# A Select Study of Mobile Health Applications in Indian Context

**Thesis**

submitted in partial fulfillment of the requirements for the degree of

**DOCTOR OF PHILOSOPHY**

by

**RAJESH R. PAI**

**SCHOOL OF MANAGEMENT**

**NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA,**

**SURATHKAL, MANGALORE – 575025**

**MAY, 2020**

# A Select Study of Mobile Health Applications in Indian Context

**Thesis**

submitted in partial fulfillment of the requirements for the degree of

**DOCTOR OF PHILOSOPHY**

by

**RAJESH R. PAI**

(165126SM16F05)

**Under the guidance of**

**Dr. Sreejith A**

**SCHOOL OF MANAGEMENT**

**NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA,**

**SURATHKAL, MANGALORE – 575025**

**MAY, 2020**

**DECLARATION**

I hereby *declare* that the Research Thesis entitled "**A SELECT STUDY OF MOBILE HEALTH APPLICATIONS IN INDIAN CONTEXT"** which is being submitted to the **National Institute of Technology Karnataka, Surathkal** in partial fulfilment of the requirements for the award of the Degree of **Doctor of Philosophy in Management** is a *bonafide report of the research work carried out by me*. The material contained in this thesis has not been submitted to any University or Institution for the award of any degree.

**Mr. Rajesh R. Pai**
Reg. No.: 165126SM16F05
School of Management

Place: NITK, Surathkal

Date: 29-05-2020

# CERTIFICATE

This is to *certify* that the Research Thesis entitled **"A SELECT STUDY OF MOBILE HEALTH APPLICATIONS IN INDIAN CONTEXT"** submitted by Mr. Rajesh R. Pai (Register Number: 165126SM16F05) as the record of the research work carried out by him, is *accepted as the Research Thesis submission* in partial fulfilment of the requirements for the award of degree of Doctor of Philosophy.

**Dr. Sreejith A**
Research Guide
Assistant Professor
School of Management
NITK, Surathkal - 575025

**Chairman, DRPC**
(Signature with Date and Seal)

# DEDICATION

***This thesis is dedicated to my beloved parents, wife, and sons***

## ACKNOWLEDGEMENT

The completion of this thesis would not have been possible without the support and cooperation of many people along the way.

I express my sincere gratitude to my research advisor **Dr. Sreejith A**, Assistant Professor, School of Management, National Institute of Technology Karnataka (NITK), Surathkal, for his constructive support and guidance throughout the course of my study, research, and thesis writing. Optimism, positive outlook, trust, urge for excellence, enthusiasm, and wisdom have been my experiences with him. I will remain highly indebted to him for being very patient and understanding in mentoring me.

I whole-heartedly thank my research progress assessment committee, **Dr. Anish S**, Associate Professor, Department of Mechanical Engineering, NITK, Surathkal, **Dr. Rajesh Acharya H**, Associate Professor, School of Management, NITK, Surathkal, **Dr. Savita Bhat** Assistant Professor, School of Management, NITK, Surathkal and our former secretary **Dr. Suprabha K. R**, Assistant Professor, School of Management, NITK, Surathkal for the guidance at each step of my study. I also express my gratitude to all my **Faculty Members** in the School of Management, NITK Surathkal, for their kind help.

I am extremely grateful to **Dr. S. Pavan Kumar**, Head & Associate Professor, School of Management, NITK Surathkal, and our previous head of the department **Prof. Dr. K B Kiran**, Professor, School of Management, NITK, Surathkal for their support in the successful completion of this research work.

I take this opportunity to thank **Prof. Dr. D. Srikanth Rao**, Director, Manipal Institute of Technology (MIT), Manipal and our previous Director **Prof. Dr. G. K. Prabhu** and all administrators of MIT and Manipal Academy of Higher Education (MAHE) for their encouragements at many instances during this research work.

I am thankful to **Mr. Francis Prashanth**, Senior Project Manager, Strategy and Projects Office at Novo Nordisk, for providing me an opportunity to attend Health 2.0 India conference 2017 by waiving the registration fees and helping me in meeting the experts, **Prof. Dr. Srinivasan Kannan**, Professor, Achutha Menon Centre for Health

Science Studies, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, for answering my queries at the conference.

I have to thank **Prof. Dr. B. Gopalkrishna**, Head, Dept. of Humanities & Management, MIT, Manipal, our previous head of the department **Prof. Dr. Lewlyn L. R. Rodrigues**, Professor, Dept. of Humanities & Management, MIT, Manipal, and **Dr. Asish Oommen Mathew**, Assistant Professor, Dept. of Humanities & Management, MIT, Manipal for their support in completion of this work.

I wish to thank my fellow research scholars **Naganna Chetty, Vanitha P. S** and **others** for their kind help. I extend my immense gratitude to my **Teachers, Colleagues, and Friends** at NITK Surathkal and MIT Manipal for their professional guidance, support, and unlimited motivation. I must thank the **Students, Patients, Doctors, and Software Developers,** whose participation made the research possible. I thank the **Reviewers** and **Publishers** of the research articles for their expert guidance.

My special thanks to all **Supporting Staff** at NITK Surathkal and MIT Manipal for helping me during these years of my study both academically and officially.

I salute many more persons, who one way or the other contributed to this thesis and whose names could not be documented for want of space.

I am deeply indebted to my wife, **Mrs. Amrithalakshmi,** sons, **Mr. Rajath R. Pai,** and **Mr. Ranjith R. Pai,** who bear with me patiently and stood like a pillar in my bad times. I express my heartfelt thanks to my **Parents, Sister, in Laws,** and extended **Family Members** for their prayers, patience, and understanding during these years.

The sad and untimely demise of my grandmother **Ms. Prema G. Pai,** is a huge personal loss to me. I remember with gratitude for her heavenly blessings.

Above all, I thank **God Almighty** for the blessings He bestowed upon me and for giving me the strength and wisdom to reach this milestone in my life. I will always remain grateful to you. Thank you.

***Rajesh R. Pai***

# EXECUTIVE SUMMARY

Mobile health (mHealth) is an essential requirement in healthcare for improving health service delivery. Despite its increasing attention across different countries, there is a dearth of evidence about its usefulness among Indian populations. The literature considers mHealth as "the use of transportation systems such as mobile medical units or vans and/or mobile phone/ICT for providing health service to the people living in a particular locality". The study aims to answer the research question "how to improve the usefulness of mobile health applications for health service delivery?" by i) analyzing the accessibility and acceptance of mobile health among the rural population; ii) studying affordability in terms of cost to consumer and financial viability of the service provider; and by iii) identifying the awareness level in the use of mobile health applications among the citizens. A convergent mixed method design has been carried out to address the research objectives.

A qualitative interview was used to measure the accessibility and acceptance of mHealth among rural regions. The study identified a lack of awareness about the term and government-initiated applications among people and doctors though it has been used for vaccination remainders and cessation programmes. The programmes and applications are available at places where network and its supporting technologies are connected to scheduling vaccinations and conducting regular interventions. The consolidation of interview findings proposed an acceptance model pertaining to rural Indian populations. The affordability of mHealth is measured by conducting interviews among technology entrepreneurs and software developers. Findings illustrated that people's need and unwillingness, lack of application infrastructure, ecosystem development, governmental policies, and training and support influences mHealth systems implementations. As Twitter in health research is a growing body of work, the study extracts its messages and performs sentiment analysis to analyze emotions and themes surrounding mHealth applications, social media games, social media movement, and mental health.

A quantitative survey approach is adopted to study the awareness level in the use of the mobile phone for health communication and delivery, and self-managing health applications among the technical and working staffs and medical and health

professionals. The study also tested the relationships between the individual characteristics, adoption characteristics of new product or service, individual cognitive factors, and health-related use behavior. The results showed that personal innovativeness, awareness, and perceived usefulness tends to explain better intention to use than they do individually.

A triangulation of studies explains that the dynamics associated with mHealth applications in the real environment are somewhat disorganized and formed a vicious cycle. This resulted in a sense of dissatisfaction among the people, healthcare practitioners, government, and the techno-entrepreneurs. The need for a sensitization programme, the right policy and the governance framework for mHealth applications would contribute to the nation’s health policy objective. Thus, recommendations from healthcare professionals influence users and patients in improving awareness that subsequently improves the intention to use and acceptance for health service delivery.

This thesis contributes by integrating multiple theoretical models and methods, i.e., qualitative and quantitative, towards the development of mobile health framework for investigating a research question. Compared to earlier studies, this study examines the relationships across the layers of people, process, and technology for achieving the research question. Future research can consider mHealth accessibility in-terms of the digital divide and medical divide, and the influence of trust, technology anxiety, environmental concerns, health severity, health susceptibility, and behavioral control on awareness and intention to use can be studied.

# TABLE OF CONTENTS


| | | |
|---|---|---|
| **EXECUTIVE SUMMARY** | | |
| **TABLE OF CONTENTS** | | i |
| **LIST OF FIGURES** | | v |
| **LIST OF TABLES** | | ix |
| **LIST OF ABBREVIATION** | | xi |
| **CHAPTER 1.** | **INTRODUCTION** | |
| 1.1 | Introduction | 1 |
| 1.2 | Definition of Mobile Health | 2 |
| 1.3 | Mobile Health Technology: Strength and Weakness | 4 |
| 1.4 | International Mobile Health Initiatives and Evidences | 6 |
| 1.5 | Healthcare Policies in India | 8 |
| 1.6 | Mobile Health in India | 14 |
| 1.7 | Mobile Health Applications across Different Application Stores | 20 |
| 1.8 | Motivation for the Study | 20 |
| 1.9 | Outline of the Study | 21 |
| 1.10 | Structure of the Report | 23 |
| **CHAPTER 2.** | **LITERATURE REVIEW** | |
| 2.1 | Introduction | 25 |
| 2.2 | Theoretical Background | 25 |
| 2.3 | Bibliometric Analysis of Mobile Health in India | 33 |
| 2.4 | Adoption of Mobile Assisted Diagnosis System | 47 |
| 2.5 | Social Media in Health Service Research | 58 |
| 2.6 | Research Gaps | 62 |
| 2.7 | Conclusion | 65 |

**CHAPTER 3. RESEARCH DESIGN**

| | | |
|---|---|---|
| 3.1 | Introduction | 67 |
| 3.2 | Research Question | 67 |
| 3.3 | Research Objectives | 67 |
| 3.4 | Conceptual Framework and Hypothesis | 68 |
| 3.5 | Operational Definitions | 69 |
| 3.6 | Context and Scope of the Study | 70 |
| 3.7 | Research Methodology | 75 |
| 3.8 | Conclusion | 87 |

**CHAPTER 4. QUALITATIVE STUDY**

| | | |
|---|---|---|
| 4.1 | Introduction | 89 |
| 4.2 | Accessibility and Acceptance of Mobile Health | 89 |
| 4.3 | Affordability of Mobile Health System | 108 |
| 4.4 | Sentiment Analysis of Social Networking Applications Health Content | 133 |
| 4.5 | Conclusion | 168 |

**CHAPTER 5. QUANTITATIVE STUDY**

| | | |
|---|---|---|
| 5.1 | Introduction | 173 |
| 5.2 | Descriptive Statistics of Awareness and Use | 173 |
| 5.3 | Hypothesis Testing of Awareness and Intention to Use | 181 |
| 5.4 | Discussion | 191 |
| 5.5 | Conclusion | 196 |

**CHAPTER 6. SYNTHESIS, IMPLICATIONS, AND RECOMMENDATIONS**

| | | |
|---|---|---|
| 6.1 | Introduction | 199 |
| 6.2 | Synthesis of the Study | 199 |
| 6.3 | Implications of the Study | 221 |
| 6.4 | Recommendations for Improving Mobile Health Applications’ Usefulness in India | 223 |

**CHAPTER 7. CONCLUSIONS**


| | | |
|---|---|---|
| 7.1 | Introduction | 239 |
| 7.2 | Summary of Empirical Study Findings | 239 |
| 7.3 | Revisiting the Research Question | 251 |
| 7.4 | The Answer to Research Question | 253 |
| 7.5 | Contribution of this Study | 256 |
| 7.6 | The Novelty of this Study | 258 |
| 7.7 | Limitations of this Thesis | 259 |
| 7.8 | Suggestions for Future Research | 261 |
| 7.9 | Conclusions | 262 |

**REFERENCES** 263

**APPENDIXCES** 321

**BIO-DATA** 335

## LIST OF FIGURES


| | | |
|---|---|---|
| Figure 1.1 | Select healthcare policies of India | 9 |
| Figure 1.2 | Global broadband subscription and Internet usage (millions) | 21 |
| Figure 2.1 | PRISMA flow diagram for selecting a research paper | 34 |
| Figure 2.2 | Wordcloud for keywords | 36 |
| Figure 2.3 | Documents by year | 36 |
| Figure 2.4 | Network visualization mapping for the keywords listed by the authors | 38 |
| Figure 2.5 | Network visualization mapping for the most prolific authors | 39 |
| Figure 2.6 | Network visualization mapping for the journal co-citation analysis | 40 |
| Figure 2.7 | Network visualization mapping for the reference co-citation analysis | 40 |
| Figure 2.8 | Network visualization mapping for the document bibliographic coupling | 41 |
| Figure 2.9 | The main themes of the study | 43 |
| Figure 3.1 | Conceptual framework of the study | 68 |
| Figure 3.2 | Convergent mixed method design | 76 |
| Figure 4.1 | A data structure of rural populations' responses for using mobile phones for health activities | 93 |
| Figure 4.2 | Proposed technology acceptance model for mobile health acceptance | 106 |
| Figure 4.3 | Conceptual-analytical model for affordability | 109 |
| Figure 4.4 | Flow diagram for extracting tweets | 134 |
| Figure 4.5 | Bigram for fitness applications | 135 |
| Figure 4.6 | Word cloud for fitness applications | 135 |
| Figure 4.7 | Sentiment analysis for fitness app based on polarity | 136 |
| Figure 4.8 | Sentiment analysis for fitness app based on emotion | 136 |
| Figure 4.9 | Bigram for diabetes applications | 137 |
| Figure 4.10 | Word cloud for diabetes applications | 138 |
| Figure 4.11 | Sentiment analysis for diabetes app based on polarity | 138 |
| Figure 4.12 | Sentiment analysis for diabetes app based on emotion | 139 |

| | | |
|---|---|---|
| Figure 4.13 | Bigram for meditation applications | 140 |
| Figure 4.14 | Word cloud for meditation applications | 140 |
| Figure 4.15 | Sentiment analysis for meditation app based on polarity | 141 |
| Figure 4.16 | Sentiment analysis for meditation app based on emotion | 141 |
| Figure 4.17 | Bigram for cancer applications | 142 |
| Figure 4.18 | Word cloud for cancer applications | 143 |
| Figure 4.19 | Sentiment analysis for cancer app based on polarity | 143 |
| Figure 4.20 | Sentiment analysis for cancer app based on emotion | 144 |
| Figure 4.21 | Boxplot for mobile health applications | 145 |
| Figure 4.22 | Sentiment scores for mHealth applications | 146 |
| Figure 4.23 | Causal loop diagram showing the relationship between the potential adopters, semi-adopters, and adopters of the mHealth system | 148 |
| Figure 4.24 | Causal loop diagram for perceived usefulness of the mHealth system | 149 |
| Figure 4.25 | Sentiment value based on polarity (I Phase) | 151 |
| Figure 4.26 | Sentiment value based on emotion (I Phase) | 151 |
| Figure 4.27 | Sentiment value based on polarity (II Phase) | 152 |
| Figure 4.28 | Sentiment value based on emotion (II Phase) | 152 |
| Figure 4.29 | Causal loop diagram for social media game | 154 |
| Figure 4.30 | Sentiment analysis based on polarity and emotions (social media movement) | 155 |
| Figure 4.31 | Boxplot for social media movement | 156 |
| Figure 4.32 | Sentiment scores for social media movement | 156 |
| Figure 4.33 | Emotion word cloud for mental health | 162 |
| Figure 4.34 | Sentiment analysis for mental health based on polarity and emotions | 162 |
| Figure 5.1 | Research model | 185 |
| Figure 5.2 | Results of the path analysis | 191 |
| Figure 6.1 | Rich picture of mobile health technology and application initiation and adoption | 216 |

| | | |
|---|---|---|
| Figure 6.2 | Rich picture explaining interactions between health officers (central and region) and software developer | 217 |
| Figure 6.3 | Rich picture explaining interactions between health professionals, health officers (region), and software developer | 218 |
| Figure 6.4 | Rich picture explaining interactions between people, health professionals, and software developer | 220 |
| Figure 6.5 | Rich picture explaining interactions between software developer, health officers (regions) and people | 221 |
| Figure 6.6 | The proposed architecture for mobile health systems in India | 234 |
| Figure 6.7 | Matrix for governance of digitalized system in health improvement | 236 |

# LIST OF TABLES


| | | |
|---|---|---|
| Table 1.1 | Strengths and weaknesses of mobile health services | 4 |
| Table 1.2 | Select health, information, and technology policies in India | 11 |
| Table 1.3 | Select health and information and communication technology indices of India | 13 |
| Table 1.4 | Select mobile health and applications units in India | 18 |
| Table 2.1 | Factors influencing awareness and acceptance of mHealth | 32 |
| Table 2.2 | Components identified from wordcloud and its classification | 36 |
| Table 2.3 | Details of the bibliographic coupling clusters | 42 |
| Table 2.4 | Select literature on awareness and use of mobile phones for health activities | 49 |
| Table 2.5 | Theories and identified variables for measuring intention to use | 51 |
| Table 2.6 | Select literatures on accessibility | 53 |
| Table 2.7 | Factors of affordable system overall effectiveness | 57 |
| Table 2.8 | Constituents of sentiment for secondary data analysis | 61 |
| Table 2.9 | Select research gaps identified from the literature | 63 |
| Table 3.1 | Operational definitions | 69 |
| Table 4.1 | Participant demographics survey results | 94 |
| Table 4.2 | Dimension of access for mobile health | 103 |
| Table 4.3 | Accessibility of select mobile health applications | 105 |
| Table 4.4 | Select mobile phones features and apps for health | 118 |
| Table 4.5 | Total number of tweets extracted | 134 |
| Table 4.6 | Tweets for fitness applications | 137 |
| Table 4.7 | Tweets for diabetes applications | 139 |
| Table 4.8 | Tweets for meditation applications | 142 |
| Table 4.9 | Tweets about cancer applications | 144 |
| Table 4.10 | Boxplot values for mobile health apps | 145 |
| Table 4.11 | Emotions and Prominent keywords for mental health | 161 |
| Table 4.12 | Summary of main themes and sub-themes identified for mental health | 164 |
| Table 5.1 | Respondents demographic characteristics | 175 |

| | | |
|---|---|---|
| Table 5.2 | Mobile phone use for health conditions | 177 |
| Table 5.3 | Comparison of the awareness about mobile phone use for health-related components among technical students and working staff, and medical students and health professionals | 178 |
| Table 5.4 | Comparison of the use of self-managing apps among technical students and working staff, and medical students and health professionals based on Chi-square test results | 179 |
| Table 5.5 | Participants demographic characteristics | 187 |
| Table 5.6 | Assessment of validity | 190 |
| Table 5.7 | Significant test results for hypothesized direct effects | 194 |
| Table 6.1 | Common variables and practices identified through the Twitter sentiment analysis | 202 |
| Table 6.2 | Synthesis matrix for awareness | 208 |
| Table 6.3 | Synthesis matrix for accessibility | 210 |
| Table 6.4 | Synthesis matrix for acceptance | 212 |
| Table 6.5 | Synthesis matrix for affordability | 214 |

## LIST OF ABBREVIATION

| | |
|---|---|
| ANM | Auxiliary Nurse Midwives |
| APPS | Applications |
| ASHA | Accredited Social Health Activists |
| ASOE | Affordable System Operational Effectiveness |
| ATT | Attitude |
| AU | Actual System Use |
| AVE | Average Variance Extracted |
| AYUSH | Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy |
| BI | Behavioral Intention to Use |
| BoP | Base of Pyramid |
| CDSCO | Central Drugs Standard Control Organization |
| CFI | Comparative Fit Index |
| COPD | Chronic Obstructive Pulmonary Disease |
| DoD | Department of Defense |
| DoI | Diffusion of Innovations |
| DOTS | Directly Observed Treatment Short course |
| EE | Effort Expectancy |
| eHealth | Electronic Health |
| eHL | eHealth Literacy |
| EHR | Electronic Health Record |
| FC | Facilitating Conditions |
| FDA | Food and Drug Administration |
| GFI | Goodness-of-Fit Index |
| GoI | Government of India |
| HBM | Health Belief Model |
| HC | Health Consciousness |
| HCP | Healthcare Provider |
| HFW | Department of Health and Family Welfare |
| HIMSS | Healthcare Information and Management Systems Society |
| HIO | Health Information Orientation |

| | |
|---|---|
| HIPAA | Health Insurance Portability and Accountability Act |
| HITECH | Health Information Technology for Economic and Clinical Health |
| HIV | Human Immunodeficiency Virus |
| ICT | Information and Communication Technologies |
| IT | Information Technologies |
| IoT | Internet of Things |
| IUSSTF | Indo-U.S. Science and Technology Forum |
| IVR | Interactive Voice Response |
| ITU | International Telecommunication Union |
| M-Cessation | Mobile Cessation |
| MCTS | Mother and Child Tracking System |
| mHealth | Mobile Health |
| MDDS | Metadata and Data Standards |
| MDG | Millennium Development Goals |
| MOHFW | Ministry of Health and Family Welfare |
| MSEE | Mobile-Service-Enabled Empowerment |
| NDHA | National Digital Health Authority |
| NFC | Near Field Communication |
| NHP | National Health Policy |
| NHM | National Health Mission |
| NITI | National Institution for Transforming India |
| PE | Performance Expectancy |
| PEOU | Perceived Ease of Use |
| PI | Personal Innovativeness |
| PNDT | Pre-Natal Diagnostic Technique |
| PU | Perceived Usefulness |
| PHC | Primary Healthcare Centres |
| RCH | Reproductive and Child Health |
| RMSEA | Root Mean Square Error of Approximation |
| SDG | Sustainable Developmental Goals |
| SI | Social Influence |

| | |
|---|---|
| SRMR | Standardized Root Mean Square Residual |
| SN | Subjective Norm |
| SMS | Short Message Service |
| TAM | Technology Acceptance Model |
| TB | Tuberculosis |
| TRAI | Telecom Regulatory Authority of India |
| TLI | Tucker-Lewis Index |
| UIP | Universal Immunization Programme |
| UGC | User-Generated Content monetization |
| UN | United Nations |
| UTAUT | Unified Theory of Acceptance and Use of Technology |
| WHO | World Health Organisation |

# CHAPTER 1

# I N T R O D U C T I O N

## 1.1. Introduction

The modern-day healthcare sector is transforming its traditional system of health service delivery to a more technology driven system. This is because of changes in peoples' lifestyle and preferences in using digital devices (such as mobile phones, wearables, tablets, etc.) which supports them in mobility, reachability, compatibility, and convenience (Kim et al., 2010). These technologies find their use in health monitoring and in communicating data to healthcare professionals at the right time in order to stay healthy, save time, and to reduce out-of-pocket expenditures. Internet of Things (IoT), the key driver for most of the digital transformations, coupled with 4G and 5G networks, is connecting individuals and doctors with personal devices and technologies for the betterment of health and quality of life across different regions. On the other hand, implementation of information systems such as decision support systems also plays an important role in sustaining competitive environment (Wang and Liu, 2005).

Realizing the potential of broadband services for health quality enhancement, the healthcare department included a process of telemedicine, Electronic Health Records (EHRs), mobile health applications (mHealth apps), etc. This surge in empowering people and healthcare through these devices and processes can be labeled as mobile health (mHealth) and can be defined as *"emerging mobile communications and network technologies for healthcare systems"* (Istepanian et al., 2006). These applications not only help patients in reducing waiting times and visits but also assist doctors in managing and accessing medical records centrally fostering patient-centric approach (Qiang et al., 2011). In low resource setting areas and developing countries, mobile health services are used for monitoring health and disease conditions. These include applications for educating people and for providing patient-centric solutions (Beratarrechea et al., 2014). These applications, through smartphones and mobile phones, are being used in countries like India, Ghana, Thailand, and Uganda. They are used for creating awareness about AIDS/HIV and TB (through SMS and call alerts); for measuring healthcare programs effectiveness; reminding patients about medication and appointments; for equipping them with required health videos and information supporting empowerment; for providing vaccinations based on evidence in the affected areas (National Health Portal of India [NHP], 2016; Sandhu, 2011; West, 2015).

The mobile health field has emerged in recent years largely due to the increase in the use of mobile phones and Internet subscriptions. It has emerged with the intention of providing access to quality healthcare facilities to the people living in low-income nations and developing countries (Mills, 2014). It basically refers to the use of mobile technology or wireless devices in receiving or communicating health information through multiple interphases with or without the use of mobile applications. These technologies help the public in creating awareness about various health-related problems, locating and scheduling appointments with doctors and physicians, resulting in continuous monitoring and treatment. Realizing these benefits, many stakeholders and techno-entrepreneurs are continuously trying to connect these devices to the public through healthcare summits in collaboration with the World Health Organization, Healthcare Information and Management Systems Society (HIMSS), etc. These devices, therefore, act as a companion for the people living in the urban and rural regions where the access to healthcare facilities is limited.

Moreover, in recent times, various research and consultation organizations have indicated that in the year 2022, the mHealth market will improve by 90.49 Billion USD (Markets and markets, 2017) by initiating mHealth solutions in the form of Short Message Service (SMS), Interactive Voice Response (IVR), or apps. These improvements are also observed in the Gartner's technology hype cycle of the year 2017 especially for the components and devices of augmented reality and IoT's (Panetta, 2017). In addition, USA, UK, and Germany are considered to be most attractive countries with India managing 8$^{th}$ position for digital health solution, based on market size, investor access and acceptance (Research2guidance, 2017).

### 1.2. Definition of Mobile Health

The purpose of this study is to improve the usefulness of mobile health application for health service delivery in the Indian context. With this aim, the current study defines the concept of usefulness as the intended use of information for understanding, gaining control, adapting or acting. It is measured based on cognition level (improving the patient knowledge and information), emotion level and intended behavior (assist a patient in managing illness) (Hölzel et al., 2015). Generally, patients measure usefulness in terms of final outcomes involved in the process of reading, understanding and responding to patient information material (Garner et al., 2012). In order to improve the usefulness, there people should have proper awareness level, favorable attitude, self-efficacy, and ease of use to predict new technology adoption (Ma and Liu, 2005). The authors have also pointed out that the components related to data confidentiality, interoperability, and reimbursement should also be addressed to increase the adoption.

Mobile technology is proved to be an important tool across various domains, and among them, the healthcare industry is one such domain which is penetrated with many solutions of providing care to the patients. Mobile health (mHealth) is an eHealth sub-segment which is defined as “a technique that uses Information and Communication Technologies (ICT) such as computers, mobile phones, communications satellite, patient monitors, etc., for accessing, storing, monitoring and delivering health services and information” (Vital Wave Consulting, 2009). The term ‘mobile health’ was coined by Robert Istepanian as “emerging mobile communications and network technologies for healthcare systems” (Istepanian et al., 2006). To date, there is no universal definition for mHealth, yet a couple of research associations or organizations have tried giving the term some definition. Some of the most commonly used definitions are presented below:

- In a mHealth Summit of the Foundation for the National Institutes of Health (2010), mHealth was defined as "the delivery of healthcare services via mobile communication devices" (Torgan, 2009).
- World Health Organisation (WHO), Global Observatory for eHealth (Goe) defined “mHealth or mobile health as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices” (World Health Organization, 2011).
- Healthcare Information and Management Systems Society (HIMSS) defines mHealth as “the connected health which is the generation, aggregation, and dissemination of health information via mobile and wireless devices and the sharing of that information between patients and providers” (mHealth, 2017).

Based on the above definitions we can define mobile health as the *“the use of transportation systems such as mobile medical units or vans and/or mobile phone/ICT* *for providing health services to the people living in a particular locality or self-care"* (Pai and Alathur, 2019). This definition instills that, mobile phones, smartphones, and mobile vans are considered to be the components of mobile health, and are used for improving health service delivery. However, this study is limited to the usefulness of mobile phones applications and smartphones applications in seeking health information and communication.

## 1.3. Mobile Health Systems: Strength and Weakness

It has been found that, in the initial phase of health service digitization, the healthcare professionals and stakeholders have to manage complexities in designing the system for its governance. The following Table 1.1 below, as supported by the literature (Aranda Jan et al., 2014; Pereira et al., 2015; Shiple, 2012; Sondaal et al., 2016; Zurovac et al., 2012; Keikhosrokiani et al., 2019) and multiple study findings, presents strengths and weaknesses in using mobile health technology for health service delivery.

**Table 1.1:** Strengths and weaknesses of mobile health services

| Strengths | Weaknesses |
|---|---|
| ***Sustainability of project*** | |
| It improves the mode of delivering health for receiving immediate access to healthcare through scheduling of doctors' appointments or managing of electronic health records. | Study results are not consistent with the patient data. |
| | Lack of evidence about the changes in the health outcomes especially when mobile health applications are used. |
| | The study reported that most of the health applications available in the play stores are suboptimal. |
| Mobile health technology helped rural people in receiving appointment reminders for vaccination, intervention, etc. from their primary healthcare centers during their maternal period and post maternal period. | Increased anxiety in using mobile phones for healthcare was reported in most of the cases due to non-physical interaction in receiving information. |
| It helped healthcare workers in avoiding multiple patients' registrations for ensuring continuous patient health monitoring. | Due to problems of literacy, people have difficulties in reading health-related information from their mobile phones. |
| The system helps in receiving accurate patient records during clinical intervention for providing timely medication and treatment. | Problems of data under-reporting and biased responses are observed in some of the cases. |

| | |
|---|---|
| ***Health system integration*** | |
| Supports patient management | Lack of awareness and unclear operating procedure among the people are needed for proper scaling-up of the mHealth system. |
| A public-private partnership has proved to be helpful and effective in the case of a telemedicine unit. | Lack of training and inadequate labor standards should be remedied for proper channelizing of the mHealth use. |
| The commitment of the government and other stakeholders towards a strategy of the country which is aligned with the WHO and others. | Inadequate health infrastructure and interoperability in certain areas resulted in the low and slow adoption of mHealth services. |
| Social influence or subjective norm such as recommendations from the doctors assist people in using mHealth services. | Most of the technology entrepreneurs and government are working towards electronic health and mobile health implementation; but only a few companies have integrated into health systems, and the rest all are working individually. |
| Initiation and implementation of research kit help in generating and supporting evidence-based practices. | |
| ***Project management process*** | |
| It supports provision for training of staff and user, depending upon their need and workflow. | The response rate is less when the application is not tailored to user needs. |
| It helps in delivering healthcare access with minimum human resource personnel. | In certain cases and emergencies, the absenteeism of workforce and staff will effect negative word-of-mouth information and dissatisfaction among people. |
| Building strong relationships between users and providers helps in achieving efficient use of the mHealth system. | Some literature indicated that mHealth application, when tested for a large group of the population, failed due to problems of interphase and connectivity. |
| It helps the user in identifying and scheduling appointments with the doctors available near the locality or regions. | |
| Mobile phone, with other peripheral health monitoring devices, helps the doctor in monitoring and treating patient continuously like Glucometers do for measuring patients' blood sugar level or febrile seizure detecting devices for children. | Due to the receipt of multiple information, the patient may find it difficult to identify and locate a solution which matches with his/her health conditions. |
| Mobile health applications help users in receiving financial incentives and offers related to medicines and other insurance services. | Lack of recommendations from the governing body or healthcare personnel leads to poor acceptance of mobile health services. |

| *Legal issues, regulations, and standards* | |
|---|---|
| In the case of mobile health application for detecting the authenticity of medication, bar-code and QR code reduce security issues. | Perceived trust and privacy concerns were a major factor for using mobile phones for health. |
| Food and Drug Administration (FDA) approved applications and services are currently transforming the way the health service is delivered. | There might be absence of FDA authority over certain application, and problems of data theft can be a reason for low adoption. |
| | Cultural norms can also play an important role in mHealth service use. |
| ***Technology and Infrastructure*** | |
| Most of the people in semi-urban areas have knowledge of using mobile phones for communication, mostly for calling. | Literature indicates that the use of mobile health systems influences problems related to battery consumption, overheating, etc. |
| People in the rural regions are not much literate so as to use mHealth apps, but if training is given, and technology is easy-to-use, then they are willing to use. | Problems of interoperability have been observed in most part of the semi-urban and rural regions. |
| The process of 99DOTS and medication remainders has helped doctors in health management because of flexible central database systems for reporting the disease condition to their peers. | In certain areas, the primary healthcare is not upgraded with necessary health facilities and doctors, which has created a negative feeling among doctors and patients. |

From the table 1.1, it can be concluded that sustainability of the project, health system integration, project management process, legal issues, regulations, and standards, and technology infrastructure should be considered for effective development of mobile health system.

### 1.4. International Mobile Health Initiatives and Evidences

The international healthcare system provides components related to health insurance, health system organization and governance, health care quality and coordination, cost containment and innovation for achieving it (The Commonwealth Fund, 2016). For promoting and delivering system integration and care, the government of Denmark made mandatory health agreements between municipalities and regions in planning and approving hospital plans and assessment of health technology by comparing reports so as to benchmark the performance of individual hospitals (Vrangbaek, 2016). Similarly, for governing health system, the government of Singapore regulates its healthcare system through legislation and enforcement. It also considers patients and other stakeholders for their sentiments and feedbacks to facilitate policy implementation (Liu and Haseltine, 2016).

Healthcare policy makers also face problems of reducing cost, improving the quality and safety of health service delivery. Moreover, with the rapid growth of mobile and communication technologies such as mobile phones, smartphones, tablets, etc. the government and the private are utilizing this channel as it can act as a promising tool for providing healthcare access. In these cases, mobile health can play an important role in providing healthcare access to people. Substantial literature is available about mHealth practices among healthcare groups and people. These groups of people have often indicated the benefits of mHealth in delivering health service to rural and urban communities. These literatures include the work specified by Silva et al. (2015) in patients diagnostic, disease control, and monitoring, helping them to provide healthcare access, regardless of time and place.

Kahn et al. (2010), listed important ways required for improving the health system of developing countries, and identified web-based data entry (mHealth tool) could be helpful in creating awareness and participation for improving disease surveillance. In addition, the effectiveness of mHealth technology in behavior change and disease management was studied by Free et al. (2013). They reported an increase in emotional self-awareness among young people suffering from mental health (Reid et al., 2012). A review by Marshall et al. (2008), concluded that smartphone use improved patients having the chronic respiratory disease in managing pulmonary rehabilitation. The change intervention and disease management through SMS have also been indicated in the systematic literature of Kayyali et al. (2017). It is also said that as part of implementation process, the healthcare providers should plan for targeted social change by providing necessary training and awareness to the health and administrative staff about the adoption of the system (Scholl et al., 2011).

In Africa, innovations in mHealth are found to be efficient and successful in delivering services for maternal care, chronic disease prevention, and management of Ebola and malaria epidemics through patient tracking and reporting in rural and urban regions (West, 2015). Similarly, TRACnet of Rwanda, Medic Mobile, MoTeCH of Ghana are some of the popular mHealth technologies and programmes are supporting the healthcare sector in HIV/AIDS, maternal and child health (Sandhu, 2011). Although the use of mobile phone in health service delivery is advantageous for the rural and urban populations, its barriers of access and lack of awareness will keep people away from using it efficiently (Boruff and Storie, 2014). Taking these factors into account, the study examines the usefulness of mobile phone and its apps for health service delivery in India.

### 1.5. Healthcare Policies in India

People across the globe are facing problems of healthcare access pertaining to the growth of various communicable and non-communicable diseases. Accordingly, the governments also have been aligning their countries health policies to that of WHO for achieving social and economic development. In India, these healthcare policies are framed according to the constitutional work structure of "right to life," obliging government towards ensuring access to health service for all (Ministry of Health and Family Welfare [MoHFW], 2009; Thomas, 2009).

The healthcare sector has been arranged by the "federal structure and the federal–state divisions of responsibilities and financing for organizing and health service delivery" (Gupta and Bhatia, 2019). In addition, the governments at the centre are responsible for "international health treaties, medical education, quality control in drug manufacturing, and family planning programs, and also prepare health policy and regulatory framework supporting the states" (Gupta and Bhatia, 2019).

The following figure 1.1, supported by the literatures (Bang et al., 2005; Curtis, 1920; Duggal, 2001; Gupta, 2011; Jagdish, 1981; Mehta, 2019; Mishra et al., 2013; NHP, 2016; National Institute of Health and Family Welfare [NIHFW], 2015; Patel, 2016; Planning Commission. Government of India, 2008, 2013, 2019; Singh and Singh, 2004; Tabish, 2001), provides select initiation and development of healthcare policies implemented in India.

### Early Initiatives (Year 1835 - 1947)

- English Education Act, Council of India supported by Lord William Bentinck.

- Medical colleges were established in Calcutta, Bombay, and Madras to support clinical training and practices and western education in India (Mishra et al., 2013).

- Montagu-Chelmsford Reforms, Government of India: Education, public health & sanitation, medical services, etc. were considered based on local interest and not for the masses (reserved lists) (Curtis, 1920).

- Year 1920: Health care expansion began through Rockefeller Foundation (Gupta, 2011).

- Year 1938: Sokhey Committee: Established national planning committee and a subcommittee to improve health situation and services (Gupta, 2011).

- Year 1946: Health Survey and Development Committee (Bhore committee): Emphasized on integrating curative and preventive medicine (National Institute of Health and Family Welfare [NIHFW], 2015).

- Year 1947: 7400 hospitals and dispensaries with a bed-population ratio of 0.24 per 1000 population (Tabish, 2001).

### Early Healthcare Expansion (Year 1948 – 1985)

- Year 1948: Health policy adopted by the first health minister conference.
- Year 1951: World Health Organization with India addressed child health and mortality as a part of first-five-year plan.
- Government sponsored family planning program initiated (Duggal, 2001).
- Year 1955: TB and leprosy control program initiated (Mehta, n.d.).

**(Second five-year-plan, 1956 - 1961)**

- Year 1958: Malaria eradication program initiated (Mehta, n.d.).
- Year 1959-62: Mudaliar Committee: Regional organizations state wise and primary health care centers were established (Sen, 2012).

**(Third five-year-plan, 1961 - 1966)**

- Year 1963: Chadah Committee: maintenance of malaria eradication program and integration of health and family planning services (Duggal, 2001).
- Year 1965 & 1966: Mukherjee Committee: pattern and financial planning under family planning. Recommended to delink malaria activities from family planning (Duggal, 2001).

**(Plan holidays, 1966 - 1969)**

- Year 1967: Jain committee: Recommended strengthening of primary healthcare across taluks and block levels including districts hospitals. Integrate medical and health services at district levels (Duggal, 2001).

**(Fourth five-year-plan, 1969 - 1974)**

- Formed auxiliary nurse midwife, basic health workers, malaria surveillance workers, vaccinators, and other health assistants.

The provision for upgrading one primary healthcare for 50000 populations equipped with a doctor, 3-4 health workers (both male and female) and female supervisor. (Jagdish, 1981).

- Shrivastav committee: 'Referral Services Complex' was established and initiated UGC reforms for health and medical education.
- Supported medical education and recommended paraprofessional and semiprofessional health workers for providing simple and curative health services.

**(Fifth five-year-plan, 1974 - 1979)**

- Healthcare accessibility was expanded to rural regions.
- Referral services was promoted across hospitals to remove deficiencies.
- Actions against eradication of communicable diseases.
- Strategies developed for improving healthcare quality by promoting health workers for education and training.
- Specialists attention was diverted towards common diseases in rural regions (Duggal, 2001).
- 'Health for All' was initialized to achieve by 2000 A.D (Singh & Singh, 2004).
- World Health Assembly endorsed and invited the Member States to formulate National Health Policy to attain targets (Singh & Singh, 2004).

**(Sixth five-year-plan, 1980 - 1985)**

- Family planning was expanded to prevent overpopulation.
- First health policy of the country was formulated and also launched rural health schemes.
- Healthcare decentralization to reduce the burden of high-level referrals (Bang et al. 2005).
- Access to government facilities especially for poor with various private investments.
- Provision for the developing health management information system was recommended.

### Technology Adoption in Healthcare (Year 1986 – 2018)

**(Seventh five-year-plan, 1985 - 1990)**

- Year 1986: Bajaj Committee: initiated specific health related programs considering clean drinking water, child norm, housing, environmental protection, and slum improvements.
- Supported alternate health delivery services, low-cost systems and technologies, and its coordination with medical systems.
- Mission approach for maternal and child health, immunization, and reproductive and child health was initiated (NHP, 2019).

**(Eighth five-year-plan, 1992 - 1997)**

- Beginning of liberalization, privatization and globalization started.
- Modernization was main agenda.
- Major objectives were controlling population growth, poverty reduction, strengthening the infrastructure, etc.

**(Ninth five-year-plan, 1985 - 1990)**

- Special emphasis was laid on health and education (Planning commission, 2019).

**(Tenth five-year-plan, 2002 - 2007)**

- Reorganization and restructuring the existing government health care system.
- Development of two-way referral systems using information technology for communication and consultation across primary care to tertiary care level.
- Logistic services for supply of drugs, vaccinations, and consumables.
- Identified alternate systems for healthcare financing.
- Skill up gradation of healthcare workers.
- Development of functional and accurate health management information system.
- Mobile clinics and mobile health units have been established in tribal areas.
- Telemedicine and consultation using information and communication systems was initiated (Planning commission, 2019).

**(Eleventh five-year-plan, 2007 - 2012)**

- Mainly targeted towards health and family welfare and Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homeopathy(AYSUH).
- Mobile medical units and mobile clinics for each districts.
- Mobile health services through Public–Private Partnership with the state.
- Mobile telemedicine van was initiated with its facility located at district hospitals and government medical colleges.
- e-Health initiatives was supported for training, education, locating facilities, and service delivery through tele-consultations (Planning commission, 2008).

**(Twelfth five-year-plan, 2012 - 2017)**

- Universal access to essential healthcare and medicine was the main agenda.
- Rashtriya Swasthya Bima Yojana was made for the Below Poverty Line (BPL) population.
- To achieve health goals, cooperation between private and public sector health care providers was established.
- Established medical schools and colleges for improving skilled human resources.
- Ensured free of cost medicines to all the patients in public facilities.
- Effective policy and regulation was put in practice to safeguard people.
- The need of a strong regulatory system and standard treatment guidelines was also given priority for improving quality and control of cost.
- Internet connectivity through mobile and computer at primary healthcare centers was initiated for strengthening integrated child development service.
- To improve research and practice on different medical condition the use of information technology and Telemedicine was prioritized (Planning commission, 2013).

