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Understanding the Internet of Things Adoption Barriers in the Healthcare Sector: Evidence from Emerging Countries

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Abstract

Background: The purpose of this paper is to explore on the main barriers related to the Internet of Things devices adoption in healthcare, with specific concern to developing countries.

Methods: A qualitative research approach with the systematic combination method has been adopted considering an Indian hospital as a research setting. Semi-structured interviews were carried out as part of the data collection process

Results: The study helped us identify some of the main factors affecting IoT adoption in the hospital, categorized under three different sections: 1) technological barriers, 2) organisational barriers, and 3) environmental barriers. Findings suggest that IoT adoption barriers in hospitals are related to adoption challenges mainly focused on technological acceptance, complexity, organisational behaviour, lack of expertise and infrastructure, lack of stringent regulations and standards and finally, the security and privacy concerns.

Conclusion: Thus, this research makes a unique contribution for researchers and hospital managers in developing countries, to understand the common barriers behind the IoT adoption process and to understand the steps to be taken to overcome these barriers.

Keywords: Internet of things, Technology adoption, Healthcare providers, Innovation, technological barriers, IoT.

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1. Introduction

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 Internet of Things (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) [1–3]. Among new technologies, the Internet of Things enable unforeseen opportunities for business applications, such as in the healthcare sector (see Kulkarni & Sathe, 2012 for a review). Specifically, the Internet of Things (hereafter, IoT) mainly refer to the world of smart object able both to be connected among them though the Internet, integrable in services delivering processes or industrial applications, and to interact with final consumers (such as smartphones, home automation, and so on [4].

Considering the opportunities enabled by IoT technologies to transform the healthcare industry by the near future, India will be one of the huge result-oriented fastest growing market globally [5]. Indeed, among the emerging countries, India is a 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. 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 labour regulations, political influence, poorly defined bankruptcy policies and social inequalities [6,7].

Overall, India may be characterized as an extreme context [8,9], 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 [10,11]. Is important to pinpoint the mechanisms that healthcare organisations are 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 [12].

By focusing on hospitals, as the primary providers of healthcare services, 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 [13]. Previous studies lack empirical evidence on barriers of IoT adoption in hospitals [14,15].

Although some of the previous studies provided relevant insights into technology adoption in healthcare [16,17], they did not address the barriers to technology adoption in hospitals from an organisational perspective. Additionally, although some studies provided valuable insights on the barriers to technology adoption in healthcare organisations [17,18] most of the studies did not explain the mechanisms to overcome the barriers.

Some hospitals are developing some mechanisms to overcome 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. Thus, this study aims to explore the barriers for IoT adoption in hospitals in developing countries and how do they overcome these barriers.

Our study on IoT adoption in hospitals could be beneficial for researchers and practitioners to understand and compare sub-sequential transformation of the healthcare industry embedded in an IoT infrastructure. Moreover, 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.

2. Theoretical Background

2.1 Technology adoption in the healthcare sector: An overview

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 and technical staff decision making in both the internal and external environment of an organisation [19–21]. According to Hameed et al (2012), actual technology and innovation adoption in an organisation 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 organisational routine.

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 [23]: 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 hospitals, systems should provide accurate, complete, and timely information to be effective in medical decision making. 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 [24]. When it comes to the adoption of new technologies in hospitals, the following section deals with the Structure of a Technological Organisation Environment (TOE) in healthcare.

2.2 Technology Organisation Environment (TOE) Framework in Healthcare

The Technology Organisation Environment (TOE) framework has been adapted for information technology (IT) adoption studies, providing a useful analytical framework useful to analysed integration of an IT innovation among specific research settings [25]. The TOE framework proposed by Tornatzky et al. (1990), examine the context of a physical decision involving an organisational level theory that explains the influence of firms process in three contexts: the organisational context, the technological context, and the environmental context (see Figure 1).

