns. It is usually a good idea to open the interview with few 'easy questions' to make the interviewee comfortable and to familiarize the participants with the subject of the interview (Dejonckheere & Vaughn, 2019). We have followed those instructions and guidelines to design the interview questionnaire in our thesis.

The objective of our research is to collect maximum information, experiences, and perceptions of technology adoption from different participants (High-level management, middle level and nurses) within the concerned hospital. Our interview protocol contains 15 major questions and five introductory questions. This protocol is divided into 4 clusters of questions; the first one is based on overall or generic questions that address participant's information, academic background, years of experience in hospitals, knowledge about IoT and technology adoption, and their daily routine in work. The second cluster of questions addresses the aspects related to technological factors. This cluster includes questions related to barriers associated with technology and the mechanisms they took to overcome such barriers. The third cluster addresses the questions related to organizational aspects. Hence this includes questions about barriers in organizational context and

mechanisms they developed to overcome such barriers. The final cluster addresses the questions related to environmental aspects, and this includes the questions to cover the environmental barriers and the mechanisms they took to overcome these barriers. The overall questions are made in such a way that the participants should provide relevant information in each stage of the adoption process. Designing the interview protocol, structuring and categorizing is done based on our tentative theoretical framework. The interview protocol is included in the appendix section.

During the entire phase, we have used a continuous back and forth process by moving between the research questions and the previous literature framework to develop a detailed interview protocol. Brainstorming was the initial step we have taken forward to construct an interview guide, i.e. simply list all the topics and questions that come to mind when we think about the research question. When we are done with the initial list, we use back and forth movement through research question and literature framework to eliminate questions and topics that seem redundant and same for all the group. In our case, questions are designed to address the organizational context as this is a major part of our literature review. Rapport is also crucial during the interview enabling the respondent to provide a rich and detailed account of the experiences at the heart of the study. Hence, we tried to generate potentially difficult questions towards the end of the interview session to have an in-depth understanding of the phenomenon when rapport has been established.

The interview was conducted digitally. The data collection took place between April and May 2021. We have conducted semi-structured interviews with three different participants from the selected hospital. One is representing high-level management, the other one represents middle-level practitioner, and the last one is from frontline staff. Table 4 presents the details of respondents and interviews.

Respondent	**Designation**	**Organizational level**	**Experience within Hospital**	**Duration (mins)**
R1	Chairman	High level management/Decision maker	18	30
R2	Admin Manager	Middle level management & executive board member	14	45
R3	Nurse	Frontline staff	9	30

Table 4: Descriptive information of interview and respondents

The first interview has been conducted with a high-level management representative (R1), who is the chairman of the hospital. As one of the decision-makers of the hospital, he has potential

knowledge and experience within the hospital industry in India and is one of the founders of the selected case hospital. He has good knowledge and experience dealing with IoT application within the healthcare industry. This interview has taken 30 minutes. This interview helped us to identify the potential organizational barriers from the management perspective in the context of technology, decision-making environment, financial, organizational culture, and external bodies (rules and obligations from local government).

The second interview has been conducted with the Administration manager (R2) of the hospital. He has been working in the hospital industry for the past 14 years and is aware of IoT concepts and trends. He is also one of the executive board members of the hospital and playing a key role in the decision-making process of the organization. This interview has taken 45 minutes.

The last interview has been conducted with a frontline staff (R3), who is very much involved with the implementation and daily operation of the system and procedures. This had given us inputs about the practical implications of IoT adoption within the hospital.

The whole interviews were conducted digitally. Two interviews were conducted in English, and one was conducted in the local language that later has been translated into English. We have recorded each interview session with the permission of respondents. This has provided more clarity in our transcription and data analysis part as we can go back to the recordings to listen and interpret the findings going back to the research question. Transcribing is the final stage of the interview session. Some of the information was collected in the local language as it was easier for them to communicate. When we collected the data, we have started with the process of transcription.

3.4.2 Data analysis

The purpose of our thesis is to identify the barriers to IoT adoption in the healthcare industry, and hence we have chosen a systematic combining method (abductive reasoning) as our choice of research approach to investigate the phenomenon. Thematic analysis (TA) should be seen as a foundational method in qualitative research since qualitative approaches are incredibly diverse, complex and nuanced (Braun & Clarke, 2006). Thematic analysis is a method for identifying, analyzing, organizing, describing and reporting themes found within a data set (Braun & Clarke, 2006; Nowell et al., 2017). They argue that a rigorous thematic analysis can produce trustworthy and insightful findings and results for the investigation of a specific phenomenon. The process involves the identification of themes through careful reading and re-reading of the data and is a form of pattern recognition within the data, where emerging themes become categories of analysis (Fereday & Muir-Cochrane, 2006). A theme captures something important about the data in relation to the research question through the interview transcribing process and represents some level of patterned response within the data set. Even though they are not the most prevalent themes across the data set, but together they may capture important elements of the research phenomenon.

Apart from this, Nowell et al (2017) claim many advantages for thematic analysis. A researcher who is relatively new in their research field and not familiar with qualitative methods, may find it easy to understand the concepts and procedure of thematic analysis. It is also a useful method to bring out different perceptions of different research participants, highlighting similarities and differences and developing unanticipated insights (Braun & Clarke, 2006; Nowell et al., 2017).

According to Braun and Clarke (2006), there are six phases in a thematic analysis and these overlapping steps are presented below;

1. Familiarizing with data: We have recorded the interview session, and it has been transcribed. Then carefully examined and read the collect data, summarized it, and major ideas were highlighted and written down for each transcript.

2. Generating initial codes: Coding refers to the process of labelling and organizing all relevant pieces of data within the entire data set to answer the research question by identifying different themes and the relationship between them. Braun and Clarke (2006) argues that, 'a code is a word or brief phrase that captures the essence of why you think a particular bit of data may be useful. Coding can be done manually or by using the software. According to Braun and Clarke (2013), these codes can be generated in two ways, either data-derived or researcher–derived codes. While translating and transcribing, we have generated these initial codes based on direct information from respondents. Memos were written down to keep track of the condensed information.

3. Searching for themes: This step is about constructing a bridge between the data and the research question. It is important to move back and forth during this process between data and literature and created a list of potential second-order themes. If the researcher goes beyond the provided data and needs creative interpretations to generate codes, this is called researcher-derived codes or latent themes (Braun & Clarke, 2013). Thus, for latent thematic analysis, the development of the themes themselves involves interpretative work, and the analysis that is produced is not just a description but is already theorized. We have followed the formulation of the latent theme in this step.

4. Reviewing themes: During this step, we checked and made sure the second-order themes worked in relation to the codes extract. Hence re-reading all transcripts is important to establish whether themes worked in relation to the data set.

5. Defining and describing the themes: We re-examined, analyzed and described the second-order themes according to their power in relation to the first-order codes and the research question.

6. Producing the report: Moving on to the final step of selection of vivid and appropriate examples of extracts that best represent each theme/subtheme are selected. Finally, papers were written by analyzing the selected extracts and ensuring their link between the research question and the literature part.

In general, the thematic analysis will help the researcher usually began by transcribing data and repeatedly reading this data, followed by coding, searching, and reviewing the themes like a back-and-forth process. Then providing definitions and finally naming the themes with their interpretations with the purpose of generating the report of the analysis. A well-conducted analysis requires interpretations by the researcher, and thematic analysis will help the process by providing a clear link between themes and aims of the study to guide the development of analytical claims.

3.4.3 Ethical Dilemmas

It is the responsibility and duty of the researcher to make sure that the research is in accordance with ethical values and has been done in a responsible manner, from the initial stages of planning until it gets published. Therefore, it is vital to become familiar with all principles and moral values before conducting a study and to eliminate ethical issues (Inieke, 2020). Some of them were carefully examined and taken into consideration from the planning phase itself in our thesis. We are hereby responsible for making sure a) anonymity b) informed consent, and c) confidentiality to be strictly followed when delivering the outcome of the report.

Saunders et al(B. Saunders et al., 2015) state that online pseudonyms and participant identity should be anonymized when conducting interviews with the respondents in qualitative research. So, when interviewing a selected group of participants, confidential information and anonymity as ethical consideration for human involvement must be considered. In our case, we will not disclose their names in the empirical data collection part, and this also applies when presenting and publishing the report.

The hospital that has been part of conducting this thesis has been intimated the subject of exploration in our study. This informed consent process is one of the central components of ethical conduct in a research study. Therefore, a description of the subject and area of interest with all relevant information is highlighted in the interview guide, which enables the participants to make the decision to participate or not. They have given the authority to decide not to answer some questions, in case, if that may potentially harm their reputation or hospital reputation in any way.