**Figure 1.1:** Select healthcare policies of India

Thus, it is evident from figure 1.1 and by considering the dimensions of the environment, child norms, healthcare infrastructure, etc. that the healthcare sector in India has been progressing positively since its initiation. In the year 2000, under 'Millennium Development Goals (MDGs)', measurable goals were set to eradicate and control poverty and hunger, child mortality, maternal health, etc. (WHO, 2015). Due to the substantial and uneven achievement of MDGs and the realization of importance of sustainability for social and economic development, various Sustainable Development Goals (SDGs) have been put in place considering various issues, with goal 3 being specifically addressed towards good health and well-being for people (WHO, 2015). Moreover, each of these SDGs has been largely equipped with a digital component; the countries' health policies have also been revised. Considering sustainability and its integration with health services, the Indian government also revised its health policies in the year 2017 as 'National Health Policy (NHP) 2017'.

The main goal of this policy is to "achieve the highest possible level of good health and well-being for all Indians through a preventive and promotive healthcare orientation in all developmental policies, and to achieve universal access to good quality healthcare services without anyone having to face financial hardship as a consequence (WHO, 2014)".

The NHP 2017 policy stresses on healthcare, health finance, information, and technology by considering the dimensions and aspects of life expectancy and healthy life, mortality by age and/ or cause, reducing disease prevalence/incidence, health service coverage, health infrastructure and human resource, and health management information which are required for preventive actions and for promoting health and wellness (NHP, 2017; National Health Systems Resource Centre [NHSRC], 2018, Sen, 2012).

Recognizing these factors, currently, the government has devised policies for introducing healthcare information management systems and the process of telemedicine in the rural areas where the access to healthcare is limited. Even then, the integration of the data in the information system appears to have a discrepancy between the availability of data type and the data needed by public health managers, researchers, and policymakers. This can be due to lack of supporting staffs and training, issues of integration with other health departments and survey-based programmes which resulted in the inefficient supply chain, stock outs, and inadequate medical expenditures (Government of Karnataka, 2017). These factors have created an impact on the peoples' out-of-pocket expenditures in most of the Indian states. Therefore, to improve this service gap, various regulatory policies have been devised by the government and healthcare provider to maintain updating with the latest technologies ensuring products and services "accessible" and "affordable" to the people.

Furthermore, there is a requirement for change in health policies due to changes in health priorities, healthcare technologies, health expenditures, and rising economic growth and its influence on fiscal capacity. Thus, the primary aim of National Health Policy (NHP) 2017 is to inform, clarify, strengthen and prioritize health systems across all possible dimensions such as health investment, healthcare service administration, promote good health by preventing disease outbreaks, incorporating technologies in healthcare system and providing access to users, introducing better financial security systems, improving health regulations and assurances. Table 1.2 provides the select health, information, and technology policies formulated by the Indian government for improving citizens' health and disease conditions.

**Table 1.2:** Select health, information, and technology policies in India (NHP, 2017; NHSRC, 2018)

| Policy Dimensions | Description |
| --- | --- |
| Healthcare | • The policy commits itself to achieve professionalism, integrity, and ethics within and across the entire system for maintaining credibility and transparency.<br>• To minimize the gender, poverty, caste disparities to reach the poorest.<br>• Improving factors of affordability by minimizing the health expenditures to less than 10 percent of total monthly consumption.<br>• To minimize exclusions on social and economic grounds.<br>• To improve patient-centered quality care with regulatory systems for monitoring.<br>• Improving accountability<br>• To promote patient access to AYUSH care services.<br>• Reaching out to the needy and rural people through mobile medical units. |

| | |
|---|---|
| Health Financing | • Allocation of resources and payments through national health accounts systems is made by giving priority to primary care followed by secondary and tertiary care units.<br>• Programme design and evaluations related to cost and its related factors are prioritized.<br>• For primary care, the operation cost will be in terms of per capita and care provider reimbursement.<br>• Equity considerations will be made and factored for difficult and vulnerable areas and for supply-side investment in infrastructure.<br>• Total allocation is also made according to differential financial ability, developmental needs and high priority districts, ensuring horizontal equity across specific population and groups.<br>• The policy of government insurance schemes is modified for creating an independent mechanism, ensuring standard treatment protocols by public and non-government hospitals.<br>• Multi-stakeholder institutional mechanisms would be devised at Centre and State levels through different trusts and/or registered societies with institutional autonomy and option for payment mechanism will be taken care of using reimbursement based on the service provided. |
| Information | • An information system with data availability and service utilization will be decentralized among public hospitals and non-government sector hospitals.<br>• Health survey would be now extended to provide information on the cost of care, financial protection, and evidence-based policies. Necessary digital tools will be installed for monitoring the impact of public health and disease interventions.<br>• Database for the use of public and researchers will be established in an easy-to-use format. |
| Technology | • The joint venture by U.S and India has laid two bilateral endowments such as the Indo-U.S. Science and Technology Forum (IUSSTF) and U.S.-India Science and Technology Endowment Fund sanctioned nearly $3 million for supporting exchange visits and technology commercialization (U.S. Mission India, 2014).<br>• The medical devices, technical specification will be procured through national health mission.<br>• The maintenance programme for biomedical equipment will be done for all the public health facilities which were previously lacking.<br>• Initiation of National Digital Health Authority (NDHA) for regulating and integrating care.<br>• This policy supports the use of Metadata and Data Standards (MDDS) & Electronic Health Record (EHR).<br>• Improving mobile health, eHealth, Internet of things, etc. for capturing real-time patient data are strategies of government.<br>• Health surveillance system would be strengthened, and provision for disease registers will be developed. |

| | |
|---|---|
| | • Establishment of integrated health information architecture, health information exchanges, and national health information network has been initiated. |

Thus, from table 1.2, it is evident that the healthcare sector in India is progressing positively towards healthcare, health finance, information, and technology. Moreover, the government has also realized the importance of medical information systems for improving the health and information technology indices (Table 1.3) and has started promoting various mobile health technologies for the benefit of citizens.

**Table 1.3:** Select health and information and communication technology indices of India

| Index and Source | Years | | | | | Remarks |
|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | |
| ***Health*** | | | | | | |
| Life Expectancy (World Health Organization) (WHO, 2019) | --- | 125 | 135 | 130 | 165 | The average life expectancy score of India is 68.8 years from 68.02 at birth in the year 2014. This rank indicates India has better control for preventing and treating health and diseases. |
| Infant Mortality (Central Intelligence Agency) (Central Intelligence Agency, 2019) | --- | 126 | 113 | 93 | 47 | In 2018, infant death (below a month) per 1000 live birth was 39.10 and was the 12th poorest nation out of 52 low-middle-income countries. This rank-based on value is better than the world's infant mortality rates. |
| Epidemiology of Diabetes Mellitus (International Diabetes Federation) (International Diabetes Federation, 2018) | --- | 02 | 02 | 02 | --- | In 2017, 72 million cases were found of Type-2 diabetic, which is expected to double by 2025. India is one among six countries in the South-East Asia region and ranks 2nd out of 194 countries in the world. This indicates a high incidence and requires specific monitoring tools to control. |
| Suicide Rate (World Health Organization) (WHO, 2019) | --- | --- | 19 | --- | 30 | India has a crude suicide rates value of 16.3 per 100000 population out of 106 countries in the year 2016. Moreover, southern states have higher suicide rates than northern parts, and this could be because of family problems and |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | illness. The rank indicates high incidence towards suicides, and requires specific tools to control. |
| ***Information and Communication Technologies*** | | | | | | |
| Information and Communication Technology (ICT) Development Index (International Telecommunication Union, 2018) | 131 | 135 | 138 | 134 | --- | This index is based on the agreed information technology indicators for 176 countries, calculated for measuring information society. The rank in 2018 appears to be propelling positively than in previous years, indicating positive improvement. |
| Global Innovation Index (Global Innovation Index, 2019) | 76 | 81 | 66 | 60 | 57 | The ranking is calculated for 126 countries based on 80 indicators for representing innovative nations in the world. This indicates steady improvement. |
| E-government Development Index (United Nations) (United Nations, 2019) | 118 | --- | 107 | --- | 96 | It considers 193 countries and ranks based on Online Service Index, Telecommunication Infrastructure Index, and the Human Capital Index for measuring digitized services. This improvement in the value indicates the need for e-governance in administration and services. |

From table 1.3, it can be concluded that though there can be a slight improvement in life expectancy, the death of the infants, epidemiology of diabetes, and suicide rates needs to be regulated. On a similar note and with respect to information and communication technologies, India is progressing positively in ICT development, innovation, and e-government index. This infers that government, healthcare professionals, and technology entrepreneurs can use information and communication technology tools such as mobile phone and its health applications, wearable, telemedicine, etc. for improving the health service delivery in India.

## 1.6. Mobile Health in India

India is considered as a low- and medium-income country by the World Bank (World Bank, 2019). To attain sustainable development goals for improving health, to end poverty, and to ensure peace and prosperity, goal #3 has been set explicitly for improving health, i.e., "to ensure healthy lives and promote well-being for all age groups."

Healthcare sector in India, which is currently facing a lot of service delivery challenges, is promoting the use of mobile phones or smartphones with its applications to bring down the cost, and to make it accessible to the people living in the rural areas. The adoption of mobile technologies is considered to be widespread and to be delivering care to doctors in developing countries like India. The reason behind the use of mobile and wireless technologies in healthcare is the increasing population and acute shortages of paramedical and administrative professionals, and infrastructure (Deloitte, 2015; Dhawan, 2015). Therefore, mobile health can be one possible solution to manage these situations, and achieve the targeted goal by using a mobile phone and its applications in healthcare service delivery. These devices support patient-centered practices, making healthcare accessible and affordable to people. The reasons behind the development of mHealth devices can be three: (1) access to Internet and Wi-Fi services, availability of smartphones, and improvements in the mobile supporting systems (Cho et al., 2014); (2) the imbalance between the number of population and availability of healthcare facilities (Gibson, 2014); and (3) increase in out-of-pocket expenditure of an individual (Wagner, 2014).

India is currently leading as the largest mobile Internet usage country among the G20 nations with 79 percent of the people accessing the web on phones, and this may reach 500 million Internet subscribers by June 2018 (Zee Business, 2018). According to Telecom Regulatory Authority of India (TRAI), the urban and rural telephone subscribers for wireless devices have an overall teledensity of 90.11 percent (TRAI, 2018) and these numbers are increasing every year. Likewise, as stated earlier, to become an economic powerhouse, India should focus on building a healthy population along with improving nation's healthcare expenditure and facilities (Srivastava, 2018). Currently being in low position, the country should utilize the Internet and other technological components to deliver healthcare services to the patient's home. Moreover, the study says, globally, India accounts for 20 percent of the burden of diseases, 27 percent of neonatal deaths and 21 percent of child deaths (Lopez et al., 2006). Therefore, promoting the use of mobile phones and its applications (apps) is considered to be vital in rural areas.

In India, as aforementioned, mHealth can be defined as *"the use of transportation systems such as mobile medical units or vans and/or mobile phone/ICT for providing health service to the people living in a particular locality"* (Pai and Alathur, 2019). This definition highlights mobile medical units which act as a primary healthcare provider (HCP) – a team comprising of a medical officer, a pharmacist, a public health nurse/auxiliary nurse midwife, a dresser, and an attendant (Jamir, 2013) for intervening people located in inaccessible areas and slums (Banerjee et al., 2012; India CSR network, 2018). It also incorporates mobile communication devices and ICTs such as mobile phones, tablet computers, and personal digital assistants, and other wearable devices used for collecting community health data and delivering it to healthcare professionals, researchers, and patients as a part of real-time monitoring and provision of care (Germanakos et al., 2005).

In consideration, various research associations have started using mobile phones for health service delivery to reach people in rural and urban areas. If this system was realized by the consumers, then its impact on healthcare delivery will alter the existing market. Accordingly, a survey conducted by Economist Intelligence Unit among consumers and medical practitioners across 10 different markets identified that 59 percent of consumers have already started using mobile health (mHealth) with a purpose of improving cost, convenience, and quality of healthcare (Levy, 2012). It is anticipated that mHealth will change the way of treatment for chronic conditions, medications, and overall health (Steinhubl et al., 2015). Furthermore, India stands second among developing countries in the adoption of mHealth based on the considerations of doctors and healthcare payers, which is inevitable (Levy, 2012). A study reported that factors such as flexibility, evidence base, sustainable business models, interoperability and standards, literacy and training, and data privacy should be considered by governments and their partner companies for the development of mHealth industry (Qiang et al., 2011).

Furthermore, Indian government under Digital India Programme (Kedar, 2015) along with Ministry of Health and Family Welfare has developed National Health Portal for improving the health of rural and urban sectors through mHealth applications (NHP, 2016). These apps are Kilkari (audio based mobile service which is aimed at pregnant women and women with child up to 1 year), mobile academy (training related to maternal and child health for the Accredited Social Health Activists), M-Cessation (for the people who is willing to quit tobacco use), Tuberculosis (TB) missed call initiatives (to provide information, counseling and treatment support services), etc. These services are currently working in the states of Punjab, Haryana, Chandigarh, Jharkhand, Odisha, Madhya Pradesh and Delhi (NHP, 2016).

Piramal Swasthya also started their pilot run for providing healthcare access to rural people of Rajasthan by offering 104 health information helpline, telemedicine services, eSwasthya, and mobile health services for maternal and child health and non-communicable diseases (Piramal Swasthya, 2019; Dogra and Hegde, 2018). These programmes in partnership with the state governments of Jharkhand, Chhattisgarh, Karnataka, Maharashtra, and Assam provide services related to the delivery of medical information, and mobile phone counseling, Dox-in-Box®, and eSwasthya programmes. They also provide mHealth services through mobile medical units equipped with technology, medical devices, medicines and health workers, visiting different places where people have barriers to access health centers (Kanter and Kim, 2019; Sangamnere and Srinivas, 2015).

For tackling health problems of women and girl child, a free mHealth unit was launched in Delhi under the initiative of Gaudium Foundation, connecting 74 districts and 250 locations in northern India by a bus cruise called "Naari Jeevan Srot Express," reaching out to more than 9.5 crore people. This bus will hold 18 medical camps in Delhi and cover multiple villages in Himachal Pradesh, Punjab, Haryana, and Jammu (United Nations Public Administration Network [UNPAN], 2014). In emergency situations, Indian citizens can dial short code 108 for receiving medical, police, and fire emergency services (Qiang et al., 2011).

Similarly, many private companies and startups are also working towards Digital India focusing on the development of mobile application for providing healthcare services to the citizens of India. Some of them are: BPL Medical Technologies Pvt. Ltd. develops all-in-one home health and wellness monitoring mobile devices called 'BPL Lifephone

Plus', allowing patients to monitor ECG, blood glucose, pulse rate activity and calories burnt and also has feedback mechanism through physicians (BPL Lifephone Plus, 2017); PharmaSecure launches Psconnect a mHealth platform to provide free tips, refill reminders and health advisors other than medicine authentication by SMS, voice and web service (PharmaSecure, 2017); Healthenablr, a telemedicine company started in Mumbai 2015, provides mHealth services such as Pocclinic and Poccare for the people who can't travel far or spend much time or those who don't have access to any other providers and now working in Mumbai, Kolkatta, and Bangalore (Healthenablr, 2017).

In addition, Khushi Baby, which is an ongoing mHealth project in the Udaipur district of Rajasthan, has initiated a recording and reporting system through Near Field Communication (NFC) stickers and necklace for the Auxiliary Nurse Midwives (ANM). The reason behind its initiation is the certain challenges faced by ANM during patient identification and registration, immunization, resource allocation, and communication, and these are found to be useful in reducing the time for data entry (Sherpa, 2016). For mothers and children during immunizations, this necklace, and necklace with voice call reminder arms did not appear to be more useful than stickers, as the call deployment was found to be inconsistent (Venkat, 2016; Nagar, 2016). Research associations such as C-DAC mobile healthcare solutions, Wipro, General Electric Healthcare, etc. are also working constantly for the development of mobile apps for students, patients, and consumers based on their need. For example, mobile phone–based clinical decision support systems for patients suffering from hypertension and diabetes mellitus (Ajay et al., 2016) (Table 1.4).

**Table 1.4:** Select mobile health and applications units in India

| Health Monitoring | mHealth Technologies | Description | Remarks | Authors |
|---|---|---|---|---|
| Health communication and disease prevention | Telemedicine | ICT use between patients and HCP located in distant places and rural regions. | Social networking equipped with telehealth and growing mobile apps, digital cameras, etc. supports interactions between patients and HCP. | Pathak and Kumar (2017); Dasgupta and Deb (2008) |

| | | | | |
|---|---|---|---|---|
| Vaccination for newborn babies and maternal women | Near Field Communication (NFC) Sticker and necklaces | Mobile phones used by community health workers for maintaining health records, antenatal care visits, and for monitoring newborn babies and maternal women. | Currently being practiced at the Udaipur state of Rajasthan wherein NFC stickers and necklaces are being worn by women and child which reminds them for vaccinations through system generated automatic calls or captured using mobile phones of frontline health workers. | Kushi Baby (2015) (www.kushibaby.org) |
| Cancer | iBreast Exam | Scanners and smartphones have been used for breast examination which is painless and radiation-free. | The device is in use in 07 countries including India. In the year 2016, the device had scanned 2,50,000 women, and treatment plans were supported by the state government for free and subsidy. | Cousins (2018); Broach et al. (2016) (www.ibreastexam.com) |

| **Website** | **mHealth apps** | **Description** |
|---|---|---|
| National Health Portal India (2016) (https://nhp.gov.in/) | No More Tension | • Stress meter helps to track and tackle stress levels. |
| | Mera Aspataal (My Hospital) | • To capture feedback of public and enrolled private health facilities through Short Message Service (SMS) etc. |
| | NHP Indradhanush Immunization | • For parents in tracking child's immunizations. |
| | India Fights Dengue | • To monitor dengue symptoms and find nearby hospital or blood bank for its treatment and includes prevention procedures. |

Moreover, mobile medical units (Nagarajan, 2018) and mobile communication devices/ICTs could also be seen being used during recent floods at Kerala. Social media and mobile phones technology have also been used for campaigning during rescue operations. Organizations such as World Vision, Kerala rescue, etc. have developed websites for collecting donations for relief, finding a person, help requests, contacting volunteer groups, etc. (World Vision, 2020; Rescue Kerala, 2018). Smartphone applications have also been developed by incorporating related information post flood, which includes illness preventions, waste management, dead animals' cremation, etc. (Harikumar, 2018). Despite the availability of these mHealth applications, evidence related to awareness about and use of them for managing health and disease conditions and their governance is still unclear among Indian citizens. As governance is considered to be the foundation for good practice, successful organizations and ethical behavior (Gross, 2013). In the healthcare sector, governance refers to a variety of steering, and rule-making related functions carried out by governments/decision makers to achieve national health policy objectives of promoting universal health coverage by safeguarding high standards of care (WHO, 2014.; Scally and Donaldson, 1998).

### 1.7. Mobile Health Applications across Different Application Stores

Statistics show that there are more than 283,000 mHealth applications (apps) displayed across the different mobile apps' stores: 125000 apps are available in iOS, 110000 apps in android, 20000 apps in windows, 18000 apps in Amazon, and 10000 apps in Blackberry world (research2guidance, 2016). Some of these applications finds their use in maintaining Health and Fitness (such as LoseIt, Google fitness, Fitbit, etc.), Diet Companion (Health and Nutrition, Calorie counter etc.), Stress Relief (Simple Yoga, Relax meditation: Sleep sounds, etc.), Diabetes (mySugr Diabetes Logbook, Glucose Buddy: Diabetes Log, etc.) etc. Among them, almost two-thirds of the application market is focused on general wellness issues such as fitness (36 percent), lifestyle and stress (17 percent), diet (12 percent), and the remaining are focused on specific health conditions, medication information and reminders, women's health and pregnancy. These apps have almost doubled over the past two years, and are estimated to grow by 900 billions of dollars value in healthcare and medical devices at the end of the year 2018 (Aitken and Lyle, 2015; Atluri, 2015).

### 1.8. Motivation for the Study

Today, the advancement of information technology and communications, especially in the field of service sectors, has improved the way the service is delivered worldwide. Previously, people were using desktop computers and laptops for information and communication delivery, which has now transformed to mobile phones and Personal Digital Assistants (PDA), which is more of digital enabled technologies or Internet of

Things (IoT). From the figure 1.2, it is concluded that the populations are shifting the method of delivering information and communication from fixed broadband to active mobile broadband, and this changes the total Internet usage which has also increased from year to year.

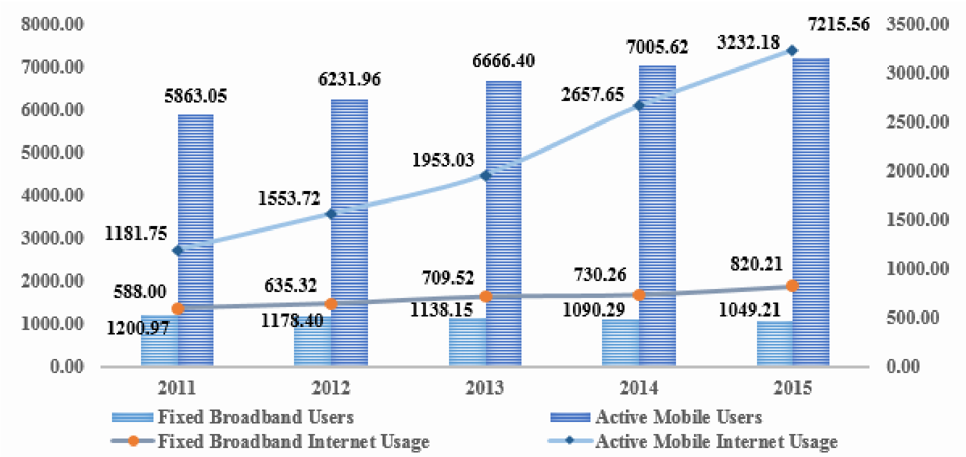



Figure 1.2: Global broadband subscription and Internet usage (millions)
Adapted from the International Telecommunication Union

Correspondingly, there is a need to address the challenges faced by the healthcare of the developing countries in terms of skilled worker shortage, lack of timely reporting surveillance and diagnostics, poor treatment adherence, poor inventory and supply chain management, slow rates of information flow and reporting delays (Lemaire, 2011).

In consideration of this, the study has been conducted to bridge the gap between the awareness of mHealth applications among the citizens, and to address the factors related to affordability and accessibility of mHealth among the technology entrepreneurs (application developers) and the rural populations.

### 1.9. Outline of the Study

Over the past several decades, the importance of promoting care to the people across the world has been increasing because of various communicable and non-communicable diseases which include smallpox, tuberculosis, malaria, heart attacks, asthma, diabetes, etc. This initiation has been started by World Health Organisation (WHO) which is still active and is playing a prominent role in regulating public health globally with knowledge and technology. In the year 2012, WHO defined its role in managing public health by encouraging partnerships, by setting norms and standards, by simulating knowledge management practices, and by providing technical support and health monitoring (WHO, 2015).

Having global health improvement as the key objective, various digital health initiatives have been enforced in the low resource setting regions for improving access, cost, quality of service and medicines. This digital health includes mobile health (mHealth), health information technology (IT), wearable devices, telehealth and telemedicine, and personalized medicine (FDA, 2019). Thus, patients and users can use such devices in order to monitor and manage their health accordingly.

The use of mobile and communication technology enables individuals to interact with people through multiple media, dependent upon individual convenience and interactions. These interactions have been found to effect a positive impact on the assessment of human factors, especially the quality of use, or usability. With the adoption of mobile phones in healthcare services, digital enabled technologies or Internet of Things (IoT) are improving the economy by reducing the gap of the medical divide. Therefore, many research associations and government are creating a decentralized system of healthcare to manage the chronic ailments, remotely using applications of telemedicine, electronic health records, mobile health (mHealth) systems, etc.

Therefore, this research tries to explore and find answers to the following research question*: How to improve the usefulness of mobile health applications for health service delivery?* Based on the research question, the following research objectives have been framed to guide the study design, data collection, and data analysis.

***Research Objective 1:*** To study the awareness level in the use of mobile health applications among the citizens.

***Research Objective 2:*** To analyze the accessibility and acceptance of mobile health among the rural population.

***Research Objective 3:*** To study the affordability in terms of cost to consumer and financial viability of the service provider (i.e., stakeholder or technology entrepreneur).

These research objectives will assist in data collection process and drives through the layers of people, process, and technology that will provide a rich depiction about the status of mobile health technology and applications in India.

### 1.10. Structure of the Report

This report is structured as follows. Chapter 2 presents the theoretical and empirical background and outlines the research question and research objectives under which this study is conducted. Chapter 3 introduces the research design and methodology for addressing the research question and research objectives. The analysis of the qualitative data is addressed in chapter 4 followed by the analysis of the quantitative data in the Chapters 5. Chapters 6 discusses the synthesis, implications and recommendations for the study. Finally, Chapter 7 presents the conclusions and recommendations.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1. Introduction

The previous sections have introduced the study background by contrasting on the definitions of mobile health and electronic health, mobile health initiatives, and technologies in India and other countries. It also emphasized on the strengths and weakness of the factors influencing the adoption of mobile phone for health and its related services.

This chapter discusses the theoretical and empirical background and identification of research gaps that are structured as follows. Section 2.2 provides a theoretical background of this study. Section 2.3 reviews literature published on mobile health in India using bibliometric analysis followed by mobile-assisted diagnosis system adoption in section 2.4. Section 2.5 discusses the importance of social media in health service research, followed by research gaps in section 2.6. Finally, this chapter ends with a conclusion in section 2.7.

## 2.2. Theoretical Background

To understand the theory behind mobile health, the primary theories related to media choice and use, technology adoption, and health belief model needs to be examined. This section provides a review of select literature underlying the people use of technologies for fulfilling the needs are discussed below.

### 2.2.1. Media Choice and Use

The choice of the computer and other media depends on the individuals need, emotions, and utility for their routine operations. By considering these factors, the following section presents select literature on theories of communication, technology adoption, and health belief.

*Computer-Mediated Communication Theories*

This theory is a field of mathematics and information systems theory which considers the technical information and human communication processes (Dainton and Zelley, 2017). With the transformation and interaction within the social and cultural platforms, the new media has increased and is transforming the lives of the individuals across the world. Therefore, many researchers across the world started working towards the use of computers or digital media for managing interactions and maintaining relationships

(Walther, 1996). This communication takes place based on intermediate feedback for the questions or dependency on any other medium for checking the messages, i.e., synchronous (video conferencing and instant messaging) and asynchronous communication (email, video messages, and text messages) and the other is based on the type of messages (James, 2014). Thus, individuals prefer a mobile phone with a combination of synchronous and asynchronous communication for assessing health-related activities.

*Uses and Gratification Theory*

This theory is an audience-centered approach, and basically, it seeks to understand what people do with media for their need and gratification, as opposed to what media does to people (Ruggiero, 2000; Severin and Tankard, 2001). People uses media to acquire knowledge and information (cognitive needs), or to satisfy the emotional needs (affective needs), or to reassure their status or credibility in the society (personal integrative needs) or to socialise with family and friends (social integrative needs) or to get relieved from tension (tension-free needs) (Bryant and Oliver, 2009). Thus, this theory assumes that the audience is not passive and take a prominent role in interpreting and integrating media to achieve their needs and gratification (Katz et al., 1973).

Whiting and Williams (2013), identified social interaction, information seeking, pass time, entertainment, relaxation, communicatory utility, convenience utility, expression of opinion, information sharing, and surveillance/knowledge are the uses and gratification which tends students to use social media. It is also observed that self-discovery, social enhancement, and the need to maintain interpersonal connectivity through behavioral intentions, cultural factors such as individualism-collectivism has an impact on social networking sites (Ifinedo, 2016). In Korea, Joo and Sang (2013) found that motivation for ritualized and effective use had a positive impact on perceived usefulness and perceived ease of use of smartphones. Convenience, sharing experiences, and entertainment was found to be useful for Second Life (a social virtual world's platform) eLearning (Gallego et al., 2016).

*E-Learning Theory*

E-Learning theories work on the principles of how electronic educational technology can be used and designed in order to promote and facilitate active learning (Mayer and

Moreno, 2003; 2007). These education theories are derived from three different perspectives with certain assumptions for understanding learning. They are Associationist / empiricist perspective, which considers learning as an activity, cognitive perspective considers learning as achieving understanding, and Situative perspective reflects learning as social practice (Mayes, and de Freitas, 2013).

Nichols (2003), proposes various principles of e-Learning, which can be applied to all situations. Some of them define e-Learning as an implementation of education within their models and educational philosophies like regular face to face learning, and distance education, or it can be behaviorism and constructivism. It also focuses on determining and implementing the use of technology rather than the type of technology with an effort on presentation and facilitation of educational content and process. Cao, Wang, and Zheng (2012) used e-Learning instructional design model based on cognitive flexibility theory for measuring feasibility and effectiveness among students and indicated that these model helps to promote intrinsic motivation, quality of learning and ability to think creatively among students. Moreover, the students should also interact with the artifacts and other available resources to support and practice, which will eventually help them in influencing the effectiveness of eLearning process (Noesgaard and Ørngreen, 2015).

*Enjoyment Performance Theory*

This theory focuses on establishing the relationships between the performances of the individual to that of the task associated with him (Tenney et al., 2016). According to this theory, the individual will perform effectively only when he/she feels particular positive feedback about the job. These feedback forms a reinforcing loop wherein, as the enjoyment activities associated with the job increases people find it very interesting to do it which increases the productivity of the firm and with proper incentive related to the position again creates interest to that person and loop continues. This loop so formed are called as a positive reinforcing loop. Similarly, on the other hand, the negative reinforcing loop is also created if the person lacks interest with the job/task associated with him/her.

### 2.2.2. Technology Adoption

In this section, literature related to technology adoption process and technology acceptance model has been discussed.

*Technology Adoption Process*

The technology adoption process is a sociological model and is an extension of the previous diffusion process model of Joe M. Bohlen, George M. Beal, and Everett M. Rogers (Bohlen et al. 1957). According to Rogers (2003), technology diffusion occurs through individuals and processes through the stages of the decision innovation process, i.e., knowledge, persuasion, decision, implementation, and confirmation (Renaud and Van Biljon, 2008). At the end of the confirmation phase, individuals will be clear of their decision whether to continue using the technology or not. The diffusion process model for acceptance, rejection, and use can also be studied through the concept of domestication of technology. It identifies the process of domestication through the dimensions of appropriation, objectification, incorporation, and conversion which ultimately result in providing intended feature use or interaction (Silverstone and Haddon 1996; Renaud and Van Biljon, 2008). Regarding healthcare technologies, domestication focusses on the ways of transforming the physical component into an instrument for solving the problems of the medical and individual community (Santos-Trigo et al. 2015; Lim 2016; Fox 2019). This also depends on social, cultural, and economic conditions (Hahn 2004).

The principle of domestication can therefore be applied to mobile health, as Roger's diffusion process model considers the decision to purchase or not to purchase a particular product and can be considered less applicable in the Indian context.

Technology Acceptance Model (TAM)

This theory identified and defines the relationship between individuals' acceptance of information science and theorized the attitude towards using technology which is a function of Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) (Davis 1993). Scholars in due course of time have replicated this study in providing empirical evidence to define associations between usefulness, ease of use, and intention to use. This model later modified and extended as TAM2 and TAM3 by incorporating factors of social influence, cognitive instrumental processes, effects of trust and perceived risk of using technology (Venkatesh and Davis 2000; Venkatesh and Bala 2008).

Lu et al. (2003) proposed this for wireless Internet by considering the components of individual differences, technology complexity, facilitating conditions, Social Influences (SI), wireless trust environment, user-perceived short and long-term usefulness, and ease of use. They concluded that the model does not consider factors influencing actual adoption. Mohamed et al. (2011) considered factors such as technology design, PEOU, and PU for measuring the intention to use and concluded that user perception about technology design influences mobile health services acceptance. Likewise, prior literatures have also included factors such as PU, PEOU, attitude, Internet use for health information (Ahadzadeh and Sharif 2017); SI, health consciousness, health information orientation, eHealth literacy, Internet health information use efficacy, PU, PEOU, and behavioral intention to use (Cho et al. 2014).

Lim et al. 2011 also included self-efficacy, technology anxiety, mobile experience, Internet experience, illness experience, PU, and PEOU. Studies also used multiple theoretical models and included components from the technology acceptance model and the health belief model (Ahadzadeh et al. 2015; Wahyuni 2017; Rahman, 2015). Kim and Park (2012) also integrated factors such as health belief and concerns, perceived seriousness and susceptibility, subjective norm, self-efficacy, PU, PEOU, reliability, attitude, and behavioral intention for measuring the acceptance of health information technology. This theory was later extended to the unified theory of acceptance and use of technology by Venkatesh et al. (2003) for measuring individuals' acceptance of information technology (Rahia et al. 2018; Alam et al., 2020).

Unified Theory of Acceptance and Use of Technology (UTAUT)

This theory explains the user intentions of information system use and its subsequent usage behavior and is based on four constructs, i.e., performance expectancy, effort expectancy, social influence, and facilitating conditions. The first three constructs represent usage intention and behavior, whereas fourth measures user behavior (Venkatesh et al. 2003). The researchers also extended this model and incorporated constructs such as attitude and leadership (BenMessaoud et al. 2011), social network (Sykes et al. 2009) perceived playfulness, perceived value, and computer self-efficacy

(Wang et al. 2009) which plays a significant role in behavioral intention of the technology.

It has been used in the areas of banking, healthcare, and e-commerce. Hoque and Sorwar (2017) tested this model among elderly populations and identified that there is a significant impact of PE, EE, SI, technology anxiety, and resistance to change on mHealth adoption. Seethamraju et al. (2017), used this model among healthcare professionals of TB treatment clinics against mobile-based IT solution acceptance and use and found that components EE, FC, PE, and SI are positively associated with healthcare professionals' behavioral intention to use. Lin and Anol (2008), extended UTAUT model for studying online social support and identified that social influence plays a significant role in influencing it. Dwivedi et al. (2016), combines the UTAUT and UTAUT2 based on technology artifacts and consumer context for generalizing mHealth adoption model and found that citizens cognitive, affective, and behavioral aspects should be considered for mHealth system acceptance.

### 2.2.3. Diffusion of Innovations

This theory tries to elucidate how, why, and at what rate new ideas and technology spread and were developed by Everett Rogers in the year 1962. According to him, the elements influencing new idea spread are the innovation, communication channels, time, and a social system which are dependent on human capital (Rogers, 2010). It also considers knowledge or awareness, persuasion, decision, use, and confirmation (Squires et al., 2007) which are required for decision making. The authors also concluded that awareness and persuasion could be a significant predictor of research-based practices among nursing staff in hospitals.

The DoI theory addresses an individual's health information technologies adoption and the means it spreads across communities. For example, Woodward et al. (2014), used this theory to explore health workers personal experiences towards eHealth innovation in post-conflict situations and identified that these innovations help relieve information and communication needs among them. Zhang et al. (2015), identified that eHealth innovation acceptance and use had been increased because of innovator group, and found literacy and low socio-economic factors as driving factor among study populations. Moreover, Nickerson et al. (2014), studied that mobile technology and smartphone apps innovation is dependent upon belief about, i.e., relative advantage, compatibility, and ease of use for technology adoption. They concluded that there is a positive belief about innovation characteristics and adopter category but a partial positive association with innovation adoption.

Since mHealth belongs to the phrase "patient-centered care," the interaction quality between patients and doctors provides clinical evidence for improving disease outcomes and quality of life (Epstein et al., 2010). In such cases, Healthcare Providers (HCP) need to consider factors making people identify health service utility is helping them in identifying behavioral research opportunities and needs existing in public health (Rosenstock, 2005). Thus, the health belief model was formulated for engaging health behavior change.

#### 2.2.4. Health Belief Model

Social psychologists developed the Health Belief Model (HBM) at U.S. Public Health Service in 1950 (Janz, and Becker 1984). It is a psychological health behavior change model, which explains and predicts activities and behaviors related to health, mainly for improving health services (Siddiqui et al. 2016). The model became popularised due to benefits in promoting behavior change about practical and psychological costs (Green and Murphy 2014). According to HBM, individuals who are engaged in promoting health behaviors depend upon health belief, perceived benefits, self-efficacy, and stimulus that motivates an individual for health behavior (Rosenstock, 1974). It also considers perceived susceptibility, perceived severity, perceived benefits, perceived barriers, health value, and cues to action for making decisions (Glanz et al. 2008).

HBM was used to study factors encouraging individuals' for utilizing mental health services and concluded with a framework for developing and evaluating programs for its awareness and appropriate service deployment (Henshaw and Freedman-Doan, 2009). HBM with cultural factors was found to influence cancer screening uptake and compliances for Hispanic women (Austin, 2002). Evans (2012), reviews Text4baby - text messaging programs for pregnant and new mothers indicates information credibility and usefulness, self-efficacy, and prenatal care-seeking helps in predicting health outcomes. Rosenstock (2005), indicated that individual health behavior is dependent on subsequent responses across decision process. For example, individuals accepting susceptibility to a particular condition try to learn and find out ways for professional diagnosis than referral system. Simmons (1958), identified that HBM applies to higher and middle-class groups than lower as these individuals are less oriented about the future. Therefore, to improve the accessibility and acceptance of health information through mobile phones, the techno-entrepreneur and the government should try to incorporate certain gamification and validated tasks of health improvement. This creates or motivates individual in using the application where the outcome will be the improved health and its behaviors. In other words, the mHealth application should be versatile enough to assist the user in improving the health ranging from managing appointments and consultations to medication reminders, including monitoring. This creates the user in getting acquainted with the device for health improvement. For example, a study conducted to measure the organizing practices in the case of crowd-based venture for resource mobilizations and found out that material and symbolic practices help the resource holding audience in enhancing or adapting their social world (Gegenhuber and Bauer, 2017). Based on these acceptance and communication theories, Table 2.1 summarizes factors which are incorporated in these models.

**Table 2.1:** The models and theories indicating factors influencing mHealth awareness and acceptance

| Constructs | TAM | TAM2 | TAM3 | UTAUT | Sarker and Wells | Renaud and Van Biljon |
|---|---|---|---|---|---|---|
| Subjective Influence | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| Perceived Ease of Use | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Perceived Usefulness | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Behavioral Intension | ✓ | ✓ | ✓ | ✓ | - | ✓ |
| Facilitating Condition | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| Demographic Factors | ✓ | - | - | ✓ | ✓ | ✓ |
| Acceptance | - | - | - | - | ✓ | ✓ |
| Awareness | - | - | - | - | - | - |

From Table 2.1, it can be considered that Sarker and Wells (2003) and Renaud and Van Biljon (2008) have emphasized a construct of acceptance in their research involving students and elderly populations, and most may not explore the dimension of awareness in acceptance models. The other models have assumed actual use construct as the acceptance itself. Therefore, the current study considers the factors of awareness, accessibility, and acceptance with the intention of measuring the usefulness of mobile health application.

## 2.3. Bibliometric Analysis of Mobile Health in India

Mobile health, m-Health, and mHealth are the three commonly used words or abbreviation for describing "the practice of medicine and public health supported by mobile devices" (WHO, 2011). For this review, we used the keyword 'mHealth' and followed the recommendations of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher et al., 2009) for analysis and conclusions.

*Eligibility Criteria*

The criteria for including and excluding research papers for the systematic review are presented. The research studies were included only if these conditions are met:

- *Access type:* Open access and Others
- *Document type:* Article and article in press
- *Subject area:* Computer Science, Engineering, Medicine, Social Sciences, Decision Sciences, Health Professions, Business, Management and Accounting, Nursing, Psychology, Dentistry, Veterinary, Environmental Science, Multidisciplinary, and Arts and Humanities.
- *Publication year:* 2008 to 2019

Thus, the articles and documents related to humanities, technical, management, and medicine were selected for systematic reviews and are included in the final study.

*Search Strategy*

For this review, we selected articles using the keyword "mHealth" from the database of Scopus and examined research studies that were published in the database from the year January 2008 to 28 June 2019.

*Sampling*

The criteria for including and excluding research papers for the systematic review are presented in figure 2.1.

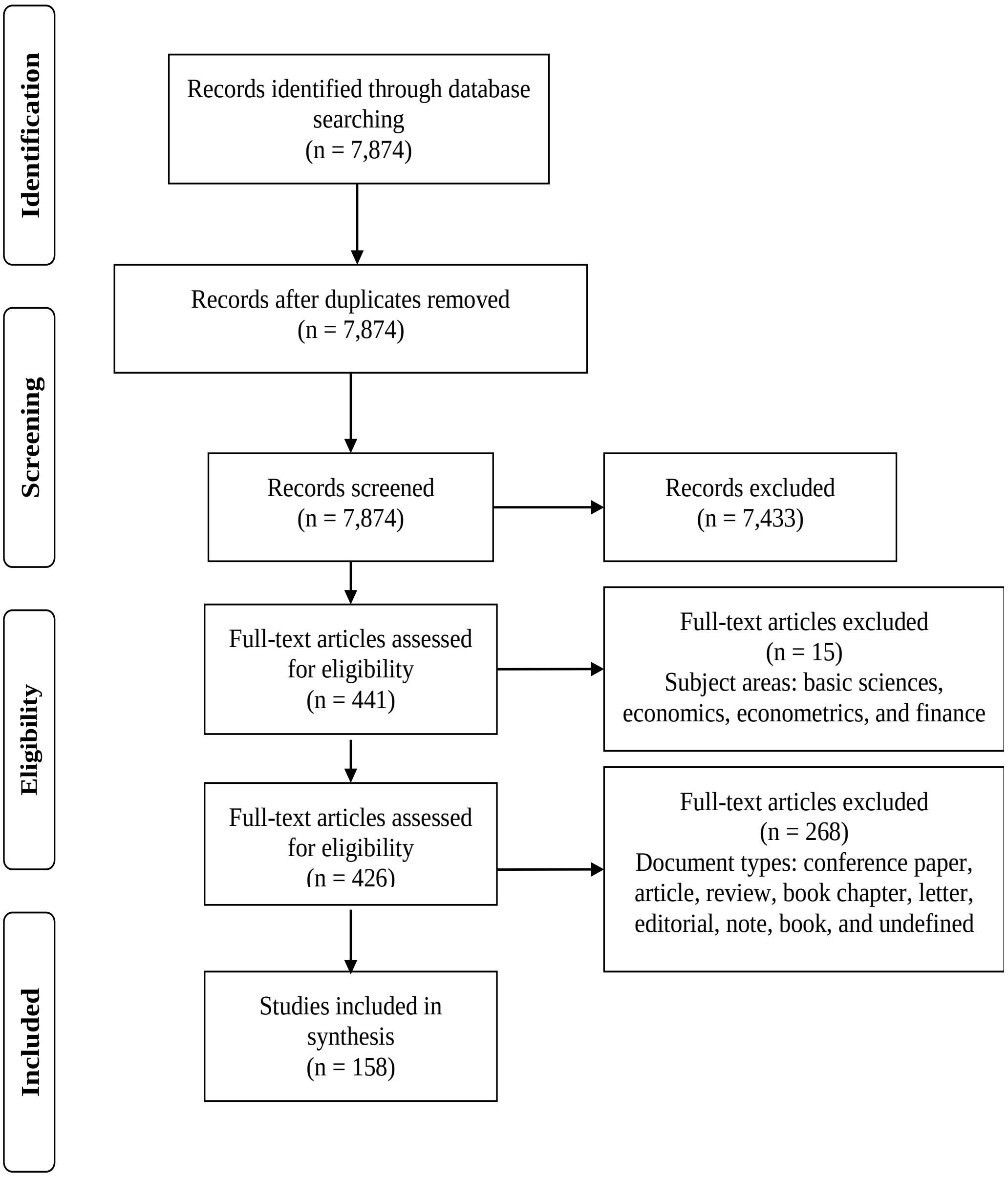



**Figure 2.1:** PRISMA flow diagram for selecting a research paper

Using the keyword search of "mHealth" a total of 7,874 documents have been identified from the Scopus database. Though the studies have been scattered across various disciplines, our intention is to analyze the literature published in the Indian context.