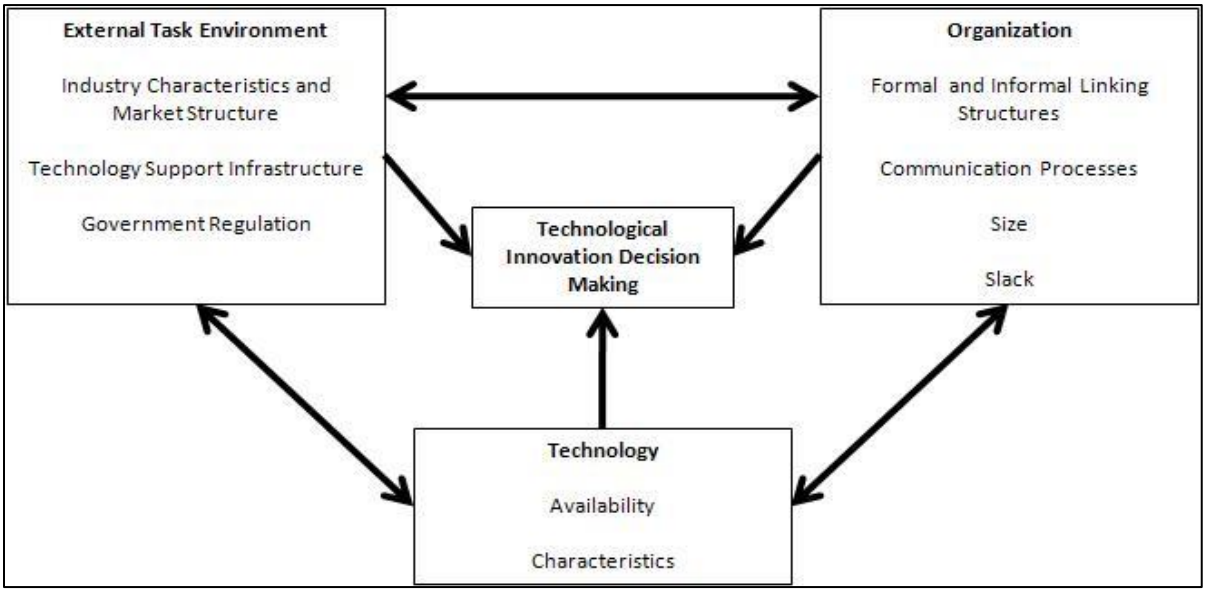

Figure (1) The TOE Framework. Extracted from [26](Tornatzky et al., 1990).

By analysing the TOE framework, the Technological context refers to both internal and external innovations that are important to the firm. Internal technologies are those that are currently in use by the organisation. External technologies are those that are available on the market but are not being used by the

organisation. According to the innovation concept [21], an individual develops an attitude toward the invention, which leads to a decision on whether to embrace or reject it [26]. 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 [27].

The environmental context is the area in which the organisation operates, 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 [26]. The environmental context includes corporate competitiveness, vendor support, and government legislation. 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 [28]. Thus, by considering the organisational, technological and environmental context on which such framework is built, the following section is dedicated to addressing the Internet of Things in the field of healthcare.

2.3 Internet of Things technologies in the healthcare sector

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. 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.

Previous studies, 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 [30]. This requires intensive use of Information Technology (IT) to gain a competitive advantage in the market, which leads to a vital source of innovation. IoT has been widely used in the healthcare industry for patient monitoring and providing better healthcare services. The last section of the literature review deals with a tentative theoretical framework for technology adoption.

2.4 Theoretical Framework

The literature 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 the Diffusion of Innovation model (hereafter, DOI) reflects only the individual behaviour in pre-adoption. 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 depicts the various barriers and mechanisms with respect to healthcare based on findings of previous studies. Figure 2 has been formulated to showcase 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 framework.

