Analysis of barriers of mHealth adoption in the context of sustainable operational practices in health care supply chains

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Abstract

Purpose – The goal of this research is to analyse the obstacles to the implementation of mobile health (mHealth) in India and to gain an understanding of the contextual inter-relationships that exist amongst those obstacles.

Design/methodology/approach – Potential barriers and their interrelationships in their respective contexts have been uncovered. Using MICMAC analysis, the categorization of these barriers was done based on their degree of reliance and driving power (DP). Furthermore, an interpretive structural modeling (ISM) framework for the barriers to mHealth activities in India has been proposed.

Findings – The study explores a total of 15 factors that reduce the efficiency of mHealth adoption in India. The findings of the Matrix Cross-Reference Multiplication Applied to a Classification (MICMAC) investigation show that the economic situation of the government, concerns regarding the safety of intellectual technologies and privacy issues are the primary obstacles because of the significant driving power they have in mHealth applications.

Practical implications – Promoters of mHealth practices may be able to make better plans if they understand the social barriers and how they affect each other; this leads to easier adoption of these practices. The findings of this study might be helpful for governments of developing nations to produce standards relating to the deployment of mHealth; this will increase the efficiency with which it is adopted.

Originality/value – At this time, there is no comprehensive analysis of the factors that influence the adoption of mobile health care with social cognitive theory in developing nations like India. In addition, there is a lack of research in investigating how each of these elements affects the success of mHealth activities and how the others interact with them. Because developed nations learnt the value of mHealth practices during the recent pandemic, this study, by investigating the obstacles to the adoption of mHealth and their inter-relationships, makes an important addition to both theory and practice.

Keywords mHealth barriers, Sustainable healthcare, Interpretive structural modelling (ISM), MICMAC analysis, Intellectual technology, Social cognitive theory

Paper type Research paper

1. Introduction

Mobile health involves the application of mobile services and its intellectual technology with the association of Internet connection to provide healthcare services more swiftly and

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efficiently; this benefits both healthcare providers and patients (Källander *et al.*, 2013). More hospitals are looking at the advantages of mobile health (mHealth) due to rising healthcare expenses and the desire for better care at home. They are seeking better communication between doctors and patients, especially those in more remote locations, as well as better utilisation of medical facilities like wireless data transmission, short message service and ease of connection with regular healthcare providers (Alam *et al.*, 2023). Better communication enhances services that prevent patients from contracting serious forms of disease. Mobile health services have been expanded to healthcare management, diagnostic surveys, data mining and consciousness in countries with significant digital technological improvement in maternal health (Al Dahdah, 2019); this has been a distinctive feature supporting the efficacy and productivity of healthcare (Ma *et al.*, 2018; Syed *et al.*, 2019; Istepanian and Al-Anzi, 2018). Traditional business methods have managed to provide significant returns on investment, with the exception of a few accessions towards healthcare units (Wailoni *et al.*, 2021). Continuous improvements in technology relating to wireless technology, Internet of things (IoT) and artificial intelligence have led to the emergence of a hyper-connected world. This has enabled practitioners and researchers to develop methods of practical implementation of intellectual technologies in mobile healthcare services (Ziouvelou and McGroarty, 2018).

Economic growth and technological development have resulted in the creation of highly automated and motorised business processes, giving rise to the establishment of the corporate system (Kamble *et al.*, 2018). Furthermore, mHealth is anticipated to include tools that will be crucial in the judgement of healthcare professionals given the increasing use of smartphones and the expanding number of clinical applications in different fields (Kaphle *et al.*, 2015; Winters *et al.*, 2018). In terms of mobile gadgets and market potential, the mobile medical industry clearly offers promising growth possibilities. Because of their suitable and quick deployment of hospital resources, mobile healthcare systems can have significant social and economic implications (Dwivedi *et al.*, 2016). The majority of healthcare professionals, especially doctors, oppose employing electronic health technology including remote patient monitoring, electronic health records and online health information (Gagnon *et al.*, 2016). A key barrier preventing healthcare providers from using intellectual technologies is resistance to change (Nilsen *et al.*, 2016). To the best of the authors' knowledge, the common intellectual technology barriers associated with mHealth have been focussed on two factors – self-behaviour and self-efficacy of both healthcare professionals and patients.

Integration of mHealth with social cognitive theory (SCT) is still a relatively novel area of research. This can create a dynamic model (Martin *et al.*, 2020) in this Industry 4.0 era. SCT focus has been on self-efficacy, behavioural theory about intellectual technology usage (Compeau *et al.*, 1999) and user behaviour involving science and technology (Lent *et al.*, 2011). Digital interventions like intellectual technologies may be an effective way to reach big, targeted audiences in mental healthcare with cognitive behavioural therapy (Kanuri *et al.*, 2020). A remote monitoring exercise programme (Rawstorn *et al.*, 2016) and smart phone related physical activity barriers with SCT have been examined (Pope and Gao, 2022). Such interventions had no influence on one's ability to self-monitor or understand personal health behaviours (Voth *et al.*, 2016).

This paper addresses the gap of poor executive functioning, lack of social support and indirect clinical support, plus many more barriers to mHealth, through a development of antiretroviral therapy by embracing SCT (Ahonkhai *et al.*, 2021). There has been a scarcity of healthcare professionals for text messaging intervention based on social cognitive theory; this work was user centric and evidence-guided, aimed at preventing postpartum smoking recurrence in women in inner cities (Wen *et al.*, 2014). SCT explored barriers to the use of digital technologies in the case of older people with cognitive impairments (Blok *et al.*, 2020). Yet, none of these studies has analysed the barriers related to intellectual technologies for adoption of mHealth in the healthcare sector based upon SCT. In order to minimise the dimensionality of the barriers influencing mHealth intellectual technology performance in the Indian healthcare sector, it is necessary to analyse the complexity of human behavioural barriers, according to SCT, and to investigate the underlying causal connections between them. In this regard, the following research questions seek to explore how to motivate healthcare workers as well as the general public in a positive way.

RQ1. Which factors are perceived as barriers for the adoption of mobile health (mHealth) technology by the Indian healthcare system?

RQ2. How do these barriers influence each other and mHealth practice adoption in the Indian healthcare system?

RQ3. Which policy implications will be helpful for enhancement of mHealth effectiveness in the digital era?

To examine these research questions, this article focusses on the following objectives.

(1) To explore the barriers to mHealth implementation in the Indian healthcare sector.

(2) To establish the contextual inter-relations between these mHealth barriers and to identify the sustainable impact of these on mHealth using interpretive structural modelling (ISM) and MICMAC analysis.

(3) To suggest policy implications for mHealth practice upgradation with the aid of blockchain technology (BCT).

Although most people today use mobile communication in their daily lives, using mHealth applications to deliver health information and care is particularly difficult and necessitates specific tactics. This research paper's aim is to compile scientific literature on the intellectual technology barriers that may encourage or inhibit the behaviour of healthcare providers and patients from using mHealth in their everyday practice. If the intellectual technology barriers are tackled wisely and responsibly by SCT, mHealth is the most cutting-edge idea that has the potential to alter the future of the Indian healthcare sector.

The remainder of the paper is structured as follows: Section 2 examines the literature of relevant works, and Section 3 outlines the research methodology. Part 4 focusses on the creation of an ISM-based model. Section 5 discusses the findings of this study. Finally, Section 6 presents the concluding remarks.

2. Literature review

A review of past articles on the barriers of social and intellectual technology of Industry 4.0 in mobile healthcare is provided in this section. Three other subsections give structure to the section.