As a preliminary search, a total of 441 documents were selected. Of these documents, 15 other documents were excluded as these documents fall into subject areas of basic sciences, economics, econometrics, and finance, achieving a total of 426 documents. These include conference paper (245), article (129), review (23), book chapter (20), letter (3), editorial (2), note (2), book (1), and undefined (1). The conference and review papers were excluded as the quality of the content may not suppress the standards of peer-reviewed journal articles (Worrall, 2016). The total number of full-text articles assessed for eligibility is 158.

*Data Analysis*

For the selected 158 articles, the systematic methodological review for mobile health was followed along with bibliographic techniques, which includes reference co-citation analysis and document bibliometric coupling analysis. For these techniques, the mapping of the reference co-citation analysis and document bibliometric coupling analysis was performed using a tool called as "Visualization of Science (VOS)" mapping software (Walsh and Renaud, 2017) and article feature was highlighted manually. The results obtained from each of these techniques are presented in the section below.

*Results*

The results of the inclusion criteria revealed that there are 47 open access and 111 other articles types that yielded various keywords (figure 2.2) from the subject areas of: Medicine (84), Computer Science (49), Engineering (46), Social Sciences (10), Biochemistry, Genetics and Molecular Biology (8), Health Professions (8), Material Science (7), Nursing (6), Physics and Astronomy (6), etc.

It was also found that the number of articles published in the journals between the year 2015 to 2019 has improved, indicating the increased interest in the research area and expansion (figure 2.3).


**Figure 2.2:** Wordcloud for keywords

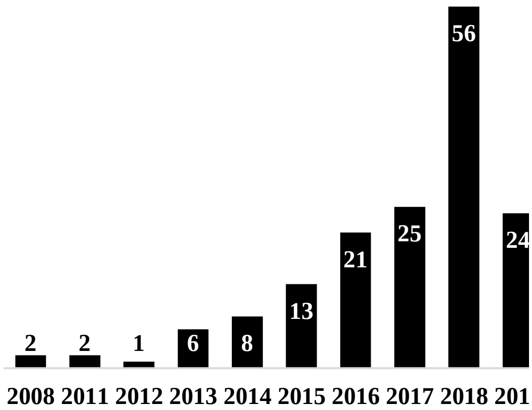



**Figure 2.3:** Documents by year

From figure 2.2, it can be indicated that the researchers working on mobile health in India have considered the following components or keywords for representing their articles (Table 2.2).

**Table 2.2:** Components identified from wordcloud and its classification

| Classification | Components/Keywords |
|---|---|
| Mobile Health Devices | Smartphone, Telemedicine, Mobile Phone, Mobile Application, Mobile Devices, Cellular Telephone Systems, Cell Phones, and Text Messaging. |
| Gender and Age Groups | Female, Adult, Male, Child, Infant, Newborn, Young Adult, Adolescent, and Aged. |
| Systems and Software | Authentication, Big Data, Internet of Things (IoT), Data Mining, Distributed Computer Systems, Clinical Decision Support System, Classifier, Cloud Computing, Medical Computing, Mobile Security, Internet, Network Security, Neural Networks, Digital Storage, Accelerometers, Application Programs, Confidentiality, Social Media, Algorithm, Classification of Information, and Mobile Telecommunication Systems. |
| Health and Disease Condition | Blood Pressure, Diabetes Mellitus, Health Auxiliary, Mental Health, Pregnancy, Child Health, Human Immunodeficiency Virus (HIV), and Chronic Disease. |
| Management | Human, Healthcare, Diagnosis, Health, Monitoring, Health Care Delivery, Hospitals, Health-care System, Organization and Management, Learning Systems, Health Care Personnel, Community Health Workers, Public Health, Clinical Trial, Costs, Self-Care, Awareness, and Diseases. |

| | |
|---|---|
| Evidence-Based Practices (Outcome) | Outcome Assessment, Cost Effectiveness, Decision Making, Health Program, Medical Information, Economics, Clinical Effectiveness, and Health Promotion. |
| Methods | Controlled Study, Randomized Controlled Trial, Major Clinical Study, and Procedures. |
| Importance of the Study | Developing Countries, India, Rural Area, Rural Population, Health Care Access, Rural Health Care, and Rural Health Services. |

The analysis of the keywords revealed eight themes that researchers have used in their research papers. They are named as mobile health devices, gender and age groups, system and software, health and disease condition, management, evidence-based practices (outcome), methods, and importance of the study.

The keywords representing the themes signifies that the researches carried out in India indicated the need and importance of mobile health for developing countries and rural regions for specific health diseases and managing health services. They have worked upon technical systems and software and carried out various interventions for improving healthcare access and supporting evidence-based practices.

### 2.3.1. Study Characteristics

For the selected 158 articles, the study characteristics involved the analysis of co-occurrence and co-authorships calculated based on authors and author keywords. The results of these analyses are described in the following sections.

*Commonly associated author keywords in the research articles*

The network visualization mapping for the keywords listed by the authors is depicted in figure 2.4. To map out the results, VOS Viewer - a freely available software was used (Van Eck and Waltman, 2009, 2013). This software not only used to create, visualize, and explore maps on-network data but can also be used for analyzing bibliometric networks (Van Eck and Waltman, 2013).

To normalize the data, fraction counting method, as suggested by Perianes-Rodriguez et al. (2016) and total link strength index for co-occurrence data (Van Eck and Waltman, 2009) is used.

For this study with 158 articles, by setting the counting method, type, unit of analysis, and threshold value as fraction counting method, co-occurrence analysis, author keywords and a minimum number of keyword occurrence as 2, a total of 68 keywords out of 598 were obtained.

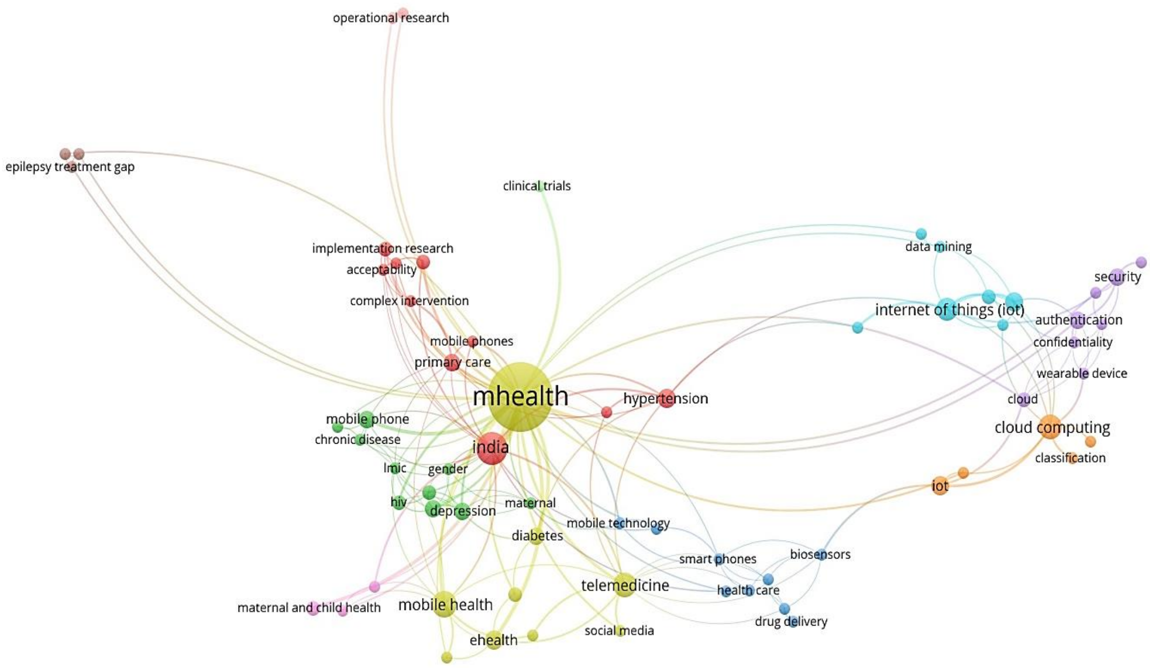



**Figure 2.4:** Network visualization mapping for the keywords listed by the authors

The visualization mapping depicted in figure 2.4 represents the following: keywords with the same color were commonly listed. For instance, keywords such as mHealth, chronic diseases, maternal and child health, telemedicine, social media, acceptability, implementation research, cloud computing, Internet of things, and smartphones, healthcare are closely related and usually appeared together. This indicates important as it has been used multiple times in the author papers.

*Active authors and their collaboration in mobile health*

The prolific authors were calculated by setting fractional counting method, type and unit of analysis as co-authorship analysis and authors, and a minimum number of documents of an author as 2. The result indicates that a total of 80 authors out of 587 are found eligible. Since not all the 80 items are connected to each other, the resulting figure 2.5 showed only the largest connected items consisting of 16 items.

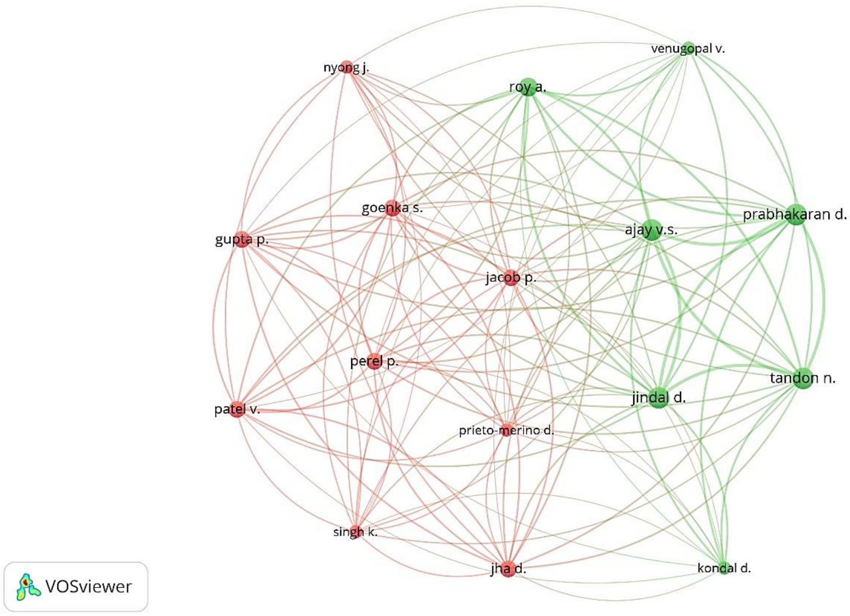



**Figure 2.5:** Network visualization mapping for the most prolific authors

From figure 2.5, it can be indicated that each circle represents an author. The circles that are connected to each other and are grouped represents the close association of one author with the another. In other words, these connected groups signify close research collaboration between the authors (Sweileh et al., 2017). For example, author Jacob P. has research collaborations with all other authors in this domain.

### 2.3.2. Co-citation analysis and Bibliographic Coupling

This study uses citation analysis to analyze *"the frequency with which two documents are cited together by other documents"* (Small, 1973). It also uses bibliographic coupling for, *"indicating whether there is any probability that the two work treats a common third work*" (Martyn, 1964).

The co-citation analysis and the bibliographic coupling for the selected articles are described in the following sections.

*Journal co-citation analysis*

The journal co-citation analysis was calculated based on the initial setting, i.e., unit of analysis as cited sources and the minimum number of citations of a source as 10. The total number of documents resulted from the initial setting is 26 out of 2920 sources. The resulting network visualization mapping obtained is shown in figure 2.6.

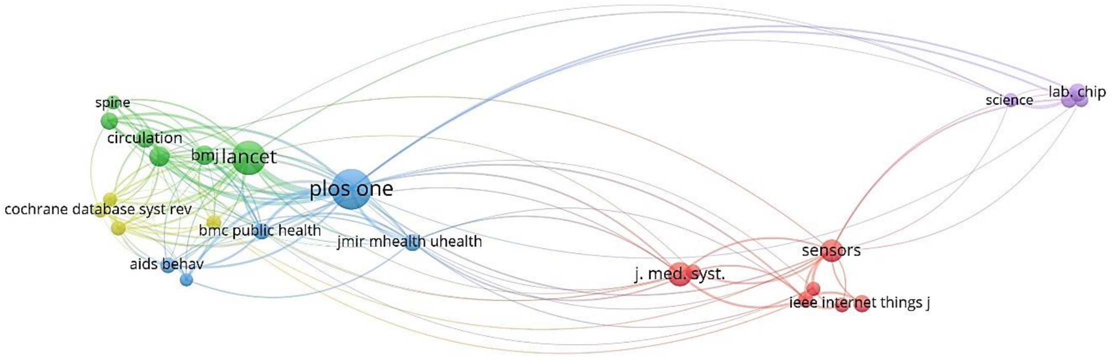



**Figure 2.6:** Network visualization mapping for the journal co-citation analysis (Source: VOSviewer)

From figure 2.6, it can be identified that the *PLOS One* (blue) has the highest number of citations, i.e., 87, followed by *The Lancet* (green) with a citation of 63. This indicates that the number of citations for mobile health in these journals was highest and co-cited by other journals (circles with the same color).

*Reference co-citation analysis*

The network visualization mapping for analyzing reference co-citation is shown in figure 2.7. It is plotted by considering the unit of analysis as cited references and a minimum number of citations of a cited reference as 2. The yielding 41 cited references from a total of 4928. Since not all the 41 items are connected to each other, the resulting figure 2.7 showed only the largest connected items consisting of 8 items.

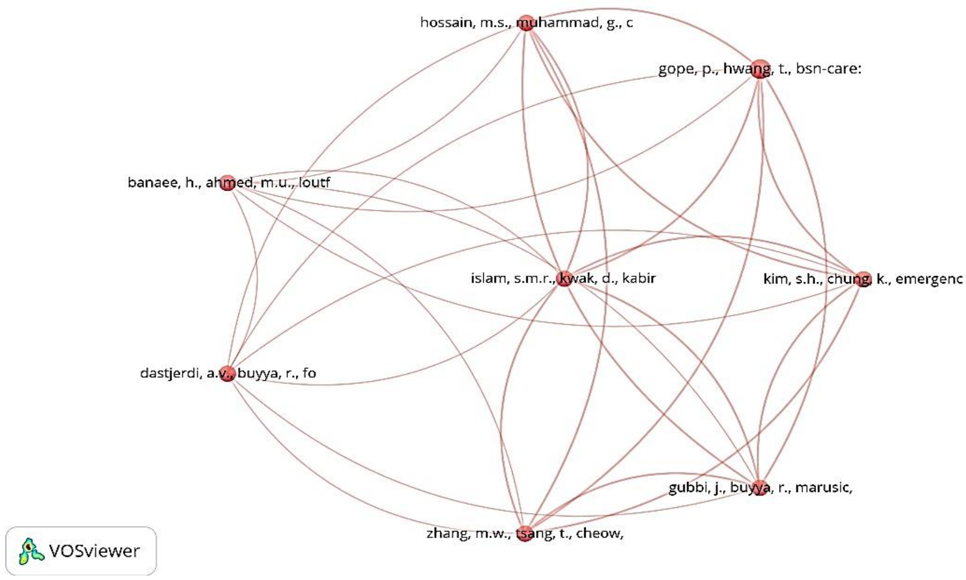



**Figure 2.7:** Network visualization mapping for the reference co-citation analysis

From figure 2.7, it can be identified that most priority should be given to the articles represented with larger circles. The size of the circles and the thickness of the link is proportional to the number of reference co-citations and co-citation indices (Walsh and Renaud, 2017). If the two circles are closer, then it can be said as the relationship between the corresponding references is stronger when calculated based on the citation numbers (Walsh and Renaud, 2017).

*Bibliographic coupling of documents*

This study also performs bibliographic coupling of the documents for the selected 158 articles. For this, the minimum number of citations of a document is set as three, and 65 articles are selected. The largest group of connected articles which are considered for network visualization mapping is only 28 as other items are not connected (figure 2.8). The analysis has also resulted in the formation of 6 clusters based on Citations (C) and Total Link Strength (TLS). "The total link strength indicates the total strength of the co-authorship links of a given researcher with other researchers" (van Eck and Waltman, 2013).

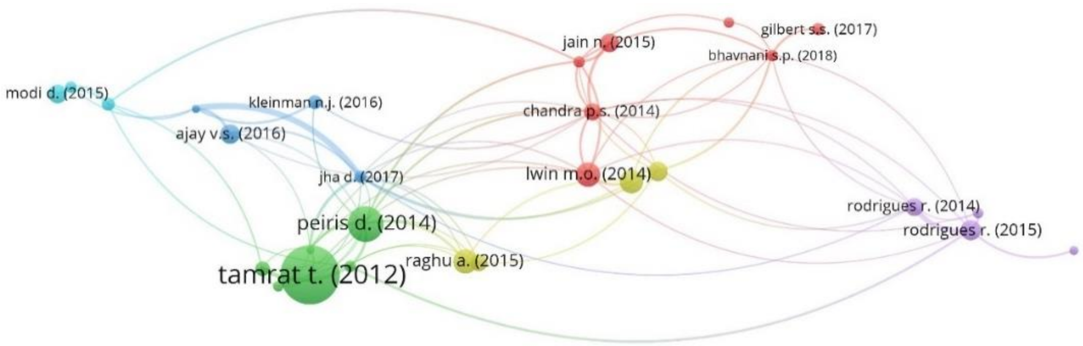



**Figure 2.8:** Network visualization mapping for the document bibliographic coupling (Source: VOSviewer)

For the results to be effective, the minimum citation value of 6 and above have been considered. Table 2.3 presents the list of documents selected based on the inclusion criteria.

The bibliographic document analysis as shown in figure 2.8 reveals that the size of the circles and the thickness of the link is proportional to the number of documents and bibliographic coupling indices (Walsh and Renaud, 2017). If the two circles are closer, then it can be said as the relationship between the corresponding documents is stronger calculated based on reference numbers (Walsh and Renaud, 2017).

The following table represents the results of bibliographic coupling (Table 2.3) analysis.

**Table 2.3:** Details of the bibliographic coupling clusters

| Cluster 1 | C | TLS | Cluster 2 | C | TLS | Cluster 3 | C | TLS |
|---|---|---|---|---|---|---|---|---|
| Bhavnani et al. (2018) | 6 | 5 | Bondale et al. (2013) | 5 | 1 | Ajay et al. (2016) | 17 | 3 |
| Chandra et al. (2014) | 13 | 7 | Feinberg et al. (2017) | 6 | 6 | Jha et al. (2017) | 7 | 12 |
| Gilbert et al. (2017) | 7 | 1 | Jarosławski and Saberwal (2014) | 10 | 4 | Kleinman et al. (2016) | 9 | 2 |
| Jain et al. (2015) | 15 | 3 | Nair and Bhaskaran (2015) | 3 | 5 | Prabhakaran et al. (2019) | 3 | 9 |
| Lwin et al. (2014) | 25 | 5 | Peiris et al. (2014) | 54 | 8 | | | |
| Nahar et al. (2017) | 6 | 7 | Tamrat and Kachnowski (2012) | 143 | 2 | | | |
| Pai and Alathur (2018) | 5 | 1 | | | | | | |
| **Cluster 4** | **C** | **TLS** | **Cluster 5** | **C** | **TLS** | **Cluster 6** | **C** | **TLS** |
| Balakrishnan et al. (2016) | 13 | 3 | Choun et al. (2015) | 4 | 1 | Modi et al. (2015) | 15 | 1 |
| Ganesan et al. (2016) | 24 | 4 | Reynolds et al. (2016) | 5 | 2 | Shields-Zeeman et al. (2017) | 8 | 4 |
| Pfammatter et al. (2016) | 16 | 5 | Rodrigues et al. (2015) | 18 | 8 | Tewari et al. (2017) | 6 | 1 |
| Raghu et al. (2015) | 25 | 4 | Rodrigues et al. (2014) | 14 | 6 | | | |

Since the purpose of this research is to provide a comprehensive review of mobile health in India, it reviews the literature obtained from the bibliographic coupling analysis (Table 2.3) and presents various methodology adopted by the researchers in this domain. The following section presents the methodological review of mobile health obtained from the bibliographic coupling data.

### 2.3.3. Methodological Review of Mobile Health in India

The bibliographic coupling of the data has revealed six different clusters of documents for the keyword and are depicted in figure 2.9 below.

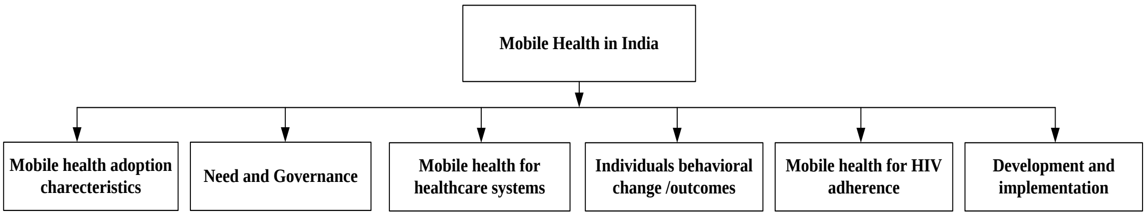



**Figure 2.9:** The main themes of the study

The description of each of these clusters indicating the main themes and are summarized in this section.

*Cluster 1- Individuals mobile health applications adoption characteristics*

The research articles clustered investigates the adoption characteristics and the use of mobile phone and its applications for specific health and disease conditions. The articles in this group adopted qualitative and quantitative studies for assessing the acceptability, feasibility, stability, performance, opportunities, and barriers of mobile phones and health applications for health management (Bhavnani et al., 2018; Chandra et al., 2014; Gilbert et al., 2017; Jain et al., 2015; Lwin et al., 2014; Nahar et al., 2017).

In this group, mobile phones (mobile health) is identified as an opportunity (Jain et al., 2015) for improving structural heart disease (Bhavnani et al., 2018), mental health service delivery (Chandra et al., 2014), preventing Dengue (Lwin et al., 2014), and immunization supply chains (Gilbert et al., 2017). The health and service delivery outcomes are also highlighted from the point of users (Jain et al., 2015), patients (Nahar et al., 2017), and health officials (Lwin et al., 2014).

The other important observation identified through two of the clustered documents is that the utility of the social media system for health management. They have used social media to measure the users/individual’s perception (Pai and Alathur, 2018) or for integrating with mobile health application for promoting and improving health literacy (Lwin et al., 2014).

*Cluster 2- Need for mobile health and its governance*

The articles in this cluster investigate the importance of mobile health applications for rural and urban regions of India, and the indicates potentialities in which the tool can be governed to meet the requirement of the community. They specify the challenges faced by the private and public organizations suggesting the need and in the use of mobile health for health improvement.

*Cluster 3- Mobile health for healthcare systems*

The articles in this cluster provide evidence for the usage of mobile health systems in conducting interventions at healthcare facilities. It synthesizes the findings from the perspective of primary and community healthcare centers located in India, which aimed towards monitoring and control of hypertension and diabetes patients.

The research articles of this group basically include various mobile health systems which are working as pilots/trials across the rural and semi-urban parts of India. These articles use cluster randomized controlled trial design to evaluate the results obtained through mobile interventions and usual care (Jha et al., 2017; Prabhakaran et al., 2019). The two articles though used intervention and control (enhanced care) arms in their study design, they considered mixed methodology, and statistical analysis as the study approaches as it would facilitate them in the integration of the results (Ajay et al., 2016; Kleinman et al., 2016).

The intervention and control arm includes people with hypertension and diabetes whose health conditions was measured for 6 to a 12-month time period. The results of the intervention arm, i.e. through mobile health systems, and control arm being the regular consenting participants are compared against each other for assessing service quality gaps. The articles in this group also considered the integration of mobile health systems with decision support systems for measuring its effectiveness. The comparative studies provided incremental benefit and satisfaction results and concluded that the mobile health systems have the potential to manage health conditions across primary care level and low resource settings.

*Cluster 4- Individuals behavioral change outcomes*

This cluster signifies the changes observed in the health of an individual by using mobile health applications and technologies. The articles measure an individual's behavioral health outcomes quantitatively with the data collected as a part of a follow-up procedure or interventions using mobile health devices or surveys. In these articles, the researchers have highlighted the importance of mobile health devices as it has brought some incremental changes in the individuals maternal and child health (Balakrishnan et al., 2016), physical activity, sitting, and weight (Ganesan et al., 2016), diabetes (Pfammatter et al., 2016), and cardiovascular disease (Raghu et al., 2015). The authors have also concluded that mobile health strengthens health systems by facilitating manpower efficiency and governance, low-cost and large-scale global implementation thereby supporting evidence-based risk prediction tool and management.

*Cluster 5- Mobile health for HIV adherence support intervention*

This group represents the literature related to the use of mobile health applications for HIV. The articles represent the perception, feasibility, acceptability, preliminary efficacy, and costs of mobile health intervention for measuring self-care and treatment adherence among patients. Two of the papers considered call service, interactive voice response (IVR) call, and a pictorial short messaging service (SMS) for the intervention group to measure the adherence (Reynoldset al., 2016; Rodrigues et al., 2015). The third paper compared the cost associated with mobile phone reminder strategies (IVR and SMS) to improve antiretroviral therapy adherence (Rodrigues et al., 2014).

The authors wherein IVR and SMS are used for HIV interventions concluded that the Mobile Phone-Based Approach for Health Improvement, Literacy and Adherence (MAHILA) trial or other mobile health applications would improve access and supports adherence and clinical outcomes. They also suggested that interventions involving two-way communications and personalizing would reduce individual perceptions towards risk and improve uptake. Though it was identified that mobile health facilitates HIV adherence, the one important component highlighted was the methodological issues, i.e., the cost of IVR and SMS, cost of applications, program costs, etc. as these would not be constant all over (Rodrigues et al., 2014).

*Cluster 6- Development and implementation of mobile health for community health workers*

The articles in this cluster have been grouped basically to provide benefits to the Accredited Social Health Activists (ASHA) workers, frontline workers, and primary care doctors. The role of the ASHA workers is to help the individual in mobilizing the beneficiaries related to health and its service delivery. However, it was identified problems of reachability or accessibility leading to low service delivery. This necessitates the implementation of mobile health applications for improving the potential of ASHA workers towards area coverage and healthcare access.

Considering the problem faced by the ASHA workers, the articles in this group have suggested the process for developing and implementing mobile health. The two of the research articles have described the contents and process required for managing mental health (Shields-Zeeman et al., 2017; Tewari et al., 2017) and an article discusses them for maternal and child health (Modi et al., 2017).

In all the three cases, ASHA workers or the community health workers are the participants of the study. A research article takes the form of the top-down approach of management wherein the patients and other peoples have been reached through proper training of frontline worker about mobile health and its navigation features (Shields-Zeeman et al., 2017). The other included a systematic process involving the identification of a gap in the current process, intervention, and post-intervention evaluation and analysis (Tewari et al., 2017). The article by Modi et al. (2017) suggests that the gap identification in regular care, followed by mobile health components and its impact, then evaluating components of acceptability, feasibility, and usefulness, and finally piloting operational delivery would be beneficial in equipping primary healthcare center staffs towards garnering commitment.

The methodology adopted for the development and evaluation of mobile health applications is largely a combination of qualitative and quantitative. The needs are identified using interviews and the data collected through fabricated mobile health applications and for comparing it with the actual results is quantitative. In all the cases, the author has identified that the study should be tested for randomized cluster trial involving pre and post interventions for improving scalability.

## 2.4. Adoption of Mobile Assisted Diagnosis System

The adoption of mobile phones for seeking health information mainly depends upon the awareness and knowledge, accessibility, and affordability among the patients, users, citizens, and stakeholders. Based on the above factors, the literature is discussed.

### 2.4.1. Awareness and Use of Mobile Health Sevices and Applications

The most common definition of awareness which is available in the literature is: "*the ability to directly know and perceive, to feel, or to be cognizant of events*" (Brands, 2017). According to the professors Jagdish Sheth and Rajendra Sisodia, for achieving a successful solution, an organization has to consider 4 major components namely acceptability, affordability, accessibility, and awareness which they represented it as 4A framework (Sheth and Sisodia, 2012). In this framework, the component acceptability represents the functional acceptability (objective performance) and psychological acceptability (subjective attributes) of the products or services offered and delivered in a particular target market. Affordability represents the psychological willingness and economic ability of the customer to purchase the products or services offered in the market. The component accessibility represents ease of acquiring and use of a particular product and service offered in the market. The final component awareness represents the adequacy of the products or services attributes and benefits which tend a potential individual to try for these products and services and reminds an existing individual to continue using these products and services. Awareness according to them can be measured with knowledge and brand awareness which indicates that most of the people will not purchase or go for particular products or services until they find a positive perception about the brand and enough information about those products or services (Sheth and Sisodia, 2012).

According to psychology, consciousness is represented as a component of awareness, and it is described as the individual state wherein they are aware of their environment, thoughts, feelings, or sensations (Natsoulas, 1987). Psychologist Sigmund Freud classified consciousness as different awareness levels namely conscious, preconscious, and unconscious. Each of these components represents an individual's configuration of his/her mind. "Conscious - it represents the part of the mind that holds what you are aware of." "Preconscious – it represents the mental activities that are presently not active but stored in individual memory." "Unconscious – includes activities of the mind which individual may not be aware of (Freud, 2018).

In an information system, *"awareness denotes knowledge created through the interaction of an agent and its environment"* (Gutwin and Greenberg, 2002). Nugent *et al*. (2011) also identified that global health policy should address the pattern of disease outbreaks by focusing on the creation and awareness of infectious diseases. In a questionnaire survey conducted among medical and engineering students located in the coastal region of India found to have lack of awareness with respect to mobile health service and applications and suggested to incorporate sensitization programs for improving the level of awareness (Parthaje et al. 2016).

The rate of awareness was also seen to be less and unfavorable among the people of Iran due to the problems of literacy and recommended to provide electronic informative-communicative resources so as to support and improve health-related conditions (Ehteshami et al. 2013). Similarly, the knowledge about the mobile health appeared to be low in the regions of Bangladesh and when interventions carried among the respondents its compliance of prescription with respect to mobile phones and physical visits appeared to be similar (Khatun et al., 2014).

Mobile health can play an essential role in providing healthcare access to people. A substantial literature is available about mHealth practices among healthcare groups and people. Among the healthcare groups, the use of mobile health (digital health) helps in generating evidence against diabetes, depression, and other clinical practices (IQVIA, n.d). In a methodological review by Klasnja and Pratt, (2012), identified that mobile phones could be used for health information services like receiving health information, consulting health professionals, improving social influence and accessibility, and utilizing entertainment based on the availability of various mobile phone features to support health goals. It is also a tool which supports behavioral changes considering health promotion and self-management because of mobility, advanced computational capacity, and access speeds (Schnall et al., 2016).

Most of these researchers have often indicated the benefits of mHealth in delivering health service to rural and urban communities. Although the use of the mobile phone in health service delivery is advantageous for the rural and urban populations, its barriers of access and lack of awareness will keep them away from using it efficiently (Boruff and Storie, 2014). Table 2.4 provides some of the select literature about the awareness and use of mobile phones for health-related activities.

**Table 2.4:** Select literature on awareness and use of mobile phones for health activities

| Authors | Study Location | Main Findings | Remarks |
|---|---|---|---|
| Sinnenberg et al. (2016) | Data collected online through Twitter for the United States | Diabetes and myocardial infarction were frequently observed term than heart failure among patients. People tweeted risk factors, awareness, and management as common themes. | Awareness, information about risk factors associated with various health diseases are the key characteristics of Twitter users. |
| Asif et al. (2018) | Questionnaire survey includes respondents from Pakistan, Turkey, and Iran | The study indicates that awareness moderates positively and found to be significant towards purchase intentions, attitude, subjective norm, perceived behavioral control, and health consciousness, except for environmental concern. | In this comparative study, the component awareness moderates positively indicating that increasing awareness leads to better organic food purchase intention. |
| Alnemer et al. (2015) | Tweets collected in the Arabic language | The study conducted by collecting tweets related to health for creating health awareness among people and the community. | Comparative analysis indicated that tweets from government institutes, physicians, and dieticians were true than non-medical institutes (tweet evaluation). |
| Ehteshami et al. (2013) | A cross-sectional analytical questionnaire survey among medical students of Iran | Researchers indicated that the awareness percentage was highest among medical students in the area of nature than treatment, diagnosis, education, and infrastructure. | The awareness level and use of mobile health technology is not positive and observed no significant association between them. |
| Ramachandran et al. (2010) | Practical demonstration and deployment of short videos to village women | The study was focused on a maternal system where health workers are engaged in encouraging pregnant women to utilize health services. | The familiarity with ICT and evidence in the form of short videos persuade villagers in |

| | | | |
|---|---|---|---|
| | and health workers of India | Resistance to change due to education, training, and status were the challenges observed for ICT interventions. | dialogue and motivate health workers. |

It was indicated that the awareness about mobile health utility is more in the engineering students than medical because of greater access to mobile phone applications for designing, testing, and development (Parthaje et al., 2016), or course-related in healthcare management and research fundamentals (Pai and Alathur, 2019). As 93.3 percent of the medical students actually use medical apps (Koh et al., 2014), and due to lack of studies about mobile health among students and working professionals an attempt has been made to study their awareness and use in the Indian context. This study therefore considers awareness as the amount of knowledge an individual has about mobile health and its benefits, and that has a crucial effect on adoption.

Mobile health use is defined *"as the degree to which people are aware of and use mobile health technology and applications for health service delivery"* (Chen et al., 2014). According to Rai et al. (2013), acceptance of consumer's mHealth depends upon use intentions for non-adopters and continue to use intentions for adopters. Authors have also stated that the acceptance also depends upon mobile health assimilation ranging from the extent of awareness and frequency of use (Rai et al. 2013). It was also identified that the lack of awareness about the online banking is considered a barrier, leading to low adoption (Sathye, 1999). Thus awareness is considered as an important factor for the intentions of technology use (Venkatesh, 1999; Ramayah et al. 2006; Prema and Clement, 2010). Considering the prior works, we can identify literature which explains the importance of mobile health technology and application for improving service delivery across different countries. However, not many types of research have been available explicitly addressing the components of awareness and use among Indian populations.

Thus, this study intends to examine the determinants of mobile health technology, and applications use intention the factors are delineated from the prior literature and theories of individual traits and adoption characteristics, technology acceptance, and health belief. Though there exists numerous individual cognitive factors and behaviors which influence intention to use, this study has considered the following factors for measuring it. They are subjective norm, health consciousness, perceived usefulness, mobile service enabled empowerment, personal innovativeness, and awareness to measure individual intention to use. These factors are considered based on perceived pressures and functionalities to use mHealth technology and applications.

The following table (Table 2.5) presents the theories and variable identified for measuring intention to use mobile health technology, and applications.

**Table 2.5:** Theories and identified variables for measuring intention to use

| Theories | Explanatory Variables | Constructs | Source |
|---|---|---|---|
| Motivational Construct | Individual Characteristics or Traits | Mobile Service Enabled Empowerment | Spreitzer (1995); Chen et al. (2014) |
| Individual Difference Variable | | Personal Innovativeness | Rai et al. (2013); Agarwal and Prasad (1998) |
| Adoption Variable | Adoption Characteristics of New Product or Service | Awareness | Sathye (1999); Al-Somali et al. (2009); Reddick and Zheng (2017) |
| Health Belief Model (HBM) | Individual Cognitive Factors | Health Consciousness | Dutta-Bergman (2004); Cho et al. (2014) |
| Technology Acceptance Model (TAM) | Health-related Use Behavior from the View of Technology | Subjective Norm | Ajzen (1988); Teo (2009); Saadi et al. (2017) |
| | | Perceived Usefulness | Hu et al. (2003); Davis (1989); Hooda et al. (2019) |
| | | Intention to Use | Bhattacherjee (2000); Wahyuni and Nurbojatmiko (2017) |

The intention to use is defined as the intentions that an individual have about using or continuing to use mobile phone technology and applications for health service. First, as people in the present generation are health consciousness and use various information systems for seeking health information, the use of mHealth technology and applications would assist them in providing self-care (Cho et al., 2014). Thus, health consciousness influences people to develop a positive attitude towards the intention to use mHealth technology and applications.

Second, when social forces act, individuals tend to take the opportunity of accepting or rejecting a new system (Venkatesh and Davis, 2000). This implies that subjective norm influences perceived usefulness and intention to use. Third, as digitalization has an influence on people lifestyles, the use of mobile phones and its applications plays a vital role in assisting them towards their daily work. It was said that people with high innovative capability often try to find out information online to cope up with uncertainties leading to positive intentions towards acceptance (Rogers, 1983). Therefore, personal innovativeness is inherently related to mHealth technology, and applications use intentions.

Fourth, due to people-centric nature, the acceptance of mHealth technology and applications are associated with intrinsic motivation and their cognitive assessments (Chen et al., 2014). So, the study considered mobile service enabled empowerment for measuring intention to use. Fifth, as aforementioned, people tend to use mHealth technology and applications if they believe to be useful, implying that perceived usefulness positively influences intention to use (Wahyuni and Nurbojatmiko, 2017).

Finally, to start using mHealth technology and applications, it is essential for the people to be aware of the service benefits (Mols et al., 1999) and should have access to utilize it (Sathye, 1999), signifying that awareness influences intention to use or acceptance. Based on this reasoning, we have identified factors related to individual cognition and behaviors to test the hypothesis formulated for measuring intention to use.

### 2.4.2. Accessibility of Mobile Health

The consideration of accessibility for mobile health systems in India is a crucial component for improving its usefulness (Sheth and Sisodia, 2012; Mazumdar-Shaw, 2018; Sengupta, 2013; Chatterjee et al., 2018).

Accessibility is the measure of a product or service, which is to be entered or reached. In a study conducted by Khatun et al. (2016), identified that the lack of mobile phone access, awareness about literacy, and trust could be a barrier to mHealth adoption. There was no difference observed between mHealth users and non-users in terms of accessibility, but the concerns about cost and service quality reduced after usage (Lee and Rho, 2013).

The following table 2.6 provides select literature about the accessibility of mobile health and health information systems.

**Table 2.6**: Select literatures on accessibility

| Authors | Description |
|---|---|
| Yu et al. (2019) | Accessibility was considered from user interface design and development and physical presentation and navigation. |
| Thurston and Thurston (2010) | Accessibility was measured based on preferred reading formats, information receipt, access to healthcare services, and communicating with staff and support. |
| O'Sullivan (2014) | The study included patients and caretakers, actions to self-care, knowledge of supportive home health technologies, experience with online technology, perceived hurdles to take-up, and trust for improving the accessibility of mobile health. |

According to Penchansky and Thomas (1981), accessibility is specific and yet overlapping dimensions of access along with availability, acceptability, affordability, and accommodation for measuring the individuals' proximity towards time and distance. These dimensions are later expanded and included awareness components by Saurman (2016). Various research has been conducted by the researchers across the countries and used this model for improving the access of healthcare services (Jacobs et al., 2011; Saurman, 2014; Kang et al., 2019). For instance, in a systematic review indicated that older Australians face access problems because of cultural and linguistic diverse populations, transport facilities leading to minimum appointment time and long waiting time, traditional practices, feeling of shame, and gender sensitivity (van Gaans and Dent, 2018).

There is a positive correlation between perceived accessibility of information and information use (Culnan, 1984). The author also indicated that perceived accessibility is a function of prior experience, physical access to the terminal and information access are independent dimensions which comprise of the command language and the desired information retrieval ability (Culnan, 1984). As aforementioned, it is the individuals who decide whether to use the information systems or not in their routine operations. In these cases, the theories of media choice and use would be beneficial. By considering various media choice and use theories and literature, McCreadie and Rice (1999) highlighted six types of accessibility, i.e., physical, economic, political, cognitive, affective, and social for addressing ICT systems and applications use in processes where the users have a choice.

In this context, since the accessibility is studied from the perspectives of individuals or users, among the different accessibility types only physical, suitability, and affective been considered (Van Oostendorp et al., 2005). *Physical accessibility* addresses the question of whether or not a user has direct access to a services, *Suitability* includes whether the medium is suitable and/or provide a specific solution to meet the specific needs of the user (McCreadie and Rice, 1999; Van Oostendorp et al., 2005), *Affective accessibility* focuses on whether a medium has been used in their daily lives (Van Oostendorp et al., 2005). The author indicates that these accessibility types is dependent on the context and use and influenced by supply and demand factors (Van Oostendorp et al., 2005). Therefore, in the case of accessibility of mobile health applications and technology is concerned, the components have been delineated from the Penchansky and Thomas's modified theory of access and literature of Van Oostendorp et al., (2005) in which the accessibility types of McCreadie and Rice (1999) is embedded.

In order to facilitate the acceptance of online systems, there is a need for training and support across the phases of initiation and over the course of its useful life (Culnan, 1984). In addition, the application should provide patient-care by considering health system-focused applications and population health-focused applications that are that proficient and comfortable level (Forrest et al., 2015; Ristau et al., 2013). Mobile health application use was low among aged peoples and otherwise common among primary care patients with limited health literacy and those with chronic conditions (Bauer et al., 2014). In a study by Chen et al., (2015) reported that the effectiveness of the fitness apps should be considered as the weight management application are suboptimal in quality. In contrary, the effectiveness of a smartphone app was found to be significant when overweight individuals use apps frequently (Chin et al., 2016).

Thus, from the literature, we can observe that the benefit and acceptance of a product or service can only be realized if the healthcare providers or the government through proper channel makes it accessible to the users or patients for day to day operations.