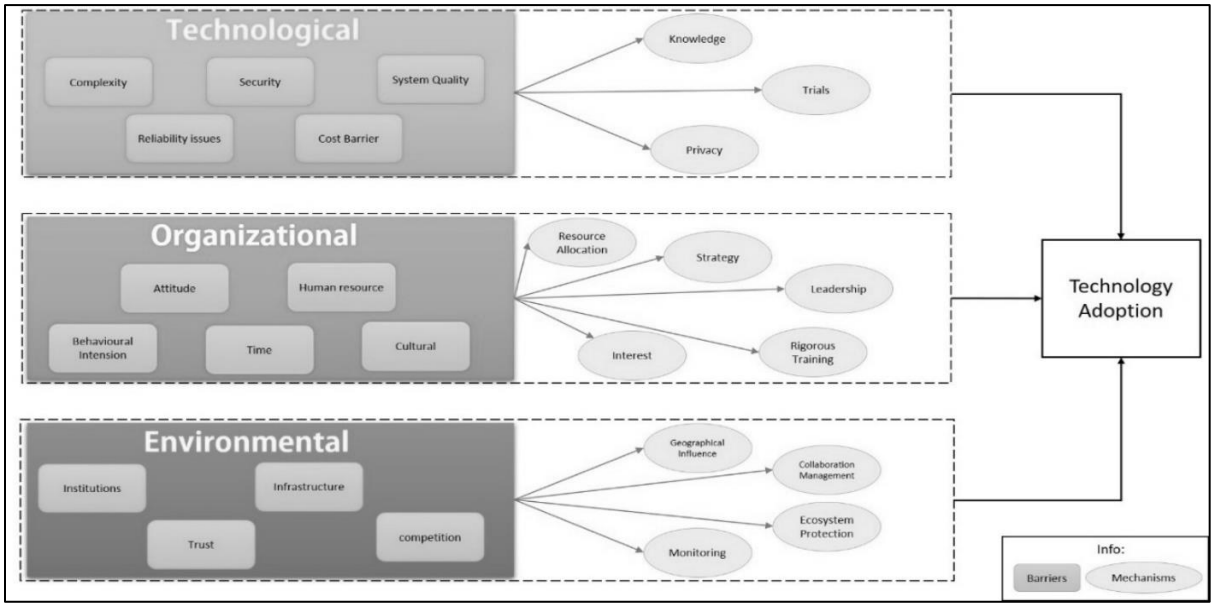

Figure (2) Technology Adoption Framework.

In Figure 2, the 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.

2.4.1 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 organisation [31]. 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. 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 [32]. Data security is a significant challenge that includes privacy, trust, and legal issues that must be taken care of during the adoption decision phase [33]. The cost of new technologies is much higher initially when made available in the market, making the adoption decision a crucial investment [34].

Knowledge acquisition is essential to get a comprehensive definition of the advancing technology

paradigm to understand its usage and characteristics [35]. 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 [36]. Privacy is another essential factor for any technology adoption, i.e., a patient's personal information may contain sensitive matter [37].

2.4.2 Organisational Context

Attitude is an individual user perspective towards the technology, depends on his/her decision to adopt the available technology [38], here the individual user of organisation context are the decision-makers. The perceived utility of the technology influences behavioural intention to adopt a new technology into their work structure [39]. 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 [33]. At an organisational level, the culture shapes the way or path to choose technology [40].

Leadership is characterized by the personal attribute to analyse 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 [41]. 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 [42].

The organisation level is responsible for analysing the existing firm capability and Allocating resources according to provide a smoother adoption process [43]. 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 [44]. In case of any new technology introduced into the organisation, 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 [45].

2.4.3 Environmental Context

The goal of policymakers to guide innovation is hampered by the availability of numerous decision-making systems with varying perspectives on adoption choices [46]. 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 [47].

Competition of better facility in similar sector poses a threat to revenue generation. Therefore,

organisations seek to have the latest helpful technology from the market before the competitors to create a competitive advantage. Trust in technology is an individual perspective over the adoption process for initial offering and the firm ability to access impact on the environment [48]. Geographic influence of the technology is based on the location of organisation i.e., defined by the population, competitiveness, and services in the region matters. Collaboration management of the technologies bought from the different supplier to the organisation and a good relationship must be maintained between the two for effective supply chain and better learning [49].

Healthcare ecosystem is characterised by 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 [50]. Monitoring refers to observing the offerings of the technology to understand the life cycle and its activities to the better extinct [51]. Based on above, we outline the following research question to be investigated: “What are the barriers for IoT adoption in hospitals in developing countries, and how do they overcome these barriers?”.