3.5 QUALITY OF RESEARCH

It is an important criterion that we need to make sure of the quality of the research phenomenon. High-quality research, just like any other study, should have a clear and justified research question that implies that the study is timely, original, rigorous and relevant. The quality of qualitative research necessitates critical reflection and justification of the selected framework underpinning the study. Hence it is of great importance that we build trustworthiness in our research in order to ensure the quality of qualitative research (Bryman & Bell, 2011). Criteria for trustworthiness in qualitative research are closely tied to the paradigmatic underpinnings of the particular discipline in which a particular investigation is conducted and is evaluated by four elements; credibility, transferability, dependability and conformability (Lincoln & Guba, 1985; Morrow, 2005).

3.5.1 Credibility

Credibility is argued to be like internal validity or the idea of internal consistency in quantitative research. Shenton (2004) argues that, this is one of the important criteria as it deals with the question 'how congruent are the findings in relation with the reality?'. Credibility is about how confident is the researcher in the truth of the research study's findings. Credibility can be achieved by prolonged and varied engagement with participants, persistent observation in the field, establishing investigators authority, collection of referential adequacy materials and peer debriefing (Lincoln & Guba, 1985). Anney (2014) states that peer debriefing is one of the best methods which provides guidance and insights for researchers to improve the quality of research. Throughout the development of our thesis, we consistently engaged in discussions with our supervisor in order to debate about the theories and methods employed in the studies and get appropriate feedback on research findings as part of peer debriefing.

Our study aims to investigate the barriers of IoT adoption in a hospital by keeping the credibility of collected data. We have chosen a semi-structured interview process as our data collection from multiple participants. Hence, in order to avoid completely baffled and optimistic answers from the participants, we have designed a set of interview questions so that, respondents can come up with different answers from their own perceptions.

3.5.2 Transferability

The terms transferability (also refers to external validity or generalizability) can be referred to the extent to which the reader is able to generalize the findings of a study to her or his own context and addresses the core issue of how far a researcher may make claims for a general application of their theory (Lincoln & Guba, 1985). In most cases, researchers cannot prove that outcomes based

on the interpretation of the data are transferable, that they can establish that this is likely to occur. The process through which the findings are derived should be explicit and repeatable as much as possible (Morrow, 2005). Shenton (2004) states that transferability refers to the degree to which the results of qualitative research can be generalized or transferred to other context or setting. Since our thesis is a single case study, we collected a rich amount of data to enable the readers of this study to determine whether these findings are transferable to his or her context. According to Robison (2014), purposive sampling strategies are non-random ways of ensuring particular categories of cases within a sampling universe, and the researcher assumes that rationale for employing this strategy is based on a-prior theoretical understanding of the specific study, and selected individuals may have unique, important and different perception towards the investigating phenomenon. Hence, we adopted a purposive sampling based on the nature of our research question and to increase the transferability of research findings.

3.5.3 Dependability

The term dependability (also called reliability in quantitative research) refers to the stability of data over time and over conditions. It deals with core issues that the way in which the study is conducted should be consistent across time, researchers and analysis techniques (Morrow, 2005). This criterion is suggested to be closely linked to credibility and equally important for qualitative research. Lincoln and Guba (1985) themselves argue that establishing dependability ensures credibility. In the same way, many researchers believe that if credibility has been demonstrated, it is not necessary to demonstrate dependability separately. Sometimes data validity is accessed using a data audit. A data audit can be conducted if the data set is both rich-thick so that an auditor can determine if the research situation applies to their circumstances (Krefting, 1991; Treharne & Riggs, 2015). This can also be achieved by developing a rich description of the study methods, establishing an audit trail and stepwise replication of the data (Denscombe, 2010; Patton, 1999). For audit trials, we regularly reported the preliminary data structure of this study to our supervisor. Additionally, we recorded all interviews during the data collection process to ensure dependability.

3.5.4 Confirmability

Bryman & Bell (2011) states that a threat is posed by the researcher's personal values and preferences on the trustworthiness or conformability of the research findings. The term confirmability (also called objectivity) is based on the acknowledgement that research is never objective. The role of triangulation in promoting such conformability must again be emphasized, in the context of investigator bias (Shenton, 2004). According to Guba (1981), practising reflexivity is a method to achieve confirmability. It is based on the perspective that the integrity of findings lies in the data and that the researcher must adequately tie together the data, analytic

processes and findings in such a way that the reader is able to confirm the adequacy of finding (Krefting, 1991; Morrow, 2005; Patton, 1999). In this study, the confirmability is assured by providing valuable arguments to justify the methods employed, based on previous studies with similar context and or phenomena. We have used some widely known and well-established theories and methods, published by some famous scientific journals, to conduct our study. And as part of the process. The digitally recorded interviews enabled us to transcribe verbatim, highlighting important statements and therefore are objective. Apart from this, the semi-structured interviews that we conducted, have been used to validate our initial findings and interpretations. This validation process proves that the collected data were interpreted in connection with the literature.

4. CASE DESCRIPTION

In this chapter, we described the details of the case hospital, specific IoT driven technology they have adopted, followed by the summary of the adoption process of this specific technology.

The case hospital is a private entity, established in 2009 by the Nadathur Group. They felt the overwhelming need to set up a world-class surgical care facility in Bangalore. Management's vision was to create a hospital with an environment akin to home which was therapeutic and conducive to healing, while simultaneously providing superior quality healthcare, patient safety and infection control of the highest standards.

It is a multispecialty hospital, with a panel of doctors and medical professionals who have developed deep expertise in their respective specialities. It is an ultra-modern hospital and wants to be recognized as a forerunner in patient care and services. The focus of the hospital has been and always will be that the 'patient comes first'- in which they are aiming to deliver ultimate customer satisfaction and to meet their needs and expectation in products and service facility. Hospital has started its operation in 2009 with minimal facilities of Orthopedics and Pediatrics for local people in the town, and during the last decade of its incredible journey of excellence in technology, products and service delivery, it has expanded to facilitate specialities like minimal access and general surgery division, Obstetrics, gynaecology and fertility with impressive transformation. They have adopted recently patient safety programs and a patient management system to become a leading service provider in healthcare care.

Hospital has made unprecedented efforts to support the professionalization of health service management and as well as initiatives to strengthen emergency care as the backbone of health service delivery system through their continuous improvements in technology and facilities. Enhancing the health workforce, ensuring equitable access to cost-effective medicines and technology, and improving health information and health information systems are some of the highlights of the hospital that makes them an outstanding organization, especially in India, where thousands of large-scale hospitals are competing for private sectors. In the present scenario, the hospital is working 24x7 with additional experts and trained staffs to deal with the increasing needs and demands of local people to overcome the corona pandemic crisis.

4.1 Internet of Things (IoT) driven technology focus

In recent years, technological improvements pertaining to measurement and information transmission has led to more comprehensive performance and stable quality of the patient monitoring products. Chronic disease management (CDM) or cardiac-related disease management is essential for the self-management of health, and IoT plays a vital role in this technology. This

technology is an integration of two different features; applications that use network protocols and intelligent services to achieve them. The device dedicated to monitoring heart activity consists of a planar sensor and is connected to a load distribution center (LDC circuit which is an inductive to digital convertor), of a micro-controller that gathers the inductive data and send them by a radio frequency module (RF) to a server. This wireless system could deliver accurate real-time patient data including ECG signal acquisition, heart rate monitoring and respiration rate measurement. This data can be transmitted to more than one monitor at a time with the application of IoT.

This cardiac monitoring is a part of the remote patient monitoring (RPMS) system, which facilitates the tracking and monitoring of patient data admitted mainly in intensive care units (ICU), critical care units (CCU), operation room (OT) and emergency treatment room (ETR). During treatment, it is highly important to continuously monitor and observe the vital parameters associated with cardiac and any fluctuations on it. Therefore, this cardiac monitoring has always been occupying a very important position in the field of medical devices across Hospitals.

This hospital has been using the traditional way of monitoring heart rate (Electrocardiogram, ECG) and artificial support system to ensure continuous breathing of patients until 2016. This became the biggest challenge of their routine operations, which had positioned them behind in technology as large hospitals have been trying to digitalize their products and services to facilitate real-time monitoring of patient data. In the year 2017, the hospital has decided to go with this IoT driven application after a long decision-making process, and it took them almost two years to identify and confirm that these new systems are far better than the previous or traditional systems as more reliable and efficient devices are used with data communication and exchange technologies that have security compatibilities.