### 2.4.3. Affordability of Mobile Health Sevices and Applications

This section explores previous literature that compares and contrasts affordability factors for achieving an affordable and cost-effective mHealth system. Before examining prior literature, it is important to discuss the conceptual definition of these factors. According to Bardley (2008), affordability is vague and rooted in the theories of economics or economic theory (Whitehead, 1991). This theory assumes it as *"a household which chooses bundles of goods and services that maximizes utility – i.e., the benefit derived per money spent – subject to its preferences and budget"* (Niëns et al., 2012). In other words, for a product/service to be affordable, the company has to consider the consumer utility aspect and value which he/she pays. In systems engineering and according to INCOSE working group, affordability is defined as *"the degree that system performance, cost, and schedule constraints are balanced over the system life, while mission needs are satisfied in concert with strategic investment and organizational needs"* (Tuttle and Bobinis, 2013).

Defense Acquisition University (2018), defined affordability as the *determination of life cycle cost of an acquisition program is in consonance with the long-range investment and force structure plans of the Department of Defense (DoD) or individual DoD components.* In addition, it is nothing but *conducting a program at a cost-constrained by the maximum resources that the DoD or its component can allocate to that capability.* It is also defined based on characteristics such as affordability, confidentiality, empathy, technical competence, accuracy, reliability, environment, and facilities (Defense Acquisition University, 2018; Mohammad Mosadeghrad, 2013). Maclennan and Williams (1990) indicated that affordability has to do with improving service quality to the people for day-to-day lives such that it doesn't constrain any outsider (or government) an unreasonable burden on family incomes (Hancock, 1993). It also supports healthcare in achieving patient satisfaction through patient-centered care, access, technical quality, efficiency, structure, and facilities which are considered to be necessary together with the continuity of care (Sofaer and Firminger, 2005; Kruk and Freedman, 2008).

The technical quality or competency is defined based on the technical accuracy of medical diagnosis and procedures to that of standard practices (Lam, 1997) and also includes staff competency in performing these tasks (Edura Wan Rashid and Kamaruzaman Jusoff, 2009). It also describes service process outcomes or interactions and is dependent on providers' professionalism and competency (Dagger et al., 2007). Moreover, for achieving an affordable solution, supportability is also an add-on for value creation and service quality improvement. Supportability should be given a major priority and has to be taken in design and development process so that the products or services have a significant impact on performing a particular task (Defense Acquisition University, 2018). Furthermore, for developing a patient-centered monitoring system, the application framework should consider mobility, context-awareness, adaptation, and execution environment as support is helping patients in early disease detection and providing homecare through displays and interphases instead of clinical intervention (Dey et al., 2017; Liu et al. 2011).

Financial viability as the component of affordability is defined as the *"capacity that an organization that requires to generate sufficient income in order to meet the operating costs and initial investment"* (Soriant 2018). To access organizations financial viability, the factors such as nature (or complexity) of goods and services, the procurement value, economy, labor, demand and supply capacity, and profit margin need to be considered (Australian Government, 2019). It involves people acting as a primary source of revenue through the purchase and use of IT and another service system without influencing any other interventions (Krishna and Madon, 2004). In healthcare organizations, financial performance is also associated with the motivation of their medical staffs, affordable care act, states and local policies, community characteristics, local delivery system, and hospital attributes (Cunningham and Felland, 2013). Altogether, these factors help in improving peoples' healthcare access in the community and thereby creating demand for providing cost-effective health service delivery.

Affordability also depends on IT expenditures for providing a common framework for evaluating services and accommodating IT budgets for future investments (Ryan and Raducha-Grace, 2009). As aforementioned, customers or users will value and prefer products or service if they feel it as cost-effective. Therefore, to achieve this organization goal, the stewardship has to consider factors from the system perspective and should maintain a balance between IT resources and assets. This includes factors related to cost, governance and compliance, variables, and usage and allocations (Zelle, 2007). Ryan and Raducha-Grace (2009), also pointed out that budgeting, accounting, and charging are the main financial management activities an organization should consider for delivering cost-effective solutions.

In a research paper by Chaamwe and Bwalya (2013), indicated a lack of integration on bank-wide systems and their silos approach resulted in increasing software acquisition, maintenance, and support cost. Thus, implementing cloud computing systems and integration of enterprise resource planning systems was recommended for rationalizing annual and maintenance license of these systems components. Thus, taking into consideration of these factors and by using service management approach for service delivery the financial management and accounting for IT service will be more effective, detailed, and efficient than it would be otherwise (Gallacher and Morris, 2012). Thus, as aforementioned, Table 2.7 presents affordable system overall effectiveness (ASOE) components (Defense Acquisition University, 2018) and variables for making mHealth systems affordable and cost-effective.

**Table 2.7:** Factors of affordable system overall effectiveness

| ASOE Components | Variables | References |
|---|---|---|
| Technical Performance | Application<br>Framework<br>Payment Models | Broens et al. (2007); Liu et al. (2011); Kibria et al. (2013); Krishnan (2017); Sofaer and Firminger (2005); Kruk and Freedman (2008); Ntaliani et al. (2008). |
| Supportability | Reliability<br>Maintainability | Nicholls (2005); Pan (1999); Frappier et al. (1994); Mohammad Mosadeghrad (2013); Edura Wan Rashid and Kamaruzaman Jusoff, (2009); Lam (1997). |
| Process Efficiency | Development<br>Utility<br>Backend Support<br>Application Features | Ababtain et al. (2013); Delgado (2017); Dey et al., (2017); Liu et al. (2011); Australian Government (2019); Hussain et al. (2018); Yadav et al (2018). |
| Affordability | Financial Viability<br>Cost-to-Consumer | Australian Government (2019); Soriant (2018); Cunningham and Felland (2013); Ryan and Raducha-Grace (2009); Yaros et al. (2010); Chaamwe and Bwalya (2013); Piscopo (2018); Varshney (2014); Defense Acquisition University, (2018). |

Due to the inadequacy of research and the condition required for achieving affordable and cost-effective system, this study tries to address the research questions of what stakeholders in India consider as a) fundamental conditions for initiating mobile health systems and b) desirable outcomes regarding affordable and cost-effective of successful mobile health systems.

### 2.5. Social Media in Health Service Research

The popularity of social media and microblogs has supported various researchers to interact with their study participants and for data mining (Sinnenberg et al., 2016). Social media analytics came into the visibility due to the availability and accessibility of a large amount of data which organizations across the world are finding it difficult to manage and derive a meaningful solution. Therefore, various analytics have been identified among them sentiment analysis is the one which assists organizations in establishing data relationships.

Sentiment analysis or opinion mining focuses on the computational study of opinions, sentiment, and emotions which are expressed in the form of text (Liu, 2010; 2012). In other words, it refers to the processing of natural language, text analysis, and biometrics to identify, extract, quantify, study the affective states, and subjective information about a product/service, or an event from the perspective of the customer through reviews, survey responses obtained from the social media or blogs (Cummings, 2010). These responses are helpful for the organizations to measure the sentiment of an individual having towards their products or services, which assists them in production and marketing.

In psychology, there exist different theories which explain peoples’ need and emotions towards the mHealth app use for health activities. But then most of these depend on how we perceive our social environment (Johnson, 2017) and this may not be constant until people get experiences over time. Hence, the following section reviews select literature which drives peoples’ needs and emotions for for certain disease specific health applications.

*Theories of Needs and Motivation*

According to Abraham H. Maslow, people will be motivated to use products only when their needs are unmet or unsatisfied (Maslow and Lewis, 1987). These unsatisfied need depends upon satisfaction which influences the behavior driving them to progress upwards in the hierarchy level as classified by Alderfer's in ERG theory of Existence (need physiological health and safety), Relatedness (need for interpersonal connections, social status, and recognition) and Growth (need for personal development) (Alderfer, 1989).

The motivations can also arise because of needs associated with achievement, power, and affiliation, as David McClelland explained in his three needs theory (Fagenson, 1992). Therefore, in the case of mHealth app use the primary reason being the disparity in the level of population and healthcare accessibility resulted in problems related to the delivery of good quality healthcare services. Since these needs are unmet, research associations, healthcare units, and the government started promoting health apps such that a number of people can have access to health information's over mobile phones.

*Theories of Emotions*

Emotions are defined as the feeling which a person expresses depending upon circumstances or environment. It can be any conscious experience characterized by intense mental actions and a high level of joy or disappointment (Panksepp, 2004). In evolutionary theories, the emotions such as fear, jealousy, anxiety, anger, and desire had evolved from early hominids, using particular adaptations such as incorporation, rejection, destruction, protection, reproduction, and exploration. These adoptions are being shared by animals, and as a result, these species processes certain traits due to their shared ancestry (Johnson, 2017; Cosmides and Tooby, 2000; Griffiths, 2004).

Social and cultural theories of emotions consider emotions which start with an idea and a product of societies and culture which are acquired by the individuals through experience (Johnson, 2017). This theory addresses emotion words used in different languages for representing a particular behavior or situation (Lutz, 2011). Example: in Japanese, the word 'Fago' describes the maturity level of the person like childishness, selfishness, etc. and 'Song' used to indicate the unacceptable behavior (Centeno, 2009). Further, emotion process starts from the perception of stimulus then triggers a response of the body and finally body responses in terms of change in blood pressure, heartbeat, facial expression, etc. i.e., the conceptualization of anxiety disorders (Rauch and Foa, 2006). For example, anger because of insult and joy because of good grades in exams.

In judgment theories of emotion process, emotions such as surprise, hope, fear, joy, relief, discomfort, disgust, etc. are considered to have an essential judgment about ourselves and our place in the world based on projection of ideas and values, structures and mythologies whereas, the cognitive theories signifies the way the individuals evaluate the situation determines the emotions (Nussbaum, 2004).

Some of these emotion theories as defined and distinguished by David G. Myers (Myers, 2010) (professor of psychology at Hope College in Michigan, United States) were:

- *James-Lange Theory:* It proposes that people will experience emotions when they perceive things. Example: When we feel sad, we cry, likewise when we feel embarrassed, we blush.
- *Cannon-Bard Theory:* This theory suggests that people will experience emotions and physiological arousal at the same time, which means that emotions and arousal are simultaneous. Example: We blush and feel embarrassed at the same time simultaneously.
- Schachter-Singer "Two-factor" Theory: It says people will experience emotions which depend upon physiological arousal and its cognitive interpretation. Example: The label which people give for the same physiological arousal at different instances and context like fear can become arousal depending upon the environment.
- *Robert Zajonc, Joseph LeDoux, and Richard Lazarus: Emotions without Awareness/Cognition Theory:* The theory states that some reactions which are emotional develop in a low road through brain skipping the thought of consciousness. Example: In the forest, we respond to the sound before assessing it.

Based on these emotional theories, table 2.8 summarizes the select theories indicating the constituents of sentiment and that are considered in secondary data analysis.

**Table 2.8:** Constituents of sentiment for secondary data analysis

| Author | Theory | Constituents of sentiment | Remarks |
|---|---|---|---|
| Cosmides and Tooby (2000) | Natural Selection in Early Hominids | Fear, Jealousy, Anxiety, Anger, Desire, Love and compassion | The study explains the possible selection occurred in response to the problems that have happened in the social environment. |
| Griffiths (2002) | Historical, but Not Adaptationist | Surprise, Anger, Fear, Sadness, Joy, and Disgust these emotions are termed as affect program emotions | The research explores an alternative that focuses on the identification of traits in a certain species due to their shared ancestry. |
| Roseman (1984) | Cognitive Appraisal Theories | Surprise, Hope, Fear, Joy, Relief, Discomfort and Disgust, Frustration, Liking and Disliking, Anger, Shame, Guilt, Pride, Reject. | The study signifies the way the individuals evaluate the situation determines the emotions and don't rely on belief, judgments, etc. |

From table 2.8, it can be considered that the constituents of emotions are developed due to the historical setting in the human body today with reference to the natural selection that occurred in the past. In some cases, the emotion process generally starts from the perception of a stimulus and then trigger responses of our body. Based on these theories, many researchers across the world have studied the sentiments or emotions of the people they followed while writing books, blogs, social networking sites, etc.

Social media, particularly social networking applications, is a multiway type of mobile health tool used by a communities and large geographical areas to share experiences on health systems and health promotion and aversion and mitigation during disasters (Kahn et al., 2010; Källander et al., 2013; Huesch et al., 2016; Guerra-Reyes et al., 2016; Lee and Moon, 2016; Chan and Chen, 2019; Chen et al., 2018). The meta-analysis revealed that social media and mobile health applications are effective in prenatal and postnatal periods (Chan and Chen, 2019). The literatures have also indicated that its use in developing countries has had a positive effect (Brusse et al., 2014) and suggests that social and economic development may be less restrictive (Chan and Chen, 2019).

The authors Pagolu et al. (2016), found that there is a strong correlation between the stock price and public opinions by analyzing Twitter data. The Twitter data is also analyzed based on volume, generic sentiment, and language model for predicting the movement of the public opinion measured through presidential approval rating, economic confidence, and the generic Congressional ballot (Cumming, 2010). Lassen et al. (2014), used sentiment analysis by developing a linear regression model for predicting the sales of the iPhone from its tweets, which are found to have a strong correlation.

The Twitter can also be used to analyze people's sentiment about particular healthcare or public health measures. Rastegar-Mojarad et al. (2015), used sentiment analysis techniques and Hadoop to analyze the patient experience of healthcare and concluded that longer the patient reviews poorer the reviews of the facility. Twitter analysis can also be used to measure the real-time barometer of public on Affordable Care Act (ACA) and identified that there exists a positive correlation between the sentiment and marketplace enrollment (Wong et al., 2015).

The researchers Paul and Dredze (2011), correlated influenza rates with the Twitter data and indicated that for a particular symptom of infections or physical injuries, the intended usage of medicine could be mentioned. It can also be used for extracting and investigating the effect of adverse drug reactions helping them in improving drug and creating popularity in the social media and other health forums (Korkontzelos et al., 2016).

Salathe´ and Khandelwal (2011), investigated the spatiotemporal sentiments for a novel vaccine which can be used to measure the intuition about that vaccine. Hence, they concluded that groups of negative vaccine sentiments lead to unprotected individual and increases disease outbreaks. Therefore, the current study also considered these theories and literature and performed secondary data analysis to understand the sentiment of the people expressed in the form of tweets and available on the social media platform.

## 2.6. Research Gaps

The following table (table 2.9) presents the research gaps that was identified based on the literature available in the area of mobile health and is attempted through this study:

**Table: 2.9:** Select research gaps identified from the literature

| Authors | Description | Remarks on the present study |
|---|---|---|
| ***Mobile health in the Indian context is yet to explain about its use among general population*** | | |
| Müller et al. (2016); Holeman et al. (2016); Pantoja et al. (2017); Pfammatter et al. (2016); Prinja et al. (2016); Sharma et al. (2017); Bassi et al. (2018) | Existing research articles often describe the importance of mobile health for low- and medium-income countries. However, very less research has been conducted on general population. | Multiple studies have been carried out by considering users, patients, students, healthcare professionals, and technology entrepreneurs and their influence of awareness, accessibility, and affordability has been studied. |
| ***Less adequate framework for mobile health applications acceptance and intention to use*** | | |
| Bondale et al. (2013); Feinberg et al. (2017); Jarosławski and Saberwal (2014); Nair and Bhaskaran (2015); Peiris et al. (2014); Tamrat and Kachnowski (2012) | Scholarly articles are often limited to address the benefits of mobile health. However, the challenges faced by people and doctors have been inadequately discussed. Likewise, fewer studies have proposed the mHealth framework specifically for rural regions. | Mobile health technology and applications framework have been developed for capturing patient data and supporting evidence-based practices. A technology acceptance model specific to Indian rural communities was developed by considering multiple theories and rural community. |
| DeSouza et al., (2014); Venkat (2016) Singh et al. (2018); Bhargava et al. (2018) | Studies have often used technology adoption, and the health belief model for studying individuals use intention. Less research has considered a motivational construct and individual difference variable with it. | A conceptual model considers these factors that have been identified and their influence on intention to use was analyzed. |
| PwC (2012); Kappal et al. (2014); Bhattacharya et al. (2018); Parthaje et al. (2016) | Scholars are less specific in describing the variable "awareness" and its influence on the "intention to use" mobile health technology and applications. | Multiple studies have been carried out to examine the awareness and use of mobile health among students, healthcare professionals, and general populations. |

| Less adequate studies to discuss the use of social network forums for health | | |
|---|---|---|
| Joseph et al. (2017); Korkontzelos et al. (2016); King et al. (2013) | The social network in health research is used to study populations' health and behaviors. However, fewer studies are available for measuring peoples' sentiment towards disease specific applications. | Multiple case studies have been incorporated to understand peoples' sentiment and identify frequent repeating keywords for certain disease specific health applications. |

Thus, mobile health plays an important role in managing health and service delivery. Since the use of mobile health applications and systems has a direct influence on the health of an individual. It becomes necessary for the technology entrepreneurs and software developers to work along with the healthcare professionals for developing customized, robust system and implementing it through the right channels either by involving doctors or physicians. These applications and systems should be monitored and regulated by standards organizations for information credibility and security and it should be maintained across all the stages of health management. In India, most of the mobile health systems and applications are working as projects or trials across different parts of the country by integrating it could help in generating evidence towards individuals' behavioral change practices or for scaling up. The data and clusters identified in this study can also be considered by the government and other stakeholders in identifying the gap in service delivery.

It was also highlighted in the literature of mobile technologies and healthcare that data confidentiality, interoperability, and reimbursement are the factors influence mobile health adoption. More recently, academicians and techno-entrepreneurs have also pointed out that lack of awareness and absence of clinical evidence is a major factor for its low adoption in rural and urban regions of developed and developing countries. Hence, mobile health technology with proper promotion, interoperability, and accuracy in data measurement are considered to be essential factors in providing health service to the citizens, thereby achieving the health policy of a country. Even though they have been used in countries like United States, United Kingdom, Korea, and Australia, its presence among Indian populations are less reported. Therefore, there is a need to study the factors of awareness, accessibility, and affordability of mobile health among the citizens, healthcare IT professionals, technology entrepreneurs, and software developers for improving its usefulness.

## 2.7. Conclusion

This chapter discussed existing theories and empirical literatures on computer and media choice, technology adoption, diffusion of innovations, and health belief model. It has also studied the literature on mobile health published in the Indian context and thus provided the basis for this research. By reviewing theories of media choice and use, it was shown that individuals are using mobile phones and smartphones devices for managing interactions and acquiring cognitive, affective, social integrative, and tension-free needs. It also allows individuals to establish the relationships between the individual’s performance and that of the task associated with him, which contributes to the promotion and facilitation of active learning. Therefore, the usefulness of mobile phones and its applications for health activities can be improved if the device helps individuals in synchronous and asynchronous interactions related to health and decision making without any difficulties.

The technology adoption literature and theory focuses specifically on the technology diffusion process that starts with knowledge, persuasion, decision, implementation, and confirmation that allows an individual to make the final decision as to whether or not to use the technology. For healthcare technologies, the decision of acceptance and rejection also depends on social, cultural, and economic conditions. The literature also indicates that information technology acceptance depends on an attitude that is a function of usefulness and ease of use. Since mobile health is a patient-centered care system, there has to be proper awareness and accessibility among the individuals and the healthcare providers for improving its governance. The health belief model on the other hand basically explains and predicts health related activities and behaviors related for improving health services. In such situations, mobile health applications allow them to increase awareness of the various diseases, and also enable them to seek and communicate health conditions with their healthcare professionals.

The study then analyzed the literature published on mobile health in the Indian context and revealed six clusters classified as individual’s mobile health applications adoption characteristics, need for mobile health and its governance, mobile health for healthcare systems and HIV adherence support intervention, individuals behavioral change outcomes, and development and implementation of mobile health for community health workers. In all cases, it was found that the study did not include the general population and that randomized cluster trials involving pre and post interventions should also be checked to improve the scalability.

After this, it was argued that the components such as awareness, accessibility, acceptance, and affordability are needed to explain and understand the concept of mobile health applications in order to achieve an effective solution. Based on these components and existing literatures, the study showed that there is an opportunity to build a strong framework that connects these components to understand and assess mobile health applications in Indian context.

Finally, the theories related to the use of social media applications in health service research has been studied independently to understand peoples' needs and emotions for certain disease specific health applications. It was studied because of the literature that suggested its usefulness in finding health information and during unexpected stressful events. This showed how to incorporate the theories and literatures into the literature to direct it work. In the next chapter, context and scope of this study and the research methodologies followed to achieve the research question will be discussed.

# CHAPTER 3

# R E S E A R C H   D E S I G N

## 3.1. Introduction

The previous sections explained the theoretical and empirical background that guided this study. This chapter discusses the research design process and methodological choice of this study based on the research question and objectives. Specifically, it explains why India is considered as an appropriate location for the study and why mixed methods research has been adopted in this thesis.

This chapter is structured as follows. Section 3.2 presents the research question for this study, followed by a research objective in section 3.3. Section 3.4 discusses the conceptual framework and hypothesis developed for this study. Section 3.5 discusses the context and scope of the study followed by specific research methods in the section 3.6. Finally, section 3.7 concludes this chapter.

## 3.2. Research Question

This research question is:

***Research Question 1:*** How to improve the usefulness of mobile health applications for health service delivery?

## 3.3. Research Objectives

Based on the research question, the following research objectives have been framed to guide the study design, data collection, and data analysis.

The conceptualization of awareness and use of mobile health technology and applications are inadequately addressed among the Indian citizen. This necessitates studying the following objective through a quantitative survey.

***Research Objective 1:*** To study the awareness level in the use of mobile health applications among citizens.

Since there is a lack of published articles about mobile health accessibility and acceptance among the rural populations and affordability at the level of technology entrepreneur or software developer, a qualitative study would be appropriate to address the following research objectives:

***Research Objective 2:*** To analyze the accessibility and acceptance of mobile health among the rural population.

***Research Objective 3:*** To study the affordability in terms of cost to consumer and financial viability of the service provider (i.e., stakeholder or technology entrepreneur).

These research objectives will assist in the data collection process and drive through the layers of people, process, and technology that will provide a rich depiction about the status of mobile health technology and applications in India.

## 3.4. Conceptual Framework and Hypothesis

Since this study includes qualitative interviews and a quantitative survey, a conceptual framework is drawn based on the guidance of theoretical and empirical background previously reviewed. The conceptual framework (Figure 3.1) drawn for this convergent mixed method design involving multiple studies (Yin, 2008) depicts the relationship between the awareness, accessibility and acceptance, and affordability, and mobile health technology and applications usefulness.

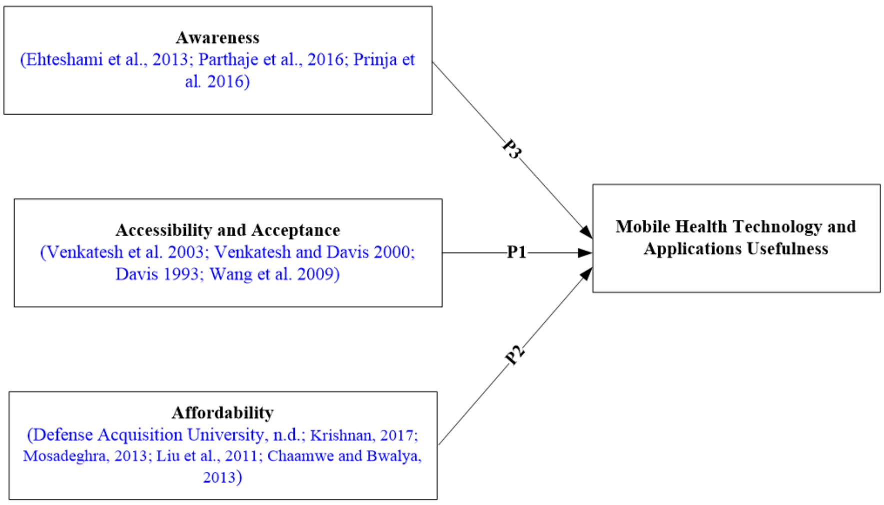



**Figure 3.1:** Conceptual framework of the study

It was said that propositions rather than hypotheses would play an essential role in addressing the research questions through multiple case studies and for developing a framework which later would guide the study in generalizing the new components or variables (Yin, 2008). This increases the testability of the study findings and provides strong evidence for theoretical testing research (De Massis and Kotlar, 2014).

***Proposition 1:*** The higher the awareness about the use of mobile health technology and applications for service delivery, the higher will be the usefulness.

***Proposition 2:*** The usefulness of mobile health technology and applications can be improved by considering the factors of accessibility and acceptance among rural people.

***Proposition 3:*** The usefulness of mobile health technology and applications can be improved by considering the factors of affordability from the perspectives of technology entrepreneurs or software developers.

These prepositions designed for this study considers the relationship as unidirectional and limits it. However, it can also be reinforcing and associated, but it has not been considered in this study.

### 3.5. Operational Definitions

The following table 3.1 provides the operational definitions for the dimensions of usefulness considered in this study.

**Table 3.1:** Operational definitions

| Dimensions | Operational Definitions |
|---|---|
| Awareness | It is defined as the amount of knowledge an individual has about mobile health and its benefits, and that has a crucial effect on adoption |
| Acceptance | Individuals acceptance of using mobile phone technology and applications for health-related activities. |
| Accessibility | It is defined as the individuals' access to mobile health medium (suitability), services (physical accessibility), and utility (affective accessibility) in their daily lives. |
| Affordability | It is defined as implementing a mobile phone technology and applications at a cost constrained by the maximum resources that the technology entrepreneur or any software developer can allocate to the needy individuals or healthcare units. |

### 3.6. Context and Scope of the Study

The previous sections have discussed the conceptual model of the study and stated its propositions for improving mobile health applications usefulness in India. This section, therefore, presents the answer to *why this research is conducted in India?*

#### 3.5.1 The Justification for Indian Context

India is located in the southern part of Asia, surrounded by the Arabian Sea and the Bay of Bengal on one side and mountains on the other (Kappal et al., 2014). It is considered as the second largest populated country in the world with a total populace of more than 1.2 billion (The World Bank, 2018) and located mainly in the rural regions (The World Bank, 2018; Chandramouli and General, 2011). Out of the total population, the age distribution of people with 25-54 years is nearly 41.24 percent and 17.79 percent for 15-24 years (Central Intelligence Agency, 2019).

The Government of India in its 12th five-year plan has designed priorities for strengthening public health systems, improving availability and qualified health personnel, accessible and affordable drugs and diagnostics, and quality assurance (Ministry of Health and Family Welfare Government of India [MoHFW], 2014). The accumulation of the people in rural regions has created problems related to the accessibility of primary healthcare services. Therefore, it is primarily managed by government and accompanied by various private healthcare institutes. Apart from these, the healthcare market also comprises departments and infrastructure related to medicine manufacturers (pharmaceuticals), diagnostic services, medical equipment and supplies, and medical insurance companies (Sengupta, 2013).

With a substantial and uneven achievement in the millennium development goals which was aimed towards poverty and hunger, child mortality, maternal health, HIV and other diseases (Sustainable Development Goals Fund [SDGF], 2018), India remained as a host of issues like poverty, malnutrition, and various diseases (Bhutia, 2014). This can be due to the imbalance created between nutrition and income and resulted in the people suffering from non-communicable diseases affecting their health, productivity, and economic growth (Mazumdar-Shaw, 2018). It is also expected that; the healthcare cost may rise significantly because of growth in the elderly population and may require frequent hospitalizations and regular monitoring practices and preventive care (HelpAge India, 2015). The lack of focus, low health awareness, and education, weak infrastructure, an inadequate workforce, poor service delivery mechanism, and low public investment in the preventive healthcare can be the reason for individual's poor health (Mazumdar-Shaw, 2018). For instance, India has only 0.7 doctors per 1000 patients and is compared to be less than the required numbers of 1:1000 as estimated by WHO (Global Health Observatory [GHO] data, 2015).

The healthcare access in India is working with 70:70 paradox, i.e., 70 percent of healthcare expenses are out of pocket expenses, of which 70 percent is spent on medicines alone, leading to impoverishment and indebtedness (Jayakrishnan et al., 2016; Golechha, 2015). This can be more of catastrophic expenditures that may result in poverty because of the healthcare cost (National Health Policy [NHP], 2015). It is also anticipated that the healthcare sector will grow from USD 100 billion of the year 2015 to 280 billion in the year 2020 because of lifestyle diseases, an aging population, rising income levels, increasing access to insurance and growing health awareness (Bobba, 2017). This creates demand for the healthcare services and challenges the system to maintain a balance between the resources and its associated cost factors thereby reducing the cost burden on the consumer through insurance schemes etc. which makes them accessible to receive quality healthcare services. Moreover, studies have indicated that the increase in affordable healthcare innovation can improve its availability and accessibility (Richard et al., 2016; Mazumdar-Shaw, 2018). The Government of India through National Rural Health Mission (NRHM) and the Ministry of Health and Family Welfare (MoHFW) have multiple mobile health projects for improving healthcare availability and accessibility. The most potential one is the 'Mother and Child Tracking System' (MCTS) for gathering health information from antenatal and postnatal women (NHP, 2016; Arul et al., 2012).

India is currently leading the mobile Internet usage among G20 nations with 79 percent of the people accessing the web on phones (StatCounter, 2017) and is currently having the second largest online market with more than 460 million Internet users (Statista, 2019). According to Telecom Regulatory Authority of India (TRAI), the urban and rural telephone subscribers for wireless devices have an overall teledensity of 90.11

percent (TRAI, 2018), and these numbers are increasing every year. This can be due to the availability and accessibility of low-priced mobile phones and geographical coverage and connectivity of mobile networks (Sharma et al., 2017).

As stated, to become an economic powerhouse, India should focus on building a healthy population along with improving the nation's healthcare expenditure and facilities (Srivastava, 2018). Currently being low, the country should utilize the Internet and other technological components to deliver healthcare services to the patient's home. Moreover, a portion of the people is dependent on primary healthcare facilities and leveraging the system would help in improving the accessibility and affordability (PwC, 2017). The study says, globally, India accounts for 20 percent of the burden of diseases (Mazumdar-Shaw, 2018), 27 percent of neonatal deaths and 21 percent of child deaths (Lopez et al., 2006). Therefore, promoting the use of mobile phones and their applications (apps) are considered to be vital in rural areas. The reason behind its use can be due to the increasing population and acute shortages of paramedical and administrative professionals, and infrastructure (Deloitte, 2015). According to PricewaterhouseCoopers (PwC), India ranks fifth among the mobile health-related searches and second among developing countries for mHealth adoption (PwC, 2012).

Creating affordable information technology for health service delivery in India is also a challenge that existed from the demand and supply side for providing services. From the point of technology developers and the government, significant investment and operating expenses should be considered to initiate mobile health service. Therefore, investment in the form of grant, aid, and capital would help in fostering innovation (Garai, 2011). Simultaneously, they have to consider from the point of people, about the adaptation of information technology for health due to lack of education, income, other socio-demographic factors, etc. The number of mobile health applications in the play stores, lack of awareness, inadequate infrastructure and security concerns, low expectations, and manual interventions can also be the barriers for adoption mobile health for health management (PwC, 2017).

The bibliometric analysis and methodological review for mobile health in India were considered. A total of 158 articles using the keywords 'mHealth' has been selected for which the study characteristics, analysis of co-occurrence, and co-authorships was computed. The number of literature published in this domain has been exponentially increasing indicating the increased interest in the research area and expansion. Apart from mHealth, the terms chronic diseases, maternal and child health, telemedicine, implementation research, cloud computing, Internet of things, smartphones, and healthcare are the commonly associated keywords listed by the authors. The co-citation of the journal indicates *PLOS One* as the most preferred journal for publishing mobile health articles. For the bibliographic coupling only the largest connected articles within the network visualization mapping have been considered. The number of articles, therefore selected for methodological review is 28 documents. The analysis revealed six clusters classified as individual's mobile health applications adoption characteristics, need for mobile health and its governance, mobile health for healthcare systems and HIV adherence support intervention, individuals behavioral change outcomes, and development and implementation of mobile health for community health workers.

The findings from the methodological review for each of the clusters identified in this study are highlighted in the following section. Firstly, in India, mobile health applications are working as projects and trials across different part for managing cardiovascular diseases, mental health, immunization, diabetes, hypertension, and physical activity. It was also identified that adequate researches had been carried out for assessing its usefulness for maternal and child health and HIV and concluded that mobile phones have the potential for assisting ASHA workers in managing antenatal care and anti-retroviral therapy process. Secondly, it was observed that mobile health also includes the use of basic mobile phone applications (such as call features, SMS features, camera applications, etc.) for medical interventions. Thus, in the Indian context, the term can be defined as "the use of transportation systems such as mobile medical units or vans and/or mobile phone/ICT for providing health services to the people living in a particular locality or self-care".

Thirdly, the peer-revived articles published in this domain and with respect to Indian populations representing the components of mobile health systems and applications framework is less adequate. This indicates that there is a need to provide a holistic framework considering people, process, and technology components. Fourth, most of the studies have compared the results obtained from the intervention arm to the control arm by considering a group of patients, but not adequate evidence is available that include general populations. Fifth, as aforementioned, lot many studies have been carried out on maternal and new mothers, but the components addressing the components of accessibility has not been discussed adequately.

The systematic literature conducted for evaluating the use of mobile health interventions among the low – and medium – income countries was found to be successful in promoting health (Sondaal et al., 2016; Hurt et al., 2016) but concluded that the study does not include the general population (Müller et al., 2016; Holeman et al., 2016; Pantoja et al., 2017). The same has been observed in the Indian context (Parthaje et al., 2016; Pfammatter et al., 2016; Prinja et al., 2016; Sharma et al., 2017; Bassi et al., 2018). This can be due to a lack of awareness (PwC, 2012; Kappal et al., 2014; Bhattacharya et al., 2018; Parthaje et al., 2016), accessibility (Mazumdar-Shaw, 2018; Sengupta, 2013; Chatterjee et al., 2018), and affordability (Mazumdar-Shaw, 2018; Sengupta, 2013; Kappal et al., 2014) issues about mobile health applications that resulted in lower impact on the healthcare sector.

### 3.5.2 The Scope of the Study

The proposed investigation takes into consideration the awareness, accessibility, and affordability of mobile health applications and systems in the Indian context. For some countries, where mobile health applications are used for communication, information seeking, and disaster management are found to be evident, but there exists a lack of published articles about its usefulness in the Indian context. Therefore, the scope of the study is confined to the:

- Healthcare solution providers and technology entrepreneurs who have already developed or in the process of developing mobile health solutions for health and service delivery.
- Select government and stakeholders in the decision-making process considering the aspect of people, process, and technology component of mobile health for good governance.

- Technical and medical institutions in designing a curriculum that discusses the importance and availability of various mobile health applications and technologies mainly for improving the awareness about technology and entrepreneurship.
- Researchers and contributors of mobile health technology and applications.
- Social media users in understanding the influence of social media games and social media movement on the mental health of an individual and how health applications could be beneficial.
- Published journal articles and conference proceedings on mobile health technology and applications.

### 3.7. Research Methodology

Mixed method research is defined as the collection and integration of both qualitative and quantitative-based data obtained using distinct designs which may involve philosophical assumptions and theoretical frameworks in a study (Creswell, 2014). It has been widely used as a methodology in the fields of social sciences (Teddlie and Tashakkori, 2009; Bryman, 2016), management (Abro et al., 2015), and accounting (Grafton et al., 2011) research. In social science, specifically health service research, it has been used in nursing, family medicine, social work, mental health, pharmacy, and allied health (Creswell et al., 2013). The reason for using it in healthcare is can be because of the complexities involved in the healthcare setting and the necessity of various methodologies for addressing these complexities (O'Cathain et al., 2013; Tariq and Woodman, 2013; Marchal et al., 2014; Lee et al., 2018; Long et al., 2018). The use of multiple methods would produce results that are more robust and compelling than single method studies (Davis et al., 2011). Moreover, due to the nature of the research gaps identified in the previous chapter (chapter 2), this thesis used mixed method research to address the research question of *"How to improve the usefulness of mobile health applications for health service delivery?"*.

Based on the research question, this thesis is designed to use convergent mixed method design and analytic procedures (Kerrigan, 2014) in which qualitative data (interview-based case study and Twitter data) and the quantitative data (questionnaire survey) are collected approximately at the same time. Such a type of mixed method design would allow the researcher to integrate the data across the stages of the project.

### 3.6.1 The Methodological Choice in this Thesis

The previous section had discussed the context and scope of the study. It showed that the use of mobile health interventions among the low – and medium – income countries was found to be successful in promoting health but suggested to include general populations. Moreover, literature also indicated that the lack of awareness, accessibility, and affordability issues about mobile health applications has resulted in low acceptance and adoption. As has been noted in chapter one and chapter two that the methodological choice in this thesis is the convergent mixed method design wherein the findings from the qualitative (interview-based case study and Twitter data) and quantitative (questionnaire survey) methods are integrated. It is used not just to compare the study findings but also included convergent analysis process (Creswell and Plano Clark, 2011) to understand the complexity of mobile health technology and applications across the layers of people, process, and technology. The use of this type of mixed method research is influenced not only by the gaps identified in the literature review but also due to the practicality of the topic in health and information systems (Figure 3.2).

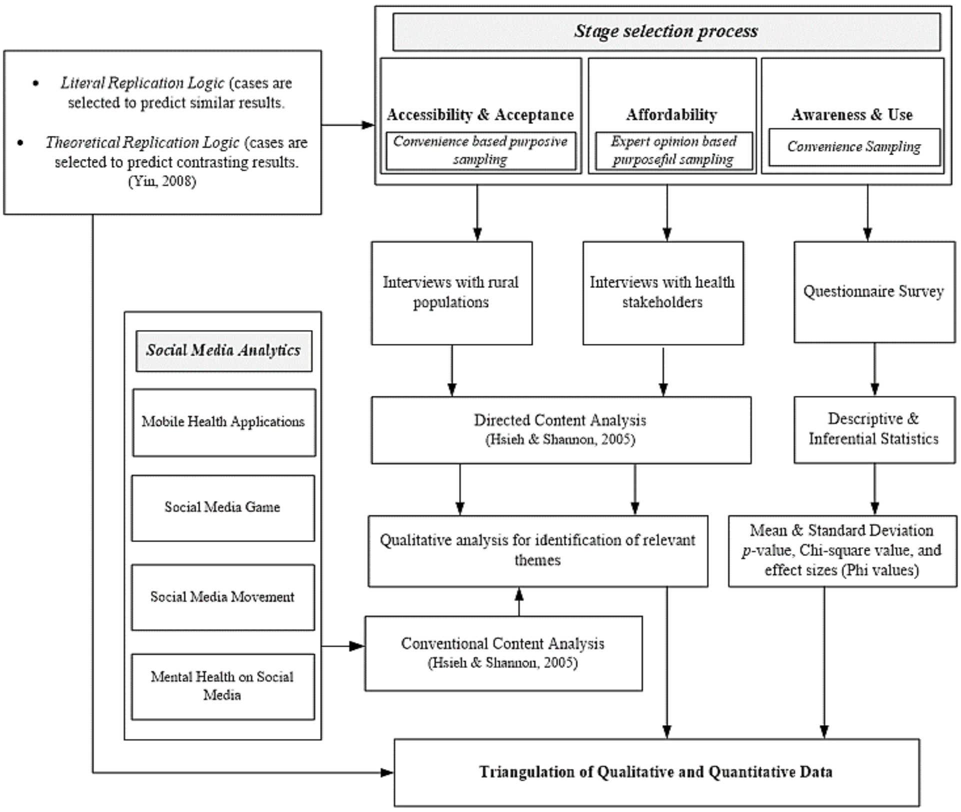



**Figure 3.2:** Convergent mixed method design

This section presents in detail why mixed method research is suitable for this study.

#### 3.6.1.1 The Justification for Mixed Method Research

For conducting research, the researcher has to consider the methodological choice. It is influenced by the available resources and philosophical assumptions about the nature of social science and society (Gill and Johnson, 2002). This includes ontological, epistemological, human nature, and methodological assumptions (Oliga, 1988; Burrell and Morgan, 2017; Holden and Lynch, 2004; Blaikie, 2007). In this study, the use of mixed method research is influenced not only by the gaps identified in the literature review but also due to the practicality of the topic in the area of health and information systems. Before proceeding with the methodological choice, it is vital to introduce the study's research history.

As has been noted in chapter two that, although a large number of mobile health applications has been initiated for improving the rural health and service delivery, there is the inadequacy of qualitative research that discusses the factors of accessibility and acceptance among rural Indian populations. To further understand, the study followed three steps approach. Firstly, previous literature related to technology acceptance has been considered for the identification of factors. Secondly, the study considered the context of Indian rural community and identified factors that might influence mobile health technology and applications acceptance. Thirdly, qualitative semi-structured interviews with 60 rural respondents, including doctors, to confirm the identified factors and for the new factors which influence acceptance of mobile health technology and applications.

Finally, the findings from each of the approaches have been triangulated and concluded by proposing a *"mobile health technology acceptance model (MHTAM) for the rural community of India"* based on the study findings. However, it was identified the existence of the virtuous cycle – people depend on healthcare professionals' for suggesting the applications and healthcare professionals depends on software developers for the affordable one. In this sense, the qualitative study was followed based on the existing models of affordability and the data were collected from direct observations and 17 in-depth interviews both online and offline involving healthcare professionals, technology entrepreneurs, and software developers.

It was also noted that there is the inadequacy of quantitative research that explains the relationship between individual cognitive factors, mobile-service-related factors, subjective norm, and health factors on mobile health awareness and use. It was identified that the limiting factor for the study would be the lack of an accepted model for measuring mobile health technology and applications awareness and use pertaining to the Indian context. Therefore, the study adopted multiple theoretical models for investigating its relationships using quantitative approaches.

Mobile health technologies and applications in India are in the initial phase of implementation and require a proper framework for its governance. Currently, the association between mobile phones and healthcare is mostly ‘indirect’. This means that individuals use basic mobile phone features such as calling and messaging apps, Internet browsers, mobile cameras, email apps, video sharing apps, social networking apps, and Internet radio apps for health communication and service delivery (WHO, 2011). It was also identified that people are using social media and its applications for seeking health information related to fitness, diabetes, cancer, and mental health. To support this, previous literature has also indicated that the population in the present generation search health material from online sources to maintain privacy and anonymity (Young, 2018) and also use social media during unexpected stressful events (Gaspar et al., 2016).

Therefore, it was considered that the data collected solely from the quantitative and case study interview might not be appropriate for describing the research phenomena. In this sense, to further understand how people express their emotions with respect to specific health conditions and potentially stressful social events, sentiment analysis has been performed for the tweets collected from the Twitter website. It was said that the use of Twitter (a multiway type of mobile health tool) for public health research is considered as a growing field (Kahn et al., 2010; Källander et al., 2013; Sinnenberg et al., 2016) and has an impact on individual’s decision-making process (Gabarron et al., 2019). Given the above consideration, it was decided to use convergent mixed method design wherein the findings from the qualitative (interview-based case study and Twitter data), and quantitative (questionnaire survey) methods are integrated to address the reason question than the use of singular methods. The following sections provide justifications for each of the qualitative and quantitative studies mentioned above.