2.1 Sustainable mobile health in the industry 4.0 era

Industry 4.0 was introduced by the German government in the year 2011. Yet it still requires a precise definition for thorough understanding and use in business, as it is still relatively new to emerging countries, particularly India (Singhal, 2021). The fourth stage of industrialisation, known as "Industry 4.0," was established through mechanisation, electrification and information management (Machado *et al.*, 2020). Industry 4.0 was established through the application of contemporary information technologies, including cyber-physical systems, the Internet of things and data analytics (big data) (Madanian *et al.*, 2019a, 2019b; Simeone *et al.*, 2021). By introducing cutting-edge technology such as artificial intelligence (AI) and BCT into the mHealth care system, I4.0 principles can link the virtual network with the actual environment; this also addresses the various barriers related to intellectual technologies (Ziouvelou and McGroarty, 2018). Kamble *et al.* identified twelve challenges to the adoption of Industry 4.0 in various manufacturing sectors in 2018. A framework was created so that Industry 4.0 could be successfully implemented by identifying the interacting linkages between these barriers using an approach called interpretive structural modeling (Kamble *et al.*, 2018). The most significant Industry 4.0 impediments for reaching circular economy, sensor technologies, design problems and cyber-physical systems are considered as barriers (Rajput and Singh, 2021). Other challenges are related to policy and skills gaps in technologies (Mehta and Awasthi, 2019). Integration improves the modularisation of Industry 4.0 into the intellectual technologies of mHealth. This leads to customisation in the outlook of both healthcare professionals and patients (Swain *et al.*, 2021b).

Healthcare is undergoing a change around the world. The exponential expansion of digital communications, in both advanced and emerging economies, combined with increased innovation in leveraging the power of emerging apps, has resulted in a surge of activities in mobile health (Wong and Sa'aid Hazley, 2021). It has empowered doctors to become more accessible to patients and opened up lines of communication amongst them. From scheduling doctor's visits to ordering lab tests, technology has increased accessibility considerably. Patients can now keep track of their reports and visits, as well as retain their medical records online for easy retrieval (Ball *et al.*, 2007). Bates *et al.* (2014) conducted an analysis of big data functions in the handling of high-cost, high-risk patients; they showed that various data analysis methods, such as algorithms and systems for monitoring can lower expenses and enhance clinical outcomes. Additionally, mobile medical care systems can transfer extra medical resources from large cities to places that lack them, such as rural areas. This procedure lessens medical resource waste (Wailoni *et al.*, 2021) and fosters sustainability (Liu *et al.*, 2019). One study suggests that the government should improve sustainable mobile healthcare in three areas, customer trust, product image and social issues, to encourage in user adoption (Liu *et al.*, 2019). Technical support teams and education uncover the challenges of mHealth in low and middle income countries (Rodriguez-Villa *et al.*, 2020). Research has shown the difficulty of managing cardiovascular disease because of concerns about how doctors could be affected by mobile devices, their usability, radiation and the need for in-person consultations (Smith *et al.*, 2015). The majority of the existing mHealth usage in India are in the fields of care delivery, mass communication, pharmacy, ability to monitor and even therapy, as demonstrated in COVID-19 patients in India (Bassi *et al.*, 2018, 2020; Nimmagadda *et al.*, 2019). Further, in India in particular, safety applications are distributed throughout the sectors of education, detection, interaction, learning and training, organising and scheduling, strategic planning, and judgement; patient education accounts for the majority of these services. The Indian healthcare system is on the verge of being reshaped by technology (Swain *et al.*, 2021a, b, c). The change management process of patients is a key part of adopting a new mHealth system that is often disregarded yet has a direct impact on the system's sustainability (Sultan *et al.*, 2009). Healthcare has the power to boost future economic growth, but it is also a critical industry in terms of "safeguarding the nation's health and wealth" (Braithwaite, 2018). The application of mobile and smart devices in healthcare has seen a tremendous recent increase; this development has been studied to a degree towards its effectiveness. Whenever smart phones are employed as a point of communication between healthcare practitioners, however, the self-monitoring of overall health is subject to bias because it is carried out by ordinary people (Bardage *et al.*, 2005; Bowring *et al.*, 2012). The result of this integration of intellectual technologies with mobile healthcare (mHealth) services has witnessed the benefits of rapid response, quicker diagnosis as well as remote treatment and infection prevention

(El-Sappagh *et al.*, 2019). Formulating and implementing operational strategies to improve long-term performance in three areas–social, environmental and economic–is the main objective of healthcare industries these days. These three components should be improved by the government and businesses in order to improve customer satisfaction in mHealth care (Bommakanti *et al.*, 2020; Liu *et al.*, 2020).

2.2 Advances in intellectual technologies and its barriers to mHealth practices

Computer vision is currently being utilised to identify confirmed cases of the COVID-19 disease by analysis of X-ray image datasets. This is due to the widespread use of digital technology in mHealth services (Obeid *et al.*, 2019; Wright, 2008; Tuncer *et al.*, 2020). AI and other tools have been united in other healthcare service areas (Benjamins *et al.*, 2019; Farhat *et al.*, 2020; Krittanawong *et al.*, 2018; Pesapane *et al.*, 2018; Rogers and Aikawa, 2019; Seetharam *et al.*, 2019; Uddin *et al.*, 2019), e.g. in the research to categorise cancer as well as treatment research, Alzheimer, stroke, cardiology, etc. (Akselrod-Ballin *et al.*, 2019; Ferroni *et al.*, 2019; Kavakiotis *et al.*, 2017; Kehl *et al.*, 2019; Kocbek *et al.*, 2016; Larburu *et al.*, 2018; Mirzaei *et al.*, 2016; Obeid *et al.*, 2019). In their study, Larburu *et al.* (2018) suggested a mHealth programme for measuring and preventing heart problems, with doctors being notified if signs are detected. Given the abundance of data linked to false alerts, a Bayes classification predictive model was employed to sort the data and limit the number of false alerts created by the network. Other similar studies include the creation of a psychological intervention that can forecast a patient's reply (Bostock *et al.*, 2019; Morrison *et al.*, 2017). Algorithms have also been used to manage digital limb, a game-based technology that employs the theory of augmented reality to cure limb pains (Prahm *et al.*, 2016). Additionally, machine learning has been used in speech recognition in people suffering from dysarthria (Hawley *et al.*, 2013). Blockchain, cloud computing and AI have all had a significant effect on the current technology being used in numerous sectors, the drugs industry being no exception. While cloud computing provides patient care features such as digital extra storage, data systems and remote monitoring, it also provides developers and medical doctors with technical independence as an integral part of the organisation (Swain *et al.*, 2021a, b, c). Because of the vast amount of data created by the use of these devices, standard data analysis techniques can overload the system, necessitating the use of statistical tools for data interpretation. IOT and AI are currently being used in digital healthcare devices like phones and point-of-care platforms all around the globe, thanks to recent advancements (Peter *et al.*, 2022). Currently, AI-enabled technologies use supervised, unstructured, or reinforced learning techniques. Machine learning, a type of AI, is being employed in image and diagnostic analytics, early disease diagnosis, self-care systems, research and innovation; it can also be used to uncover regularities. BCT, based on the notion of a distributed ledger system, allows for a decentralised system. This notion has been implemented in edge computing, which combines peer-to-peer networking, distributed digital data, immutability, privacy and cloud access; this is seen in well-known cryptocurrency setups such as Bitcoin and Ethereum (Wright, 2008). Regarding the need for transferring data that allows access, integrity and privacy, BCT enables security and scalability when paired with some other techniques in the medical sector. This also facilitates accomplishment of a broad network of mHealth services (Cyran, 2018).