3. Methods

In order to ensure methodological fit and considering the nature of research question, an explorative research design based on qualitative approach has been chosen to deep analyse the phenomenon under investigation [52]. We found that qualitative is the appropriate choice to facilitate exploration of the phenomenon [53–55]. Moreover, we argue that qualitative methods such as interviews can provide a deeper understanding of social phenomena. Furthermore, 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 [56,57]. Thus, in this paper semi-structured interviews with professionals involved directly and indirectly in the decision-making process of technology adoption, have been performed.

According to Saunders et al. (2009), there are two types of approaches that can be used in a qualitative research method, Inductive and deductive [53,58]. It has been argued that the qualitative researcher can adopt both inductive and deductive processes [54,59]. 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 [60]. 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 [58,61]. In contrast, inductive reasoning makes broad generalization from specific observation and is allowing to draw a theory conclusion from existing data [53,60].

We argue that an integrated approach is the 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 [62]. 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 [63]. This inspires us to choose a systematic combining approach to investigate the barriers to IoT adoption, which will help to interpret the raw data and will improve our understanding of theoretical and empirical aspects.

As our aim is to explore the barriers for IoT adoption in hospitals in developing countries and how they overcome these barriers, we adopted a case study approach. To understand and examine the process of technology adoption in the Indian healthcare industry, a hospital was selected, and data were collected through semi-structured interviews. An Indian hospital has been chosen as a research setting: We have selected the case hospital under purposive sampling, based on the criterion strategy [9,64,65]. 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, the considered hospital may represent a fruitful research setting and peek the most relevant insights to capture the phenomenon under investigation. We have chosen a medium-sized hospital in our interpretive case study research as there are numerous hospitals across the country. 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 [66].

3.1 Data and in-depth interviews

By following the proposed research method, our 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. 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 [2]. 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 [67]. This has led us to select respondents from a different hierarchical level within the hospital. We identified and selected individuals that are especially knowledgeable about or experienced with phenomena [65]. 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 organisation could help us to generate a clear picture of the process. Thematic analysis should be seen as a foundational method in qualitative research since qualitative approaches are incredibly diverse, complex and nuanced [68]. Thematic analysis is a method for identifying, analysing, organising, describing and reporting themes found within a data set [68,69].

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 [70]. 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. It is also a useful method to bring out different perceptions of different research participants, highlighting similarities and differences and developing unanticipated insights [68,69]. In general, the thematic analysis usually began with the researcher 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.

4. Findings

Findings suggests that three fundamental barriers influence IoT adoption in hospital, and specifically related to 1) Technological barriers (in terms of product complexity, interoperability concern, data insecurity, financial investments), 2) Organisational barriers (in terms of lack of skilled people, structural and cultural conflicts, behavioural intentions, time constraints), and 3) Environmental barriers (in terms of unaccountability of service provider, lack of explicit institutional policies, and slow pace of infrastructure development) (see Figure 3).