#### 3.6.1.2 Rural Interview-Based Case Study

In India, mobile phones are being used widely because of low tariff and are considered to be the economically feasible mode of communication (DeSouza et al., 2014; Shet et al., 2010). Further, the number of rural telephone subscribers is 514.35 million (Telecom Regulatory Authority of India, 2018) and 70 percent of the urban poor households spend around 3 percent of their earning on mobile every month (TRAI, 2013). The Government of India under National Rural Health Mission has initiated the use of mobile phones for the purpose of antenatal and postnatal women health service delivery (Chib et al., 2012; MoHFW, 2016). It is also used to communicate with the central government employees to inform about the Central Government Health Scheme (CGHS) (DeSouza et al., 2014). Considering the nature of the rural healthcare system, it becomes inevitable to study rural people's awareness, accessibility, and perceptions about the acceptance of mobile phones for health service delivery.

The prior literature with respect to South India revealed that mobile phone access was relatively high suggesting the usability of mobile phone interventions for health communications (Shet et al., 2010; DeSouza et al., 2014; Saha and Lewis, 2016). It was also identified that the use of basic mobile phones, lack of awareness, demographic factors, study setting, and other contextual factors would improve the accessibility of ICT enabled intervention (Sinha and Varghese, 2015; DeSouza et al., 2014; Srivastava and Shainesh, 2015; Mazumdar-Shaw, 2018). Given the above consideration, it was decided to carry out a qualitative interview-based case study in the state of Karnataka (located in the south of India).

According to Karnataka Integrated Public Health Policy 2017, Karnataka has controlled the infant mortality rate from 47 to28 per 1000 live births, and Maternal Mortality Ratio from 178 to 133 per 100,000 numbers and the birth and death rates for 1000 populations are 18.3 and 7.0 numbers. Even though there are specific achievements in the infant mortality rate, but the inequalities in health outcomes and access to healthcare services as evidenced by the indicators for vulnerable groups and different geographies are still not proper in terms of health infrastructure and services, quality of care, stagnation in child health, shortages of specialists, etc. (Health and Family Welfare Services, 2017).

In the year 2004, in association with ISRO and Department of Health and Family Welfare, Government of Karnataka introduced Telemedicine Network Project in Karnataka. In its first phase, the project was implemented in 12 districts, and by the year 2008, it became operationalized in 25 districts with five specialty hospitals in Bangalore and Mysore (Holla, 2013). In the year 2011, the Health and Family Welfare Department Karnataka initiated Mother and Child Tracking System (MCTS) with the aim of using mobile phone technology to facilitate and monitor service delivery for micro birth planning, and immunization to enhance care to mother and child so as to have a positive impact on the infant mortality rate and maternal mortality ratio (Technopak Healthcare Outlook, 2012; NRHM, 2016). This system was then extended to Reproductive and Child Health (RCH) through ASHA workers to communicate effectively with the people, doctors, nurses, and Auxiliary Nurse Midwives (ANMs) (Yasmeen, 2013).

The Ministry of Health with Family Welfare India started promoting the use of information and communication technologies and health financing methodologies for a stronger and rapid response to the TB epidemic (MoHFW, 2017). In this connection, a comprehensive surveillance system called eNikshay (which connects TB patients and their providers will be supported by the call center for monitoring) and 99 DOTS has been initiated. Both of these technologies help the health functionaries at various levels in providing SMS services which have been used effectively for communication with patients and monitoring the program on day to day basis (MoHFW, 2017; Oberoi et al., 2016).

Hence, this study focusses on studying the perception, accessibility, and acceptance of mobile health among the rural areas of Udupi and Hassan Districts. The reason behind the selections of these regions is based on the literacy rate when compared to that of Karnataka and the distance to the nearest district hospitals. This is because of the fact that, for promoting digital transformations, the role of literacy and ICT are closely related to advances and participate in human communications by receiving and producing the information (Sinha and Varghese, 2015; Srivastava and Shainesh, 2015; Warschauer, 2011; Neter and Brainin, 2012; Chetty et al., 2017).

### 3.6.1.3 Questionnaire Design and Administration

To address the research question of *"How to improve the usefulness of mobile health applications for health service delivery?"*, this study considers various components (acceptability or acceptance, affordability, accessibility, and awareness) acting as a barrier to access for healthcare (Sheth and Sisodia, 2011; Jacobs et al., 2012; Penchansky and Thomas, 1981; Zhen and Mansori, 2012; van Gaans and Dent, 2018; WHO, 2019). These components are considered as the research objectives of the study, and accordingly, the questionnaire has been designed and administered.

*Rural interview-based case study*

A qualitative approach has been followed to address the two research questions: Firstly, *What are the factors that influence mobile health technology and applications acceptance for health service delivery in India?* Secondly, *How these factors can be integrated into the technology acceptance model, which can be limited to the rural Indian populations?* is phenomenon-driven research (Eisenhardt and Graebner, 2007). The use of qualitative data helps in describing the phenomenon by exploring key events, practices, and its underlying reason (Mousavi and Bossink, 2017).

A purposive-convenient sampling method was used to select study locations and interview respondents. The criteria for selecting this sampling method is justified in the previous sections. For study locations, the criteria included the value of literacy rate when compared to that of Karnataka and the distance to the nearest district hospitals. For instance, it was noted that nearly about 70 percent of the people living in these areas take consultations from primary healthcare centers as the distance to district's hospitals, and other health units are more than 10 km. Therefore, this method is used to collect data enabling the researcher to explore and understand central themes and sub-themes related to the study (Ritchie et al. 2014; Teddlie and Yu 2007).

Guided by the objective, a semi-structured interview was conducted in the rural regions of Udupi and Hassan of Karnataka state. For the study, a conceptual-analytical model has been used to derive themes based on prior literature related to technology acceptance (Lim et al., 2011; Cho et al., 2014; Venkatesh et al., 2012; O'Sullivan, 2014) and the context of Indian rural community, and from insights gained through discussions with two primary healthcare doctors and two residents of these regions. Based on these inputs and feedbacks, modifications have been done, and the final interview guide was prepared. Using this technique, a total of 60 semi-structured interviews (including doctors), were conducted in these regions. As a part of the main study, the primary instrument used for data collection was direct observation and included interviews for eliciting perception, accessibility, and acceptance of mobile phone for managing health and disease conditions. This supported in describing their perceptions and other determinants associated with the study. The data collection period was three months, i.e., from May 2017 to July 2017.

Interview questions were asked in the Kannada language. Specifically, the interviewee was asked to describe their illness experience, healthcare access, health consciousness, and health orientation, considering the past six months, which helped in measuring their health conditions and problems. Additional questions were asked during the interview. The minimum time to complete an interview was calculated, and the average time is 21 minutes. The recordings of the interview were taken on an agreement with the participants using a mobile phone. The answers from the people were written in the research notes maintained. Finally, through triangulation of data, a detailed understanding of the research phenomenon and possible reduction of bias in interviews with respondents has been achieved.

*Expert interview-based case study*

Due to the inadequacy of research about the condition required for achieving affordable and cost-effective system outcomes and what describes success from stakeholder's perspective associated with mHealth activities. This study tries to address research questions of what stakeholders in India consider as a) fundamental conditions for initiating mHealth systems and b) desirable outcomes regarding affordable and cost-effective of successful mHealth systems. To address these research questions, a qualitative research design was selected to derive key themes and used an inductive approach to organize emerging codes as per a priori themes.

This study uses an expert opinion based purposive sampling to select samples and involves observations and 17 in-depth qualitative interviews among stakeholders. The sampling process followed is based on technology developers of three mHealth services (Shiple, 2012) such as *mobile care devices* (includes wireless devices like electronic health records, mobile imaging, etc.), *Telehealth services* (includes video, high bandwidth and remote nursing facility or monitoring, and vehicles as primary enablers) and *Home Health and Wellness devices* (includes home electronic devices for real-time monitoring, patient health record etc.). The data collection period was three months from April 2018 to June 2018.

For this study, a conceptual-analytical model was developed based on existing models of affordability. This model has got four themes of focus that were relevant to achieve affordable system operational effectiveness. These included stakeholders such as healthcare professionals, technology entrepreneurs, and software developers working in the field of health information and mHealth systems. These were used for developing an instrument for each stakeholder group. In this study, questions were designed to elucidate factors of Affordable System Operational Effectiveness (ASOE). The interview guide was prepared using previous literature, official reports, and insights gained from various digital health conferences available online. Based on these inputs and feedbacks from professors of information management, modifications have been done, and the final interview guide was prepared. These insights help decision-makers to identify and develop a rationale for mHealth affordability.

*Questionnaire survey from the citizens*

It was identified that there exists various literature that explains the importance of mobile phone technology and apps for improving health and service delivery across different countries. However, not many quantitative studies have been available explicitly addressing the components of awareness and use among Indian populations. Thus, this study attempts to fill the gap through Descriptive Statistics: It involves data comparison between technical students, working staff, medical students, and health professionals of India with a purpose to determine the awareness and use of mobile phones and applications for health service delivery. Hypothesis Testing: It includes factors that are delineated from the prior literature and theories of individual traits and adoption characteristics, technology acceptance, and health belief model to examine the determinants of mobile health technology and applications awareness and use intention.

The study variables were identified from the literature review. Then, the questionnaire was in English language and pre-tested offline with 01 medical practitioners, 02 management professors, and 03 students. Their suggestions pertaining to the component and structure were taken, and modifications have been done accordingly.

*Descriptive Statistics*

A cross-sectional study was conducted to measure peoples' awareness and use of mobile phone technology and applications for receiving health information from December 2017 to May 2018. Participants were selected based on convenience and simple random sampling, wherein the former is used for collecting responses from the students of engineering and medical colleges and the later among respondents working in engineering and medicine. A pre-tested questionnaire was designed using existing literature (Kayyali et al., 2017; Parthaje et al., 2016; Ehteshami et al., 2013; Khatun et al., 2014; Atulomah et al., 2010) and offline focus group interviews. The focus groups consisting of two working-class individuals, three engineering college students, and two medical college students contributed to the study by suggesting questions related to familiarity or awareness about the term "mobile health", health conditions, and mobile phones used for communicating or receiving health information. Based on these suggestions, the questionnaire was modified and pre-tested offline for identifying unclear wordings, components, and structure. These questions are measured using Likert scales and include open answer type.

*Hypothesis Testing: Intention to Use*

The items for the construct *mobile service enabled empowerment* was measured using five items of Spreitzer (1995). These instruments have been accepted and used in mobile banking and health service research of Donner and Tellez (2008) and Chen et al. (2014). Items for *personal innovativeness* was measured with five items adapted from the literature of Agarwal and Prasad (1998) and Rai et al. (2013) and modified slightly to fit the study context. The construct *health consciousness* was measured using five items of Dutta-Bergman (2004) scale. Items for the *subjective norm* and *perceived usefulness* has been taken from the literature of Hu et al. (2003) and Davis (1989) and incorporated suggested changes. The construct *awareness* was measured using four items of Sathye (1999) and that of *intention to use* consisted of two items taken from Bhattacherjee (2000). These items are grouped as indicated by Davis and Venkatesh (1996) with such that it ensures a logical flow of ideas between the items.

Mobile health applications can be broadly classified under four categories, i.e., wellness management, health condition management, and users of mobile applications for health. In the first phase, stratified random sampling is used for collecting the data. For this, one mHealth applications from each of the aforementioned classification were chosen. Accordingly, the link to the questionnaire (prepared using Google docs) was posted online in the individuals' message box of mHealth applications pages available on social media (i.e., Twitter and Facebook). In the second stage, convenience sampling is used to collect the data. For this, data was collected through personal contacts from the students of engineering and medical colleges and successively asking them to send it to their contacts (snowball). In both of these cases, participants were explicitly informed about the importance of the responses and the future use of the data for the academic purpose. The survey was carried out between December 2017 and May 2018, and the average time was calculated to be 15 minutes.

*Awareness and Use*

For measuring awareness and use of mobile health technology and applications, theoretical models of TAM, UTAUT, DoI, HBM and awareness and use model were referred. The items for the construct mobile service enabled empowerment (Spreitzer, 1995; Chen et al., 2014), personal innovativeness (Agarwal and Prasad, 1998; Rai et al., 2013), health consciousness (Dutta-Bergman, 2004), health information orientation (Dutta-Bergman, 2004), electronic health literacy (Bodie and Dutta, 2008), perceived severity, and perceived susceptibility (Ahadzadeh et al., 2015), subjective norm and perceived usefulness (Hu et al., 2003; Davis, 1989), and awareness (Sathye, 1999) are connected logically.

To achieve national representation from other states of India, an online survey questionnaire was forwarded through emails requests to the people working in medical and technical domains and academic sectors across the regions of Delhi, Kolkata, and Ahmedabad which are chosen randomly. The link to the survey was also posted as personal messages on social networking sites 'Facebook and LinkedIn' which are dedicated to health-related pages chosen randomly. Offline questionnaires are distributed to students and academicians selected randomly from the engineering, nursing, and management colleges located in Kerala (India).

#### 3.6.1.4 Justification for Social Media Analytics

The Web 2.0 had created the popularity of social media and microblogs as a source of communication (Saif et al., 2012) and supported various researchers to interact with their study participants and for data mining (Sinnenberg et al., 2016). Social media analytics plays a vital role in understanding the peoples' opinion, which is expressed as real-time messages or as tweets in social media. Among which the most commonly used social media analytics for understanding the opinion is the sentiment analysis. In fact, the sentiment of the people has an influence on measuring the acceptance and rejection level of certain products, services, technologies, or any ordinances (Pai and Alathur, 2018; Singh et al., 2018; Chan and Guillet, 2011; Stephen and Galak, 2010; Trainor et al., 2014; Tess, 2013; King et al., 2013). Twitter is frequently used to study the people's sentiment because of its popularity based on a maximum number of users and billions of page views (Gautam, 2014). It is used as it provides the real-time nature of the content, and the ease in accessing and searching publicly available information (Sinnenberg et al., 2016). In Twitter, a user can post message or tweets followed by the establishment of hashtags, thereby forming a base for data extractions and analysis (Lakhiwal and Kar, 2016).

Realizing these benefits, healthcare professionals, government officials, and policymakers started using social media for understanding public health and behavior and better governance (Lee and Kwak, 2012). The use of Twitter in health research is considered as a growing body of work and researchers have used this platform to study the population health and behavior (King et al., 2013; Chew and Eysenbach, 2010; Neiger et al., 2013). For example, the Twitter website for national health portal India basically helps an individual to get informed about various health and disease conditions through their social media webpages. Social media are used as a medium to target any social or political issues and to seek public support for a cause which is either done by making its meme or creating awareness about the problem faced by an individual because of its existence and practice (Joseph et al., 2017). For example, during the social media movement in India and abroad, many individuals have used this platform to share their difficulties and experiences faced by them from society. With the availability of an enormous amount of these data in the online and social media, its analytics has primarily gained importance among researchers and professionals in decision making. Therefore, this study involves social media analytics for health technologies, a health condition, the recent outbreak of social media game and social media movement to analyze the result of peoples' sentiment and to examine specific themes which individuals are concerned about.

### 3.8. Conclusion

This chapter has described the methodological decision the researcher made and the overall procedures for collecting, analyzing, interpreting, and reporting data in detail. By following the convergent mixed method design, the researcher believes that the use of qualitative and quantitative data not only help us in comparing the study findings but also in convergent analysis process thereby improving the validity of the overall research.

This chapter had shown the overall procedure which had adopted in this study. Firstly, it has presented the research questions and objectives for this study. Secondly, it discussed the conceptual framework and hypothesis for the performing convergent mixed method design. Thirdly, this chapter sets in the context and scope of the study. Finally, the justification for the methodological choice has been discussed. Since it was decided to use convergent mixed method design wherein the findings from the qualitative (interview-based case study and Twitter data), and quantitative (questionnaire survey) methods are integrated to address the reason question. This feels that the use of mixed method research would be advantageous in enhancing the validity of the overall research than to use singular methods.

# CHAPTER 4

# QUALITATIVE STUDY

## 4.1. Introduction

The previous sections have discussed the methodological choice adopted in the current study. This chapter addresses the qualitative component of the thesis in detail. It attempts to analyze the: (i) the accessibility and acceptance of mobile health among the rural population; (ii) the affordability factors from the view point of the technology entrepreneurs, healthcare professionals, and software developers located in India.

This chapter is structured as follows. Section 4.2 and section 4.3 analyses the process of data collection, data analysis, and results involved in the qualitative study of accessibility and acceptance (research objective 2) and the affordability (research objective 3) of mobile health. The sentiment analysis of social networking applications health content is discussed in Section 4.4. Finally, section 4.5 concludes this chapter.

## 4.2. Accessibility and Acceptance of Mobile Health

This chapter aims to provide an answer for questions related to accessibility and acceptance of mobile health among rural people.

### 4.2.1. Mobile Health in Rural Regions of Karnataka State

According to Karnataka Integrated Public Health Policy (2017), Karnataka has controlled the infant mortality rate from 47 to 28 per 1000 live births, maternal mortality ratio from 178 to 133 per 100,000 numbers, and the birth and death rates for 1000 populations to 18.3 and 7.0. Even though these are certain achievements in the infant mortality rate, the inequalities in health outcomes and healthcare access as evidenced by the indicators for vulnerable groups and geographies are still not mitigated in terms of health infrastructure and services, quality of care, stagnation in child health, shortages of specialists etc. (Health and Family Welfare Services, 2017).

In the year 2004, in association with the Indian Space Research Organisation (ISRO) and Department of Health and Family Welfare (HFW), the Government of Karnataka introduced Telemedicine Network Project in Karnataka. In its first phase, the project was implemented in 12 districts, and by the year 2008, it became operationalized in 25 districts with five specialty hospitals in Bangalore and Mysore districts of Karnataka (Holla, 2013). In the year 2011, HFW Department of Karnataka initiated Mother and Child Tracking System (MCTS) with the aim of using mobile phone to facilitate and monitor service delivery for micro-birth planning, and immunization to enhance care to mother and child with a positive impact on infant mortality rate and maternal mortality ratio (Technopak Healthcare Outlook, 2012; National Rural Health Mission, 2016). This system was then extended to Reproductive and Child Health (RCH) through Accredited Social Health Activists (ASHA) workers to communicate effectively with the people, doctors, nurses, and Auxiliary Nurse Midwives (ANMs) (Yasmeen, 2013).

The ministry of health with family welfare India started promoting the use of Information and Communication Technologies (ICT), and health financing methodologies for a stronger and rapid response to the TB epidemic (Ministry of Health with Family Welfare, 2017). In this connection, a comprehensive surveillance system called eNikshay (which connects TB patients and their providers through a call center for monitoring) and 99 DOTS process has been initiated. Both of these technologies help the health functionaries at various levels in providing SMS services, which have been used effectively for communication with patients and monitoring the program on day to day basis (MoHFW, 2017; Oberoi et al., 2016). However, the challenges faced by the people or health workers concerning mobile health accessibility and acceptance have been poorly articulated for Indian rural population (Ramachandran et al. 2010; Chen et al. 2014). The reason could be the lack of awareness, training, and resistance to change. Accessibility of mobile health is a key barrier in not using them efficiently (Boruff and Storie 2014; Ramachandran et al. 2010). Otherwise, the barrier could be due to the newness of the concept, working in the initial phase of service delivery process and requirement of a proper framework for its governance (Organization for Economic Co-operation and Development [OECD], 2017).

This study focuses on studying the accessibility and acceptance of mHealth among the rural areas of Udupi and Hassan Districts of Karnataka state. The selection of these regions is based on the ration of their literacy rate to that of the average value of the state. As literacy of the people and accessibility of ICT promotes participation in human communications (Warschauer, 2011; Chetty et al., 2017) and strengthening of the social difference (Neter and Brainin, 2011). Therefore, considering the scenario of mobile health in India, this research aims at:

- *To identify the barriers to and experiences of using mobile health technology and applications for healthcare service delivery among rural populations and healthcare centers located in India.*
- *To identify the factors that influence mobile health technology and application acceptance for health service delivery in India.*
- *To integrate these factors into the technology acceptance model that can be limited to rural Indian populations.*

To addresses the questions, the study followed three steps approach. Firstly, prior literature related to technology acceptance has been considered for the identification of factors. Secondly, the study considered the context of the Indian rural community and identified factors that might influence mobile health technology and application acceptance. Thirdly, qualitative semi-structured interviews with 60 rural respondents, including doctors, have been used to confirm the identified factors and for the new factors which influence acceptance of mobile health technology and applications. Finally, the findings from each of the approaches have been triangulated and concluded by proposing a *"mobile health technology acceptance model (MHTAM) for the rural community of India,"* based on the study findings.

### 4.2.2. Research Methods

A qualitative approach has been followed to address the above mentioned secondary research objectives. It is phenomenon-driven research (Eisenhardt and Graebner 2007). The use of qualitative data helps in describing the phenomenon by exploring key events, practices, and their underlying reason (Mousavi and Bossink 2017). Therefore, this study aims at a detailed understanding of the factors found in the qualitative dataset collected through various data sources.

*Sampling: Population and Study Site*

A convenient sampling method was used to select the study locations (i.e., rural) and sample populations. The regions have been identified based on literacy rate and healthcare facility access. The total populations in the study areas of Udupi, i.e., Nanchar and Yedthare, are 2691, and 9627 respectively, whereas in the areas of Hassan, i.e. Basavapatna and Hanbal the same are 3974 and 2468 respectively. In the study areas, it was observed that nearly 70% of the people living in these areas take consultations from primary healthcare centers as the distance to nearest district's hospitals and other health units is more than 10 km. The PHC available in these localities is constantly working towards the improvement of healthcare service by supporting the National Policy of Digital India - an initiative to use mobile phones for health service delivery. The PHC is presently using mobile phones for providing health services for female patients during maternal and child health, and for the patients suffering from Tuberculosis. Using this sampling method, a total of 60 semi-structured interviews, including those with doctors, were conducted in these regions. The study elicits awareness, perceptions, acceptance, and use of mobile phones for managing health and disease conditions. This supported in describing their perceptions and other determinants associated with the study. The interview guide was prepared based on this (Appendix II).

*Data Collection*

The primary instrument used for data collection was direct observation and interviews with consent (Appendix I) of the people and doctors living in these regions, based on the objective of the study and prior literature. The data collection period was three months, i.e., from May 2017 to July 2017. Interview questions were asked in Kannada language. Specifically, the interviewee was asked to describe their illness experience, healthcare access, health consciousness, and health orientation, considering the past six months, which helped in measuring their health conditions and problems. Additional questions were asked during the interview. The minimum time to complete an interview was calculated, and the average time calculated was 21 minutes. The recordings of the interview were taken on an agreement with the participants using a mobile phone. The answers from the people were written in the research notes maintained. Finally, through the triangulation of the data, a detailed understanding of the research phenomenon has been made.

*Data Analysis*

The data analysis was performed by deriving analytical themes using the conceptual-analytical model and Gioia methodology (Figure 4.1). Gioia methodology is a systematic approach to developing new concepts and articulating grounded theory basically to bring qualitative rigor in inductive research (Gioia et al. 2012). More specifically, for reducing data into theoretical themes (not all themes are realized), an axial coding guided by a theoretical framework was followed (Strauss and Corbin 1990). Thus, looking at the similarities and linkages among themes, data were derived (Mousavi and Bossink 2017). These codes were analyzed and organized as per priori themes from the model (Langley 1999).

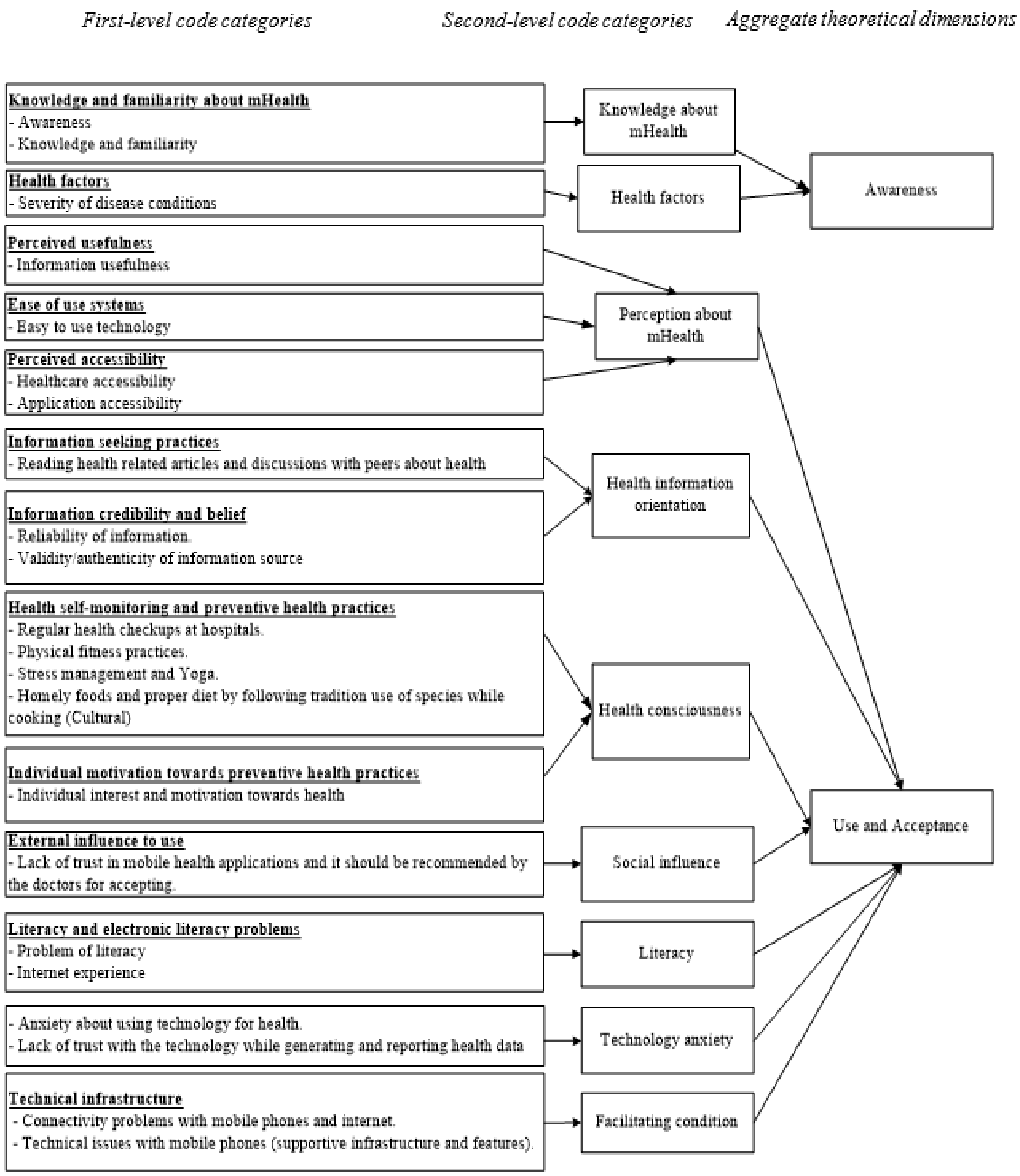



**Figure 4.1:** A data structure of rural populations' responses for using mobile phones for health activities.

This stage, therefore, became a more theory-driven analysis as it tries to capture concepts for identifying theoretical dimensions present in the data (Mousavi and Bossink 2017).

In the next step, the data identified were aggregated through theoretical coding process supporting broader themes. The experts reviewed these for agreement, and in case of disagreement, further discussions were carried out, which guided their allocation to form a thematic group. In this study, after analyzing the contents from the literature and the primary interviews, a total of 09 groups have been formed, which have been coded under two major dimensions: awareness, use, and acceptance using RQDA, which are summarized in Figure 4.1 as these represent data structuring process outcome.

Thus, at the operational level, this study helps in exploring the sequence of interaction that occurred in mobile health applications and services in India until July 2017. In addition, the study tries to provide a comprehensive understanding of mobile health applications and services using rich qualitative data (Eisenhardt and Graebner 2007).

### 4.2.3. Results and Findings

The interview guide containing the research questions is described in the four sections. Section 1 presents the participants' demographics. Section 2 describes the participants' health and healthcare characteristics. Section 3 specifies the factors identified from the theoretical models. Other factors identified during the interview process are discussed in the final section 4.

*Section 1: Participants' demographic characteristics*

The participants' demographic characteristics are provided in Table 4.1. A total of 60 participants participated in the interview. Among them, 57% corresponds to the female population of age 21-40 years. Three participants are of age greater than 50, and four are of 19 years. The interviews were completed with an average of 21 minutes.

**Table 4.1**: Participant Demographics Survey Results

| Characteristics | Subcategory | Number |
|---|---|---|
| Respondent type | Patients | 13 |
| | Caretakers (family members) | 38 |
| | Both | 09 |
| Gender | Female | 34 |
| | Male | 26 |

| | | |
|---|---|---|
| Age (years) | < 20 | 04 |
| | 21 - 30 | 31 |
| | 31 - 40 | 16 |
| | 41 - 50 | 06 |
| | > 50 | 03 |
| Interview Duration (minutes) | Mean interview time | 21 |
| | Shortest interview | 8 |
| | Longest interview | 33 |
| Respondent Language (to speak) | Kannada | 60 |
| | Tulu | 15 |
| | Hindi | 31 |
| Respondent Language (to read and write) | Kannada | 51 |
| | English | 39 |
| | Hindi | 33 |
| The location where respondents live | Udupi District | 28 |
| | Hassan District | 32 |
| Occupation | Student | 12 |
| | House maker | 28 |
| | Daily wage workforce | 19 |
| | Healthcare professional | 01 |
| Highest Education | High school (<10) | 28 |
| | 10+2 or PUC | 18 |
| | University | 14 |
| Type of mobile phone used | 3G, 4G phones | 22 |
| | Handphones | 34 |
| | Others | 04 |
| Total number of mobile phones in a family | 0 | 04 |
| | 1 | 56 |
| | 2 | 23 |
| | > 2 | Nil |
| Length of use of mobile phones (years) | 0-2 | 02 |
| | 3-5 | 11 |
| | 6-8 | 34 |
| | 8+ | 13 |
| Purpose of mobile phones other than calls | Videos | 44 |
| | Facebook | 32 |
| | Music | 46 |
| | SMS | 15 |
| | WhatsApp | 36 |
| | Skype | 02 |
| | Others | Nil |

All participants know to speak the Kannada language, but only 46 participants know to read and write. Respondents in these regions carry at least one mobile phone (56 numbers (no.)) and mainly used it to communicate with their relatives, friends, and family members by calling. Some participants use mobiles for WhatsApp (36 no.), Music (46 no.), Videos (44 no.), and Facebook (32 no.).

*Section 2: Participants' health and healthcare characteristics*

This section provides details about the illness experience and healthcare accessibility of an individual located in the study area.

***Illness experience*** was defined as an individual condition for the disease. Respondents spoke about health/illness problems observed in the last six months or at present, and several times he/she visited the hospital for consultations. It also includes questions related to the presence of people with similar symptoms being diagnosed and their efforts in self-care.

Most participants have reported that they had or have health problems of diarrhea and stomach infection (3 no.), asthma (1 no.), cold (12 no.), viral fever (6 no.), eye infection (3 no.), migraine (2 no.), malaria (2 no.), diabetes (12 no.), typhoid (3 no.), and jaundice (1 no.). Respondents had taken medicines and consultations from hospitals such as primary health care centers (8 no.), clinics (10 no.), private hospitals (9 no.), and government hospitals (29 no.) located at 5kms (23 no.), 6kms and more (33 no.).

> *I do not have any illness problems if in case I get cold, I use…tablet, or for quick relief, I mix it in hot water and inhale for some time (Respondent 7).*
>
> *We usually go to a clinic located near government high school, i.e., about 1.5 km from my house … and if it is severe, then only we go to a private hospital located at 15 km. (Respondent 12).*

A doctor who participated in the interview agreed that people tend to take appointment or visit hospital only when health conditions become severe, which restrict them in their work.

> *People here in this region are dependent on their daily wages for food, and they usually do not bother for common cold and fever until it makes them fall weak (Doctor).*

***Healthcare access*** encompasses questions related to time and distance from home to hospital, appointment types during regular working hours and at weekends, difficulty encountered in consultations and service level expected from doctors/physicians.

> *When I was in… ten to fifteen years back, I got Asthma, and it was severe due to which I had to visit the doctor once a week for his advice and now as I am settled here in …, the asthma problem is less and I usually go to a clinic only during re-filling of the asthma pump (inhalers) or when there are no medicines available at home (Respondent 2).*

This implies that in the early stages of the health problem, people tend to use quick-relief medications and visit hospitals if it is severe. The doctor's appointment will be managed through their personal contacts; otherwise, they have problems in identifying the right doctors for treatment.

In a study region, a doctor reported the difficulty level which he faces due to lack of healthcare access. He reported problems such as not getting proper time for having morning breakfast and lunch because of frequent calls from patients, and others, as it is the only health center present in that locality.

> *I am working here for seven years as an orthopedic surgeon, but people approach me for different health problems due to a lack of staff, which I find difficult to treat.*
> *Due to the lack of healthcare equipment and specialized doctors, sometimes I suggest people go to … the city to get treatment.*

*Section 3: Factors identified from the theoretical models*

Considering various theoretical models and contexts, we assessed factors related to social influence, perceived health risk, health consciousness, and health information orientation, which are described in the following sections.

***Health consciousness*** and ***health information orientation*** encompass questions related to the consciousness of the participants towards health, which includes eating habits, exercising, and other preventive measures. Based on the responses the components such as health self-monitoring (ability to observe and evaluate one's behavior (Lupton 2013)), and individual's motivation and involvement ("refers to consumers' goal-directed arousal to engage in preventive health behaviors" (Moorman and Matulich 1993)) towards preventive health practices were identified and linked to second-order theme, i.e., health consciousness which is developed as per priori themes.

The study findings indicate that people are very much conscious about their health in terms of having proper diet by eating roti or chapatti instead of rice at night (35 respondents) or by doing exercises (23 respondents). Some have also reported that they would have Jeera and other spices in their curries for reducing fat and stomach bloating, (04 respondents) and would preferably have homely foods, both veg and non-veg (42 respondents).

People also listen to Frequency Modulation (FM) and music from their phones to keep them relaxed and for getting sleep (34 respondents). Some even watch health-related videos on Facebook and online (18 respondents), read articles from newspapers (21 respondents), and collect health information from other people when they go to work (42 respondents).

> *No health-related mobile application I have downloaded or referred to, but I watch videos related to different exercises or asanas to stay fit (Respondent 27).*

Findings imply that people tend to use their diet plan to maintain their health and watch YouTube videos online to stay fit.

Similarly, we analyzed the interview responses for peoples' interest in health topics/articles and their influence on decision making (i.e., Health information orientation). We identified dialogues related to information-seeking behavior/practices and information credibility and belief. "Information seeking behavior refers to the way people search for and utilize information" (Wilson 2000) whereas, information belief refers to psychological characteristics of health consciousness (Feseha and Gerbaba 2012).

> *I read health-related articles from the newspapers which are in Kannada language and follow only a few because I do not know what will happen if I follow that, and most of the time, my son and daughter will pounce upon me for making this… alternatively, any foodstuffs as it may incur some side effects like cold, fever, or stomachache, which I had last time (Respondent 6).*

***Social influence:*** This component tries to understand from whom they expect to get health-related information. When interviewed, it was found that about 65% of respondents agreed to use mHealth apps if their doctor suggested to them, and the remaining 35% refused as they trusted doctors more in physical presence than through technology.

> *I will use health application only if my doctor suggests to me to use that (Respondent 60).*
>
> *If you teach me how to use the Internet, I will definitely use it (Respondent 17).*
>
> *The use of mobile phones in health? No, don't believe it, as visiting the hospital personally gives more relaxation to my mind (Respondent 24).*

Findings indicate that there exists an internal motive to use health apps, and the recommendations from the doctor have a role to play in promoting its use, as people are concerned about the risk associated with it.

> *I am willing to use this only if the doctor suggests to me to follow or else no, as I don't have any trust* with *it" (Respondent 53).*
>
> *"I prefer to receive health information through the call, not through SMS and not on a daily basis, but at least once a week is good" (Respondent 46).*

These findings indicate that people prefer to get call alerts rather than SMS messages due to low literacy level, and use it if they are easy to operate.

***Perceived health risk:*** It is defined as "one's opinion of how serious a condition and its consequences are" (Siddiqui et al. 2016). During interviews, most of the respondents cited the seriousness of disease conditions which they are facing and its effects on their day-to-day operation.

*“Last time I was suffering from Dengue, which made me a weak for around one month, as I was alone at home, I frequently used to travel to a doctor located 5kms away for consultations” (Respondent 43).*

*Section 4: Other factors identified during the interview process*

This section presents the factors identified during the interview process.

***Knowledge about the health information technologies*** component considers participants' knowledge of the use of health information technologies. This study encompasses questions related to mobile phone use or the Internet for health information and their experiences.

*I had used the Internet to refer to symptoms and precautions to tackle Malaria when I got it three months back but did not follow them fully (Respondent 37).*

*Yes, I have heard about diabetes machine from a house where I work (Respondent 29).*

Knowledge about mobile health was low among people in that region. The people having Internet knowledge (Lim et al. 2011) and certain literacy level are aware of self-care technologies and have tried to get health information.

***Awareness about Mobile Health Applications or Units:*** Participants have reported that they are not much aware or have not referred to health apps initiated by the government of India because of lack of Internet access and trust. They have also reported literacy problems and agreed to use it if nurses or doctors recommend them.

Twenty-four female respondents agreed that they had followed a similar process (use of mHealth) during pregnancy. During this period, nurses in the Primary Healthcare Centres (PHC) of that locality called to the registered numbers and reminded them of the next visit for any medications or treatment (Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA) programme). The number is made available in ‘Thayi Card’ – a comprehensive mother and child registration booklet for protecting maternal and child health.

*When I was pregnant, I used to get calls from ASHA workers and PHC sometimes regarding the appointment date for vaccination or treatment, which gave me an alert for the next visit. It is a good initiative by the Government (Respondent 4).*

*One of my neighbors is a nurse in some clinic or hospital; she was told once that there was a programme by the government for reducing some diseases where we have to call some numbers for medicine (Respondent 36).*

A group of respondents said they had downloaded certain mHealth apps because their friend was using them and suggested to them to use it.

*I am using this app (...), which my friend downloaded and told me to use it when walking and working. He also said to them that it would show the number of steps and fat burnt while working and walking to stay fit, but I do not know what fat and all. Still, I use it sometimes, assuming that it helps (Respondent 56).*

The majority of female respondents are aware of mobile phone use in health service as they have/had received calls from PHC for check-ups and medication reminders. In some cases, having basic knowledge and through external means, people tend to use health apps.

***Assessing Interest and Acceptance of Mobile Medical Technology***

This component reflects the interest of the people in assessing or accepting mobile phones in health-related activities. Of 60 respondents, about 49 (i.e., 81.6%) were open to receive any health-related information either through call (48 respondents) or SMS (36 respondents). However, they agreed to use it if a doctor or nurse recommend them and teach them about its basic operations (71.6%).

*"When I was in Government Hospital, I had a friend who is a tech-savvy kind of person and has developed databases for patient records and other related apps to his office. Since I wanted some software apps which will help patients suffering from TB with HIV in managing their diseases in the form of the prescription reminder, refilling the medications or for monitoring the health conditions, he discarded the idea saying that patients with TB infection or infected with HIV need continuous monitoring and care in reducing it. Now I am in… and if you come up one with any such idea, I can help* you *in developing its application (Doctor).*

Doctors have started finding the use of mHealth, realizing it as a possible source for providing affordable and continuous care.

#### 4.2.4. Discussions

The resources needed for maintaining a balance between population disparity and healthcare access are putting pressure on government and technology entrepreneurs for incorporating information technology or mobile media devices in their health service delivery process. This move is aligned towards preventable, accessible, and affordable health services delivery for achieving sustainable development goals by 2030, which involves patient-centric healthcare practices for continuous health monitoring and communicating health outcomes among healthcare professionals. In the low resource setting areas or rural regions, even though they are using mobile phones in primary healthcare centers, the mechanism for supporting and managing patient data (as in district healthcare centers for the 99DOTS process) is still lacking along with degrees of awareness and familiarity.

By analyzing prior literature regarding mobile phone use for health service delivery, the study considered 09 second-level code categories: knowledge and perception about mHealth, health factors, health information orientation, health consciousness, social influence, literacy, technology anxiety, and facilitating conditions. Each of these codes involves opinions collected from the interviews and emphasizes their importance for acceptance and use of it for health service delivery. Various literature have studied these components for analyzing health information technology acceptance or adoption among users/patients and healthcare professionals (Mengesha and Garfield, 2019).

For example, in a cross-sectional comparison concerning information technology in pre and post-adoption (continued use) belief identified that intention to adopt technology is solely dependent upon normative pressures (potential adopter) and attitude in the case of user intention. The pre-adoption attitude is dependent upon perception about usefulness, ease of use, etc. while the post-adoption attitude is dependent upon perception about image and belief of usefulness (Karahanna et al. 1999). Therefore, mobile phones have the potential to eradicate particular diseases by promoting awareness, monitoring, treating, and controlling and thereby enabling people towards healthcare access at the right time.

To measure the accessibility of mobile health, the dimension of access has been considered. For this, the interview responses of the healthcare professionals and the patients and people have been mapped to explore and understand sub-themes related to the study (Ritchie et al. 2014; Teddlie and Yu 2007). The following table 4.2 presents the dimension of access for mobile health across the study areas.