This paper will provide an insight into the more significant challenges that countries have in adopting mHealth, as well as some potential solutions. India has a doctor-to-patient ratio of 1: 10,189, which is ten times lower than the 1:1,000 proposed by the World Health Organisation (Bostock *et al.*, 2019). India also requires three times the number of nurses and five times the number of physicians it currently has. Infectious diseases and illnesses, chronic disorders and other concerns influence the lives of the general population. Doctors have recorded 47% of technical challenges and 39% of time scheduling concerns with telemedicine; 31% of patients felt uncomfortable facing the camera, while 24% had technological issues (Acharya and Rai, 2016). While health resources are redundant in certain major cities, this reflects the variation of medical resources and the difficulties faced by nurses working with mHealth technology. These problems include helping women with HIV (Chandra *et al.*, 2018; Reynolds *et al.*, 2016); thematic analysis of barriers in yoga programmes in India (Keay *et al.*, 2018); poor policies and financial barriers associated with female mortality (Bhatia *et al.*, 2021); stable electricity supplies and renewable energy scarcity in Uttarakhand after people have struggled with health issues caused by Covid-19 (Chauhan and Saini, 2015; Pradhan *et al.*, 2020). One of the biggest obstacles to broader adoption of mHealth, according to healthcare professionals, especially physicians, is a lack of available technology (O'Connor and O'Donoghue, 2015). Despite broad technological advancements, the adoption of new technologies, particularly mHealth, is now hindered by a lack of suitable evidence-based and tailored methods (Steinhubl *et al.*, 2013, 2015). Healthcare workers are facing difficulties according to proper regulation-based research into electronic health records (Medhanyie *et al.*, 2015; Lavariega *et al.*, 2016); a lack of interoperability with digital systems (Swain and Muduli, 2023); integrated health data, security and exchange of information amongst providers (Gleason, 2015); legal risks, social and cultural problems (Nebeker *et al.*, 2017). Interstate medical licencing regulations continue to be difficult leading to a lack of political willpower (Weinstein *et al.*, 2014); women and girls are facing problems in policy implementation in rural areas (Parajuli and Doneys, 2017); barriers to self-management of healthcare resulting from privacy and security concerns (Terry, 2015). Despite having no obvious physical or cognitive barriers, healthcare workers with minimal computer literacy are unwilling to complete their jobs through mHealth applications. This makes them less inclined to use mHealth technologies (Medhanyie *et al.*, 2015; Lavariega *et al.*, 2016; Kao and Liebovitz, 2017). A significant barrier to the adoption of mHealth technologies is the absence of face-to-face human interactions; people still want physical interaction (Nebeker *et al.*, 2017; Dunlop and Brewster, 2002). The expansion of mHealth technology, in the opinion of healthcare providers, is hampered by a lack of standards; this includes standards for identifiers, communications (Rassi *et al.*, 2018), organisation and structure, professional terminology and classification, security and access control. As a result, robust technology standards for mHealth must be created (Kumar *et al.*, 2021; Kao and Liebovitz, 2017).

In the literature review conducted on social contingency theory as well as mHealth intellectual technology, barriers have been identified by various keywords such as barriers, challenges, obstacles, problems, limitations in mHealth. Other key words used in the review include telehealth, smart phone, cell phone, smart devices, mobile device for the healthcare sector. In this study, we have listed 15 intellectual technology barriers relating to mHealth through this literature review in the Indian healthcare sector as presented in Table 1. However, there is little empirical research on these barriers; the few studies that do exist frequently mix together various aspects of mHealth technology, including practice and obstacles (Patri and Suresh, 2018). In order to understand how these obstacles interact with one another, how they impact the adoption of mHealth care practices, and how they affect associated intellectual technological obstacles, a thorough and methodical examination of these obstacles is required.

2.3 Research gap

In India, the healthcare industry faces a myriad of challenges, including limited access, minimal insurance penetration and a rise in chronic disease. The current work intends to fill research gaps in current literature and emphasise the relevance of intellectual technology barriers in the mobile healthcare industry leading to sustainability for the benefit of the

SL. No.	mHealth Barriers upon intellectual technology	Description	References
1	Stable electricity availability and web access (m-HB 1)	Stable electricity and 5G enabled Internet facility required for storage of healthcare data in the cloud server. In remote areas, it is quite impossible to serve the Internet service for mobile healthcare issue towards intellectual technology	Qureshi *et al.* (2022), Reed *et al.* (2020), Adibi (2014), Chauhan and Saini (2015), Pradhan *et al.* (2020)
2	Devices must be calibrated on a regular basis (m-HB 2)	Calibration, or the verification of any healthcare measurement device's accuracy, has a significant impact on the quality-of-care delivery in mobile healthcare and also need signal improvement in mobile health care facilities	Kaushik *et al.* (2020), Sebetci and Algur (2015), Abelson *et al.* (2017), Jain *et al.* (2015)
3	Large technological gap with the users (m-HB 3)	Huge technological literacy appears while using mHealth service with the patients, particularly an old generation living in rural areas	Agrawal *et al.* (2020), Bessin *et al.* (2020), Ghosh and Dey (2021), Swain *et al.* (2021a), Zakerabasali *et al.* (2021), Kuek and Hakkennes (2020), O'Connor and O'Donoghue (2015)
4	Lack of political willpower (m-HB 4)	Political representatives frequently do not seek money for health care and, it appears that health-care policymaking has low political responsibility and is least aligned with the demands of the people	Gore (2021), Ramani and Mavalankar (2006), Lluch (2011), Weinstein *et al.* (2014), Parajuli and Doneys (2017)
5	Weak relationship of doctor-to-populace ratio (m-HB 5)	knowledge disparity between physicians and patients is another significant issue in m-Health system, not feeling comfortable and also facing intellectual technology barrier to share all the details which shows a big issue between doctors and patients	Reed *et al.* (2020), Bessin *et al.* (2020), Abelson *et al.* (2017)
6	A scarcity of qualified health-care workers (m-HB 6)	These include lack of qualification of healthcare worker on new mHealth solutions and weak technical knowledge of intellectual technology	Gaglani and Topol (2014), Zakerabasali *et al.* (2021), Nilsen *et al.* (2016), Kuek and Hakkennes (2020)
7	Different cell phone companies have different sensors (m-HB 7)	Different sensors incorporated in gadgets or wearables can facilitate access to mHealth services, which can be activated as soon as an anomaly is detected or an emergency signal is triggered. Majority of users have the problem on intellectual technology assisted smart devices, as the different mobile phone have different types of sensors attached	Bell *et al.* (2011), Mascolo (2010), Bommakanti *et al.* (2020)

(*continued*)

Table 1.
Barriers of mHealth services adoption in India*

SL. No.	mHealth Barriers upon intellectual technology	Description	References
8	Competent personnel/ talents emigrating (m-HB 8)	The talented workers are settled in most of the towns for better healthcare facility and advanced technology	Liu *et al.* (2020), Lluch (2011)
9	Privacy issue (m-HB 9)	IoT has launched in a massive shift in the medical field. The difficulties and a survey of data security in relation to IoT in the cloud server has increased non-compliance and threat in the medical field. Many disciplines be included in the research to examine the issue and discover the realities of the problem in order to resolve mobile health services	Alasmari and Anwar (2017), Muhammad *et al.* (2017), Zakerabasali *et al.* (2021), Abelson *et al.* (2017), Kao and Liebovitz (2017)
10	Security attachments are required (m-HB 10)	Data are critical to the IoT system's success, there are a number of concerns about data management, including how medical data are collected and handled in terms of storage, processing and access by selected users through intellectual technology	Kosaraju (2021), Baker and Stanley (2018), Simon *et al.* (2009), Kao and Liebovitz (2017), Gleason (2015)
11	Staff apprehension and habitual change (m-HB 11)	Habitual change of staff might be impossible to adopt these intellectual technologies used in mHealth services. The popularity of training courses, online certifications and specialisations in mHealth is already expanding, according to medical professionals' responses	McConnochie (2019), Pulla, (2016), Zakerabasali *et al.* (2021), Kuek and Hakkennes, (2020)
12	Physicians do not have significant advantages, rewards, or assistance (m-HB 12)	Physicians wants to be updated in the intellectual technologies like IOT based healthcare equipment in the medical field but there is no such facility to develop by itself	Agarwal *et al.* (2020), Lluch, (2011), O'Connor and O'Donoghue (2015)
13	The government's economic condition (m-HB 13)	A coordinated effort by healthcare executives and providers, backed by the government, could go a long way towards improving India's medical ecosystem by embracing mobile technology. Due to government economic condition, large scale of technology cannot be implemented properly in the healthcare sector	Raina and Spaces (2021), Mathur *et al.* (2017), Kao and Liebovitz (2017)
14	Lack of supervisory agency (m-HB 14)	There is a lack in the use of intellectual technology like misinterpretation of mHealth application	Flodgren *et al.* (2015), Powell *et al.* (2014), Masterson Creber *et al.* (2016), Stoyanov *et al.* (2016), Zakerabasali *et al.* (2021), Kao and Liebovitz (2017)