As stated by Herzlinger (2006), AlHogail (2018) and Singh & Holmström (2015), innovation and technology adoption in healthcare and hospitals are always complex and complicated process. In the same way, the case hospital has undergone numerous challenges throughout the different stages of the adoption process starting from initiation to implementation phase, to introduce an IoT driven cardiac monitoring system within their hospital. For a hospital which is categorized under small-medium enterprise (SME), adopting such an innovative technology by overcoming all the possible barrier is a dream come true moment in the year 2019. In the last two years, hospital has been using this cardiac monitoring system without any interventions and continuously focusing on research and development activities to bring out the best possible technology and solutions to their consumers.

This inspires us to select the concerned case hospital and specific technology to address the research question and to investigate the underlying barriers that the hospital has faced in IoT adoption strategies and steps they have taken towards mitigating the barriers.

4.2 Summary of Adoption process: Management Perception

Hospital administration and management are aware of the technology called Internet of Things (IoT). The overall healthcare delivery across hospitals is increasingly connected with the applications of IoT. As per the management, IoT growth is global and crosses multiple business sectors, but no sector is being impacted as quickly or pervasively as the healthcare industry. According to the participants, the possibility of IoT would bring about a revolution in healthcare in the future. Hospital would be the most prominent and promising sector to undergo drastic transformation by means of IoT adoption. They know IoT adoption and implementation in hospitals will facilitate improvement in patient safety, patient experience and operational efficiencies. This is one of the reasons hospital have chosen to move forward with a new cardiac monitoring system in hospital. But, management said, for a medium-sized hospital in a developing country, it is a big challenge as the entire process must pass through different phases with limited resources.

In the year 2015, the chairman of the hospital presented their future vision and mission in front of the executive board committee to digitize the service facility within the hospital in support of the initiative taken by the Government of India- 'towards digitalization' in 2015. So, during this pre-adoption phase, the first thing that came to his mind is to introduce an IoT driven cardiac monitor within the hospital. Accordingly, he only took the initiative to present this specific mission and delegate the responsibilities to the respective team to make an action plan during the initial phase itself. During the healthcare and life science professional exhibition in 2016 held in Bangalore, he happened to meet with one of the world's leading healthcare solutions provider. They introduced their latest IoT driven cardiac monitor to the management. They got in-depth information and features of connected devices from them, which they could use potentially to bring out radical changes within their hospital care delivery.

When the hospital decided to adopt this new technology, the main concern for hospital management was that they had experienced some tough moments with their previous supplier who provided remote patient monitor back in 2012. The lack of technology developments and proper service support had led to disaster. Finally, the product itself became obsolete from the market. Since they do not want to have the same scenario with the ongoing changes, consistent discussion and further developments were in process between both parties. In the same way, when the hospital decided to acquire this technology, they assessed the technological capabilities and market opportunities, as well as the capability of the hospital to absorb and make use of this technology in the right way. Since this hospital is not the early adopter in the market, they must make a detailed analysis on the integration of technology with the present system, create an effective organizational structure for successful adoption and implementation and ultimately, customer-focused approach to delivering satisfaction. Initially, they had some internal conflict between different departments, raising objections and different opinions to the management movement. They understand people's

reluctance to accept change is equally relevant. Bring out technological changes in any organization is a challenging task. The organizational characteristics and the way they give attention to the central problem to manage the innovation and adoption journey is made their success.

Hospital management has allocated necessary resources, including a skilled team to learn more about the technology before it gets implemented. Further developments on the implementation stage were not smooth as they started to learn more and more about the technology, infrastructural support, organizational culture and acceptance, environmental limitations, and institutional approvals. Management claims they had to pass through some tough situation, and it was really an ordeal moment for them. In each step, they took the right mechanisms to overcome the barriers and finally, the project was successfully implemented in 2019. For a typical SME categorized hospital with limited resources, it was a tough journey of the technology adoption process, and the overall process has taken around two years.

5. FINDINGS AND ANALYSIS

In this chapter, we present the empirical findings by analyzing the collected data. Since our aim is to answer the research questions -*What are the barriers for IoT adoption in hospitals in developing countries and how do they overcome these barriers?*

We identified that the barriers to technology adoption in healthcare and subsequent mechanism to overcome these barriers could be described over three dimensions; technological, organizational, and environmental. These dimensions are described as overarching dimensions.

5.1 Findings from the interview: Barrier dimension

The relation between overarching dimensions, second-order themes and first-order codes are presented in table 5. In the subsequent subchapter, we described the meaning of each dimension and second-order themes, along with some quotations from interviews to support our empirical findings.

-What are the barriers for IoT adoption in hospitals in developing countries and how do they overcome these barriers?

5.1.1 Technological Dimension

The technology IoT is growing at an incredibly fast pace and have become an integral part of our daily lives through different applications. We found, when it comes to hospitals, the potential is seemingly endless. To explore and exploit the technology for the purpose of operational efficiency and customer satisfaction in hospitals, a lot of factors should take into consideration. Technological dimension refers to technological characteristics and, in our case, it represents limitations and barriers of technology during the pre-adoption, adoption and post-adoption process. This dimension includes the following themes:

Product Complexity

During the pre-adoption phase, when the management is planning to take the initiative towards IoT driven cardiac monitor in the hospital, at least some of the people in each department had a concern about product features and specifications. When introducing a new technology either in products or service, adopters should make sure the product is easy to handle in a way that people can easily adapt to changing technological environment and try to avoid as much complication with new technology.

Overarching Dimension	Second-order themes	First-order codes	Quotations
Technology - related barriers	Product complexity	Complications of new product	'Introducing new product is always creating complications with technology'- R1
		Operational difficulties	'People are worried on how to handle the specific product or applications itself'-R2
	Interoperability concerns	Slow system integration	'Doesn't support and connect efficiently with existing system in the hospital'-R1
		Inaccurate data exchange	'Inefficient connectivity between devices leads to poor data exchange'-R2 -
	Data insecurity	Data mismanagement	'Overall IoT network creates complications in managing huge amount of generated data'-R1
		System vulnerability	'Poor system interface and device connectivity increases the risk of cyber-attacks'-R2
	Financial investment	High acquisition cost	'For a medium sized hospital ,cost of acquiring new technology is always challenging'- R1
		High maintenance cost	'Apart from capital investment, huge amount is required to ensure proper operation and maintenance'- R2
Organizational – related barriers	Lack of skilled people	Unavailability of expert people	**'**We don't have qualified and experienced people to work on this IoT cardiac system'-R1
	Structural and cultural conflicts	Cultural difference leads to communication gap	'Working culture has delayed the initial processes due to lack of communication between the departments'-R1
		Hierarchical structure	'cultural differences in the hierarchical level towards the adoption process' - R3

	Behavioral intentions	Contrasting attitude of employees	'Conflicting interest of attitude within the organization impacts negatively the overall working environment and slows down the implementation process'-R3
	Time constraints	Require more time and effort to familiar with application	'As a user perspective, getting used to the technology require more time and keen of interest from our side. We don't have enough time to interact with this system'- R3
Environmental – related barriers	Unaccountability of service provider	Lack of trust on supplier	'In India, we can find numerous suppliers and manufacturers for this specific cardiac system, but tough to trust on them for reliable and efficient service.' -R1
		Inconsistent support from supplier	'Probability of occurring a pitfall is more when we deal with some suppliers specially for an IoT service purchasing'- R2
	Lack of explicit institutional policies	No strong rules to protect IoT environment	'There is no stringent protocols and support from government to protect IoT system and environment'- R1
		Lack of legitimate standards	'Lack of standardization in IoT will create misconduct'- R2
	Slow pace of infrastructure development	Lack of sufficient IT support	'Existing IT network was not supporting the system'-R1 'Remote devices weren't working effectively with available IT support and internet facility was poor'-R2

Table 5: Representative chart of dimension and order codes on barriers

'Introducing new product is always creating complications with technology'- R1

'People are worried on how to handle the specific product or applications itself'-R2

Some downstream people are concerned with the level of product complexity, especially when the idea towards IoT adoption is proposed in the pre-adoption phase. According to the management, high product complexity will lead to a high cost of acquisition and makes the operation unadaptable. This again creates some complications between the staffs to run the system efficiently. Hospital intended to make paperless workflows in the overall system function and service. They have implemented EMR, which will record patient visits and data management. Even though hospital management and staffs are experienced in technology adoption, introducing something new in IoT is always challenging as the product should be easy to handle without affecting the overall operational efficiency.