Table 4.2: Dimension of access for mobile health

| Main Themes | Subthemes (healthcare) | Subthemes (patients) |
|---|---|---|
| Accommodation | Lack of health information technology infrastructures and supporting staff to manage the data records.<br><br>Need for more effective staff for managing and communicating maternal patient vaccination status to district hospitals.<br><br>Lack of supportive medical staff during weekends.<br><br>Training should be given pre and post implementations of health information technology. | Language and literacy problems observed as they generally speak the local language.<br><br>People are anxious to use mobile phones for health services.<br><br>Problems of mobile and Internet connectivity |
| Awareness | Knowledge and familiarity about the term mobile health are less among the staff.<br><br>Lack of awareness observed among doctors and supporting staff when asked about government initiated mobile health applications.<br><br>Use mobile phones for vaccination and treatment remainders for pregnant and new mothers and for TB patients. | People watch content related to health and communicate with doctors on video applications and calling and SMS applications but lack knowledge and familiarity about the term mobile health.<br><br>Lack of awareness about the government initiated mobile health applications.<br><br>Literacy problems act as a barrier to locating and identifying the right applications.<br><br>The credibility of the information and sources is not trustworthy. |

| | | |
|---|---|---|
| Affordability | Difficulties in the purchasing process for high-end technology supportive devices to store patient records.<br><br>The process involved in setting up of structure, systems, and software is time-consuming as it has to go different channels for approval.<br><br>Should be effective and create value for the amount paid. | Difficulties in purchasing smartphones among daily wage people.<br><br>The application should be cost-effective.<br><br>Should provide value for the amount paid. |
| Accessibility | The nearest district hospital is more than 10 km, and people visit primary healthcare for medical consultations.<br><br>Power breakdowns and mobile network problems limit access and adoption of health information technology.<br><br>Difficulties observed during software breakdowns as the service center is at a distant place. | Difficulties in paying transportation cost as there is a lack of bus connectivity towards the hospital area.<br><br>Problems with mobile networks and Internet connectivity. |
| Availability | Lack of doctors in primary healthcare and one doctor has to address the patient's queries.<br><br>Problems in the manual data entry process for reporting maternal status to the peers and district hospitals.<br><br>Technical staff should be available on time to avoid discrepancies. | Waiting time will be more and less time for consultation.<br><br>Problems of medical interventions during weekends. |
| Acceptability | Indian penal code (section 304) has been imposed on doctors to restrict mobile communication for health consultations.<br><br>People try false dialing for a 99DOTS process for eradicating TB. The negative perception of the mobile phone as it is hazardous.<br><br>Mobile health technology and applications should be customized according to the need and processes. | People prefer personal visits to mobile intervention.<br><br>Preference given to traditional homemade therapies as a preventive and reactive approach.<br><br>Recommendations from doctors are necessary for using mobile health applications. |

Thus, for improving the mobile health accessibility, the technology entrepreneurs and other stakeholders need to consider the factors listed in table 4.2. The study also identified that, though people and healthcare professionals lack awareness about the term ‘mobile health’ and government-initiated applications’, primary healthcare centers and district hospitals have been found to be using them for vaccination reminders and documentation (Table 4.3).

In this regard, the study tries to analyze the accessibility of two government-initiated mobile health applications, using the components of physical, suitability, and affective, as suggested by Van Oostendorp et al. (2005) with modified access theory of McCreadie and Rice (1999).

Table 4.3: Accessibility of select mobile health applications

| Accessibility | Remarks |
|---|---|
| **Physical Accessibility** | In the study area, the use of the mobile phone for health service is currently available for reproductive and child health programmes (24), Indradhanush and cessations programmes (11), and 99DOTS process (1).<br>Problems of literacy and health literacy, Internet and mobile phone connectivity, supportive infrastructures, and features limits itself from being accessible.<br>ASHA workers of that locality help maternal women in registering them for Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA) programme for informing medications or treatment. |
| **Suitability** | Female respondents receive treatment and vaccination reminders through mobile phones during maternal and child treatment and are benefited.<br>The 99DOTS process helps in eradication of TB, but in some case, people try false calling, which limits itself in addressing the need.<br>People who have used fitness applications (9 respondents) have agreed that they have been benefited from the application. |
| **Affective Accessibility** | People agreed that they had used basic mobile phone applications for searching nearby hospitals, communicating with doctors for scheduling appointments and consultations during unavoidable conditions such as weekends and at night. |

This shows that the distribution of mHealth across the rural regions is still in an initial stage of service delivery, where it is used mainly for reproductive and child health programmes than telemedicine and the 99DOTS process. These programmes are in practice at places where network and its supporting technologies are connected and are available for decision making, scheduling vaccinations, and conducting regular interventions. The lack of awareness, trust, and evidence (health outcomes), primarily affects the acceptance of mHealth. Thus, consolidating the findings, the extended technology acceptance model is proposed specifically for rural Indian populations (Figure 4.2).

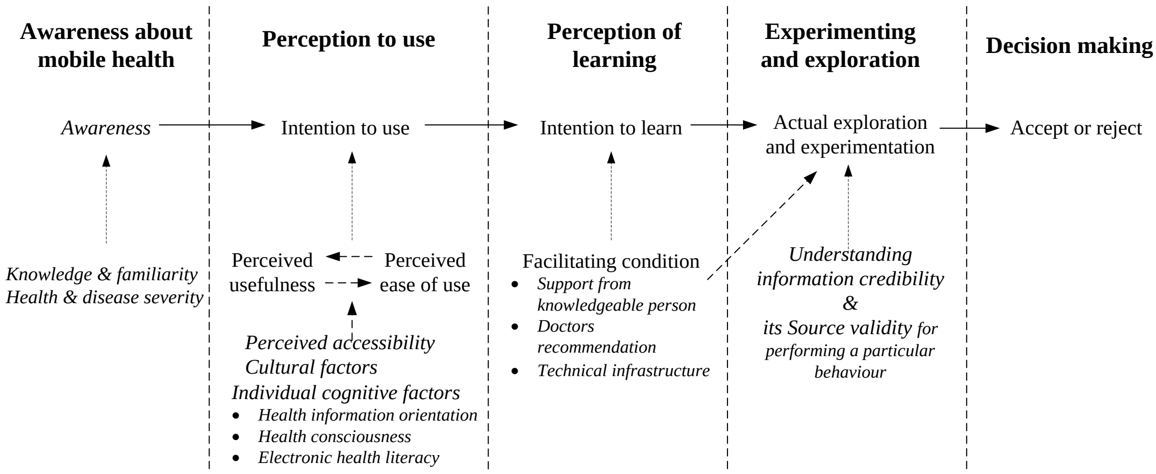



**Figure 4.2:** Proposed technology acceptance model for mobile health acceptance in India.

This model validates the existing models of Renaud and Van Biljon (2008) and Kim et al. (2016), and incorporates components related to awareness, knowledge, and familiarity supported by the components perceived accessibility and traditional/cultural factors, which are considered to be important in the Indian context.

The model has five phases, which are described in the following section: awareness, the perception about using, the perception about learning, individual exploration and experimentation, and decision making. Except for the awareness phase, the remaining phases are supported by Kim et al. (2016).

- *Awareness of mobile health*: the phase in which people are aware, familiar, and knowledgeable about the term mobile health applications and services, which are influenced by health and disease severity.

- *Perception about using mobile health*: the phase in which a user forms the intention to use mobile health applications and services (Kim et al. 2016), which is influenced by perception about usefulness, ease of use, and accessibility, which in turn is influenced by other individual cognitive factors i.e. health information orientation, health consciousness, and electronic literacy (Cho et al. 2014).
- *Perception about learning mobile health:* the phase in which user forms the intention to learn mobile health applications and services (Kim et al. 2016), which is influenced by facilitating conditions in the form of social influence, support from a knowledgeable person, and technical infrastructure.
- *Individual explorations and experimentation (or personal innovativeness) on mobile health:* the phase in which user explores and experiments with mobile health applications and services (Kim et al. 2016), which are influenced by understanding information credibility and source validity for performing a particular task.
- *Decision Making:* the phase in which an individual decides to either accept or reject the use of mobile health applications and services.

Through this study, we identified that actual use and acceptance are conceptually different constructs. Actual use of mHealth services is dependent upon need (health care access and illness experience), awareness, demographic factors, participant's health consciousness, and information orientation, perception factors (usefulness, ease of use, and health factors) and facilitating conditions (technical infrastructure) whereas acceptance depends on attitude towards it (Karahanna et al. 1999).

The individual's exploration and experimentation with mHealth applications and services will lead to actual use (Renaud and Van Biljon 2008; Kim *et al.* 2016). Several respondents have cited the acceptance of mHealth services based on the recommendations of doctor or physician encouragement as it lacks trust and evidence in quality outcomes. This could imply that social influence or healthcare personnel play a significant role in mHealth acceptance.

The study also tried to understand the awareness level and acceptance among rural people. The study respondents revealed instances indicating lack of healthcare access, communication issues, etc. making them health conscious. A doctor reported lack of basic infrastructure, and felt that specialized staff, privacy act, etc. would create an impact on the implementation and recommendation of mHealth services to people. This evidence suggests that government supports in upgradation of infrastructure, sufficient training facilities to people staff, ease of use of systems can facilitate mHealth use among people. Thus, it seems logical that interview responses imply that with specific literacy level improvement in mHealth awareness can lead to its acceptance.

Hence, based on the findings, the hypothesis can be formulated as *"There is a moderate degree of mobile health accessibility among the rural people."* Similarly, as cited by the respondents doctors' recommendation is required for acceptance of mHealth, therefore the hypothesis can be formulated as *"subjective norm influences positively in improving the perception of mobile health among rural people."*

## 4.3. Affordability of Mobile Health System

The purpose of this study was to identify the stakeholder perspectives for achieving affordable and cost-effective system outcomes and what describes success associated with mHealth systems in India. This study identifies stakeholder views on a) fundamental conditions for initiating mobile health (mHealth) systems and b) desirable outcomes regarding affordable and cost-effectiveness of successful mHealth systems.

### 4.3.1. Study Design

For this study, a conceptual-analytical model was developed based on the existing models of affordability (Figure 4.3).

This model has got four themes of focus that were relevant to achieve Affordable System Operational Effectiveness (ASOE). These included stakeholders such as healthcare professionals, technology entrepreneurs, and software developers working in the field of health information and mHealth systems.

The components of the model were used for developing the instrument for each stakeholder group and for guiding the analysis and presenting the findings.

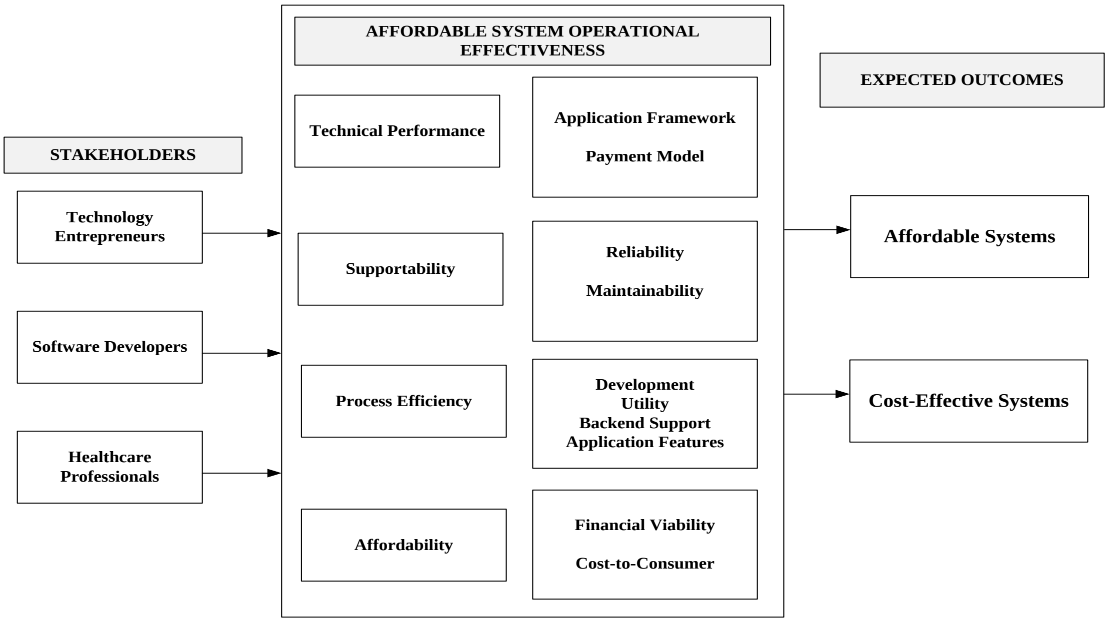



**Figure 4.3:** Conceptual-analytical model for affordability

In this study, questions were designed to elucidate the factors of ASOE considering technical performance, supportability, process efficiency, and affordability. The interview guide was prepared using previous literature, governmental reports, and insights gained from various digital health conferences available online. Based on these inputs and feedbacks from professors of information management, modifications were made, and the final interview guide was prepared (Appendix III). These insights help decision-makers to identify and develop a rationale for mHealth affordability.

*Sampling Methods*

This study uses a criterion-based purposive sampling to select samples, and it involves observations and 17 in-depth qualitative interviews (online and offline) among stakeholders. The sampling process followed is based on technology developers of three mHealth services (Shiple, 2012) such as *mobile care devices* (includes wireless devices like electronic health records, mobile imaging, etc.), *Telehealth services* (includes video, high bandwidth and remote nursing facility or monitoring, and vehicles as primary enablers) and *Home Health and Wellness devices* (includes home electronic devices for real-time monitoring, patient health record etc.).

*Data Collection*

The primary instrument used for data collection was direct observations and interviews, both online and offline involving stakeholders. The data collection period was three months from April 2018 to June 2018. The interviewees were asked to describe their experiences about the challenges encountered during the initiation and development of mHealth applications for Indian populations, considering the components of ASOE. Additional questions were asked in the interview to get further insights. The recordings of the interview were taken using a mobile phone. In addition, the answers from the stakeholders were also written in the research notes maintained.

### 4.3.2. Data Analysis and Results

***Affordable System Operational Effectiveness for Mobile Health***

To deal with affordable system issues in India, the components of technical performance and supportability, process efficiency, and affordability need to be studied (Defense Acquisition University, 2018; Dallosta and Simcik, 2012; Liu et al. 2011).

For achieving ASOE, the project manager has to consider the return on investment by maintaining a balance between technical performance, supportability, and process efficiency. Thus, the ASOE concept focusses on the stakeholder perspective on how well the system performs its missions over a sustained period, besides the capacity to surge given the individual's operating budget (Defense Acquisition University, 2018). Therefore, considering these factors, the following subsection presents the views of stakeholders' processes towards affordability and cost-effectiveness of mHealth applications and services.

#### 4.3.2.1 Technical Performance

The technical performance of the mHealth application can be achieved based on its application framework and payment models used for monitoring, diagnosing, and treating various diseases and health conditions.

*Application Framework*

The healthcare sector of India is progressing at a compounded annual growth rate of 15% and has created opportunities for payers, providers, and medical technology ( India Brand Equity Foundation [IBEF], 2018). Therefore, these organizations should practice evidence-based management by orientating themselves towards end results, meeting the rules and regulations of the governing body such as the Food and Drug Administration (FDA) of the U.S, etc. Therefore,

> *For user-centric healthcare governance, the organization has to develop content based on the searches, devise a mechanism for networking so that the consumer can connect to the provider, which also helps the organization in data driving decisions driving through partnership reforms (Healthcare Professional).*

Moreover, to support digitization in India, its importance and the needs have to be understood along with their limitations. Therefore, the framework should also focus on creating awareness about technology and disease conditions, followed by information accuracy and credibility.

> *With the help of smartphones, the information which was not accessible before, is now accessible, and through them awareness about various health issues can be disseminated. Apart from literacy, connectivity, and technology infrastructure, if the feedback mechanism is not taken into account for addressing the patients' grievances, the concept of digitization will not be taken to a higher level (Political Scholar).*

Furthermore, where digital health is concerned, people basically consider the value and risk associated with it. Thus, the consumer value proposition will be focused on providing knowledge to get the right care at the right time and place. For this, "*in its first place, it is important to connect healthcare organizations and their professionals online so that an eco-system is created around them which will enable participants to talk with each other and this is what we have followed in our journey" (Health IT professional).* This helps in business improvement. At the same time, factors such as literacy, income, age, and other cultural dimensions should also be considered: the majority of the populations in India are living in rural regions. The political scholar cited as follows:

> *For digitization in healthcare, the principle 'professionalism with a human touch' should be followed at every stage of its governance.*

Findings imply that professionalism in healthcare and setting up of an ecosystem had a role to play in mHealth application and systems affordability. Once it is enabled, the next challenging task is to generate data for driving divisions using different tools and various partnership reforms, etc. These data not only help the end-user in receiving timely diagnosis and treatment but also help the healthcare system to schedule future tasks and action plans. This can be seen in the Kushi Baby project, wherein Near Field Communication (NFC) devices (necklace and stickers) have been used for monitoring and recording data of maternal and child immunizations in the last mile. In this case, mobile phones with built-in NFC reader or write are used by the ANM or community workers or Accredited Social Health Activist (ASHA) to read or update the information. This device is considered to be a cost-effective, less-powered, and locally customized device for reducing vaccination issues (Kushi Baby, 2015). This device is synchronized with the backend office wherein health administrators can monitor vaccination status for better decision making.

The mobile health application framework should also be built around data visualization and context-aware features as it will be helpful for the user in improving usability and validating results generated from the workouts. Regarding these factors, health IT professionals agreed and stated that:

> *Yes, of course, especially in the Indian market where advertisements play a major role in marketing.*
>
> *The effective distribution of healthcare facilities can be achieved through data visualization in mHealth apps. The trends of the disease and the apps will be useful for assessing the attention to be given for a particular disease or other support in a particular population or geographical location.*

This supports Broens et al. (2007) study, wherein context-aware application development is used to derive mobility, context-awareness and adaptation support, and execution environment.

*Payment Models*

Payment models encourage providers to maximize their efficiencies and to coordinate it across the continuum, allowing structured and collaborative healthcare systems for managing patient health, considering the affordable care act (Kibria et al. 2013). This can be achieved through value-based purchasing and patient-centered medical homes.

*Value-Based Purchasing*

The value-based purchasing in healthcare targets at transforming fee-for-service to a pay-for-performance delivery model. In the initial fee-for-service model, the quality of care is unbundled and usually it prefers to order more tests, leading to unnecessary costs and time. The pay-for-performance delivery model comprises components related to the quality of patient outcomes, cost-effective delivery, and patient satisfaction in determining the compensation to the provider. Many countries are almost closer to this system, but India still has a long way to go (Krishnan, 2017). To quote from a Healthcare IT professional:

> *In the case of mHealth applications, people are now looking for convenience, so that is the technology which is heading us to drive value by providing single resources at multiple locations and patient experience, which needs to be considered. This helps in tailoring the service delivery model by focusing on the roles rather than the technology that was followed by the west to equip in India as the same model will not work.*

This implies that the healthcare sector in India with respect to digital health is still in its initial phase of delivering services as there is no proper evidence with respect to the value-based purchasing model of pay-for-performance. Though setting up of healthcare ecosystem helps the patient to identify their doctors online, but as of now, there exists a gap in standardizations, good regulation, and trust as there is no provision for copy-paste mechanism in healthcare. As a medical professional said:

> *No copy-paste mechanism is in place in healthcare, and the possible way is to go deeper into people. That's where we will get much impact. This can also help us in identifying a niche market and learn where the markets are going towards, as history always repeats itself, steady enough, you could follow and predict what's going to happen over the next 5-10 years.*

*Patient-Centered Medical Homes*

This system of health care delivery model provides care across the continuum with the help of a medical practitioner, along with the primary care provider at the center for coordinating care and chronic conditions of the patients (Kibria et al. 2013).

In India, this system of delivering care is being practiced at certain places of Rajasthan (Kushi Baby project), and the rural region of Karnataka. The mobile phone plays a significant role in providing immunization and vaccination reminders and appointments every Thursday, controlled, and monitored by the Primary Healthcare Centre (PHC) of the locality. This helps the maternal women in saving frequent traveling, and waiting time and other costs associated with it. Since all these health-related transactions are happening through ASHA or community workers, the concerned PHC can suggest treatment plans for improving the service quality of that locality. This process of integrating healthcare process across the continuum helps patients in delivering healthcare services effectively. To quote it from a medical technology consultant:

> *If we consider giving a complete solution to the provider and customer, then we need to understand the need for the technology, taking into consideration all factors from the point of service process view. This is what we can see in the remote monitoring devices such as telemedicine and so on.*
>
> *In our hospital, for delivering care, we integrated the entire process for chemotherapy patients. For example, we found patient waiting was an issue, and started adopting people to pick up blood samples from home, run the test prior to and scheduled next-day appointments and chemotherapy if necessary. We also brought in logistics mechanisms by incorporating ... and ... into the system for pick up and drop off patients and provided home nursing facilities as most of them reported that post-chemotherapy makes them feel tired and weak. We also started delivering them with diet and protein-rich food through food carriers like ... as many nurses started to complain. This integration process helped us in improving the reach, customer interaction, and patient feedback systems.*

Findings imply that, though the process of integration helps in reaching the patients and their feedback, these outcomes may not be accessible and affordable to all the levels of the population community; instead they can be best suited for people living in urban and semi-urban locations. The adoption and implementation of these models in rural regions are in a state of progress, with the technology being at the forefront, driven by a doctor or healthcare professional at the center of the fulcrum, convincing patients to use mHealth services.

#### 4.3.2.2 Supportability

It is the capacity of a total system framework to support operations and readiness needs for supporting the environment for the duration of its life-cycle at an affordable cost (Nicholls, 2005).

*Reliability*

It is defined as the probability of failure-free software operation for a specified period of time in a specified environment (Pan, 1999). Reliability of the mHealth applications plays an important role in influencing patient health outcomes because of the lack of information credibility, security, or any other issues associated with it, which results in poor adoption and acceptance. In most of the cases, healthcare professionals do not prefer to use all the health applications which a software developer develops and often look for tailored systems and application which exactly suit their requirements returning best value for their money.

> *As a healthcare provider and technology entrepreneur, I find software providers always come up with readymade solutions, without studying the treatment process which I perform in my hospital. This discourages me from using it as the device may not suit my requirements.*

*Maintainability*

In software engineering, maintainability is defined as the ease at which the software can be modified (Frappier et al., 1994). Since this study includes views of stakeholders towards mHealth applications, the above definition holds worthy for explaining its components. For maintainability other than technological complexity, interoperability, etc. the components of staff turnover, key support, and technical assistance should also be considered, and the same have been explained in this section below.

*Staff Turnover, Key Support, and Technical Assistance*

The main intention of promoting mHealth is to provide healthcare service using the system of telehealth, mobile care, and home health and wellness, helping the patient in receiving timely healthcare, reducing patient travel and cost. It would be possible if there is a proper system and support from software developers, healthcare providers, and patients to form a complete ecosystem.

As these devices are mainly used for health-related activities, in this current scenario doctor or healthcare professionals act as a fulcrum for promoting the use of it for the people, and require necessary training programmes from the software developer for familiarizing it. For example, these applications have found their use in tracking and reporting Ebola and malaria epidemics in the rural and urban regions of Africa (West, 2015). They were considered to be successful in controlling epidemics.

On the contrary, a lack of coordination has been cited by a healthcare professional: *There was a technological innovation for measuring the glucose level in the blood for Type II diabetic patients, and the same was suggested to a healthcare system which eventually failed due to lack of support and training in post installations and disease reporting issues*.

#### 4.3.2.3 Process Efficiency

According to Defense Acquisition University, process efficiency focuses on how well the system can be produced, operated, serviced, and maintained (Defense Acquisition University, 2018). Therefore, process efficiency in mHealth application considers apps development process (production), apps utility for healthcare professionals, patients, and users (operation), apps backend technologies support (serviced), and promotion of additional features for retaining the user (maintained).

*Development*

The mobile application development process starts with idea generation or discovery, followed by design and development, progressing through testing, deployment, and maintenance, and finally, marketing (Panko, 2017). *Idea generation stage* should address the need for the development of the apps taking into consideration users or business goals, analytics for measuring app performance, and short and long-term budgets for creating the app and maintaining it (Delgado, 2017). This stage also includes market surveys to identify competitor's markets and apps utility measures for prototype creation and project planning. Additionally, it considers minimum project size requirements for ensuring valuable agreements between app developers and clients for starting the project.

*The design and development stage* includes understanding the project's wire-framing, visual design, and user experience design from the perspective of customers. It also considers the use of hybrid and native frameworks depending on their target operating systems. *Testing, deployment, and maintenance stage* includes in-depth testing for measuring product quality in terms of glitches, lags, or any other issues. Moreover, updating and regular maintenance need to be undertaken such that the developed applications stand out in their application stores (Panko, 2017).

*Marketing of the app* is an important step as that of designing, and involves consideration of marketing plans and budgets. Application developers should also indicate the application's value proposition, important features, illustrations, and visualization to make it appealing, and to build trust among users. Consequently, they should also look for app reviews and feedbacks for measuring performance and quality (Delgado, 2017).

*Utility*

The utility of mHealth application is considered from the point of a healthcare provider for managing patients having specific health and disease conditions, and from that of users for managing lifestyle diseases. In India, the government and some private organizations are constantly working on improving health services through mobile phones and health applications.

Some of the commonly used mobile phone features and applications used by the people and doctors seeking health information and communication are listed in the following table 4.4.

**Table 4.4:** Select mobile phones features and apps for health

| Mobile Phone Features | Health Information Seeking and Communication |
|---|---|
| Google Maps | • To identify the nearest hospital during normal and emergency situations. |
| WhatsApp Messenger | • Delivering primary care by inspecting the images or videos of an injury or any physically distinguishable rashes assisting doctors or physicians in providing medical consultations at the right time.<br>• For communicating medication prescriptions and reminders, health reports to patients, and scheduling appointments. |
| Basic Feature Phones | **Call:**<br>• Nurses in Primary Healthcare Centres (PHC) use it for communicating people regarding medications and other health information through ASHA workers.<br>• It is used 99Dots process wherein; Tuberculosis patients give a missed call to a telephone number to indicate that the person has taken the medication as prescribed by the doctors who are also recorded in the hospital database.<br>**SMS:**<br>• It is used by nurses in PHC to communicate the patient's vaccination reports to central health database servers.<br>• In the 99Dots process, doctors of that area or ward will also get an intimation through SMS about the patients who have not taken the medications as suggested. |
| Facebook and Twitter | • For finding reviews about the treatment, patients experience disease and their health experience.<br>• It is also used in scheduling appointments and consultations or getting responses from their doctors.<br>• In the year 2016, with the outbreak of Zika virus, public health (@CDCgov, @MoHFW_India) started providing information on its symptoms, transmission, localization, and prevention techniques through Twitter and Facebook. |
| Frequency Modulation (FM) in mobile phones | • In creating awareness about particular disease symptoms and its treatment condition.<br>• It acts as interphase to maintain adequate health and energy levels through different varieties of song tracks. |
| Skype and Camera Phone | • Skype has found its use in treating and consulting patients by voice, using a microphone, webcam, and instant messages over the Internet as a practice for telemedicine or through geotagging people during emergency situations. |

| | |
|---|---|
| YouTube | • Used in communicating health information through videos of healthy diets, exercises and fitness practices, disease symptoms and vaccinations, etc. |
| Emails | • In clinical interventions, emails are used to send and receive health records of the patients from their doctors.<br>• To create awareness about various diseases outbreaks, treatment conditions, various medical equipment, insurance policies, and medicine offers such that people may find it easy during prescription refilling and other health treatment. |

*Backend Support*

To support and make health applications work freely within mobile platforms, app developers should consider various technical components during the initial stage and post-installation of their development. Some of the technicalities include software packages for managing process and real-time data, storage, integration, and caching, primary platform structure using clouds or any other, desktop-based UI, Bootstrap, server mechanisms, etc. (Müthing et al., 2019; Liu et al., 2011; Silva et al., 2019). The use of cloud storage, content delivery networks, digital right management, server-load balancer, audio-video transcoder, and self-intuitive and user-friendly interphase are also important due to multiple operations and tasks (Suciu et al., 2015; Silva et al., 2015; Wang et al., 2016; Al-Ghamdi et al., 2019). Therefore, all these components, with necessary security and interphase, help end-user in receiving and communicating data to the provider at the right time.

> *Health data, being so crucial, needs to be protected, and the policies should be specifically framed for health data. This may hinder data analytics research by private parties (Health IT Professional).*

In the post-installation stage, the application developer should act as a helping hand between the healthcare provider and patient/user during technical complexities and breakdowns. In addition, they also have to provide subsequent training programs to the healthcare provider and/or patients for using it.

> *Technical assistance should be given to the staff, which is a prerequisite during technology transfer (Health IT Professional).*

*Application Features*

In India, people prefer visiting healthcare professionals personally than through mobile interventions. In such cases, convincing people to use mobile devices is a challenging task, and often software developers take doctor assistance in recommending it to people. As people have a perception that mobile phones are injurious to health due to radiation and other phenomenon, arranging for making proper training and awareness programs through their family doctors helps in addressing it.

> *Workshops, social media campaign, patient reach through hospitals, awareness programs in schools and colleges (Health IT Professional).*

Consequently, apart from technical components, design, and visualization, the developer should also consider various features for inclusion in the app. Some of these include: registration/login options, editable user profile, integration with social network and other digital devices like wristband etc., option to set personalized tasks, user statistics (daily, monthly etc.), diet plan and relevant exercises that are update frequently, cloud storage, virtual-reality and e-commerce options, geo-location integration, payment option (free, subscription, and premium), and push notifications on dashboards (Kishore, 2017). These will help people with a sense of trust and satisfaction with the device.

#### 4.3.2.4 Affordability

Affordability in this study focuses on the components related to financial viability and cost-to-consumers when measured from the perspective of health IT professionals, doctors, and techno-entrepreneurs. These are explained as follows:

*Financial Viability*

*Mobile Health Environment*

For achieving an affordable cost, the mHealth environment considers the nature of the demand for the digital and/or mHealth market, innovation for underserved, market policy, and mHealth use among people of India. These are explained in the following subsection.

*Nature of Demand*

The policy of Make in India has been initiated in order to bring in various technologies and innovations across various sectors for enabling empowerment, equity, and efficiency by combining people with the government for sharing knowledge and bridging the gap between demand and supply (Gupta, 2014). With the rapid advancement in technology and the innovation, the traditional system of health service delivery is now transformed and integrated, taking into consideration service process view for improving the value of the business. Innovation in healthcare is considered as thrust, and acts as a key factor for the success of the program (Velu, 2017).

> *Technology innovation should be considered as ethical since people usually don't agree with the technology used in health delivery. This means that the technology should be incorporated into the system with the required number of valid data to save lives (ethical), and for consideration of digital intervention pathways helping society in tackling disease outbreaks (Healthcare Provider).*

This implies that there is greater need and demand for digital technologies in the rural regions than in urban region. When asked about it, healthcare professional stated as follows:

> *There is demand and need for health information among the people as more and more people have access to the Internet and have got choices for selecting their doctors or even have the option of putting their health conditions online, which gets multiple responses within a fraction of time. But they generally now looking at the outcomes and how it has been treated?*

But the problems existing here are either because of the unwillingness of the people towards such technologies or lack of interest shown by their health centers. This may occur because of improper distribution of medical practitioners and resource availability at a particular locality, which can be sorted by redesigning or restructuring the process of the healthcare system of that locality. As mentioned by techno-entrepreneur, *technology, coupled with incentivization, changes the behavior, enabling efficient delivery of care.*

*Innovations for Underserved*

The use of innovation in IT plays a significant role in providing healthcare access to people living in rural regions. As cited by the healthcare professional that:

> *Mobile phones are much needed to combat the doctor-patient disparity ratio in rural areas. Implementation is easier by employing a few people with basic computer knowledge and Internet facilities enabled in the areas to connect with a doctor sitting in the place of his comfort and treating patients through video conferencing. 80% of patients treated do not need a physical examination in the OPDs.*

By realizing this, various investments have been made by the center and state governments for using the health information system for the benefit of these people. In addition, to promote appropriate, safe, and effective use, technological systems, including point-of-care devices based on research and innovations, have also been incorporated into the national healthcare systems. For fostering the broadband Internet systems among people and healthcare centers, a project for "Bandwidth Maximizer" has been initiated at Dharamsala, which combines local content caching and filtering, enabling faster multiple upstream connections (Ginguld et al. 2010).

At present, in India, digital and mHealth innovations are available for mother and child health, but the majority of them are working as pilots for chronic diseases and health conditions. This can be due to the problem of technology acceptance by the people or healthcare practitioners, or due to avoiding of initial and preventive treatment services. As stated by the technology entrepreneur:

> *I have seen a high-end instrument being procured in a … healthcare center and found a lack of utility as they consider it as a referral center by definition or by protocol, and they manage to refer but may not give definite treatment.*

Apart from technology, innovations have taken place in providing various insurance schemes such as Rashtriya Swasthya Bhima Yojana, Yeshasvini, etc. against health conditions and diseases, thus reducing the out-of-pocket cost expenditures for the people.

*Regulatory Policy*

Realizing the importance of mobile platforms in healthcare service delivery, FDA has set out guidelines for the manufacturers, distributors, and other entities towards authorizing software applications and mobile medical devices for health activities. According to FDA, the mobile applications which do not meet the definition of the Federal Food, Drug, and Cosmetic Act and impose a low risk to the public will not enforce requirements under the act (FDA, 2019). While for mobile medical applications, the product should meet the definition mentioned in section 201(h) and should be approved by the FDA review of a premarket submission, or otherwise, should be FDA classified.

In India, guidelines for the medical applications and diagnostics techniques have been controlled under the Central Drugs Standard Control Organization (CDSCO) and Pre-Natal Diagnostic Techniques (PNDT) Act. For imported and manufactured medical devices, as mentioned by Kotlo et al., (2015), there is no proper specific guideline for medical applications under medical devices. Since the devices are manufactured by IT professionals and experts from various domains, there is a need for regulatory policies for medical apps, as the rural segment of population in India has been unserved with affordable medical care. Therefore, these regulated devices will assist people in receiving healthcare access, and will also help organizations in achieving market share.

Technology entrepreneurs and healthcare providers in India have come up with different Android-based mobile applications, and have failed to reach the target market due to the condemnation of the device under Pre-Natal Diagnostic Techniques (PNDT) Act. As quoted by technology entrepreneur:

> *The company '…' have developed two android based mobile applications for … and … called '…' and '…', but unfortunately, governmental regulation has stopped access, which I feel regulations itself act as a barrier for some of the best technologies for improving patient's health.*

The current policy on entrepreneurship in India supports setting up incubation facilities under the Base of the Pyramid (BoP) directly or through government partnerships. This incubation helps startups in providing mentorship, incubation, and technical assistance by providing seed capital or growth equity working to become self-sustaining under BoP segment. For example:

> *Due to the problem of access from patient and healthcare, handheld android mobile devices '…' used for ear infection screening and treatment wherein the healthcare worker can record the data of the patient and refer them efficiently to their corresponding specialists. This is merely self-sustaining pilot models in India because the patients are subsidized with the cost of the ear screening and surgeries, making it affordable to the people (Technology Entrepreneur).*

*Aging Populations and Citizens Unhealthy Lifestyles*

According to the census of the year 2011, India has 104 million people aged 60 years and above (Gangopadhyay, 2016). Due to people's increased longevity, and falling fertility, a concern may exist among the governments about complex health, social, and economic challenges for the present and future generations (Agarwal et al., 2016). This is because of industrialization, migration, and urbanization, which has fragmented the joint family system into nuclear families (Kaldate, 1962; Rao, 1973). In earlier times, the elderly population was dependent on joint families for care, and such support has now been more or less marginalized in their respective families. Therefore, a digital and/or mHealth system can act as a medium for providing healthcare access and making it cost-effective.

Moreover, the aged population may face problems of severe health problems, including that of eyesight and hearing, and may face issues with electronic literacy due to which resistance to using will be more. Therefore, these elderly populations which are capable of using mobile phones can be provided with the necessary training and/or assistance in consulting doctors through mobile phones. For others, home nurses can be a point of contact between doctors and elderly patients for timely interventions.

> *People need to be educated on the basic usage of health portals or mobile phones to converse with doctors (Health IT professional).*
>
> *A certain percentage of the amount should be paid to the government as tax. They can utilize it for developing health application which can be installed in mobile*

*phones due to fewer prices, and through health workers or nurses we can reach or assist patient to use it. This makes it accessible and affordable (IT professional).*

Nowadays, due to the nature of work and complexity, people often find minimum time for exercises, and have even stopped jogging or visiting gym to a large extent. This has also created an imbalance in their daily food habits, and other unhealthy lifestyle practices resulting in the majority of the population suffering from asthma, gastritis, obesity, diabetes, cancer, etc. As a reactive strategy, various policies have been formulated, encouraging women in rural and urban regions towards health and social change. As a political scholar has cited that:

*Empowering women, empowering the family, empowering society will ultimately empower the nation.*

Moreover, to promote healthy living, the government has also started uplifting traditional yoga practices by celebrating 'International Yoga Day,' thereby supporting software developers in uploading videos of yoga and exercises in their health application for practicing during free times at homes. To create awareness about such applications, various promotion strategies in social media and television have been used through celebrities endorsing their products and services, stating their importance for health.

*Cost-to-Consumer*

To support cost-effective and affordable mHealth application and services in India, the cost factors related to IT accounting, charging, and budgeting are explained as follows.

*Factors of IT Accounting*

*Cost of Medical Devices and Mobile Health Applications*

The medical devices development starts from idea generation, concept development (9 months, INR 500,000-1,500,000), filing of patents (3 months, INR200,000-400,000), alpha prototype development and testing (6 and 3 months, INR1,000,000-1,500,000 and 200,000-400,000), beta prototype development and testing (3-6 and 9 months, INR1,000,000-1,500,000 and INR800,000-1,000,000), manpower calculations (3 months, INR400,000-600,000), manufacturing design (3 months, INR500,000), regulatory and reimbursement pathway (6 and 3 months, INR1,000,000 and 200,000), manufacturing with ISO standards (6 months, INR 10,000,000 approx.), sterilization and packing (2 months, INR200,000-300,000), marketing (6-9 months, INR4,000,000-500,000), and distribution (6 months, INR2,000,000-1,500,000) (Chaturvedi, 2016). Similarly, for developing mobile health applications, the costs are estimated based on apps' complexity and size, number of platforms you want to run, and country of the development center (Kishore, 2017). In India, approximately an average health and fitness app cost for android mobile phones includes technical documentation ($1000-2000), UI/UX design ($1500-3000), front-end and back-end development ($10000-20000), MVP testing ($2000-4000), polishing and bug fixing ($1000-2000), and varies with the addition of extra features (Kishore, 2017).

*Project Portfolio Management Systems*

It is centralized management involving multiple portfolios used for achieving strategic business objectives by identifying, prioritizing, authorizing, managing, and controlling projects, programs, other related works (Project Management Institute, 2015). These systems help in integrating the process from the initiation to completion, and can be manual or automated (Kaewta and Chutima, 2014). In healthcare, these systems help in improving system processes and service quality. The digital and mHealth applications in India are at the entrant level, and are working as pilots across different parts of the country. As aforementioned, for providing the full delivery of service, there is a requirement of developing an ecosystem enabling the healthcare professionals and their teams to be connected with their patients minimizing in a loss in the patient's admission by getting them earlier at the right time for right treatments. As cited:

> *Do we want to be ready with this technological innovation, which can be right? And when we identify this, we see issues related to computers' ability to manage multiple vendors in terms of the right solution and regulations for the serving clinical community and outside. Therefore, the project portfolio management system can be a better solution for all these problems (Healthcare Provider).*
>
> *The improvement requires all levels of the system because the technology needs to be improved in primary, secondary, and tertiary levels (Health IT Provider).*

*Factors of IT Charging*

It is an activity for billing the internal and external customers for IT services (Ryan and Raducha-Grace, 2009). For using mobile phones for health service delivery, firstly, factors related to interoperability and Internet connectivity, without which accessibility will be a problem, will have to be considered. In India, most of the people are now subscribed to mobile phones, and their number is increasing, indicating that there are less connectivity issues. Second, affordability factors, due to wide varieties of pricing strategies from mobile phone manufacturers, people are now receiving mobile handsets at an affordable price even with Internet access at a reasonable cost such that people can conveniently use it for banking and other purposes, thereby can support Digital India campaign. In this study, IT professionals working in the healthcare sector cited:

> *The digital health implementation has reached the area where the connectivity is available. The challenge lying here is the awareness of the app among common people using smartphones. The awareness about the facilities available in the digital health platform is also important.*

Third, the mobile phone features: since mHealth applications are in the initial phase of health service delivery in India, people use basic mobile features (Table 4.4) for medication reminders, treatments, etc. supporting evidence-based practices of primary healthcare centers. Regarding health applications, people are using it for day-to-day activities, but there is no proper evidence and support for a change in people's behavioral outcomes as there is no copy-paste model that exists in healthcare. Fourth is capitation: IT charging also includes a mechanism for making payment arrangements for health professionals such as doctors, physicians, and nurses. This mechanism should be implemented in such a way that the health professionals should not be disappointed with the payment model impacting the quality of service delivered.

> *Here comes the big hurdle. The payment of doctors should not see a downward curve as this is the most demotivated factor for any doctor to adopt a change (Doctor).*

The mHealth application should take into consideration capitation, coupled with a value-based purchasing model, assisting health professionals in receiving timely payment for the services delivered.

*Since the application is for a large mass of people, the profit margin depends on the number of people using it. Once the product is deployed, the operating cost is less.*

*Factors of IT Budgeting*

It recognizes future IT-related costs for a specific service, operation, or customer for a given time period (Ryan and Raducha-Grace, 2009; Ammenwerth and De Keizer, 2016). This study considers factors of IT budgeting from the point of cost absorbed by the business unit, government, or nonprofit organization as a line item for the budget. As a part of the 11th five-year plan, the GoI has allocated 89% of the health budget to National Rural Health Mission for improving the healthcare infrastructure and manpower shortages (Sengupta, 2013).

The total budget required for the development of mHealth applications for a single platform of iOS or Android is about $15000-30000, and these amounts are apportioned in steps according to design requirements, as explained in the IT accounting section. The company forecasts the budget requirements depending on the survey and impact analysis involving crowdsourcing. An IT professional working for the development of mHealth application stated as:

*A survey is conducted to assess the importance of the application, the impact analysis will be performed on the targeted population, and in some cases, the opinion is got through crowdsourcing.*

### 4.3.3. Discussions

The analysis shows that there were adequate digital and mHealth solutions for achieving its affordable-system-operational-effectiveness. This study examined the ASOE components from the perspectives of stakeholders such as health IT professionals and consultants, technology entrepreneurs, and healthcare professionals based in India. In doing so, it assessed technical performance, supportability, process efficiency, and affordability of digital and mHealth applications among stakeholders. Study findings not only provided us with the major challenges but also indicated the issues which might arise in the supply side (even having new innovations) in bringing technologies to market on a larger scale.

*People's Need and Unwillingness*

We identified that the use of the mobile phone for managing issues related to maternal women (for medication reminders and treatments), and 99DOTS process for TB (initial stages), was accepted by the people. Here, mobile phones act as a communicating medium between ASHA workers and healthcare providers. The evidence related to accessibility and acceptance and use of digital or mHealth applications among Indian citizens is inadequate. Technology entrepreneurs and healthcare providers indicated that most of the people are not willing to accept mHealth or digital application because of information credibility, literacy, connectivity issues, and low trust. Researchers also indicated that the digital divide and cultural difference too has an influence on ICT and mHealth adoption among people (Ayanso and Lertwachara, 2015; Dwivedi et al. 2016). Thus, the hypothesis can be postulated as *peoples' need and willingness influence stakeholders in implementing mHealth applications for health service delivery*.