Table 1. (*continued*)

SL. No.	mHealth Barriers upon intellectual technology	Description	References
15	Social and cultural problems (m-HB 15)	A social revolution in the case of Internet communiqué as a result of IoT; this has had a substantial impact on the extension of many challenging units, specifically in the field of implantable implants	Mascolo, (2010), Kao and Liebovitz (2017), Alsughayr, (2015), Nebeker *et al.* (2017)

*Source: Authors own work

Table 1.

environment. To date, no research has looked into social cognitive theory and the environmental implications of sustainable mobile healthcare development in the Industry 4.0 era. This knowledge gap prompts us to investigate the social challenges surrounding the adoption of Industry 4.0 in the context of cognitive technologies in mHealth with the use of a simple hierarchical model. As a result, the goal of this research is to look at the intellectual technology barriers in the mHealth infrastructure.

3. Research methodology

ISM is a well tried methodology to determine the links between the many factors that solve a problem or different types of challenges (Watson, 1978). The structural model can be used to understand the intricate relationships between barriers. In this tool, there are three dimensions: Expert interpretative judgements are denoted by the letter "I". "S" denotes a structural relationship between concerns, while "M" denotes a specific relationship between variables and a graphical representation of that relationship (Pandey *et al.*, 2018). Impact Matrix Cross-Reference Multiplication Applied to a Classification (MICMAC) analysis is used to examine the driving and dependent powers of distinct components. The MICMAC approach focuses on the multiplication properties of matrices (Benjumea-Arias *et al.*, 2016). ISM is designed to be used when logical and coherent thinking is necessary in order to handle a complex problem. It can be used to impose order and purpose on the complicated inter-relationships between variables. ISM is generally meant for use in groups, but it can also be used alone. ISM is capable of developing an early model using management practices like brainstorming, nominal groups methods and concept development (Talib *et al.*, 2011). In this case, the involvement of ISM is appropriate. The technique used in this study implies that it is appropriate, as shown in Figure 1.

Initially, from SCOPUS and Web of Science data bases, the theoretical concepts and previous investigations to mobile health barriers on intellectual technologies are established in this study as mentioned in Figure 2. To complement this task, a questionnaire was drawn up based on the barriers identified. This was circulated to 55 health and medical specialists. A systematic random approach is used to decide on this number of experts. As per the researcher's point of view, a total of 21 surveys are administered. The findings from these lead to the identification of 15 barriers as potential hurdles to long-term mobile health in healthcare centres (Table 1). The ISM questionnaire is constructed based on identified hurdles to the adoption of sustainable mHealth in health facilities. By collecting ISM surveys and assessing replies dependent on the frequency of response, a Self-Interaction Matrix of Barriers is created. When all responses are combined, a group judgement is made. To evaluate barriers, a textual relation of the kind "leads to" is chosen. This means that one barrier relates to another. As a result, a textual connection between hurdles to the adoption of sustainable mobile health in health facilities is established.

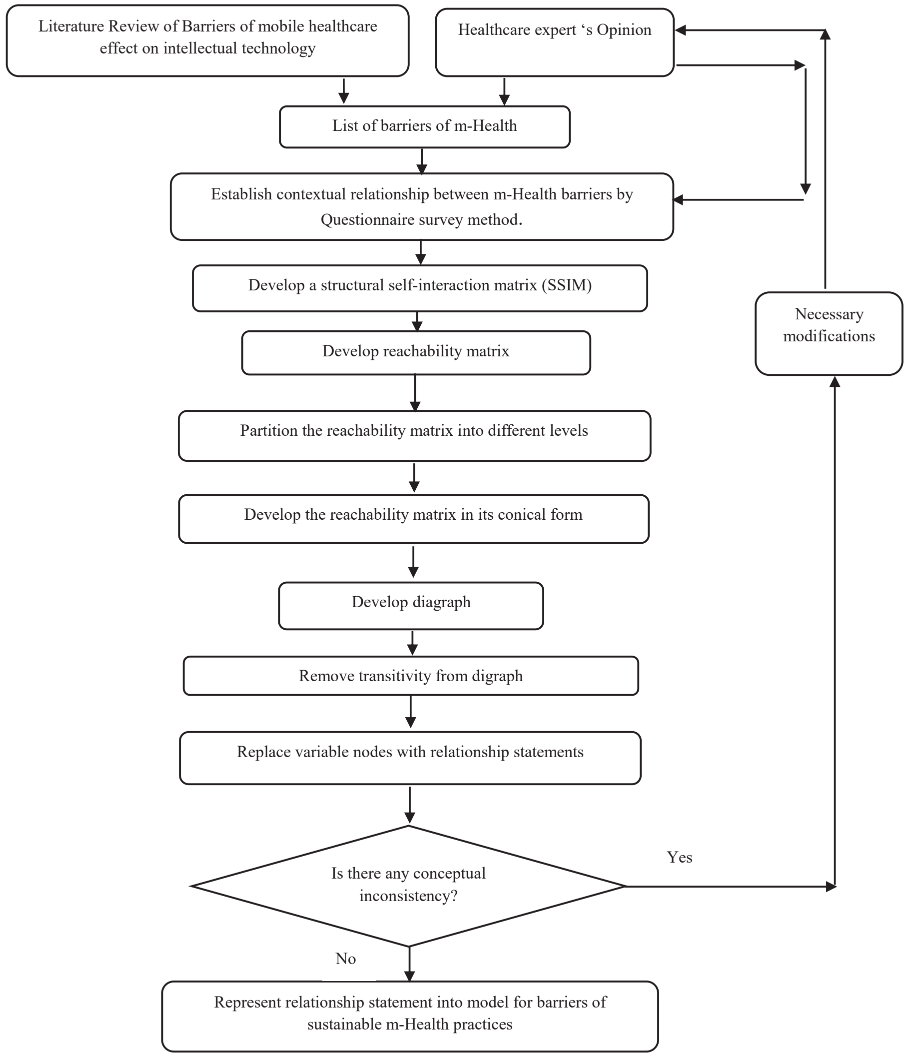
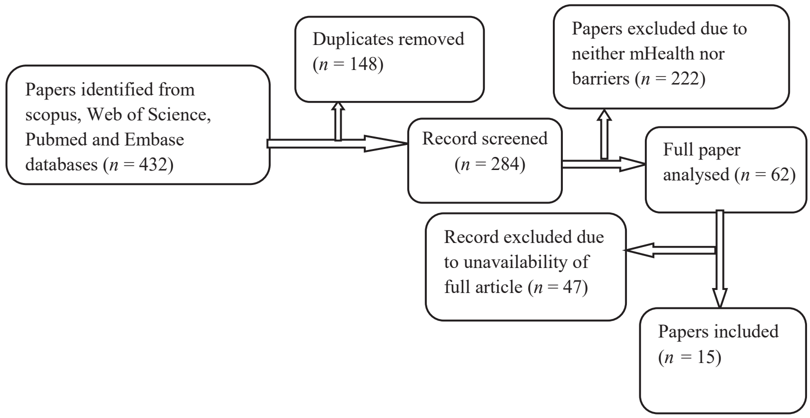


Figure 1.
ISM Flowchart with detailed work

Source(s): Authors own work

3.1 Questionnaire formulation

The application of collected mHealth barriers of intellectual technologies is validated through an empirical investigation. To validate these barriers, several surveys are created to elicit opinions from respondents. For each assessment, responses are assessed on a Likert scale from 1 to 5, with 1 representing "strongly disagree" and 5 representing "strongly agree." Results from different age groups are collated as well as from different professions. This shows that males within the age group 21–30 years are the main mHealth users.