Interoperability Concerns

Interoperability is a major concern when it comes to IoT adoption in hospitals. System interoperability refers to the ability of two or more devices and systems to work in conjunction effectively in a network. In the year 2010, the hospital is equipped with a network server to manage the ICU patient remotely. Lack of proper integration between the devices has put the entire system down. They have been trying to resolve the issue closely in connection with the supplier. Unfortunately, the system became obsolete in 2015 from the market due to technical failures and other competitors' entry. Modern IoT systems are often built by composing subsystems. Additionally, these systems may need to interact horizontally with other existing systems in the hospital. As per respondents R1 & R2, this cardiac monitor needs to be connected with existing remote monitors in the same network. So, it is mandatory to make sure the capacity to store a huge amount of data and system integration efficiency. They added, as long as there is no appropriate integration in the connected network, the functionality of the system gets complicated and run out of use.

'Doesn't support and connect efficiently with existing system in the hospital'-R1

'Inefficient connectivity between devices leads to poor data exchange'-R2

The lack of interoperability means the data cannot be exchanged effectively between the overlapping devices and systems. This is one of the severe barriers to IoT adoption. IoT is an evolving field, and it is evident that new type of sensor devices in different forms will be available in the market in the near future, and interoperability between already available systems and new devices is of extreme importance. Organizations may not be able to adopt different IoT

applications and software when they are switching to different service providers as it may entail financial loss and bring about product functionality and stability issues.

Data Insecurity

IoT in hospitals consists of various types of body sensors to measure blood pressure, heart rate, temperature etc. One of the security issues related to IoT adoption in hospital is that manufacturers producing them are often too careless when it comes to proper testing and timely validation of software. This is one of the limitations of IoT adoption in a technological context. According to the participant's statement, in a day-to-day operation within the hospital, it is important to store a huge amount of generated data without any intervention and should be accessible remotely for authorized staffs. The security of data is always the biggest concern. As stated earlier, a hospital has an average of 200 patients per day, hence it is tough to store such a huge amount of data in a safe and secured environment. Ultimately it is important to maintain the relationship with our customers by ensuring they receive ultimate satisfaction from each one of us. So, privacy really matters when it comes to customer satisfaction. Privacy concerns are related to the fear that cybercriminals will have easy access to sensitive data. In a country like India, where cyber-attacks and data mismanagement is quite often, it is the biggest barrier for a hospital to make sure system efficiency. System vulnerability will lead to cyber-attacks and data loss. This is going to be a serious concern during the adoption and post-adoption stages.

'Overall IoT network creates complications in managing huge amount of generated data'-R1

'Poor system interface and device connectivity increases the risk of cyber-attacks'-R2

As stated by hospital management, returning to what happened in 2012, they had a bad experience with the previous supplier in the same IoT adoption of the remote monitoring system. One of the biggest challenges we have faced with our previous supplier is, their products are more vulnerable to data leaks and eventually, the product became obsolete from the market. Since there is a lack of universal IoT standard, manufacturers will continue creating devices with poor security. The primary source of most IoT related security issues generated due to manufactures do not spend enough time and resource on security concerns. Lack of compliance from manufacturers and security problems from device update management leads to a drastic disaster of the specific monitoring system in the hospital. We identified from participants response that hacking and data ownership are possible relative threats due to security breach and vulnerability of devices. This data loss can be misused by hackers, which in turn could lead to potential losses for the organization as well. To exemplify the security and privacy breach scenario, management added that insurance companies are increasingly using patient data to understand a potential insurer's risk and offering a lower premium to the people who are under the potential life threat treatment.

Financial Investment

Resource management is an important criterion in any organization and is refers to the effective and effective development of an organization's resources at times when needed. Such resources may include financial resources, human and inventory resources. When it comes to IoT adoption, overall financial investment such as capital investment, budget planning and maintenance cost is all became a huge barrier. Technology adoption often requires investments over time. We understood from management perception, when it comes to hospitals in developing country like India, it is highly competitive across the country as there are many hospitals within a specific geographical region itself. According to them, in a city like Bangalore, there are many multi-speciality hospitals that are competing in the field. They could get the benefit out of this technology adoption if they are early adopters in the IoT driven cardiac monitor.

'For a medium sized hospital, cost of acquiring new technology is always challenging'- R1

'Apart from capital investment, huge amount is required to ensure proper operation and maintenance'- R2

They added, technology adoption and implementation always require huge investments. Not just the money we invest for the adoption process, but the time and cost they use for running the technology in the most efficient way for our customers. They were early adopters when they adopted IoT enabled remote monitoring system in the year 2010. But the situation became entirely different when they decided to adopt IoT driven cardiac monitor in 2016. The very first point that comes to management when it comes to the adoption of new technology is the financial stability of the hospital and the investment required for the same. For any other industry, management will have a plan to discuss the return on investment (ROI) with all stakeholders in the initial stage. Whereas in the hospital industry, it is a tail end part. They can't predict the potential commercial involvement of the project, but they have to move forward by taking all possible risk.

The initial investment needed to implement an IoT driven cardiac monitoring system in the hospital is one of the biggest challenge slowing the adoption process. Considering the previous experience with remote patient monitor, the hospital has to invest a huge amount for proper maintenance, data backup and recovery in case of system down or data loss. This is all part of running cost to make sure smooth and efficient operational achievement. ROI is always uncertain in the context. Due to ongoing security issues and implementation challenges, large scale deployments and ROI may take longer than expected to materialize.

5.1.2 Organizational Dimension

This section mainly refers to the barriers identified from the organizational point of view. Organizational characteristics play an important role in technology adoption. In our case, we have identified some organizational barriers which prevent the hospitals from adopting IoT driven applications, as presented below.

Lack of Skilled People

When hospital management is going through the pre-adoption phase of IoT driven cardiac monitor, the primary challenge they have faced is the lack of qualified and experienced people within the existing crew. Embracing a new technology like IoT requires a new and quality mindset along with highly skilled people who are proficient enough to handle the product or overall system within the hospital. In a developing country like India, half of the IoT adopters are facing the same problem.

''We don't have qualified and experienced people to work on this IoT cardiac system'-R1

We identified from participant's response that hospital is lacking the right talented and reliable people to efficiently handle the entire adoption process starting from pre-adoption to post-adoption. Human resource department has faced some difficulties with finding out the right talents. Management said, skilled people are always an asset to the organization to achieve organizational goals. IoT is revolving and keep on changing the entire ecosystem in healthcare. One of the negative impacts of not having the right people to handle the technology is that, suppliers and vendors can misuse this opportunity to provide the worst service installations. This can generate financial loss and slowing down the entire adoption process. IoT is a relatively new technology and has tremendous applications within the healthcare sector. When it comes to a medium-sized hospital, it is a kind of different experience as they have limited space within the organization. According to the administration point of view, they have a team of qualified professionals in each department, but still, they lack expert people within IoT application who are familiar with incremental changes in the field.

Structural & Cultural Conflicts

This is an essential part of organizational barriers identified during the pre-adoption stage itself. The decision-making process that an organization needs to go through when deciding whether to adopt or reject new technology can vary depending on the type of organization, management practices, involvement of stakeholders and different actors. We identified that this hospital has different stakeholders, different departments, doctors, administration, nurses, and other frontline staffs. Making the right decision at the right time is critical for organizational achievement. Organizational structure and culture play a vital role in deciding the introduction of new

technology and make explicit action plans to implement the technology as well. Irrespective of the management decision, whoever working in the organization traditionally forced to follow the organizational principles in any industry is very common.

To characterize the adoption mechanism of new technology in a workplace, we emphasize the importance of organizational structure and culture within the hospital. The organizational structure and culture are both closely interlinked in any organization. Lack of inspiration towards a change will directly affect the working culture in the organization. The structure will influence companywide measures and performance, such as profitability and speed of adopting new technology. An organization with a high adoption rate adopt innovations more frequently and more consistently. It reflects the organization's responsibility, working culture to enhance performance and its ability to adopt innovation quickly relative to its competitors within the industry.

'Working culture has delayed the initial processes due to lack of communication between the departments'-R1.

'Cultural differences in the hierarchical level towards the adoption process'- R3

Hospital has a traditional working culture and moral values when it comes to certain changes in their system and services. Working culture has created a wider communication gap between different managers within the different department, doctors and other board members. This has delayed the entire pre-adoption phase to convince and get approval from all concerned people. This working culture has created conflicts between managers and administrative staffs in the organization chart. This had a negative impact on the adoption decision phases in the initial stage.