*Application Infrastructure and Affordability*

The role of mHealth application in the stages of health communication such as locating hospitals and pharmacies, identifying doctors, arranging medical records and scheduling appointments, etc. is accepted among people and other stakeholders of a hospital. But when it comes to mHealth solutions for diagnosis and treatment, people in India prefer to visit healthcare professionals personally rather than through mobile interventions. This can be due to the negative perception about mobile devices, technical problems (such as connectivity and voice clarity), and/or it can be because doctors' verbal behavior (i.e., gestures and tones) during personal visits is missing in mobile phone consultations. This can be tackled by doctors recommending mHealth applications and telemedicine processes to their patients for improving the positive belief.

When considering affordability as an important factor, two components need to be considered, i.e., affordability of insurance schemes and other health technologies. Researchers have indicated the influence of affordable health insurance on social security, financial protection, and health service delivery (Bhan et al. 2017; Zallman et al. 2015; Xiong et al. 2018). Therefore, people who are not aware of insurance schemes should be promoted through radio, television, FM, etc. such that they can register for it and avail during emergencies. For example, United India Insurance Company life insurance schemes for health, vehicles, rural, personal, etc. or Pradhan Mantri Jeevan Jyoti Bima Yojana. Most of the people can use digital technologies to locate such hospitals and use various insurance schemes provided by the government or private hospitals for the treatment. The other affordability factors are the use of digital/mobile equipped medical technologies. For example, for cancer detection instrument, the cost of the cartridge and other tool costs more, which may not be affordable for a common man even after insurance claims. In these cases, the service providers are considering investment options based on locality before enabling such devices towards the point of care. In India, various researches are in continuous process of making this device affordable at the point of care such that even a common man can get the best treatment. Thus, the hypothesis can be formulated as *technical infrastructure, and affordability factors influence stakeholders in implementing mHealth applications for health service delivery*.

*Ecosystem Development*

Healthcare professionals during interviews cited that digital and mHealth solutions developed by technology entrepreneurs and software developers often fail in addressing their needs and utility. Problems with connectivity and integration with the healthcare systems and devices can also be a factor for poorer acceptance. This can probably be due to a poor understanding of the healthcare systems about diagnoses and treatment procedures involving doctors. Most of the health software developers come up with solutions by incorporating the western model and trying to implement in the Indian healthcare industry.

*The complexity of healthcare in India is much more as it doesn't work with the principle of 'one size fits all,' and also there is no proper provision of technology for doing things.*

As India's socioeconomic and demographic profile and disease patterns are different, there is no possibility of adopting a copy-paste mechanism. Therefore, they have to understand the system and develop tailored processes which address the need and utility of the healthcare system and professionals.

The development of an ecosystem will contribute to the interaction between the patients and health professionals or service providers in improving their trust, which further improves their business. In India, most of the mHealth applications are working as pilots across different places, and there is no proper evidence about the people's health improvements caused by using these devices, indicating a lack of model validity. Therefore, setting up an ecosystem by making it a single-point access portal for healthcare professionals to come online, or by integrating all these software providers working together with healthcare departments under one single roof can help in improving business through various payment models, enabling evidence-based practices and people lives, and supporting digital India campaign.

The usability of the mHealth application can play an important role in supporting user-centric healthcare governance. People in recent times look for a convenient solution and use the Internet and social media to get an instant solution to their health problems. For example, any health condition or health symptoms on the Internet and other social networking sites will provide more responses from users and health professionals across countries, suggesting immediate relief medications, etc.

These responses help users or information seeker to decide whether to visit a healthcare facility or not for their health conditions. If the user plans to consult a doctor, the reviews about doctors, hospitals, treatment and diagnosis plans, and consultation time will help the needy. This leads to enormous amount of data for a particular cause, and if these content search data and survey data are extracted efficiently by using necessary data mining tools and analytics, it will be a value-added process for the organization.

This helps the healthcare provider or techno-entrepreneur in resolving problems of data integration, information requirement, and connectivity between doctor and patient, assisting the organization in making decisions through partnership reforms. Thus, the hypothesis can be formulated as the *development of ecosystem influences stakeholders in implementing mHealth applications for health service delivery*.

*Governmental Policies*

It has been observed from software developers that, even though the policies for using of mobile phones and their application in healthcare were suggested, the mechanism for carrying out these process and interventions is still not clear in terms of service delivery. This indicates that the awareness about the health application availability in the government website NHP India is less and is not yet popularized among people. Moreover, people also might have confusion in using these applications, considering that their hospitals may not support or recommend it.

It was also observed that certain digital technologies procured by the hospital are not having much usability, and when identified, the structure or perception of the people about that healthcare and lack of health professional recommendations towards using these devices are disconnected. Therefore, proper structuring of healthcare systems and providing necessary information about mHealth applications to the concerned medical facilities should be made clear among the people. As innovative mHealth solutions such as mobile medical units and basic features mobile application use during an emergency situation and health communications have helped people in receiving immediate casualty treatment and care at the right time.

Prior literature has indicated that market competition, openness in economic policies, e-commerce support with suitable legislation, and public-private partnerships have influenced ICT development and adoption in Poland and Slovakia (Ayanso and Lertwachara, 2015). Technology entrepreneurs and software developers also feel that healthcare organizational and governmental policies acting as an enabler are also a barrier (example, Indian penal code of section 304) for mHealth implementation. Thus, from the findings, we can postulate the hypothesis as *government policies influence stakeholders in implementing mHealth applications for health service delivery*.

It is observed that some of the medical applications which are doing well in other countries are not accepted in India. This can be due to a lack of involvement with the healthcare teams while framing the policies, and this has also been identified by Mars and Scott (2010) during the investigation of global eHealth policies. Software developers also indicated that the laws scrutinized and enforced by CDSCO and PNDT or any other government bodies, and lack of proper scientific guidelines for mHealth applications can be factors hindering implementation (Kotlo et al., 2015; Malvey and Slovensky, 2017).

Therefore, proper regulations and specific guidelines by the government and teams towards applications can help the rural and inaccessible areas in providing health service delivery.

*Training and Support*

Most of the healthcare professionals in India have identified that lack of training and support by the software developers is a reason for not accepting their long-term contract. Since most of the healthcare professionals are busy in their work activities, and cannot dedicate more time to these technical systems and software applications, the situation would expect developer's assistance in solving their problems, which otherwise leads to patient queues, improper workflow, and sometimes erroneous treatments.

Necessary training and support at right times would assist healthcare providers and patients in monitoring and streamlining their health activities regularly. Thus, the hypothesis can be formulated as *training and support influences stakeholders in implementing mHealth applications for health service delivery*.

## 4.4. Sentiment Analysis of Social Networking Applications Health Content

This section presents the research questions of What do people feel and talk about mobile health applications, social media game (BlueWhale Challenge), social media movement (MeToo), and mental health on social media? The following section presents the process involved in data collection and analysis for each of the components listed previously.

### 4.4.1. Sentiment Analysis of Mobile Health Applications

The methodology followed in this research is qualitative with the data extracted from a social networking site "Twitter" using RStudio.

The framework for tweet extraction is represented in figure 4.4.

Twitter sentiment analysis

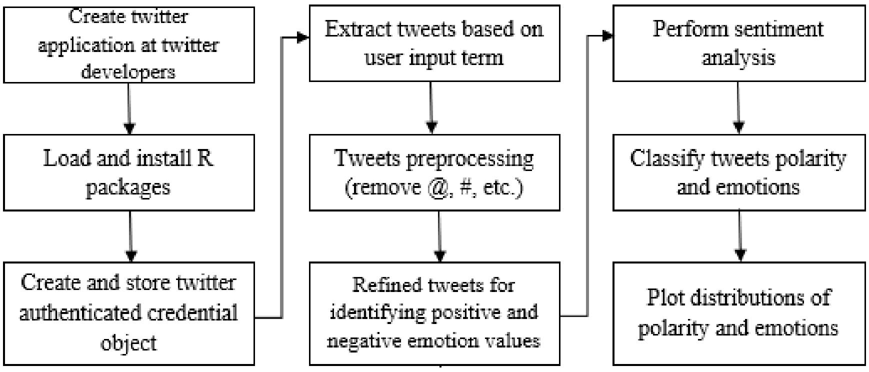



**Figure 4.4:** Flow diagram for extracting tweets

*Dataset*

RStudio tool is used to extract Twitter access using ROAuth and web API (Application Programming Interface) and requested 1000 tweets each for four different phrases of mHealth apps, namely fitness app, diabetes app, meditation app, and cancer app. Tweets were extracted for the latest 8 days starting from 08 June 2017 to 15 June 2017, and sentiment analysis was performed to measure its polarity and emotions.

*Sentiment analysis of tweets*

This paper uses word cloud, and bigram for variable frequency identification found on the Twitter website. From this platform, using R codes tweets with keywords viz. fitness app, diabetes app, meditation app, and cancer app were extracted, and sentiment analysis was performed. Table 4.5 indicates tweets requested and obtained for each of the mHealth apps:

Table 4.5**:** Total number of tweets extracted

| mHealth apps | Tweets requested | Tweets obtained |
|---|---|---|
| Fitness app | 1000 | 1000 |
| Diabetes app | 1000 | 365 |
| Meditation app | 1000 | 1000 |
| Cancer app | 1000 | 827 |

*Result and Analysis*

The RStudio requested 1000 tweets for which bigram, word cloud, and sentiment scores were calculated under four different cases depending upon the type of mHealth apps.

*Case i: Twitter analytics for fitness applications*

The figures 4.5 and 4.6 indicate that people using iPhones are aware of fitness apps which are new and freely available, and are discussing its importance in managing services at a clinic or in maintaining a balanced diet (food diary, nutrition, etc.). Moreover, users may also consider if these are suggested by clinics or hospitals such as the Mayo clinic, etc.

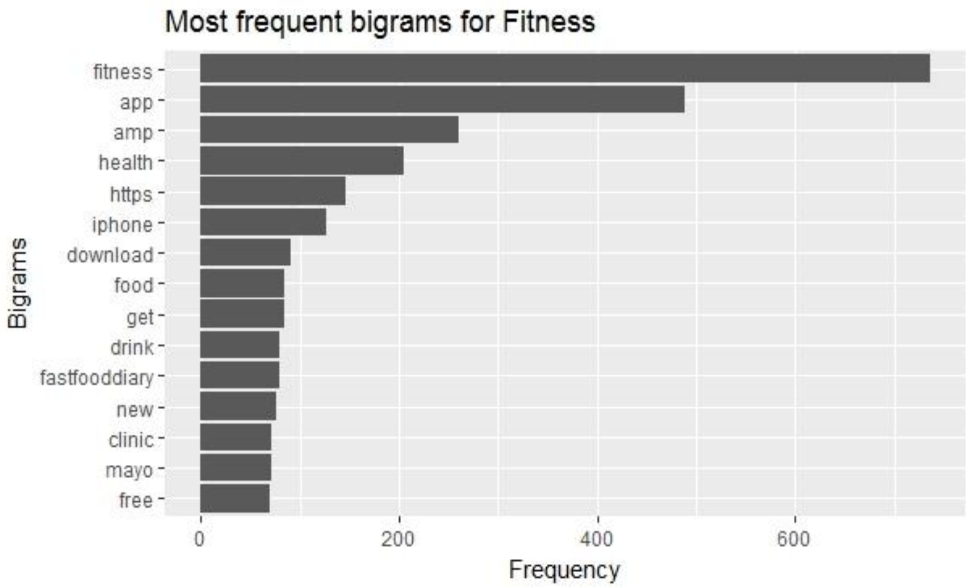



**Figure 4.5:** Bigram for fitness applications


**Figure 4.6:** Word cloud for fitness applications

The figure 4.7 specifies that about 74% of the tweets have positive sentiments, indicating that people are seriously considering fitness apps as a tool for improving their health.

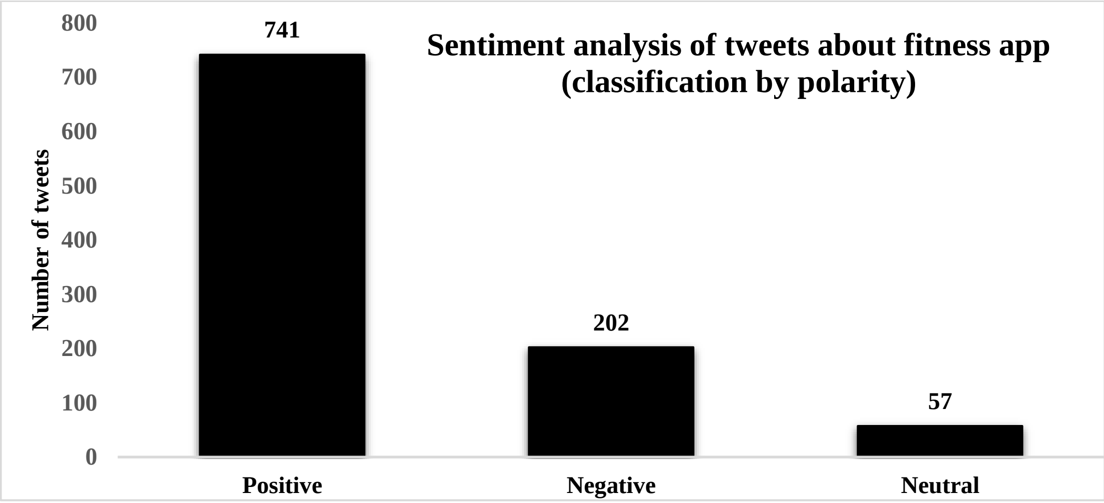



**Figure 4.7:** Sentiment analysis for fitness app based on polarity

It is supported by figure 4.8, indicating application users' emotion as joyful (132 tweets) and higher when compared to other emotion components.

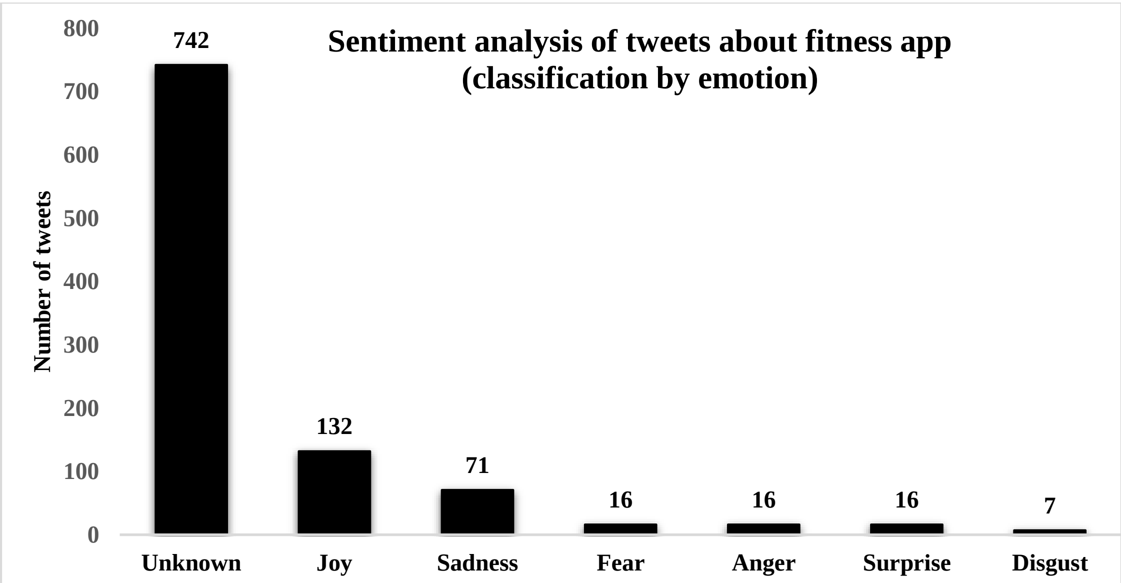



**Figure 4.8:** Sentiment analysis for fitness app based on emotion

The following Table 4.6 below shows select tweets with its polarity and emotion values.

Table 4.6: Tweets for fitness applications

| Tweets | Emotion | Polarity |
|---|---|---|
| Jenn at jensfunfinds says her favorite thing about japrasportpace is the fitness test that comes with the app | Unknown | Positive |
| Officially logged my meals into my fitness pal app for days in a row highly recommend it to everyone takes minutes | Fear | Positive |
| NL sports coming soon to a sports team near you sport coaching training apps tech fitness | Joy | Positive |
| Can I put on my fitness app that I did in of squats because I squatted down to get my hidden treats and I was too high to get back up | Anger | Negative |
| Get a free day pass to best fitness activate now with my special code | Sadness | Neutral |
| Discover why today is an amazing day to get started on that fitness or business goal | Surprise | Neutral |
| Genuinely paying pound a month for a fitness app if this won't motivate me nothing will be tired of feeling crap | Disgust | Neutral |

***Case ii: Twitter analytics for diabetes applications***

The figures 4.9 and 4.10 indicate that people may be aware of diabetes mobile apps used for monitoring glucose levels in the blood through one-touch digital health meters, revealing the type of hypoglycemia (type 1 and type 2) among the people.

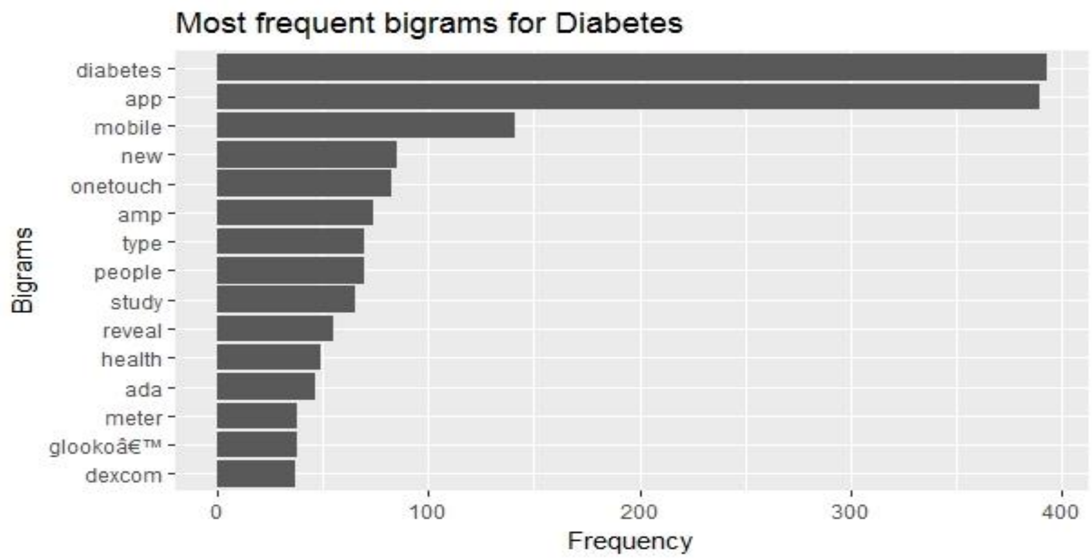



**Figure 4.9:** Bigram for diabetes applications

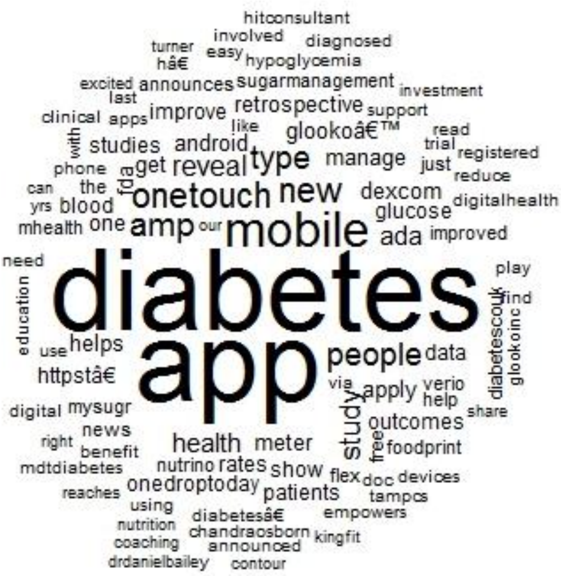



**Figure 4.10:** Word cloud for diabetes applications

The total number of tweets for the diabetes app extracted during the analysis period was only 365. This value appears to be less than fitness application, and may improve over time as the positive sentiment tweets are 259, representing 26% of the total tweets extracted (figure 4.11).

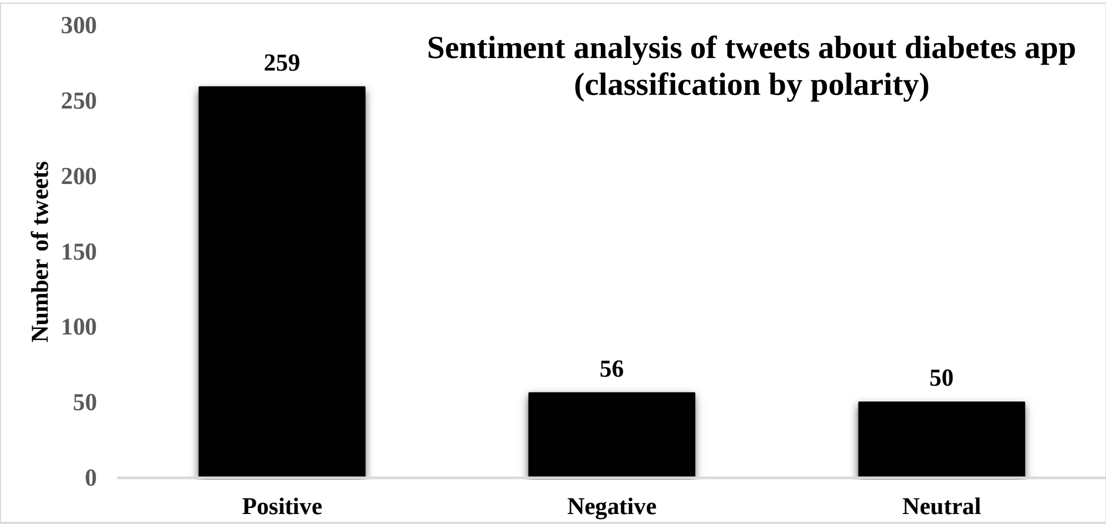



**Figure 4.11:** Sentiment analysis for diabetes app based on polarity

The reason behind this may be the awareness or interoperability issues between users and doctors in establishing interphase resulted in sadness. Alternatively, people using this app frequently, on a daily basis, are found to be joyful in using the application (figure 4.12).

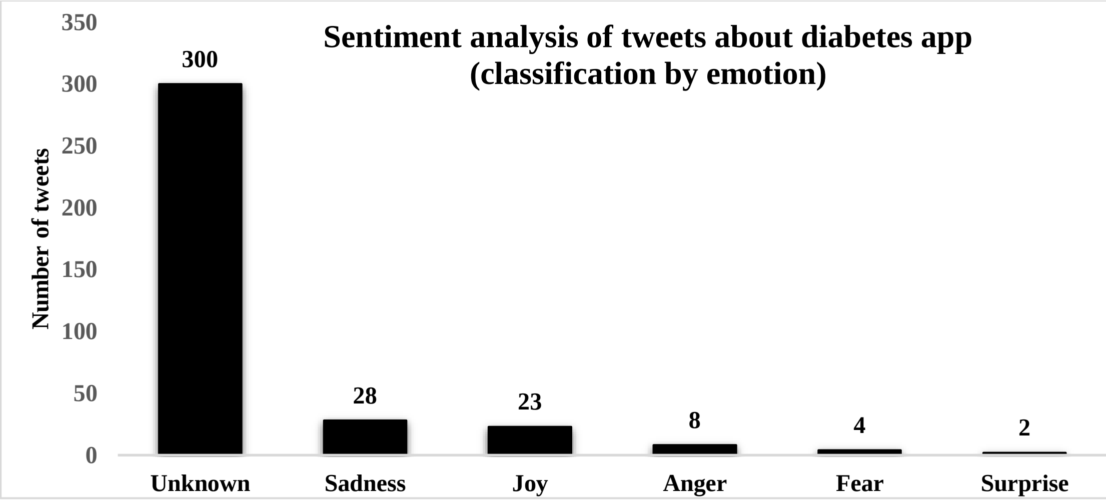



**Figure 4.12:** Sentiment analysis for diabetes app based on emotion

The following Table 4.7 provides the analysis of tweets extracted based on emotion and polarity.

Table 4.7: Tweets for diabetes applications

| Tweets | Emotion | Polarity |
|---|---|---|
| A mobile app for the self-management of type diabetes among adolescent a randomized controlled trial | Unknown | Positive |
| Wear your medical alert bracelet or update the health on your smartphone, so others know you have type diabetes | Fear | Positive |
| Glad to hear I saw this Israeli app that can personalize diets to prevent or deal with diabetes very cool | Joy | Positive |
| He knows how to scan the QR code and get the diabetes risk score app | Anger | Negative |
| At a time when insulin amp other diabetes drugs are soaring Amazon creates a stupid distraction diabetes app contest duped again, folks | Surprise | Negative |
| Discover how breakthrough diet sensor nutrition app helps in managing diabetes weight loss and improves fitness | Sadness | Neutral |

*Case iii: Twitter analytics for meditation applications*

The figures 4.13 and 4.14 illustrate that people often talk about these applications due to their mindfulness and deep sound features, which are binaural, and are available freely in mobile play stores.

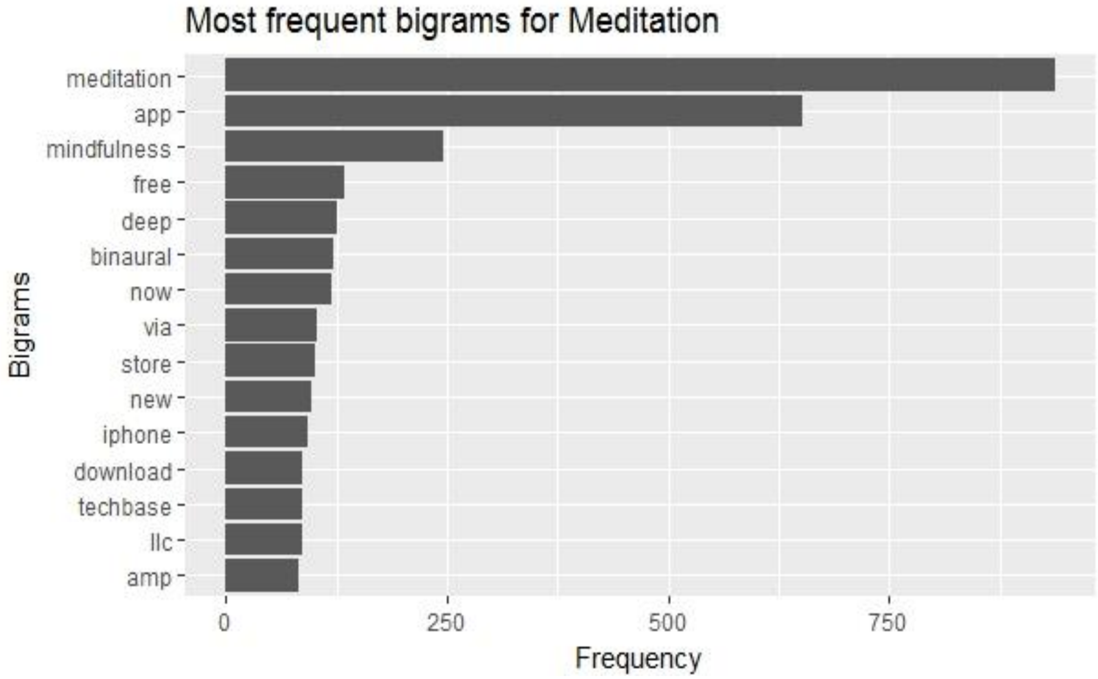



**Figure 4.13:** Bigram for meditation applications

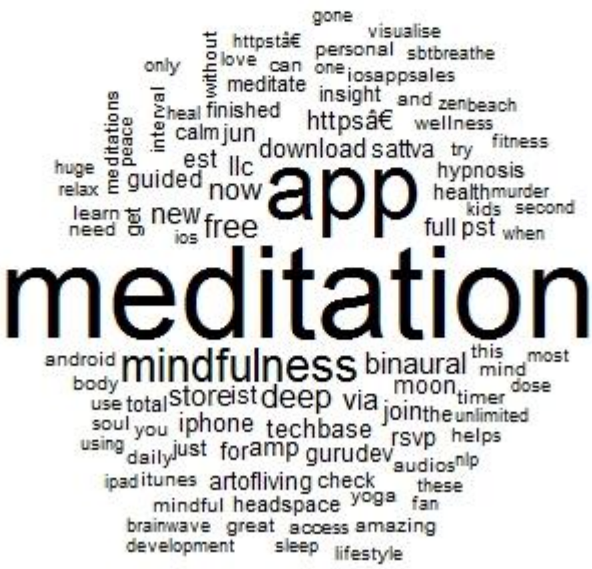



**Figure 4.14:** Word cloud for meditation applications

This application helps the users to feel relaxed through their audios and improve concentration helping them in brain development.

From the figure 4.15, we can identify that there is a positive opinion about the meditation app among people, as the total number of positive sentiment is 810, which corresponds to 81% of the total tweets extracted.

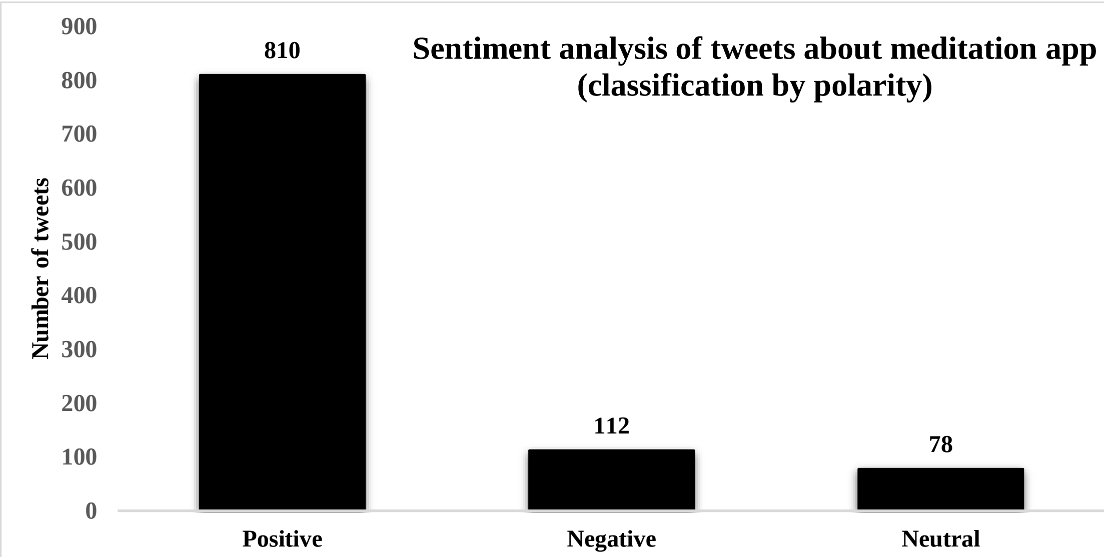



**Figure 4.15:** Sentiment analysis for meditation app based on polarity

Results of the sentiment analysis also indicate that 8.1% of the people/user are joyful in their perception and use of this app (figure 4.16).

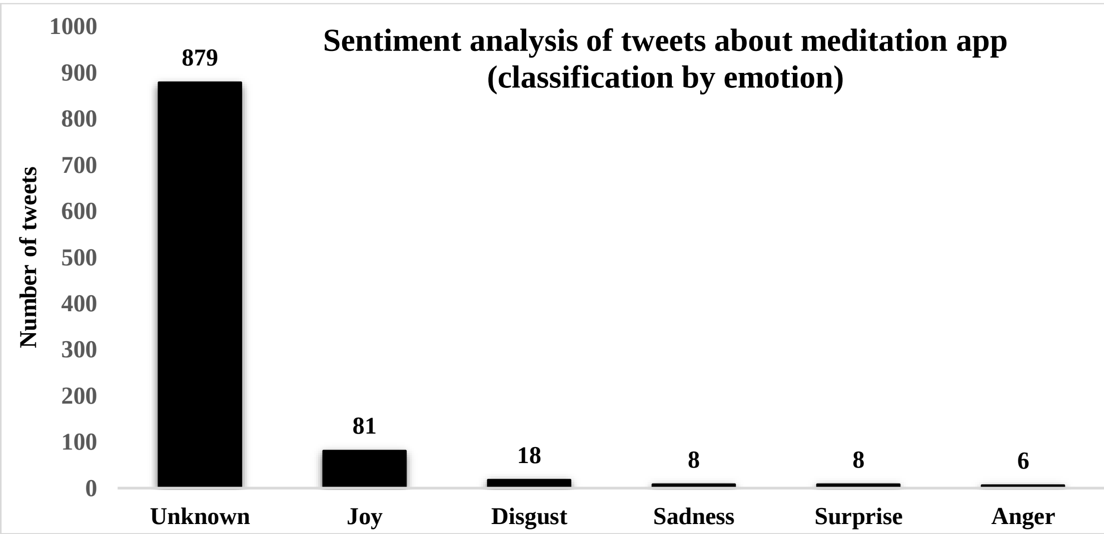



**Figure 4.16:** Sentiment analysis for meditation app based on emotion

This signifies that the meditation app is working fine, and people are satisfied with it. Some of the select comments about these applications are shown in table 4.8 below.

Table 4.8: Tweets for meditation applications

| Tweets | Emotion | Polarity |
|---|---|---|
| Meditation app headspace hires a new chief business officer tech crunch | Unknown | Positive |
| Is the best app in fall asleep to the meditation sleep times in likes 25 seconds amazing | Joy | Positive |
| How to deal with pesky thoughts in meditation success | Anger | Negative |
| Headspace's revamped app helps busy people turn meditation into habit wellness | Disgust | Negative |
| Heal your body mind and soul with these amazing meditation on iTunes for iPhone | Surprise | Neutral |
| Wow just discovered meditation apps is there such a thing as a get off your butt amp write app cos hearing katching amwriting | Sadness | Neutral |

***Case iv: Twitter analytics for cancer applications***

The figures 4.17 and 4.18 show that people are discussing about cancer application available in different play stores but are much concerned about the survival benefits as it is paradoxical in nature with an example being 'a cough turned out to be lung cancer via the app.'

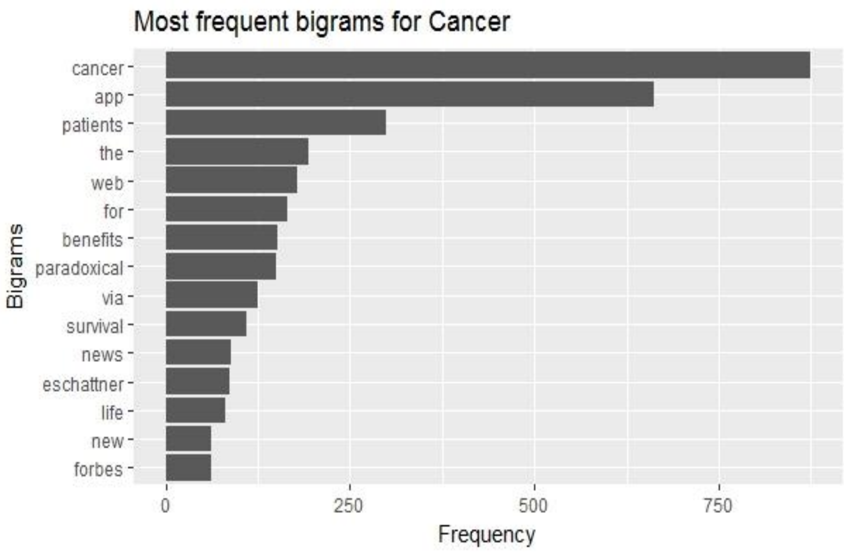



**Figure 4.17:** Bigram for cancer application


**Figure 4.18:** Word cloud for cancer application

Many users suggest that use of mobile cancer application in the early stages of diagnosis by displaying some documented symptoms can be helpful in improving and saving lives. For the cancer application, the number of positive sentiments is less compared to that of negative sentiments (figure 4.19). This indicates that the perception and use of this application appear to be less as most of the people may prefer visiting the doctors personally than through smartphones for their regular checkups.

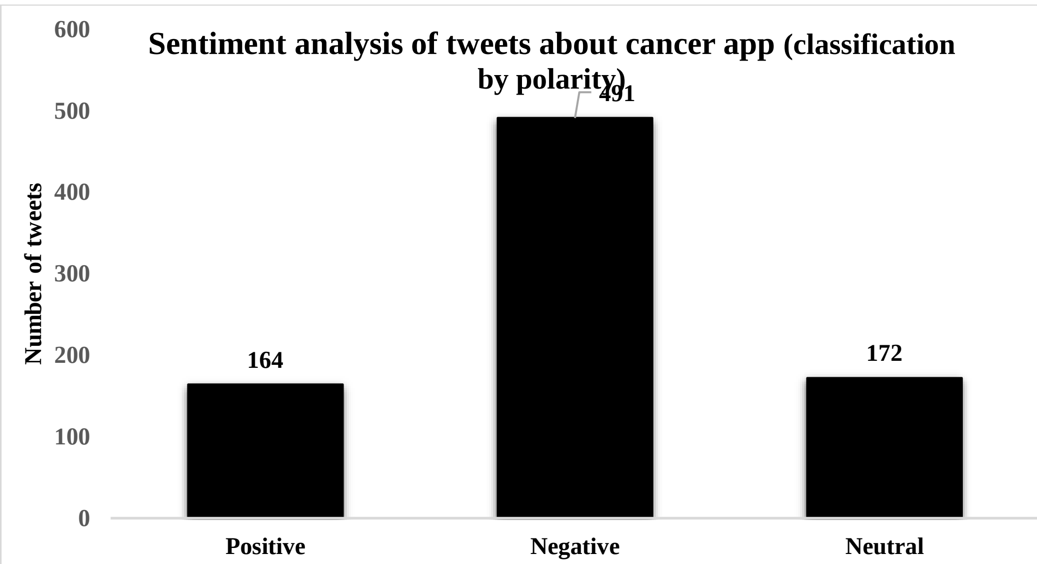



**Figure 4.19:** Sentiment analysis for cancer app based on polarity

Though there are more negative sentiment values, people have expressed joyfulness (60 tweets) when compared with other emotional parameters (figure 4.20).

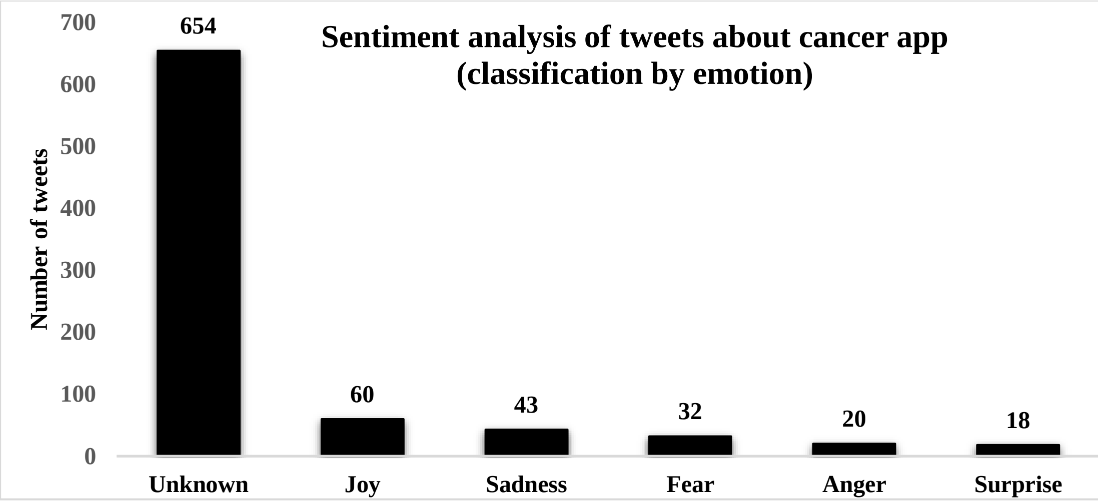



**Figure 4.20:** Sentiment analysis for cancer app based on emotion

This result can be because of features such as diet tracker, first aid process, finding the doctor and booking appointments, etc., which are available in this application. Table 4.9 below shows the examples of different tweets extracted from various cancer applications.

Table 4.9: Tweets about cancer applications

| Tweets | Emotion | Polarity |
|---|---|---|
| Sharktankaucancer touches us all, so I really want this app to succeed amp make life impact changes | Unknown | Positive |
| Our nutrition app can help you find the optimal diet for any stage of your cancer journey | Fear | Positive |
| Great to see innovative thinkers in the cancer care space sharktankau | Joy | Positive |
| Cancer app rides high on emotion surfer creates comic relief for patient brain tumor | Anger | Negative |
| Get the free mindfulness app for those living with cancer and their caregivers | Sadness | Negative |
| Cancer aid is the top cancer app in Australia UK amp the US used by more than k people in countries | Surprise | Neutral |

***Boxplot and sentiment scores for mobile health applications***

The following figure (figures 4.21 and 4.22) shows the boxplot indicating interquartile range values and sentiment scores for four different mHealth applications.

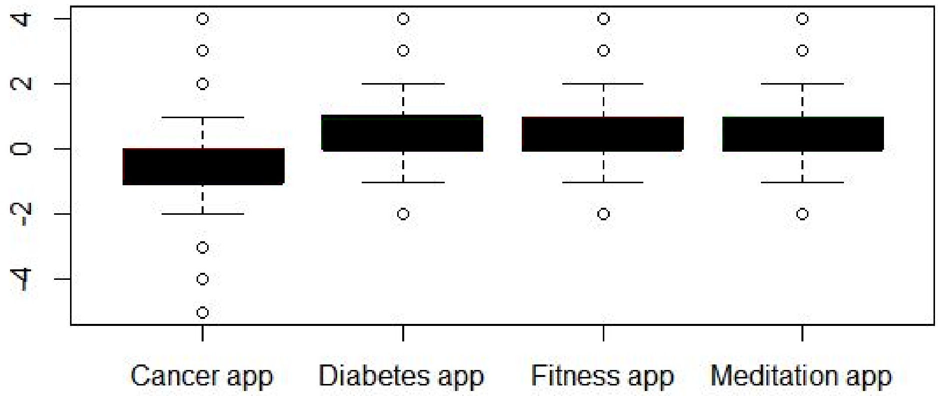



**Figure 4.21:** Boxplot for mobile health applications

Considering the cancer app (figure 4.21), we can identify the existence of positive skewness (median less than mean) in the negative region as the data are distributed below the median values of the boxplot. This indicates that people's perception of the use of cancer app is less than the average perception or use, which is also identified in figure 4.22. Table 4.10 shows the boxplot for mHealth application indicating median, quartile and adjacent values.