Source(s): Authors own work

Figure 2. Literature review search strategy

3.2 Data collection

Those surveyed must have utilised a mHealth service. This was deemed to be imperative since the whole focus of the study is examining the mobile healthcare hurdles regarding the adoption of the health 4.0 concept. The set of questionnaires was issued to a range of the population of all ages in order to obtain responses from those involved in the field of mHealth care. The information from these professionals was collected using a purposive and randomised sampling strategy. Initially, eligible respondents were contacted, and the research team was able to connect with other operatives functioning in the same region through them. A total of 210 people were approached for online surveys as a result of the sampling process. Over the course of two months (February 2022 to March 2022), 113 replies were received from the total number of people contacted. This method is used to validate barriers associated with mobile healthcare adoption towards intellectual technologies. The details of respondents are summarised in Table 2.

4. ISM methodology implementation

ISM is a technique created to address challenges or concerns that are impacted by numerous variables and their interactions. It is an interactive process that records and methodically applies the knowledge and expertise of specialists for organising various interdependent and aspects of a phenomenon, improving understanding of the phenomenon as a whole and the function of each element (Farris and Sage, 1975). The following stages are often used to apply the ISM approach.

4.1 Structural self-interaction matrix (SSIM)

Each pair of items chosen in the first phase is connected by relationships. This is accomplished by gathering expert opinions and creating a structural self-interaction matrix (SSIM) as shown in Table 3. The structural model is constructed from the final reachability matrix, as shown in Table 5. An arrow pointing from I to J depicts the relationship between the obstacles J and I. A digraph is the product of this process. The digraph is finally turned into the ISM model by removing the transitivity as indicated in the ISM technique.

Considering each variable's set, the existence of a relationship between any two barriers (I and J) means that the connection is questioned. The direction of relationship between the barriers (I and J) is denoted by four symbols:

V= Barrier I will assist in the achievement of barrier J

Table 2.
Details of survey respondents [mHealth users]*

Profile of respondents	Criteria	Total	Percentage
Age	Between 5 and 20	3	2.7%
	Between 21 and 30	50	44.2%
	Between 31 and 40	27	23.9%
	Between 41 and 50	24	21.2%
	Above 50	9	8%
Gender	Male	79	69.9%
	Female	34	30.1%
Level of Education	Intermediate	6	5.3%
	Graduate	45	39.8%
	Post graduate	42	37.2%
	Doctorate	20	17.7%

*__Source(s):__ Authors own work

A = Barrier J will assist in the achievement of barrier I

X = Barriers I and J will assist each other in achieving their goals

O= I and J are unrelated barriers

4.2 Initial reachability matrix

SSIM is used to create a reachability matrix in this stage. By converting information from every SSIM cell into binary digits, the SSIM structure is turned into an initial reachability grid format (i.e. ones or zeros) as shown in Table 4. The following rules are used to carry out this transformation.

(1) If the entry in the cell (I, J) in the SSIM is V, then the cell (I, J) entry becomes 1 and the cell (J, I) entry becomes 0.

(2) If the entry in the cell (I, J) in the SSIM is A, then the cell (I, J) entry becomes 0 and the cell (J, I) entry becomes 1.

(3) If the entry in the cell (I, J) in the SSIM is X, then the entries in both the cells (I, J) and (J, I) become 1.

(4) If the entry in the cell (I, J) in the SSIM is O, then the entries in both the cells (I, J) and (J, I) become 0.

Incorporating the transitivity, the ISM methodology yields the final reachability matrix for the obstacles, as illustrated in Table 5. The final reachability matrix will include some entries derived through pair-wise comparisons as well as some inferred elements.

4.3 Level partitioning

The final reachability matrix yields the reachability in Table 5 and antecedent set (Warfield, 1974) for each barrier. The reachability set for a given variable is made up of the variable and the other variables that it may aid in achieving. The antecedent set includes the variable and any additional factors that may aid in obtaining it. The intersection of these sets is then calculated for all variables. The highest variable in the ISM hierarchies is given to the variable wherein the reachability and intersection sets are identical and which would not help attain any other variable beyond their own level. After the top-class element has been identified, it is removed from the remaining variables. The 15 barriers are described in this study, together with their reachability set, antecedent set, intersection set and levels as shown in Tables 6 and 7.

Table 3. Structural self-interaction matrix*

m-Health Barriers	m-HB15	m-HB14	m-HB13	m-HB12	m-HB11	m-HB10	m-HB9	m-HB8	m-HB7	m-HB6	m-HB5	m-HB4	m-HB3	m-HB2
m-HB 1	A	O	A	A	O	A	A	O	O	O	A	O	A	X
m-HB 2	A	A	A	A	O	A	A	O	X	A	A	A	A	
m-HB 3	V	V	A	V	O	A	V	O	V	V	A	V		
m-HB 4	A	A	A	A	O	A	A	A	V	X	A			
m-HB 5	V	V	A	V	O	A	A	V	V	V				
m-HB 6	A	X	A	A	O	A	O	O	O					
m-HB 7	O	O	A	O	X	A	A	O						
m-HB 8	A	O	A	X	V	A	O							
m-HB 9	V	V	A	V	V	A								
m-HB 10	V	V	A	V	V									
m-HB 11	O	O	A	O										
m-HB 12	O	O	A											
m-HB 13	V	V												
m-HB 14	A													

***Source(s):** Authors own work

Table 4.
Initial reachability matrix*

m-Health Barriers	m-HB1	m-HB2	m-HB3	m-HB4	m-HB5	m-HB6	m-HB7	m-HB8	m-HB9	m-HB10	m-HB11	m-HB12	m-HB13	m-HB14	m-HB15	Driving power
m-HB 1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
m-HB 2	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	3
m-HB 3	1	1	1	1	0	1	1	0	1	0	0	1	0	1	1	10
m-HB 4	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	4
m-HB 5	1	1	1	1	1	1	1	1	0	0	0	1	0	1	1	11
m-HB 6	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	4
m-HB 7	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	3
m-HB 8	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	4
m-HB 9	1	1	0	1	1	0	1	0	1	0	1	1	0	1	1	10
m-HB 10	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	14
m-HB 11	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	2
m-HB 12	1	1	0	1	0	1	0	1	0	0	0	1	0	0	0	6
m-HB 13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
m-HB 14	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	3
m-HB 15	1	1	0	1	0	1	0	1	0	0	0	0	0	1	1	7
Dependence Power	9	13	4	10	4	9	9	6	4	2	6	7	1	8	6	98