Behavioral Intentions

Employees naturally behave differently at work than they do in society. It is mainly due to the structured organizational environment and internal politics. In general, a variety of factors influence organizational behavior, including structure, policies and procedures, management effectiveness and interaction between colleagues. In a developing country like India, where there are no clearly defined labor laws and no strict regulations to keep minimum salary ranges for employees, people are sometimes forced to work under management pressure. In fact, India can be listed as the bottom player when it comes to paying for healthcare workers. In such cases, lack of sufficient support and motivation from management will influence the individual behavior in a negative way. As stated by R3, gender, age, and experience really matter when it comes to the performance evaluation of employees. Working in a private hospital without any time limit is creating mental and physical pressure. This can be reflected in certain employee's behavior, and they had the same scenario in the hospital.

''Conflicting interest of attitude within the organization impacts negatively the overall working environment and slows down the implementation process-R3

Everyone has a different perception about this IoT cardiac monitoring system, and certain people do not want to support and or intentionally creates objections in the implementation stage. This conflict of interest in attitude has had some impacts on time management, effective communication, and teamwork skills. This contrasting attitude from employees to employees differed in terms of age, gender, and personal traits in the hospital. It is very tough to change people's attitude with respect to the employer's working environment.

Time Constraints

This is an important barrier identified from the perception of participant 3 (R3). For a medium-sized hospital with a limited number of professional nurses, the first thing that comes to their mind in the pre-adoption phase is the time required to learn and to be familiar with the application or specific product.

'As a user perspective, getting used to the technology require more time and keen of interest from our side. We don't have enough time to interact with this system'- R3

Getting used to new technology or product requires keen interest from bottom people and spend effective time. According to R2, the hospital is treating around 200 patients/day on average. So, it is tough to assign a specific person/ group that continues to work on it. For a hospital with limited resources and where people are always busy treating patients at a different level, dedicating a huge amount of time to learn and familiarize with technology is a challenging concept. The age is directly reflecting here in this context. Some young staffs are taking keen interest to learn quickly whereas others take a longer time. The product complexity theme is directly related to the time constraint's theme in this technological dimension. But in practice, this barrier is identified during the post-adoption stage. As highlighted by the hospital, initially, they had a limited number of experienced and skilled nurses in the front-line of operation.

5.1.3 Environmental Dimension

In this section, we discuss the field or area the hospital dimension operates and determines the market barriers to IoT adoption. This section also speaks of the hospital's ability to different services and legitimates involvement as a barrier during the IoT adoption.

Unaccountability of Service Providers

The exploitation of technology on demand is a problem that India is generally facing due the uncontrolled population growth. As repeatedly mentioned by hospital management, they previously faced a problem with a remote monitoring system which is installed in 2010. The hospital was relying on the supplier for technology upgradation and trustworthy services. But every technology has a limited life span. The system needs further reconsideration in the market when there are many competitors. Unfortunately, their supplier cannot catch up with present market demand and changes. Hence the product became obsolete.

'In India, we can find numerous suppliers and manufacturers for this specific cardiac system, but tough to trust on them for reliable and efficient service-R1

'Probability of occurring a pitfall is more when we deal with some suppliers specially for an IoT service purchasing'- R2

As stated by respondent 1, when choosing a technology and supplier, technology should facilitate connecting and operate the existing remote system efficiently. Supplier-manufacturer relationship and communication play a vital role in this case. If something goes wrong with the system, we must contact the supplier, and they must contact the manufacturer, which is a long process. In some cases, suppliers will not even respond on time. The same thing is applicable for IT service providers, remote monitor providers, system, and software providers as there are numerous suppliers and manufacturers in every corner of India. Finding the most accountable one for a consistent relationship need trust between both parties and this is one of the prominent challenge hospitals has faced.

Lack of Explicit Institutional Policies

The most crucial barriers which really affect IoT adoption and implementation from the external environment is the lack of the right institutional policies. As explained by R1 and R2, IoT is a disruptive innovation, which has the potential to restructure and dictate future processes and market mechanism of entire hospital services. This requires uninterrupted support from local government, well-defined rules and legitimation, and sufficient infrastructure development for internet and electricity from local service providers. Understanding those external factors that drive a company's decision to adopt and implement IoT is an inevitable part of the process, which in turn will decide the overall performance as well.

Respondent 1 added that even though the government of India has taken initiatives to support digitalization in the healthcare industry, IoT is a relatively new concept that needs to be standardized within a set of protocols. Many governments across the world have taken steps towards stimulating the deployment of IPv6 as an enabler for IoT adoption in healthcare. Whereas in India, it is still under process and yet to reach many rural areas.

'There is no stringent protocols and support from government to protect IoT system and environment'- R1.

'If something goes wrong with the system, tough to recover data as we don't have strict rules to eliminate misconduct'- R2.

The overall system is supported by the internet. In a developing country like India, we can't expect to have uninterrupted internet service 24 x 7. The same applies in the case of electricity as well. We have backup plans to support our whole crew and customers but within a limited available resource. In a developing country like India, with an almost 1.35 billion population, sufficient infrastructure development is occurring at a low pace. Internet connectivity and uninterrupted electricity are two major factors required to make sure the smooth and efficient operation of IoT applications. As the size of the IoT market grows exponentially, it is difficult to have sufficient internet bandwidth and continuous power supply from local service providers. The lack of strong IoT regulations and protocols is a big part of why the IoT remains a severe security risk, and the probability of getting a cyber-attack is even worst as more devices are being connected. When medical devices are interconnected to the internet, it is not hard to imagine the scenario of a potential disaster unfolding in the absence of sufficient regulation. The government is taking time in catching up with proper standardization and implementing stringent regulations in the country.

Slow Pace of Infrastructure Development

We identified one of the hidden challenges of IoT adoption in the hospital was the lack of IT infrastructure to support and compatible with IoT application. When they decided to adopt IoT cardiac monitor, their requirement was to connect all remote monitors within the network to keep monitoring remotely. It was not an issue under discussion from the initial stage of the adoption process.

'Existing IT network was not supporting the system'-R1

'Remote devices weren't working effectively with available IT support and internet facility wa poor'-R2

The supplier's communication and recommendation are also not clearly highlighted to modify the existing IT infrastructure. This problem has been faced at the last moment when they tried to test the system. At the very final moment, they realized they do not have the necessary IT back up, and the system needs further developments to support the whole functionality, and it is tough to get 24x7 high-speed internet support as infrastructure development is occurring at a low pace in the country.

5.2 Findings from interview: Mechanisms to overcome barriers.

In the previous section, we discussed the barrier perspective in a different context from the interview data. In the next section, the same thematic analysis has been followed on the mechanism or overcoming activity steps by the hospital. We have gathered this information from the interview data. The mechanism has been described in similar three dimensions as of barriers to make reader feasible with the findings, i.e., Technology dimension, Organizational dimension, and Environmental dimension.

5.2.1 Technology Mechanisms.

In the technology-based mechanism, we find out the internal and external innovation activities that help in IoT adoption. The findings based on our interview tells us that the hospital has constantly been analysing the barriers for providing better efficient services:

Acquisition of Technical Knowledge

We observe from the interview that any new technology is addressed to its broad application and usability in the organization before processing it. In our interview, respondent R2 working in the management department tell us about one of his experience in their study of technical knowledge acquisition helped in the adoption a IoT product. This new IoT based cardio monitoring system that connects over the cloud server recording the patient's data and seamlessly transfer between devices, helped doctors looking at patients remotely. Whereas previously, the frontline staff had to traditionally visit patient to have a check on his/her condition over a regular interval of time.

'We understand the paradigm of the new technology and its characteristics' -R2

In the IoT, adoption of this specific cardio monitoring system was less complex and was easier to adapt as it built on the previous version performing the same task but sharing the information overcloud. Hence, less complexity in device with the right knowledge acquisition makes it easier to adopt in hospital.

Ensuring the privacy of patient's data

In the current decade, most of the things have been digitalised in hospital by erasing the traditional way of paper recording of patient's data, e.g., EMR. The hospital collects patient's data such as name, age, address, and telephone number, it is crucial to keep it confidential. The respondent R1 say that many hospitals follow the unethical way of selling these data to third party companies e.g., insurance companies, fitness gadgets retailers etc., for revenue, so as to target a specific audience.