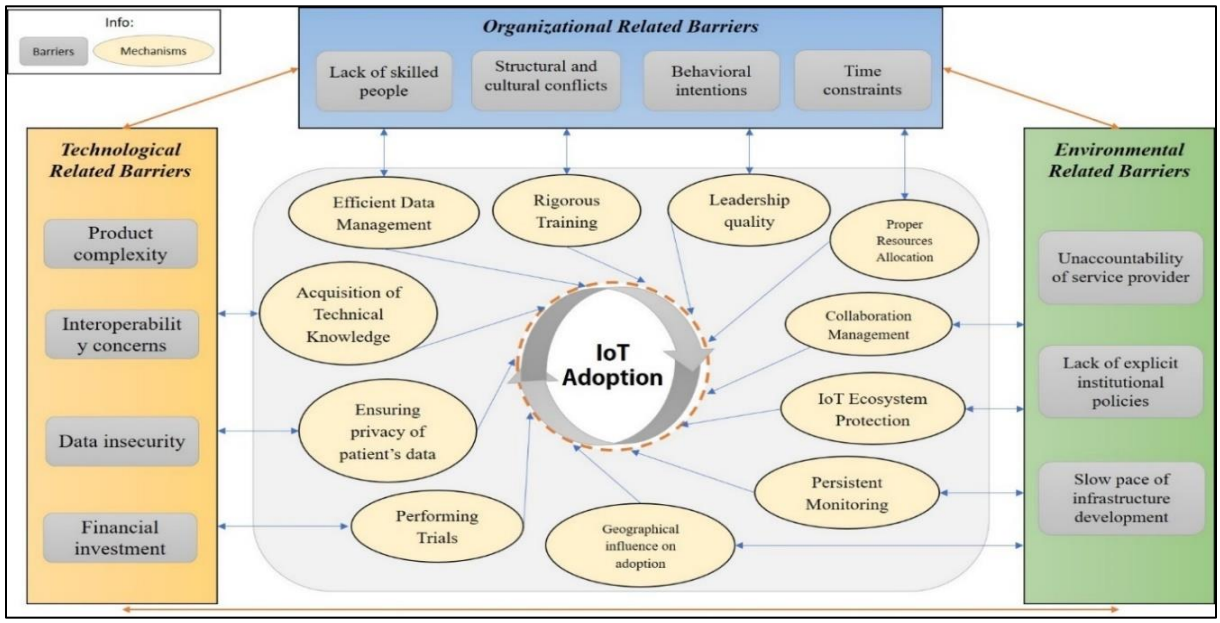

Figure (3) Analytical Framework.

The technological barriers we identified are related to product complexity, interoperability concerns, data insecurity, and financial investment required for technology acquisition. The product complexity 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 organisation to withdraw from technology adoption[71]. 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 [72,73].

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 [74,75]. 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 [35]. 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 [37].

4.1 Organisational barriers

Organisational characteristics such as organisational structure, culture and behaviour are critical aspects for leading towards technological changes [76,77]. These are the potential barriers identified originating from the organisational dimension in the Indian context. Culture and structure are recognized as important variables influencing the organisational decision-making environment [78]. These could be the main distinguishing factors between developing countries and developed countries deciding the pace of innovation adoption. Organisational culture is strongly influenced by the surrounding societal or national culture, and that it is, therefore, possible to identify the difference in organisational behaviour among developing countries[79].

In the organisational 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 [41]. 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 [44]. 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 [45].

4.2 Environmental barriers

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 organisation. Lack of sufficient infrastructure will enhance the impact of interventions in technology adoption and implementation [80].

Governmental authorities and other local institutions in developing countries define strict policies and regulations to standardize the IoT and to provide explicit guidelines for its implementation [81]. Organisations 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 [48,82]. 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 [49]. 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[51]. Geographic influence of technology depending on organisation location, characterized by population, competitiveness, and services in the region, is important [83].

5. Conclusions

This paper aimed to shed light on the barriers influencing IoT adoption in healthcare, with specifically concern in developing countries. An Indian hospital has been chosen as a research setting; Findings reveal three potential barriers influencing the IoT integration success in healthcare environments, in terms of technological, organisational, and environmental barriers. Among the IoT, IoMT may help monitor, inform and notify not only caregivers (e.g., as for carers, family members caring for a disabled person), and give health care providers real data to identify problems before they become critical.

Firstly, a study on existing literature on technology adoption with respect to healthcare has been reviewed. We identified some of the recognized barrier and mechanisms for technology adoption in the literature review. Followed by an explanation with respect to IoT behaviour in a general organisational context. Secondly, we elaborated an 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 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, an analytical framework was developed on barriers to IoT adoption and mechanisms they developed to overcome these barriers in the hospital. This research makes 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 to overcome these barriers.

Practically, managers and decision makers should focus on such results to reduce behaviour that hinders the adoption of IoT technology in healthcare, alleviating the components that build organisational barriers.

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 organisations in our study. Despite the fact that we believe our findings are 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.

Future research may investigate different geographical regions or developing countries by applying the adopted framework to understand relevant barriers, acting in correcting them, increasing awareness in the healthcare sector. Moreover, our study does not consider the final user's perspective and their intentions to use IoT devices for monitoring their health status, thus cooperating with hospital and healthcare professionals: Thus, future studies may investigate the same phenomena in large hospitals across developing countries as it may have some different experiences and perceptions towards technology adoption, specifically focusing on consumers' perspective.

6. Declarations

Conflict of Interest Statement

The authors have no conflict of interests to declare.

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