*Source: Authors own work

Table 5. Final reachability matrix*

m-Health Barriers	m-HB1	m-HB2	m-HB3	m-HB4	m-HB5	m-HB6	m-HB7	m-HB8	m-HB9	m-HB10	m-HB11	m-HB12	m-HB13	m-HB14	m-HB15	Driving power
m-HB 1	1	1	0	0	0	0	1*	0	0	0	1*	0	0	0	0	4
m-HB 2	1	1	0	0	0	0	1	0	0	0	1*	0	0	0	0	4
m-HB 3	1	1	1	1	1*	1	1	1*	1	0	1*	1	0	1	1	13
m-HB 4	1*	1	0	1	0	1	1	0	0	0	1*	0	0	1*	0	7
m-HB 5	1	1	1	1	1	1	1	1	1*	0	1*	1	0	1	1	13
m-HB 6	1*	1	0	1	0	1	1*	0	0	0	1*	0	0	1	0	7
m-HB 7	1*	1	0	0	0	0	1	0	0	0	1	0	0	0	0	4
m-HB 8	1*	1*	0	1	0	1*	1*	1	0	0	1	1	0	1*	0	9
m-HB 9	1	1	1*	1	1	1*	1	1*	1	0	1	1	0	1	1	13
m-HB 10	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	14
m-HB 11	1*	1*	0	0	0	0	1	0	0	0	1	0	0	0	0	4
m-HB 12	1	1	0	1	0	1	1*	1	0	0	1*	1	0	1*	0	9
m-HB 13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
m-HB 14	1*	1	0	1*	0	1	1*	0	0	0	1*	0	0	1	0	7
m-HB 15	1	1	0	1	0	1	1*	1	0	0	1*	1	0	1	1	10
Dependence Power	15	15	5	11	5	11	15	8	5	2	15	8	1	11	6	133

*Source(s): Authors own work

Table 6.
Level partitioning Iteration-1*

m-Health Barriers	Reachability set	Antecedent set	Intersection set	Level
m-HB 1	1, 2, 7, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 7, 11	1
m-HB 2	1, 2, 7, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 7, 11	1
m-HB 3	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 14, 15	3, 5, 9, 10, 13	3, 5, 9	
m-HB 4	1, 2, 4, 6, 7, 11, 14	3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 15	4, 6, 14	
m-HB 5	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 14, 15	3, 5, 9, 10, 13	3, 5, 9	
m-HB 6	1, 2, 4, 6, 7, 11, 14	3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 15	4, 6, 14	
m-HB 7	1, 2, 7, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 7, 11	1
m-HB 8	1, 2, 4, 6, 7, 8, 11, 12, 14	3, 5, 8, 9, 10, 12, 13, 15	8, 12	
m-HB 9	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 14, 15	3, 5, 9, 10, 13	3, 5, 9	
m-HB 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15	10, 13	10	
m-HB 11	1, 2, 7, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 7, 11	1
m-HB 12	1, 2, 4, 6, 7, 8, 11, 12, 14	3, 5, 8, 9, 10, 12, 13, 15	8, 12	
m-HB 13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	13	13	
m-HB 14	1, 2, 4, 6, 7, 11, 14	3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 15	4, 6, 14	
m-HB 15	1, 2, 4, 6, 7, 8, 11, 12, 14, 15	3, 5, 9, 10, 13, 15	15	

***Source(s):** Authors own work

Barriers	Reachability set	Antecedent set	Intersection set	Level
m-HB 1	1, 2, 7, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 7, 11	1
m-HB 2	1, 2, 7, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 7, 11	1
m-HB 3	3, 5, 9	3, 5, 9, 10, 13	3, 5, 9	5
m-HB 4	4, 6, 14	3, 4, 5, 6, 8, 9, 10, 12, 13,14, 15	4, 6, 14	2
m-HB 5	3, 5, 9	3, 5, 9, 10, 13	3, 5, 9	5
m-HB 6	4, 6, 14	3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 15	4, 6, 14	2
m-HB 7	1, 2, 7, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 7, 11	1
m-HB 8	8, 12	3, 5, 8, 9, 10, 12, 13, 15	8, 12	3
m-HB 9	3, 5, 9	3, 5, 9, 10, 13	3, 5, 9	5
m-HB 10	10	10,13	10	6
m-HB 11	1, 2, 7, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	1, 2, 7, 11	1
m-HB 12	8, 12	3, 5, 8, 9, 10, 12, 13, 15	8, 12	3
m-HB 13	13	13	13	7
m-HB 14	4, 6, 14	3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 15	4, 6, 14	2
m-HB 15	15	3, 5, 9, 10, 13, 15	15	4

*Source(s):** Authors own work

Table 7. Final level partitioning*

4.4 Hierarchical modelling of barriers employing ISM

The digraph is constructed when the framework is created from the final reachability matrix. The digraph is turned into the ISM model as shown in Figure 3 after eliminating the transitivity as indicated in the ISM technique.

(1) The upper edge barriers (level I, here) are located on the top of the digraph, whereas the second barriers are placed below the upper edge barriers in this created model.

(2) Further barriers are placed in the structure as per their ranks until the lowest level barrier (level VII in this case) is placed at the end of the digraph.

(3) After this, the government economic condition (m-HB 13), having level VII, is considered as highest level with maximum driving power and minimum dependence power at the end of the diagraph.

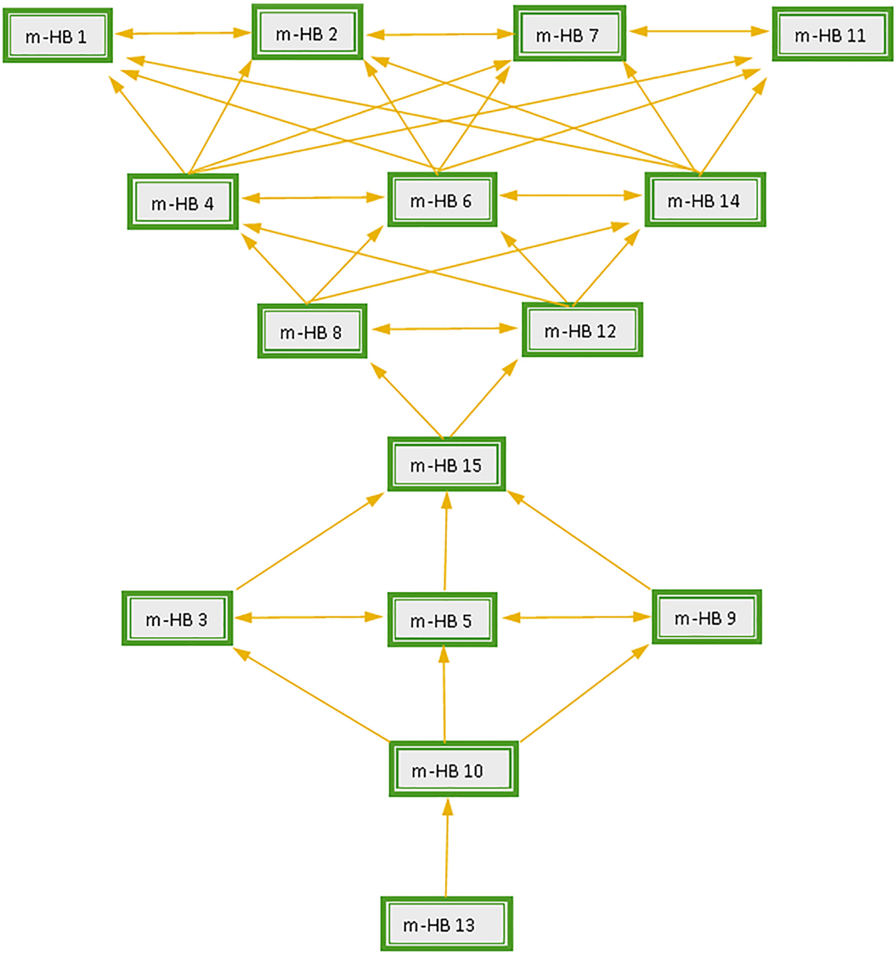
(4) It has the capacity to drive the security attachment required for mobile healthcare (m-HB 10); this security attachment (m-HB 10, level VI) leads to a large technological gap with users (m-HB 3, level V) and also creates privacy issues (m-HB 9, level V).