Overarching Dimension	Second-order themes	First-order codes	Quotations
Technology Mechanisms	Acquisition of Technical Knowledge	Understating the usability	'We understand the paradigm of the new technology and its characteristics' -R2
	Ensuring privacy of patient's data	Ensuring confidentiality of patient's data	'Hospital collects patient's private data such as address, telephone, and from previous history to present health stats that would be kept confidential and not shared with third party services.' -R1
		Restricting the internal access of data	'Data are stored safely with encryption and can only be accessed to authorized personnel in the hospital.' -R2
	Performing Trials	Dependability on the technology	'The main goal of new technology is for providing effective service and is tested vigorously by us' -R1
		Customer's satisfaction	'Any new technology would take time to gain trust over the customer and hence we take feedback to serve better' -R2
Organizational Mechanisms	Efficient Data Management	Stable Connection	'We consider connection between multiple devices are important and have our own local server.' -R2
		Integration of data	'The IoT technology will connect and operate with existing server remotely and update records seamlessly'-R1
		Data storage in cloud servers	'We invest on cloud database, as data keeps increasing and is proportional to patient's inflow to the hospital' -R2
	Rigorous Training	Taking steps to capture the technology	'Technology is changing every day, and it is important to make sure people in the organization is capturing the changes, especially in the hospital sector.' -R2
		Self-effort	'As a practitioner, to explain my patient's about advancing technology drives keen interest to learn about them.' - R3
	Leadership quality	Initiative as behavioral intension	'We look at the purpose of a technology from upcoming medical equipment exhibitions that can facilitate solving any problem from the hospital to be more efficiently' -R2

		Visionary	‘We collect the data from relevant department and pass proposal to top management for approval’ -R2
	Proper Resources Allocation	Investment requirement	‘Financial stability is analyzed based on the revenue generated and new technology cost is analyzed based on ROI’ -R1
		Marketing strategy	‘We publicize our new technology through social media and advertisement to gain our customers’ -R2
		Technicians Group	‘We keep a minimum of 8 technicians within the hospital to address any bugs or issue of the technology immediately’ -R2
Environmental Mechanisms	Collaboration management	Consistent relationship with supplier	‘We maintain good relationship with the supplier to help gain trust and readiness with new technological solutions’ -R2
		Keeping interest of service providers	‘In case of any breach, the service provider as a backup data and helps in fixing the bugs related issues’-R1
	IoT ecosystem protection	Government initiative for data protection	‘Personal data protection act (DPB) controls the data collection, processing, and protection of the clients that is vital for development managers’ -R2
	Persistent monitoring	Standardization policies amendment	‘Governmental is working continuously to support and standardize the IoT environment in healthcare’ -R1
	Geographical influence on adoption	Region of the hospital	‘The geographic location plays a vital role in providing efficient hospital services’ -R3

Table 6: Dimension and order codes for solution

In our case, the hospital does not share the data with any other companies to ensure patient's privacy and trust over the hospital.

'Hospital collects patient's private data from previous history to present health stats that would be kept confidential and not shared with third party services.' -R1

'Data are stored safely with encryption and can only be accessed to authorized personnel in the hospital.' -R2

The data collected in the hospital (EMR) are encrypted to avoid any security breach from external factors and can be accessed only by the authorized personnel, says respondent R2. Authorized personnel consist mainly of frontline worker, as this IoT technology is to make things easier for frontline staff and patients. This approach has made to gain trust from the patient over the hospital reputation, which is crucial for their ethics.

Performing Trials

The fact of having a new technology, which is easier to operate, is not just enough. The new IoT device, in our case study, the cardio monitoring system, is ready to adopt the system as it's the same as the previous non-IoT models. Even in this case, there pose a threat to new bugs in the functionality and hence is recommended to perform n number of trails before offering it to the public.

'The main goal of new technology is for providing effective service and is tested vigorously by us' -R1

'Any new technology would take time to gain trust over the customer and hence we take feedback to serve better' -R2

The IoT device does make it simpler and efficient in operation but would be tested vigorously to verify the accuracy, and efficient lossless data, says responded R1. As per respondent R2, they take feedback from the customer experience to know their perspective and improve further upon their efficient service.

5.2.2 Organizational Mechanisms

In the organizational-based mechanism, we assess the scope, scale and managerial activities that help in IoT adoption. Based on our interview findings, we can conclude that the hospital has been continually analysing the impediments to offering more efficient services:

Rigorous Training

The whole point of the adoption of new IoT based technology is to keep updated with better and efficient services. The management must take measures in capturing this technology to the frontline staffs. Since, most of the frontline come from the medical background and have less technical skills over an IoT device. The respondent R2 working in the management department, tell us that they organise rigorous training to the frontline with minimum hours of training before using the device on the patients, and sometimes, they have been offered incentives for their effort in understanding the technology.

'Technology is changing every day, and it is important to make sure people in the organization is capturing the changes, especially in the hospital sector.' -R2

'As a practitioner, to explain my patient's about advancing technology drives keen interest to learn about them.' - R3

The frontline staff, respondent R3 tells us that the advancing new IoT technology has made medical monitoring easier and to share knowledge on how things work to their patients, they develop an interest in understanding the new technology.

Efficient Data Management

In the hospital sector, when it comes to IoT, all the system are connected over the internet that is basically a connection over servers. The hospital should have a stable connection between the multiple devices and make sure to have remote control over them.

'The IoT technology will connect and operate with existing server remotely and update records seamlessly' -R1

'We invest on cloud database, as data keeps increasing and is proportional to patient's inflow to the hospital' -R2

As per respondent R2, they invest in cloud servers to have a backup in case of system failure can lead to disaster in patient's data. Hence, it is backed up on the cloud to avoid any loss in the hospital. Increasing patient data has made them invest more in data management services. This has made both the patients and the hospital safe from data loss in this digital era.

Leadership

The innovation is driven by behavioural intentions of the working professionals or the management that recognise the need or solve a problem for the upcoming technologies from different healthcare exhibitions and takes the initiative to use the application for the organization. The management is responsible for collecting the required data and formulating a proposal to top management. Based on this report, the top management would take a decision on the approval for the IoT technology adoption.

'We look at the purpose of a technology from upcoming medical equipment exhibitions that can facilitate solving any problem from the hospital to be more efficiently' -R2

'We collect the data from relevant department and pass proposal to top management for approval' -R2

According to R2, the data. The management must think strategically of implementing the technology practically. The visionary of management is important on this aspect to complete the initiated task, whether it's a risky or successful play on their motivation to adopt the technology.

Resource Allocation

Any technology that comes into the market would be costlier, and the investment is based on the hospital revenue generated. The ROI is always analysed before pooling the funds into the technology. Financial stability would be analysed before making any huge investment in the technology.

'We publicize our new technology through social media and advertisement to gain our customers' -R2

'We keep a minimum of 8 technicians within the hospital to address any bugs or issue of the technology immediately' -R2

According to R2, after adopting the technology, it is the management responsibility to promote the technology on the various platform via advertisements that help to attract patients' preferences in hospitals. The management also poses a minimum set of technicians to help the practitioners or various department operators to handle bug or glitch in IoT services. The hospital is made sure to run smoothly to earn a good reputation which in turn helps in revenue generation.

5.2.3 Environmental Mechanisms

In the environmental-based mechanism, we analyse the market, rival and firm's ability activities that help in IoT adoption. According to the conclusions of our interview, the hospital has been continually analysing the impediments to offering more efficient services:

Collaboration management

Many hospitals buy technology from different medical device manufacturers based on their specific usage e.g., Siemens, GE. So, the hospitals maintain a good relationship with their usual supplier for the devices, which helps in gaining trust. The supplier would help them with providing readily available technology when something new is introduced into the market. The supplier relationship also helps in maintaining a good supply chain and learning methods for competitive advantage.

'We maintain good relationship with the supplier to help gain trust and readiness with new technological solutions' -R2

'In case of any breach, the service provider as a backup data and helps in fixing the bugs related issues'-R1

Respondent R1 share us their interest with the service provider has made them provide a smooth backup with technical support in case of higher technical support that cannot be fixed by the hospital technicians team. As many IoT devices involve a lot of sensor and are of a high valued processing system, some issues are to be attended to only by the service technicians.

IoT Ecosystem

The Indian government has a legislate known as personal data protection (DPB) that controls the data collection, processing, and protection of the clients. The true ecosystem is with protecting the information values and creating a knowledge network with relevant data to benefit each other.

Personal data protection act (DPB) controls the data collection, processing, and protection of the clients that is vital for development managers' -R2

The general data of certain category such as number of patients visits, number of patients regarding different health issues are analysed by developing manager to find the necessity IoT devices for the hospital. The ecosystem shares the values of using the information in building a sustainable society.

Persistent Monitoring

Constant monitoring of the government policy to improvise and build together on IoT adoption is important. The government is trying to facilitate with standardisation to run an IoT environment with benefits in a subsidiary of medical equipment taxes. Things keep changing over time, and it is required for constant monitoring of the policies to play within the institution's law.