(5) Further, this combination of issues creates problems for doctors and patients due to the weak relationship (m-HB 5, level V). Similarly, the weak relationship of doctor to populace (m-HB 5, level V) leads to social and cultural problems (m-HB 15, level IV).

(6) Due to social and cultural problems, competent personnel are emigrating (m-HB 8, level III); also, physicians are not receiving significant advantage, rewards, etc. (m-HB 12, level III). Consequently, level III leads to lack of political power (m-HB 4, level II); this political power influences the scarcity of qualified health workers (m-HB 6, level II).

(7) A scarcity of qualified health workers is mutually linked with a lack of supervisory agencies (m-HB 14, level II). Level II barriers lead to stable electricity supply and web access (m-HB 1, level I), calibration of devices on a regular basis (m-HB 2, level I), different cell phones have different sensors (m-HB 7, level I) and also staff apprehension (m-HB 11, level I).

This model shows the detailed implementation of barriers on mobile healthcare provision.

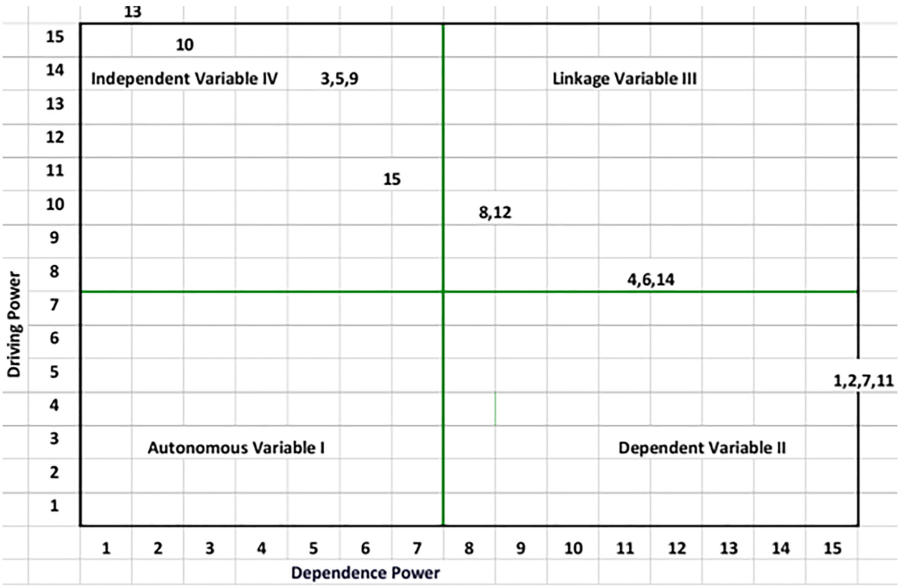


Source(s): Authors own work

Figure 3.
ISM based hierarchical model for mobile healthcare adoption barriers

4.5 MICMAC study of the barriers

The goal of the MICMAC study is to consider the driving power and the relationship amongst variables (Mandal and Deshmukh, 1994). The mHealth barriers previously outlined are divided into four groups in this study (Figure 4). The "autonomous variables" in the first clustering have a low driving power and low dependency. These variables are somewhat disjointed from the system; they have only a few weak ties. The "dependent variables" make up the second clustering, which has a low driving power but a high degree of reliance. The third clustering shows both high driving and dependence power. These elements are unstable because any change they undergo has an impact on others and has a reciprocal effect on themselves. The fourth cluster contains "independent variables" with high driving power but low dependency. Table 6 shows the driving power and dependency of each of these factors. The dependency and the driving power are shown in this table by the addition of a "1" to the columns and rows, respectively. Following that, the driver power-dependence diagram is drawn, as illustrated in Figure 4. For example, it has been concluded that from Table 5, one



Source(s): Authors own work

Figure 4. Driving-dependence power diagram

barrier (the government economic condition) has high driving power, 15, and less dependence power; i.e. 1 lies in the fourth cluster of the ISM structure.

5. Discussion

The interpretative structural modelling approach is used to create the research model; this is a good way to recognise the intricate relationships between system elements. The first step in implementing sustainable mHealth in healthcare centres is to identify the 15 barriers and understand their relationships. Without considering these hurdles, initiatives to establish more digital mHealth management in healthcare institutions will fail. As a result, implementing this method provides a proper scope for decision-making for both healthcare centre management and other beneficiaries. These findings point to the use of research knowledge by healthcare management and decision-makers. The vicinity of other obstacles to these barriers is revealed by the findings of the MICMAC study; any modification in one of these barriers influences the other barriers. The derived model's practical applications are explained by these findings. In order to eradicate barriers, mobile health facilities should initially concentrate on low levels of the model based on the power of impact and dependency of each barrier.

(1) This driving-dependence power grid (Figure 4) provides useful information on the relative relevance and interdependencies of sustainable mHealth barriers towards digital technologies. This could be beneficial to decision-makers and practitioners alike for recognising and addressing these barriers very clearly.

(2) Figure 4 shows that the first cluster (autonomous variables) has weak driving and also weak dependence power. Results indicate that there are no barriers present in this cluster.

(3) The second cluster (dependent variables) has less driving power and high dependence power. The barriers m-HB 4, m-HB 6 and m-HB 14 have driving power

7 and dependence power 11. The barriers m-HB 1, m-HB 2, m-HB 7 and m-HB 11 have driving power 4 and dependence power 15.

(4) The third cluster (linkage variables) has two barriers, m-HB 8 and m-HB 12, which contain driving power 9 and dependence power 8. These barriers are mutually connected to each other.

(5) The fourth cluster (independent variables) has strong driving power and weak dependence power. The barrier m-HB 13 has driving power 15 and dependence power 1; m-HB 10 has driving power 14 and dependence power 2; m-HB 3, m-HB 5 and m-HB 9 have driving power 13 and dependence power 5; m-HB 15 has driving power 10 and dependence power 6.

This summarises the importance of planning an approach to tackling mobile health barriers in the healthcare industry. As a result, judgement should be made to eliminate those obstacles which have the potential to influence other barriers. This is a top priority.

5.1 Managerial implications of the research

The opinions of management in mobile healthcare adoption on intellectual technology barriers have been considered in this research. In this article, 15 barriers are identified with the help of a critical literature survey and healthcare experts. By conducting an online survey (questionnaire method) of mHealth users, it has been evidenced that there are major issues regarding the intellectual technology adoption amongst these users. Management should focus on these issues. They can be best solved by a consortium blockchain network (called Healchain); this will ensure privacy and security of healthcare data (Ni *et al.*, 2019). In addition, healthcare management should focus on the research findings which need to be implemented in the immediate future. Mandatory policy making by the government is necessary for this to happen.

The following are the primary contributions of the study.

(1) This research finds that government economic conditions, security attachment to intellectual devices, privacy issues and large technological gaps with users are the main barriers; focus should be given to these areas by managerial teams (Kao and Liebovitz, 2017).

(2) The above barriers lead to other barriers such as weak relationships of doctors to the populace (Abelson *et al.*, 2017), social barriers (Liu and Varshney, 2020) and cultural problems. Prompt action to eliminate these roadblocks by management would not only encourage adoption of these intellectual technologies (Usher *et al.*, 2013) but also enhance the quality of diagnostic care, allowing mHealth's full potential to be realised.

(3) The national literacy rate as well as linguistic diversity are essential factors for management to consider. Only 72.1% of India's population is literate; this can create a communication barrier between a patient in one region and a doctor in another who may need further training (Zolfo *et al.*, 2010; Cho *et al.*, 2021). For sustainability of mHealth, intervallic forcasting is needed to manage social and cultural changes.

(4) The Internet and increased broadband connections are still the cornerstones of present mobile healthcare; good communication makes systems more practical and profitable in far-flung locales as shown by social cognitive theory (Xu *et al.*, 2021).

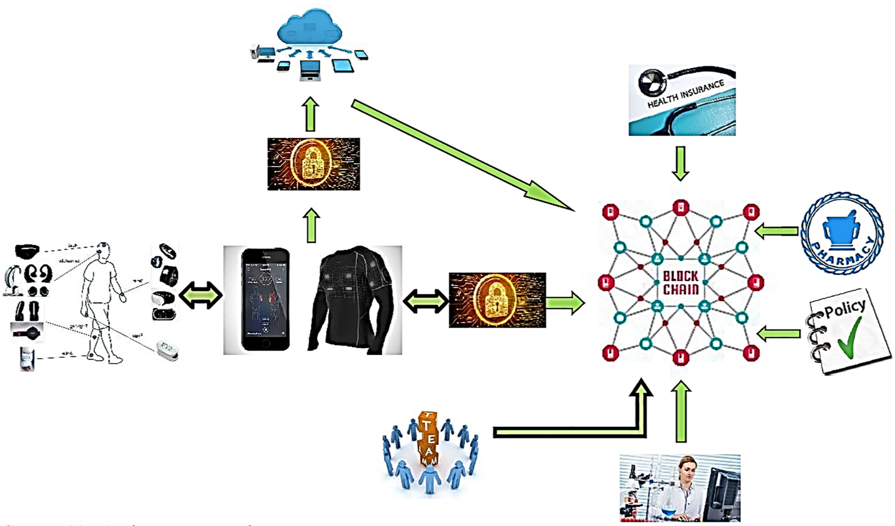
(5) The evolution of intellectual device preferences may suggest shifting customer preferences given today's mobile technologies. The groundwork for choosing these devices, on the other hand, has not been clearly outlined. End users' technological knowledge, local mobile healthcare systems, the quality of the intervention and also

the availability of funding must all be considered to sustain effective intellectual technology. These should all be considered when making a managerial decision. As these strategies are targeted at regional patients and mobile healthcare providers to promote autonomy and mHealth promotion in regions, the importance of this information becomes even greater (Bassi *et al.*, 2018).

(6) This research looks into how mHealth integration with intellectual technology affects the healthcare sector.

5.2 Theoretical implications of the research

The implementation of BCT (Xiong *et al.*, 2018), a new innovation, can help governments and healthcare management organisations to make concrete decisions about policy planning, resource allocation, waste management (Swain *et al.*, 2017), how to address unique health concerns and regional needs (Ahram *et al.*, 2017). By examining these barriers, managers can encourage the motivation of their healthcare sectors to adopt mHealth services and take the crucial remedial action as developed in Figure 5. Blockchain-integrated mHealth systems provide a high level of safety and ensure patient privacy. Important features offered by this platform are immutability, non-repudiation, clarity and a decrease in the need for middlemen. In light of this, this study provides a unique method for using blockchain based in mHealth systems. We provide a method of authentication that links each monitoring equipment to the certified mHealth application. There have been numerous proposals to integrate BCT with individual health record systems in order to protect patient privacy (Dwivedi *et al.*, 2019; Shen *et al.*, 2019; Yue *et al.*, 2016). As intellectual technology has developed rapidly, patients need secure and safe availability of services through BCT. It is connected with mHealth delivery in smart watches, clothes and many more accessories. All types of medical data can be kept and shared securely by patients as well as healthcare workers in a blockchain network called healthcare data gateway architecture (HGD) using cloud storage (Yue *et al.*, 2016). In order to remove the need for a central organisation that generally controls and distributes data, blockchain is made a crucial component of this system. It provides a distributed ledger that can keep an immutable record of network transactions (Alladi *et al.*, 2019). There is no



Source(s): Authors own work

Figure 5. Conceptual development of mHealth with intelligent technologies

requirement for a trusted third party, often present in cryptographic systems, to generate and provide users with the encryption/decryption keys. The role of trusted authority is taken over by the administrator device. In this approach, the patient can create keys on their own and restrict who has access to the data (Tomaz *et al.*, 2020). Finally all blockchain networks are connected with health insurance providers, policy makers, pharmacies, hospitals and many other relevant agencies. This can be very helpful for patients and all healthcare workers, while providing safety and security. The speciality of this system is the capability of handling patients' medical records; this is only possible with the permission of each individual patient. This feature is represented by a two headed arrow between mHealth and blockchain services as shown in Figure 5. Therefore, whenever and wherever you go for a health check, there is no need for the same health checkup to be repeated. The conceptual development of mHealth integrated BCT can be a valuable tool for management to improve a hospital's performance through intellectual technology (Ichikawa *et al.*, 2017; Pinto *et al.*, 2022; Sharma *et al.*, 2023; Wang *et al.*, 2023). It can help to overcome the barriers faced by mHealth services.

6. Conclusion

Sustainability difficulties and problems in various sectors, particularly mHealth sustainability, have risen sharply. Mobile healthcare facilities are no exception. Sustainability should be reflected in their normal practice for a variety of reasons, including the consideration of sustainable mHealth with intellectual technologies. Given the complexity of the topic of sustainable mHealth management with social cognitive theory, this study has constructed a conceptual analysis in order to discover the relationships between the barriers to adopting sustainable mHealth management utilising the views of both health care professionals and mHealth users. Given the abundance of cybercriminals in this digital age, healthcare institutions struggle with security and privacy challenges. BCT offers some potential solutions for these problems. In order to ensure the confidentiality of medical information, this study suggests some social cognitive ideas based on blockchain architecture for intellectual healthcare systems. Mobile health service organised training modules on intellectual technology can help healthcare professionals keep up to date on methodological, social and legal issues. In India, progress in the use of mobile healthcare is projected to continue, creating a highest quality standard. A more robust healthcare delivery system than both South Africa and Germany is the objective. With government supervision, providing 5G network to the healthcare industry with the adoption of BCT to address privacy and security concerns, will be of great benefit to the mobile healthcare industry.

This paper advances the current knowledge base by revealing the structural links that exist between influential mHealth barriers. Based on conversations and working experiences with a group of 21 experts and professionals from healthcare management, we have established 15 relevant intellectual technology barriers on applying mHealth services. We have scrutinised their links and influence by using an ISM technique. Our findings support the associated literature in terms of the impact of each of the intellectual technology's barriers on mHealth integration. These factors constitute a structured system of seven levels with different degrees of influence of each barrier on the others. Amongst the findings of our work, we note in particular, the influence and driving power of the nature of the relationships between intellectual technologies on the implementation of mHealth services. We find that government economic conditions and security attachment to the devices have high influence on the execution of mHealth services. This leads to the privacy issue of healthcare data as well as creating problems in the relationship of doctor to patients. We also observe that management support is essential by implementing BCT for mHealth deployment. The suggested plan secures the generation and maintenance of information sheets, which enhance the functionality of the healthcare system. Priorities are government economic conditions and security issues, both in the last level. Understanding how these two barriers affect the implementation of mHealth with intellectual technology can help managers when planning and allocating resources to achieve the best possible outcomes.

A mobile health service that approaches viable resolutions is easy and economical; it can help to encourage a logical allocation and ensure availability of medical resources in the long run. Despite giving useful insights into the inter-relationships amongst numerous barriers affecting mHealth practices in the Indian healthcare sector, this model fails to quantify the impact of each aspect. Future research can employ a graph theoretic and matrix technique to quantify the influence of each element. Furthermore, this approach is reliant on expert judgement and has not been statistically tested. SEM can evaluate a model that has previously been developed, but is unable to create the initial model. Because ISM and SEM are complementary in nature, SEM will be used to evaluate the adequacy of the model in future.

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