'Governmental is working continuously to support and standardize the IoT environment in healthcare' -R1

The government have come up with programs to drive patients towards hospital such as, e.g., vaccination drives, blood donation etc. The hospital encourages patients in driving trust towards their method of treatment and technology used during medication.

Geographical influence on adoption

The location of the hospital is in a metropolitan city, i.e., Bangalore has an electricity to internet connection 24*7 despite any interference, there is a backup with generators and local servers to support smooth running. The geographic influence drives the hospital's patient flow, competitiveness, and value creation to the IoT adopted devices.

'The geographic location plays a vital role in providing efficient hospital services' -R3

The respondent R3 says that if the hospital was situated in the rural, adoption of IoT devices was irrelevant with not much patient flow to manage. Even if the technology has readiness potential in a hospital situated in a rural region, patient's will not travel from urban city to rural for an emergency application and it's not feasible or create value from the environmental perspective.

6. DISCUSSION & CONCLUSION

This chapter discusses and presents the overall findings from different dimensions in an analytical framework. Firstly, a tentative theoretical framework was built upon the literature study for the interview. Secondly, we used the data collected from the interview by conducting a thematic analysis that explained into dimensions and themes. We used the overall dimension and second-order codes to make our final framework to explain and answer our research question.

6.1 Analytical Framework

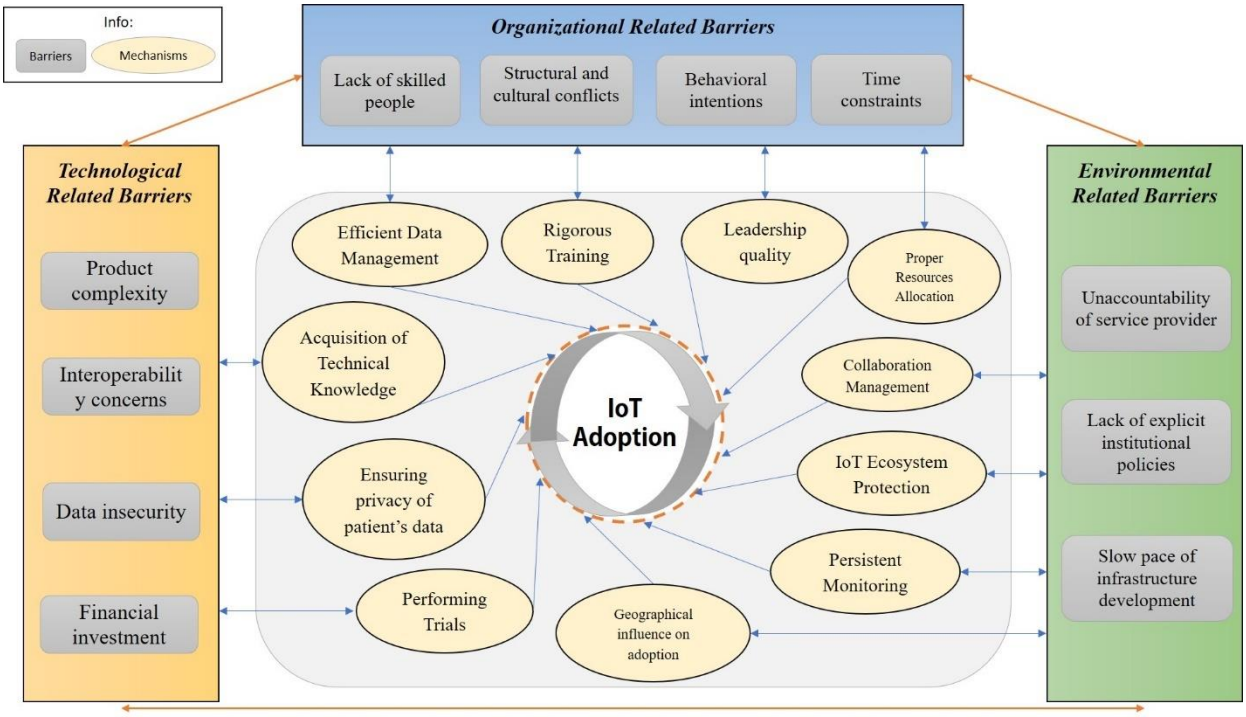

Figure 7: Analytical framework

The above *figure 7* represents the final framework to the barrier listed from the respondent's information and brief mechanisms developed by the hospital in overcoming the challenges.

6.2 Discussion of research question:

In this sub-chapter, we are discussing our findings in relation to the research questions and connecting with a literature review to bring the answers in the right direction.

RQ. What are the barriers for IoT adoption in hospitals in developing countries and how do they overcome these barriers?

The identified barriers are listed into three different dimensions as per the tentative theoretical framework we developed for the study and information we received from the specific case hospital participants, which implies to most cases in developing countries. Our findings are in alignment with the tentative theoretical framework we developed based on previous literatures in the same field. Integration of IoT in hospitals in developing countries is a complicated process as it the overall process has to pass through different stages and required external support as well. According to the participants, the perception towards the IoT adoption process is an important aspect. People will have different perception towards a single phenomenon, and so they can point out different problems during each phase of the adoption process, certainly going through their involvement.

Barriers and mechanisms to overcome these barriers are categorized into Technological, Organizational and Environmental dimensions in our study:

Some of the technological barriers that we identified from our study are product complexity, interoperability concerns, Data insecurity and financial investment required for technology acquisition. IoT is not a one-size fit for all kind of solutions in the hospital. The complexity of the product is a major concern in IoT applications which is putting some hindrances to the hospitals to go for technology adoption. The state of being not easy to handle the product lead the entire organization to withdraw from technology adoption(Pappas et al., 2021). In the same way, interoperability concerns and data insecurity are other important barriers to IoT adoption that most developing countries will have to face. In an IoT network, the performance of the network is measured by system integration efficiency, capacity to store and exchange a huge amount of data, real-time monitoring and system resilience power (Elkhodr et al., 2016; Inieke, 2020). Products manufactured by various companies do not necessarily comply with certain standards and regulations, which make the overall system vulnerable to cyber-attacks. Ultimately, this will end up with potential financial losses and creates chaos in society by misusing patient data. The cost of acquisition, maintenance and financial sustainability are the main financial barriers of the technological dimension which pull back the developing countries to adopt the technology. Addressing these potential financial barriers is an essential criterion for developing countries in order for them to embark this technology adoption pace same as developed countries (Alazie Dagnaw & Ebabye Tsige, 2019; Langley et al., 2021)

In the technology mechanism part, we have identified that acquisition of technical knowledge, ensuring the privacy of patient's data, and performing trials are the key mechanisms from our analysis. These mechanisms are the possible solution to technology-related barriers in IoT adoption. Acquiring technical knowledge is required to obtain a full understanding of the emerging technological paradigm to comprehend its utilization and characteristics (Liu et al., 2017). Performing Trail is completed before they are made available to the public to ensure their operation and error-free capture of data as part of their dependability (Polhemus et al., 2019). Another key consideration for any technology adoption is the privacy of patient's data, as patient personal information may contain sensitive information. Personal data processing, such as health condition and history, as well as access to this information Because the data will be available in the database, access should be restricted and proper authentication provided (Sulaiman & Magaireah, 2014).

As mentioned in the literature review and interview from different respondents of the case hospital, organizational characteristics such as organizational structure, culture and behavior are the mother for leading towards technological changes (Gallivan, 2001; Kimberly & Evanisko, 1981). These are the potential barriers identified originating from the organizational dimension in the Indian context. Culture and structure are recognized as the most important variables influencing the organizational decision-making environment (Kuziemsky, 2016). These are the main distinguishing factors between developing countries and developed countries deciding the pace of innovation adoption. Organizational culture is strongly influenced by the surrounding societal or national culture, and that it is, therefore, possible to identify the difference in organizational behavior among developing countries (Cimperman et al., 2016; Janicijevic, 2013). This is identified as a major barrier in the technology adoption process as different hierarchical managers and employees will have slightly different approach towards the changes in an organization (Ajzen & Fishbein, 1977; Cicibas & Yildirim, 2018; Melitski et al., 2010). Similarly, lack of skilled people to handle the overall technology adoption process and time constraints of employees within the organization are also identified from the same dimension.

In the organizational mechanism part, we have identified that leadership quality, efficient data management, rigorous training, and proper resources allocations play a role in making IoT adoption smoother in the hospital. Leadership is defined by the ability to evaluate an issue and come up with an intellectual solution to stimulate one's way of thinking. Leadership entails enthusiastically embracing and pursuing it in exchange for a dependent benefit (Schepers et al., 2005). Data management of integrating technology into the current structure gives flexibility and agility within the workforce, and this is administered by several levels of permissions prior to deployment (Chelmis & Prasanna, 2013). When a new technology is introduced into the hospital, rigorous training must be offered to make the user completely aware of the device/service and capable of managing things (Zakaria et al., 2010).

The most common challenges of IoT adoption that hospitals in developing countries may face is something out of their control. This can be related to environmental-related barriers. The unaccountability of service providers, lack of institutional policies, and slow pace of infrastructure development to support the IoT are the main barriers we identified in our study. Infrastructure development and institutional policies are the crucial drivers of innovation adoption for any organization. Lack of sufficient infrastructure will enhance the impact of interventions in technology adoption and implementation (Bergoeing et al., 2015; Luthra et al., 2018). Governmental authorities and other local institutions in developing countries should define strict policies and regulations to standardize the IoT and to provide explicit guidelines for its implementation (Laurell, 2018). Organizations lack information about the existence and quality of service providers in new technology in developing countries, as building up trust between both parties is a vital element for the successful adoption and implementation of technology (AlHogail & AlShahrani, 2019; Arfi et al., 2021). Even though, these are the potential environmental barriers we identified in our study, they may have slight deviations in each country as infrastructure development, and governmental policies are not moving in the same direction across developing countries.

In the environmental mechanism part, we have identified that collaboration management, IoT ecosystem protection, persistent monitoring, and geographical influence the IoT adoption in hospital. Collaboration management of the technologies purchased from various suppliers to the hospital are well connected between the two to have an effective supply chain and improved learning (Nyame-Asiamah, 2020). The healthcare ecosystem is a legitimate ecosystem with protected information-sharing values that demand stakeholders to establish a knowledge network in which all actors in the healthcare process, including patients, benefit from each other's perspectives(Choukou, 2021). Monitoring refers to examining the technological offerings to better comprehend the life cycle and its operations (Bryan et al., 2014). Geographic influence of technology depending on organization location, i.e., characterized by population, competitiveness, and services in the region, is important. In a city, it is more important than in a rural region (Cicibas & Yildirim, 2018).

6.3 Conclusion:

This sub-chapter gives an overview of our study in terms of introduction, framework development, method choices and a brief of findings and analysis part. Furthermore, implications, limitation of the study and suggestion for future research are also stated.

In the hospital sector, technology adoption will ensure an increase in performance, productivity, and competency. The concept of IoT adoption has received great attention from academics and medical scientists because of its potential in diverse fields of use in healthcare. The introduction of IoT in hospitals can bring various benefits to healthcare delivery, but technological innovation and adoption is a complicated process when it comes to hospitals (Glover et al., 2020; Herzlinger, 2006). In this study, we have conducted a study on IoT adoption in a specific Indian hospital to investigate and identify the barriers which either prevent hospitals from adopting IoT technology or slowing down the adoption process and to identify the steps they take to overcome those barriers. The study tries to explore the barriers and overcoming solutions for IoT adoption in developing country's hospitals which is explicitly unexplored by previous researchers.

Firstly, a study on existing literature on technology adoption with respect to healthcare has been reviewed carefully. We identified some of the recognized barrier and mechanisms for technology adoption in the literature review. We understood the user acceptance model, UTAUT, and TOE framework from the previous theories with respect to technology adoption. Followed by an explanation with respect to IoT behavior in a general organizational context.

Secondly, we built a tentative analytical framework by modifying the TOE framework based on a literature study recognizing the barrier and mechanism with respect to technology adoption. We used this as a base in understanding each term and its context with respect to adoption. We use this as a reference in building our questionnaire prototype that has been used for our case study. We have attached all the questionnaires below in the appendix.

Then, we deployed qualitative research in our study. By choosing an abductive approach and thematic analysis, we argue that researchers can deliver the right output with an in-depth understanding of the phenomena.

In the final part, we identified the main findings, analyzed the findings by thematic analysis, developed themes that are linked to our research questions and made an analytical framework on barriers for IoT adoption and mechanisms they developed to overcome these barriers in the hospital. This research has a unique contribution for researchers and hospital decision-makers in developing countries to understand the common barriers behind the IoT adoption process and to understand the steps to be taken forward to overcome those barriers.

6.4 Implications

Numerous literatures in our review explain the theories and barrier to the adoption from different researchers' perspective. However, in our study, we have analyzed the management and practitioner's perspective to identify the barrier and solution adopted by the hospital. The resulting framework from this thesis contributes to the existing literatures concepts. The framework shows theoretical implication between the previous diverse approach in technology adoption and our specific view, with respect to developing country keeping Indian context.

In this thesis, we have an applicable conclusion, as our analysis is based on the primary data collected from the real case scenario. The mechanisms to overcome the barriers have already been adopted and stands valid for practical implication. This study can guide management with behavioral intensions to technological adoption as the potential barrier has been explained with a resolution, making a smoother process for their decision.

6.5 Limitations of this study

Our study has focused the insight of the barriers and mechanisms to overcome the barriers of IoT adoption in healthcare with a hospital case study from India. Even though we have justified in the problem identification that India would be the right choice to represent developing countries context, the situation might be different across each country. Our study is specifically based on a particular IoT application that a medium-sized hospital has adopted. IoT is a broad concept and has unlimited opportunities within healthcare. We didn't focus on typical healthcare organizations in our study. Despite the fact that we believe the solution in our finding is valid in the conducted developing country, it may not be completely effective as generalized to all healthcare. Healthcare can account for additional barriers that may pose a challenge in other developing countries because of their difference in work culture, climate, and government policies which may or may not come under the same dimensions.

6.6 Future research

In the above section, we have highlighted that the study has gathered information and formulated the finding that has come to the notice of our research which was focused on a specific IoT driven application adopted by a medium-sized hospital in India. The findings may not explore all the barriers in the technology adoption of healthcare in the developing country due to the time constraints of our study and as the domain is massive. However, there is still additional research that can be conducted on technology adoption in healthcare in the developing country context.

Future research may focus on:

- To study the barriers on different IoT devices and services in specific, that may unveil different challenges.
- To articulate similar research on various geographical region or developing country and developing a framework that benefits other researchers and knowledge awareness to another adopter in the healthcare sector.
- To analyze data from end-user perspective, this method has been often ignored or neglected in user acceptance of technology adoption.
- To investigate the same phenomena in large hospitals across developing countries as it may have some different experiences and perceptions towards technology adoption.

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8. APPENDIX

Interview Protocol:

Background questions:

1. What is your formal position and current duties?
2. What is your education and professional experience?
3. How long have you been working for the current organization?
4. How familiar are you with the concept of IoT?
5. Can you describe a process of IoT adoption in the hospital?
6. Can you specify the overall process in relation to the cardiac monitor that the hospital has adopted?

Technological context:

1. How do you recognize the need for this specific technology?
2. Can you describe the technological challenges that management has gone through? Did knowledge bring in to the organizational level?
3. How do you define the fund structure and financial investment required for successful adoption and implementation?
4. What was your contribution to overcoming the technological problems?
5. How effectively you managed the overall barriers until the implementation?

Organizational context:

1. How was the organizational behavior toward the IoT adoption?
2. How effectively have organizational characteristics influenced on technology adoption?
3. What are the common internal organizational problems when you decided to adopt this cardiac monitor?

4. Compared
5. to technological context, how effectively you managed to overcome organizational barriers?
6. Can you describe each stage of problem identification and experience of developing mechanisms?

Environmental context:

1. How did you measure the external barriers to the IoT adoption process?
2. Can you explain the governmental and political concerns or interventions?
3. How do you describe the external development factors that affected the IoT adoption and implementation?
4. How did you manage the overall process with the present institutional and infrastructure conditions?
5. What are the most challenging steps when it comes to IoT service suppliers?

Arjun Thyagaraj:
The author of this thesis is pursuing his Master's degree in Industrial Management and Innovation, at Halmstad University since 2019. He has completed his bachelor's degree in mechanical engineering.

Krishnakumar Narayanan:
The author of this thesis is pursuing his Master's degree in Industrial Management and Innovation, at Halmstad University since 2019. He has completed his bachelor's degree in mechanical engineering.

HALMSTAD UNIVERSITY

PO Box 823, SE-301 18 Halmstad
Phone: +35 46 16 71 00
E-mail: registrator@hh.se
www.hh.se