Table 4.10: Boxplot values for mobile health apps

| mHealth Apps | Median | Quartile Values | | Adjacent Values | |
|---|---|---|---|---|---|
| | | Upper | Lower | Upper | Lower |
| Fitness | -1 | -1 | - | +1 | -1 |
| Diabetes | +1 | - | +1 | +2 | -1 |
| Meditation | 0 | +1 | - | +2 | -1 |
| Cancer | 0 | +1 | - | +2 | -1 |

Moreover, for the diabetes app, the median is more than the mean (negative skewness) but in the positive region. These extreme positive sentiments are considered to be good for the company because of the people's positive perception towards the app use (figure 4.21). This can also be identified from figure 4.22 as more than 50% of the data falls onto the right side or positive side of the graph.

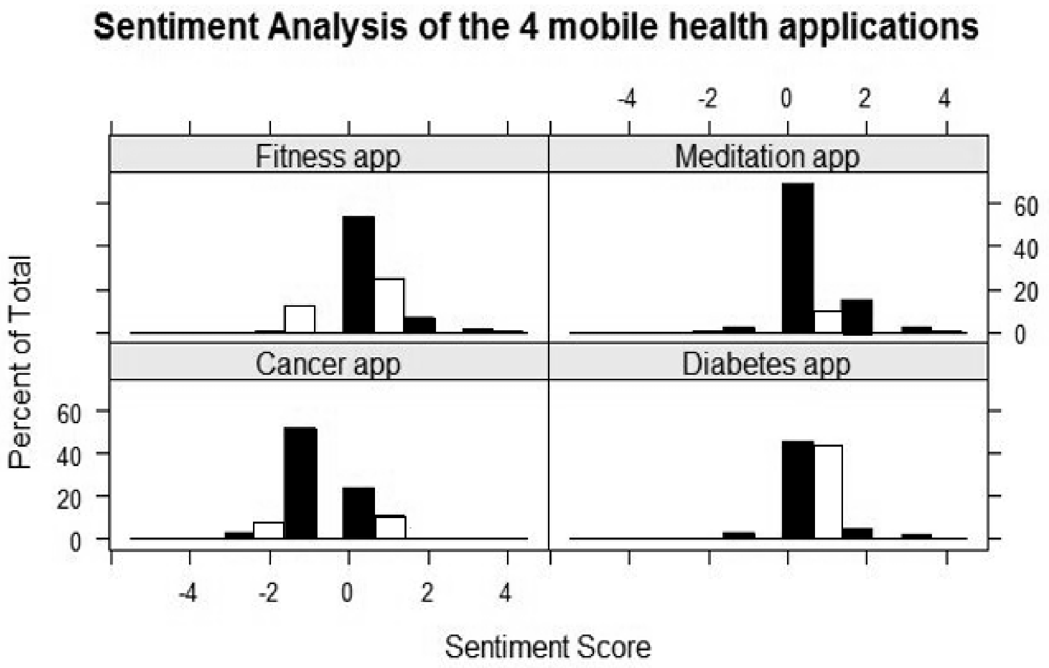



**Figure 4.22:** Sentiment scores for mHealth applications

Positive skewness is also seen even in the case of fitness and meditation app (figure 4.21) with the data in the positive region having almost the same sentiments value with progressive signs about the apps as 50% of data falls on the positive side (figure 4.22). This means that people realized the importance and tended to use these applications to maintain their health, which can, in turn, help the company to update its health applications to remain competitive.

*Discussions*

This study examined the sentiment value for four mobile health applications, i.e., fitness, diabetes, meditation, and cancer applications by extracting tweets from the Twitter website and also performs content analysis depicting causal relationships for accessibility and acceptability of mobile health applications. This helps the healthcare facility and the application developers in understanding an individual's sentiment and also supports them in analyzing the dynamics involved in adopting a new system or modifying an existing one. In doing so, it was identified that except for cancer application, there exists a positive polarity towards the fitness, diabetes, and meditation applications among the users.

The content analysis performed on tweets can be used to study the interactions between the dependent and independent variables of a system that is defined (Tse et al., 1989).

In this case, a system thinking approach in the form of a causal loop diagram (Chen, 2011; Mutingi, 2014; Sedarati and Baktash, 2017; Fisher et al., 2000) was followed for identifying and understanding the influence of these variables involved in making mobile health applications accessible and adaptable to the people. From figure 4.23 and figure 4.24, we can consider the presence of reinforcing and balancing feedback loops for understanding systems' behavior.

The first reinforcing loop R1, named as "benefits from the use of mHealth loop," connects the user and mHealth application willingness in increasing the completion rate. This means that more the number of mHealth users, more they satisfy the application resulting in effective utilization of mHealth system, thus achieving the desired health target. At the point of time when the user gets benefitted, their desire for mHealth also increases. This encourages healthcare providers or application developers to put effort into the quality improvement of the information system, which improves the overall system quality. When this increases, the user may feel that the system is becoming more useful and easier to use, which leads to dependent and willing to use.

The second reinforcing loop R2, named as "users' perception of quality and usage," basically explains, more the number of users more they will satisfy with the system and feels that the system is becoming more useful, increasing the attitude of using health application more than they used earlier.

The third reinforcement loop R3, named as the "learning loop" is developed based on user learning which takes place when the user actually uses the system. In other words, more the number of users more the learning taking place and with electronic health (eHealth) literacy develops self-efficacy or confidence in achieving targets easily, thereby increasing attitude and willingness to use the system.

"Market saturation loop (R4)" and "word of mouth loop (R5)" focuses on transforming new and potential adopters to semi-adopters, which later become the adopters of the system. The story behind these loops represents, as the potential adopter of the system through proper promotional take-ups (by creating awareness) improves the take-up rate, which also increases along with the adopters' contact through word of mouth take-up resulting from mHealth system/application adoption.

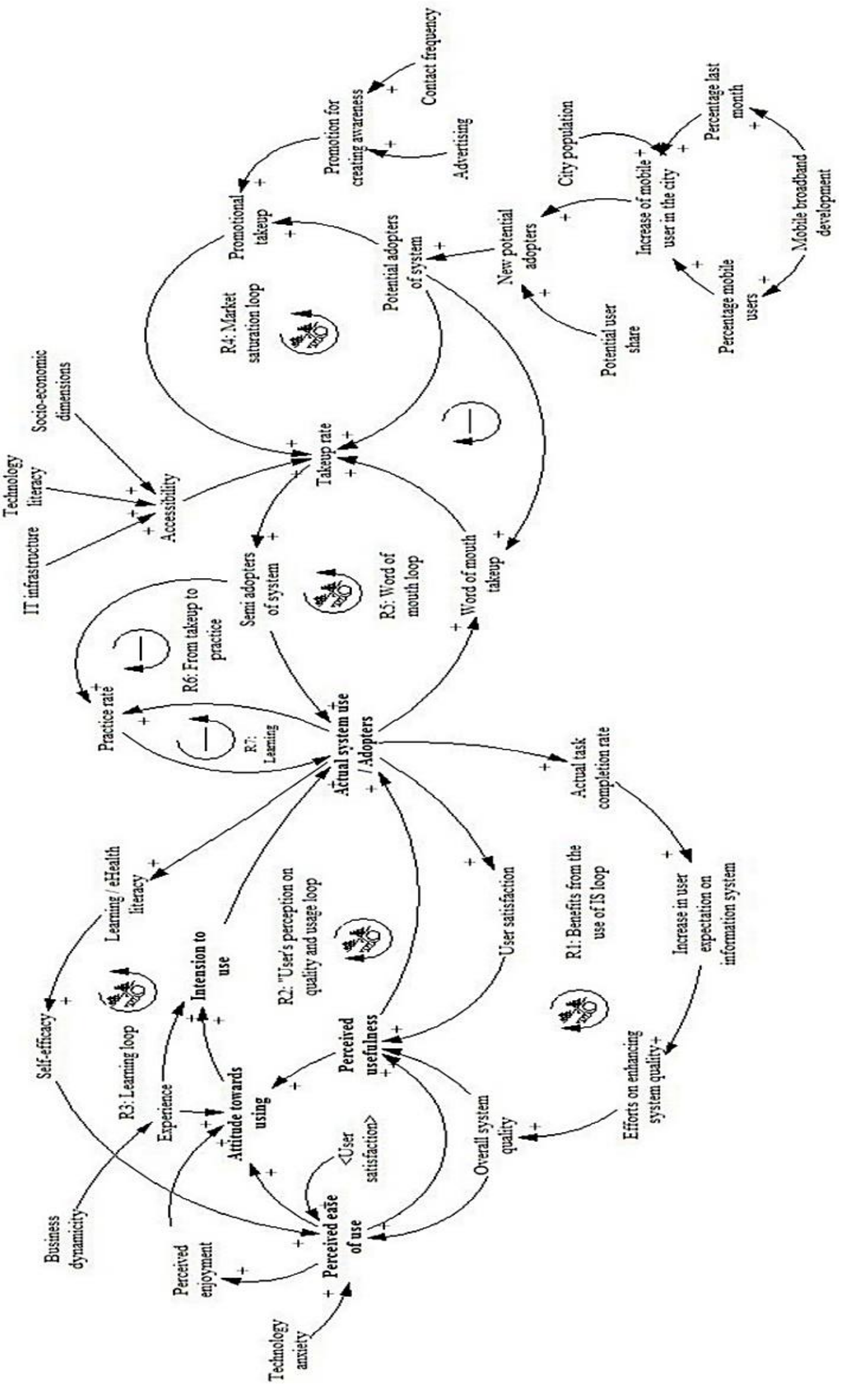



**Figure 4.23:** Causal loop diagram showing the relationship between the potential adopters, semi-adopters, and adopters of the mHealth system

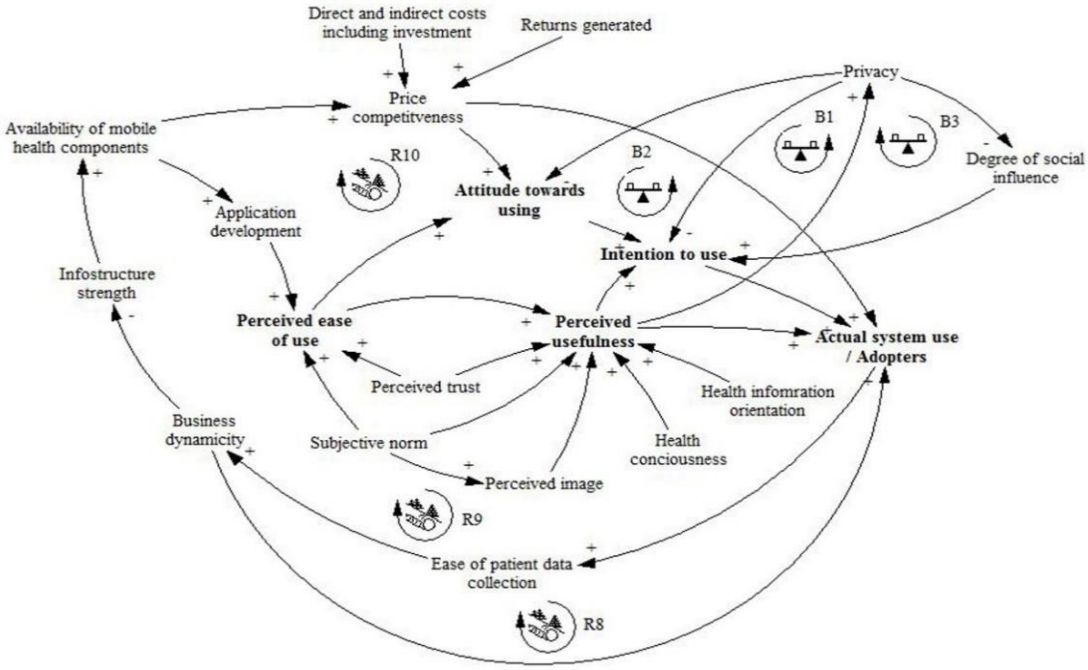



**Figure 4.24:** Causal loop diagram for perceived usefulness of the mHealth system

This increase in the take-up rate reduces the number of potential adopters, thereby reducing the adoption or use of the system. Moreover, the take-up rate is also influenced by the accessibility factors, i.e., IT infrastructure, technology literacy, and socioeconomic dimensions (such as age, income, and education) relating to mHealth system or application.

The reinforcement loops R6 and R7 represents the transformation of the users from semi-potential adopters to adopters (or actual system use) through practice rate and learning on continuous use of the system. In a mHealth system, more the number of adopters or users more ease in the patient data collection, facilitating data process assisting healthcare providers in business dynamicity, thereby creating experience economy for the user. Similarly, with the increase of the dynamicity of the business, the actual system use, or adopters also increases (loop R8).

The availability of components and proper application development helps the user in easy use of the health application, which in turn influences the perceived usefulness of the user and their actual system use (loop R9). Moreover, the availability of the mHealth components helps the service providers in maintaining price competitiveness, which helps them to decide whether to release the mHealth device or not (loop R10).

The balancing feedback loops B1, B2, and B3 correspond to the privacy of the patient data in creating a degree of social influence or attitude towards using or intend to use as most of the users are concerned about these factors for system use.

### 4.4.2. Sentiment Analysis of Social Media Game

*Methodology*

For sentiment analysis, R package "sentiment" and Liu and Hu opinion lexicon (containing around 6800 positive and negative words) are used (Jurka, 2012; Opinion Lexicon, 2019). These packages help in analyzing and classifying the text based on polarity (positive, negative, or neutral) and emotion (anger, disgust, fear, joy, sadness, and surprise) values (Chaumartin, 2007).

*Data Collection*

With the help of R tool, ROAuth, geo-code (20.5936840,78.9628800,1269219sqmi), and web API (Application Programming Interface), and on filtering extracted 2939 tweets in the first and 1500 tweets in the second phase. Tweets were collected using the select keyword search or hashtag for the latest sixteen days' time period, i.e., from 16 August 2017 to 31 August 2017. The purpose of splitting data into two phases was to study the emotion of the people immediately followed after the outbreak of the game and how did the scenario change later on and during the second week. In the first phase, it was observed that many reported self-harm practices and evidence had been observed across different parts of the world when compared to the second phase. Accordingly, we can observe that higher number of messages/tweets collection from 16 August 2017 to 23 August 2017, as people were criticizing and acting aggressively against the game by creating awareness and controlling youths' populations from becoming a victim of these games.

*Results and Analysis*

For the messages extracted, sentiment analysis was performed in both the phases separately so as to measure the peoples' perception behind social media game which is measured using polarity (positive, negative, and neutral) and emotions (fear, joy, disgust, sadness, anger, and surprise).

*The first phase (16 August to 23 August 2017):* In the first phase, a total of 3193 messages were extracted from the social media website, and on filtration (removing duplications), only 2939 messages were selected for further analysis. The result of the sentiment analysis based on polarity and emotions (I phase) was identified, as shown in figure 4.25 and figure 4.26.

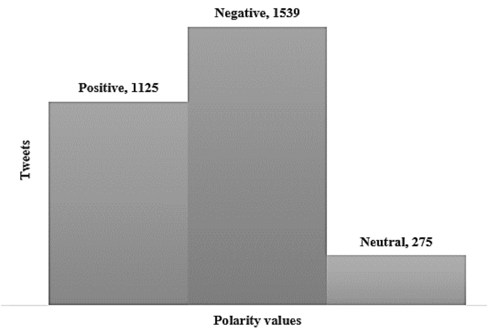



**Figure 4.25: Sentiment value based on polarity**

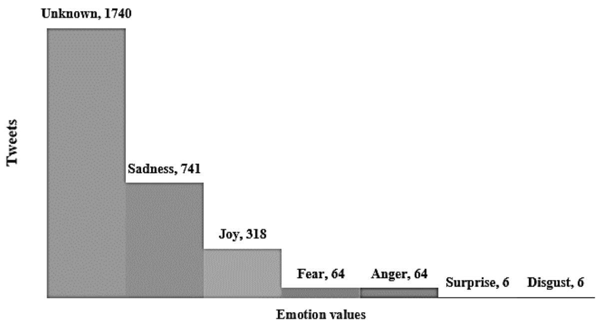
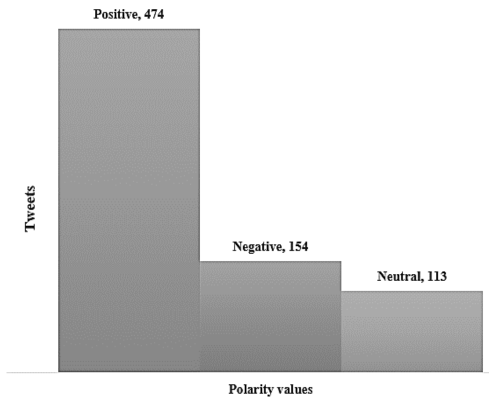



**Figure 4.26: Sentiment value based on emotion**

From figures 4.25 and 4.26, it can be considered that in the initial phases of the week, the total number of negative messages is more than positive messages. The analysis of messages revealed that people are very much afraid and saddened about the suicide cases, and are now trying to convey other individuals/users to keep away from this game. The users of social media have also posted about the need for the regulatory and controlling mechanism to stopover as the game is growing within the country and others at a faster rate. Thus, we can infer that, during the outbreak of this game, people through messages were trying to make social media users and others aware of the impact of this game and also suggesting parents, schools, and organizations monitor their kids and other youth population from becoming the victim.

*The second phase (24 August to 31 August 2017):* The total number of messages extracted using RStudio was 1500 messages, of which only 741 messages were considered for analysis. For these 741 messages, the total number of positive, negative, and neutral sentiment values and emotion values (II phase) are given in the figure (figure 4.27 and figure 4.28) below:



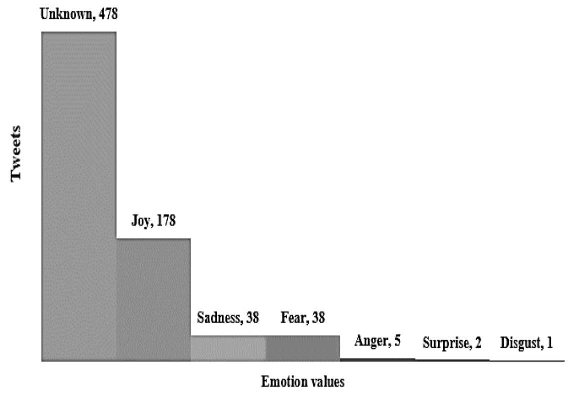




**Figure 4.27:** **Sentiment value based on polarity** **Figure 4.28:** **Sentiment value based on emotion**

From the figure 4.27, we can observe that about 64% (474) of the messages are having positive sentiments, which means that the deaths of teenagers across the world have created awareness among people about this social media game challenge. The police department and governments are trying very hard to identify the people who have involved this game so that they can save their life.

During this phase, interestingly, the parents, teachers, police department, and other governing bodies may have identified such cases and stopped them from completing the tasks and/or suicide (Banerjie, 2017; Priya, 2017). This might have created a joyous condition among the people as it can be identified in figure 4.28, where the total percentage of messages classified as joy appears to be more than sadness and others.

Therefore, we can infer that people may be raged towards self-harm and suicide death, which is happening across the world because of this game, and at the same time they are happy and joyous maybe because of the actions took the cybersecurity people and government against it. Conversely, the people are very cheerful with the government as they have taken a strong decision to ban it, which otherwise had created a fear among the people. Messages were also found to be joyous because the police department had identified the suspect behind this game of self-harm, and at the same time they also started to identify and track the people who are playing this game, and in most of the case they have rescued the teenagers from completing the final stage.

Apart from these messages, some of them were directed towards the parents in monitoring the daily activities of their children, to use passwords and parental control settings to their mobile phones. In schools, the teachers have to sensitize the students from playing this game by making them aware of the dangers caused.

*Discussions*

From this study, it can be observed people who are initially unaware and playing about this social media game or self-mutilation game had become the victim of this game by making self-harm (suicide) as it is the last task, and these are mainly the people (basically the teenagers) who associated with the problems of isolation, harassment, and bullying. Moreover, with the instantaneous laws and policies of the government to remove the game, the people are now aware of the game and have expressed the joyfulness towards the decision taken by the government and the work of policemen in saving the lives of the people. These emotions have also been reflected in the Twitter sentiment analysis plots (figures 4.27 and 4.28).

Based on the tweets, content analysis has been done by identifying repeating keywords or texts and used a system thinking approach for depicting a causal loop diagram (CLD) for self-harming practices or BlueWhale games. As aforementioned, the study findings and prior literature shows isolation, harassment, and bullying are the key factors for individuals becoming a victim of depression, loneliness, and over-excitement.

Therefore, these components are taken as the dependent variables, and its dynamics and influence on mental health problems had been studied using CLD. For example, in this study, tweets of the people have indicated that addiction, social abuse, and hoarding issues support isolation of individuals which in turn influences mental health and over time these practices continuously achieve a positive reinforcement loop making people take up the decision of suicide or death (Figure 4.29).

To control and save individuals from these vicious situations, greater support is required from their family, friends, relatives, and their communities in creating awareness, monitoring and tracking, banning mobile phones inside school premises, and implementation of various policies against blocking unsecured websites and other malicious links.

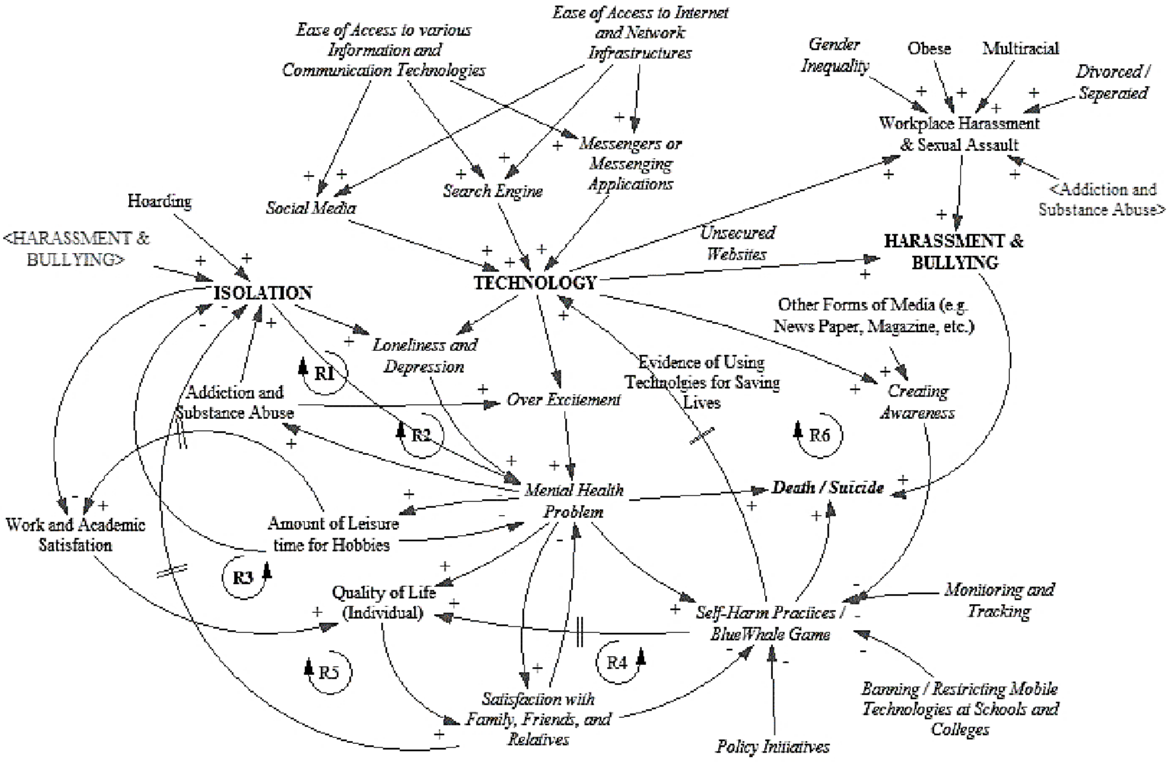



**Figure 4.29:** Causal Loop Diagram for Social Media Game

Here mobile and communication technologies can also act as a medium for controlling this situation. As the people in the current generation continuously look for portable and user-friendly electronic gadgets with higher access speeds, supporting a wide variety of features for making their day-to-day lives easier. Moreover, doctors and healthcare professionals also indicate that young and adult populations tend to get information from online sources instead of talking to parents and peers (Young, 2018).

In such cases, the healthcare solution providers can take this opportunity to connect technology to healthcare through various mental health mobile applications like No More Tension (2016), which individuals can use during mental health problems. Generally, when technology is connected to healthcare, common barriers which people usually resist is because of trust and evidence with technology and information. This can be sorted out with the help of doctors' recommendation (as people more often trust doctor) and a technology which acts a medium for creating awareness and central repository which help in storing all the evidence wherein technology has been used to save lives (Figure 4.29).

Furthermore, we have also recognized that the people who are having a problem with mental health will try to find out ways to get temporary relief, in such cases, all these kinds of self-harm games will give certain satisfaction. To overcome this problem, we can connect and validate this study to the theories of media and technological communication, emotion and psychology, and hypodermic needle model, which basically focuses on anxiety, stress, depression, aggression, and violent behavior resulting because of online video games.

### 4.4.3. Sentiment Analysis of Social Media Movement

*Methodology*

With the help of the RStudio tool and by using Rcodes, extracted 71,769 tweets using hashtags were collected from 1 November 2018 to 7 December 2018. The data extracted were cleaned and processed for further analysis.

*Results and Analysis*

This section discusses the findings from the sentiment analysis of the tweets for identifying the specific themes surrounding a social media movement.

*Sentiment Analysis of Social Media*

The data extracted were analyzed for identifying the polarity and emotion values (figure 4.30), which is classified according to the Syuzhet package function available in RStudio library and correspondingly boxplot, and its related sentiment score has been calculated.

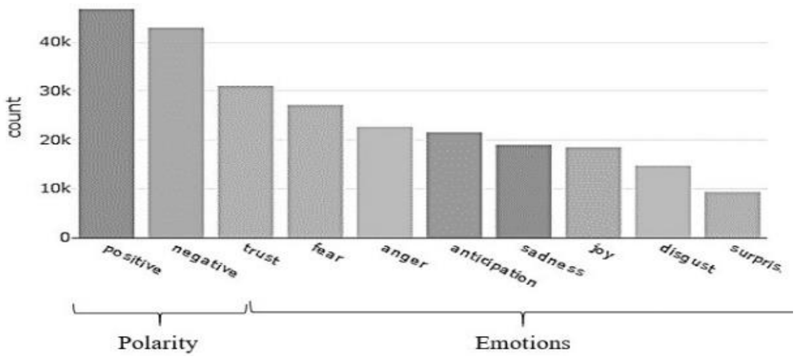



**Figure 4.30:** Sentiment analysis based on polarity and emotions

From word cloud analysis, it was identified that the word "women" had been found frequently in the tweets of the users, which is acting either in the direction of support or found criticizing this movement. Similarly, when calculated sentiment values based on polarity and emotions, it was identified that the total number of positive sentiment values is more than that of negative (Fig. 1). This can be because of the fact that the people once who remained silent and experienced or experiencing sexual harassment and violations at their workplaces or homes are now coming forward to reach out to the public to make others aware and to get support or seek justice against it. The emotion values indicate that individuals have repeatedly mentioned about trust (31345), fear (27207), anger (22776), and anticipation (21720) over others.

*Sentiment Analysis of Social Media*

From figure 4.31 and figure 4.32, we can identify that the mass of the data distribution is concentrated in its center, and its tail on the left side is longer than that of right. This indicates that the distribution is negatively skewed as the mean value is less than that of the median value in the negative region. The graphs signify that people may be supportive of women empowerment movement and are likely to hide the larger amount of people who are supportive towards the elimination of all forms of sexual harassment and other violations expanding the average value.

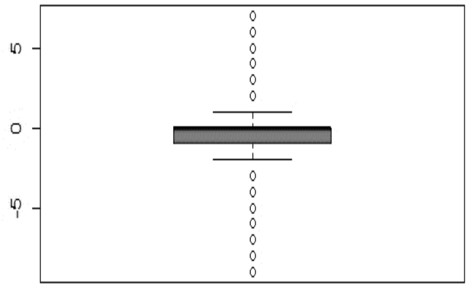


**Figure 4.31:** Boxplot

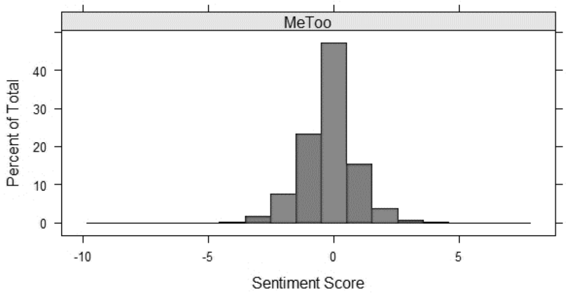



**Figure 4.22:** Sentiment scores

In fact, people have a bad experience, and opinion about sexual harassments is happening across various sectors and are often trying to bring it to a large audience for the creating awareness and support which all together help this country in developing effective policies and actions against such offenses.

*Discussions*

The present study investigates the sentiment and emotions of the Twitter users through sentiment analysis and also discusses specific themes which the individuals are concerned about. The results showed that women had been largely associated with harassments and violence at their workplaces and/or at homes. The polarity value also indicates that people are feeling positive about the MeToo movement as the harassment, which was ones within the wall of the offices and homes are now shared among the public for making others aware and seeking support. However, the emotion values show trust, fear, anger, and anticipation has been repeatedly used over others. This signifies that the individuals and victims feared harassments as they suffered from a problem relating to mental health when they eventually lost trust with the employers and others. The content analysis of the tweets identified major themes such as harassment, gender, sexual penetration, women, sectors, reform movements, culture, political, health risk, story, and right time are found to be commonly repeated keywords in the tweets.

Since sexual harassment and abuse in India have been happening for a very long time, it is the only time that has captured the attention of all the population. This is mainly because of the accessibility and availability of social media and rapid developments in information and communication technologies like mobile phones, tablets, etc. Though the government has implemented certain policies and actions against harassments and other illegal activities happening across the social media and other online forms, its involvement in all the forms of harassment and violation are not covered in their policies. For example, the Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013, i.e., the PoSH Act has been implemented in India to eradicate harassment of women at their workplace. However, this act has got some disadvantages like deadlines for filing the complaints, lack of clarity in handling incidents of sexual harassment, etc. (KelpHR, 2018).

Moreover, it is also observed that the MeToo movement has created an influence on dislodging scores of an individual from their high-power positions (Brown, 2018). Some of which are explained in the sections below.

*Political Sector*

In India, the use of social media to a large extent, especially in political communication, was started during the Indian general election in the year 2014. Social media such as Twitter was used in most of the cases for campaigning and communicating with the electorate, which subsequently observed an increase in the poll results and created a winning moment for that candidate (Tiwari, 2018). This led various other parties to use social media platforms for campaigning and other political communications. This time due to accusations in the sexual harassment against a minister and the demand from the feminist group had created a displacement in his political life (Tiwari, 2018). The following tweets indicate it:

> *The entire #metoo campaign seems to have been kickstarted just to remove … from … as he is doing good work.*
>
> *More power to you … we all feel your pain. May evil … get the punishment he has evaded far too long.*

Thus, the use of MeToo is considered to be a significant development in Indian politics; however, the case is still on for considering it as a political conspiracy or not.

*Film and Entertainment Sector*

In this sector, MeToo has created a strong influence on the celebrities and other crew members if involved in a case either as a plaintiff or a defendant. For example, in the case of celebrities, if an actor/actress files a complaint against any director or another actor/actress, or others, it was found that the numbers of offers for acting in movies has been greatly reduced maybe because of disagreement from the other co-actor/actress or fear in involving them in their movie projects. This has created a negative impact on their acting carrier, which might influence other individuals from refraining themselves away from filing complaints against sexual harassment and abuse in the upcoming years. The same is the case in the music academy, dance academy, and poetry.

*Newspaper Industry*

It was observed that the newspaper industry had also affected by the storm of MeToo, and many of the prominent newspaper editors had also received complaints regarding their involvement in sexual misconduct with an individual. Even though editors of the newspapers have stepped down from their positions, however, till now, there is no proper clarity and evidence about their involvement in these allegations and might have been created because of any personal rivalry or to dislodging that individual from that position, etc.

Moreover, for a keyword search of ‘MeToo,’ apart from normal tweets about sexual harassment and abuse allegations against individuals irrespective of different sectors, it was also observed that some of the tweets had been indicated regarding their impact on individual health. For example, the *#MeToo movement affects mental and physical health*. Thus, it can be concluded that sexual harassment and abuse have an influence on the mental and physical health of an individual and may require a proper governing structure towards the early prevention of individuals from becoming the victim of such activities, thereby saving people from improper mental and physical health. A tweet has been found in support of this, i.e., *how can early prevention from violence help raise healthy and empowered individuals?* Similarly, a tweet was found promoting awareness about mobile applications, which can be used for reporting sexual harassment instantly, i.e., *please download the … Mobile app on Android and iOS to report sexual violence anonymously. #MeToo #TimesUp*.

Moreover, when it comes to sexual harassment and violence, even the organization plays an important role in providing justice to an individual or to protect them from such complaints. For example, in financial institutions such as banks, mergers, and acquisitions, various advisory members or #MeToo representatives have been appointed to protect themselves during negotiations and contract agreements (McGregor, 2018).

Morris et al. (2018) indicated that healthcare organization is particularly at risk when it comes to sexual harassment claims, as healthcare professionals’ main task is to work closely with the victims to seek evidence and support without blurring any of the body or body parts. In such cases, the healthcare organization should act vigilantly, quickly address complaints, document misconduct, and comply with healthcare-specific obligations to address problems of MeToo (Morris et al., 2018). These processes can be coupled with a smartphone application, as many of them use it for day-to-day activities. The smartphone application helps during potential harassment situations and provide early preventive guidance for the individual.

Furthermore, due to complexities and fear involved in reporting sexual harassment and their repercussions on losing the position, career, social status, etc. Many individuals try to remain silent, thereby making them get involved in problems related to mental health. In such circumstances, these individuals can be connected to their respective healthcare professionals through smartphone applications and receive consultations for the same, which addresses the problem of mental health over time. However, doctors also indicated that in the present generation both the young and adult population search health material from online source rather than speaking to their parents or peers so that their privacy and anonymity is protected (Young, 2018). Thus, mobile health applications can be a possible solution for tackling the problems of harassment and mental health.

### 4.4.4. Sentiment Analysis of Mental Health

*Methodology*

The methodology followed in this study is qualitative, and the data was extracted from the Twitter website using RStudio. The steps involved in the extraction of the posts for the keyword 'mental health' have been followed, as described in the research of Pai and Alathur (2018).

*Data Collection*

For a keyword search of 'mental health', a total of 98,720 posts have been extracted from the Twitter website for a period of two months starting from 01 November 2018 to 31 December 2018. The reason for extracting the posts during this time period is because of the outbreak of social media movement (MeToo). These posts are not geo-coded, which indicates that the study is restricted only to the content which the users have posted on the website and has nothing to do with the region or country. Depending on the posts extracted the sentiment analysis in the form of polarity and emotions were carried out. In addition, the content analysis has been performed on the posts, and subsequently, using inductive coding approach themes have been generated.

*Results and Analysis*

This section discusses the results obtained from the sentiment analysis, which is followed by the identification of specific themes surrounding mental health.

*Sentiment Analysis*

To analyze the results of polarity and emotion associated with the discussion of mental health, it is important to perform sentiment analysis for the extracted posts. In this study, using the Syuzhet and sentiment analysis packages of RStudio, sentiment analysis has been performed. Also, the word cloud has been drawn for depicting the posts according to emotion components, i.e., joy, sadness, surprise, anger, fear, and disgust (Chaumartin, 2007) (figure 4.33).

The frequent occurring keywords identified in figure 4.33 are represented in table 4.11.

**Table 4.11:** Emotions and Prominent keywords for mental health

| Emotions | Prominent Keywords |
|---|---|
| Trust | Support, School, Understand, Health, Important. |
| Fear | Mental, Govern, Problem, Risk, Scandal, Difficult. |
| Anger | Suicide, Anxiety, Stress, Struggle, Challenge, Accuse. |
| Anticipation | Time, Tomorrow, Come, Start, Take. |
| Sadness | Depress, Tough, Worries, Blue, Pain, Case, Neglect, Ill. |
| Joy | Happiness, Love, Green, Share, Name, Friend, Proud, Improve. |
| Disgust | Stigma, MeToo, Abuse, Feel, Bad, Disease, Women, Power, Suffer, Homeless. |
| Surprise | Good, Hope, Young, Money, Wonder, Excite. Thank, Break. |

From table 4.11, it can be indicated that the people largely consider schools and other institutions to be the source for creating awareness and for providing training about the implications of mental health.

As schools and educational institutions are considered as the right place to educate young generation people about the importance of mental health. Moreover, at the same time, people expect government and other governing bodies to support (resources and financial) the healthcare departments in managing the mental health problem of people.


**Figure 4.33:** Emotion word cloud for mental health

The sentiment analysis of the posts based on the polarities and emotion values has been calculated and depicted in figure 4.34.

From figure 4.34, it can be indicated that the total number of positive sentiment count (84343) is more than that of negative (51600), signifying that people have a positive sentiment about mental health. As cited by an individual that: *positive, running mentalhealth, exercise*. This means that people have realized the importance of running and other healthy exercises for improving the mental health status and now they are posting their stories and experiences for motivating others.

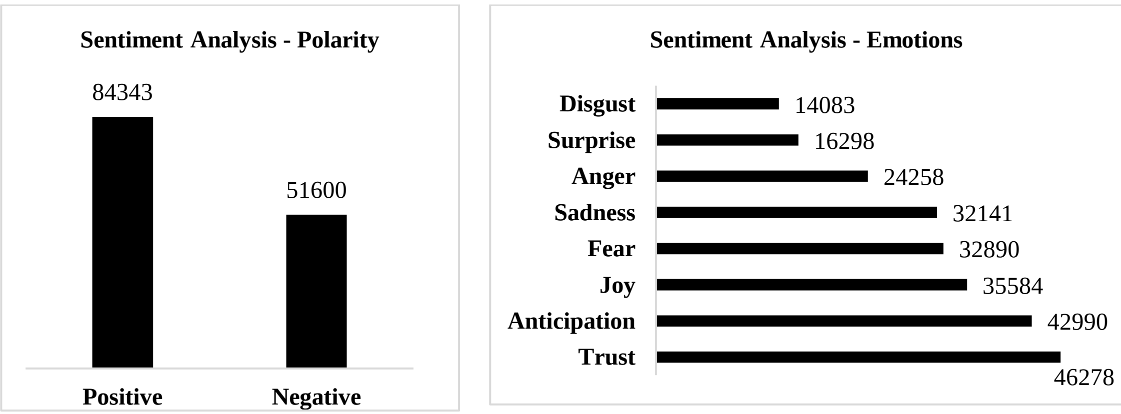



**Figure 4.34:** Sentiment analysis for mental health based on polarity and emotions

Likewise, the emotion sentiment indicates that people have largely expressed trust (46278), joy (35584), and anticipation (42990), among others in their posts. This indicates that people are trusting schools to promote awareness and anticipate other governing bodies to frame mental health policies and health improvement programmes to control them. Moreover, the support from the doctors has also been appreciated by users several times in their messages.

The people have also shared some of their experiences (negative) about the healthcare facility and doctors. For example, "*over-prescribingpills, olderpeople*". And in some cases, people are also requesting doctors and other stakeholders to listen to their problems for addressing mental health conditions. Like, "*mentalhealthdoctors, administrators*". This indicates that healthcare professionals, schools, and other governmental support have a role to play in improving the mental health conditions of the people.

Interestingly, people have often cited the need for information and communication technology services such as telemedicine, health applications, virtual assistant, etc. and are joyous about its use in managing mental health conditions. For example, most people suffering from mental illnesses do not receive treatment or receive suboptimal treatment in such cases, technologies may offer new opportunities *mentalhealthmachines techforthewin*. This can be because of waiting lines for the appointments at hospitals or to maintain an individual's anonymity and privacy. Realizing the need for technology use, people are now expecting and anticipating mental health applications to consider data privacy and reliability factors for making it popular and useful to the people. Thus, the sentiment analysis of the posts contributed to the study in identifying the polarity and emotion values for the keyword 'mental health'. Subsequently, to study users' concertation about mental health, content analysis has been carried out separately, and posts are forming the specific themes that have been represented.

*Content Analysis*

Since mental health is a highly sensitized topic, it becomes important to study and understand the contents of the user's posts. For this, by using the latent dirichlet allocation modeling technique, various sub-themes have been extracted and are connected to main themes for representing an individual's consternation about mental health. Table 4.12 shows the main themes and their corresponding sub-themes that are identified from this technique. A summary of the main themes and their corresponding sub-themes has been listed below.

- *Casualties*: For the posts related to mental health, the causalities identified in this study are largely the women and student populations. However, in some cases, even the employees, parents, and disabled people have also become the victim of mental health conditions because of pregnancy issues, workload, harassments, and abuse at their workplaces, schools, and/or homes.

**Table 4.12:** Summary of main themes and sub-themes identified for mental health

| Main themes | Sub-themes |
|---|---|
| Casualties | Women, parents, elementary school students, high school students, teens, employees, and disabled people. |
| Parenting | Childcare, children, child welfare services, adopted children, human services, the fee for healthcare services, managed care, disability, education. |
| Harassments and resulting actions | Abuse, stress, disability discrimination, educational discrimination, sexism, suicide, rape, bullying, depression, self-harm, mental illness. |
| Disability types and disorder characteristics | Intellectual disability, learning disabilities, mental world, mental disorders, mental wellness, bipolar disorder, x linked mental retardation, schizophrenia, separation anxiety, major depressive disorder, post-traumatic stress disorder, psychological stress, traumatic events, occupational stress injuries. |
| Health services and it's quality improvement practices | Health benefits, healthcare quality, health information, health promotions, health outcomes, health promotions, disease risk, mental health services, mental health programs, community mental health services, psychiatric hospitals, public health nursing, sentinel surveillance, medical personnel, technology, telemedicine, home care services, meditation. |
| Mental health controlling mechanism | Schools and educational professions, doctors, social media, mental health awareness, mental health policies, mental health insurance, technology, smartphone, physical exercises, motivation, remembering good times, yoga, and meditation. |
| Sharing news and seeking/providing support | #metoo, #abuse, #trauma, #teens, #mentalhealthawareness, #rape, #youth, #suicideprevention, #bullying, #anxiety, #mentalillness, #depression, #addiction, #schools, #parenting #families, #stigma, #lifestyle, #alcohol, #autism, #behaviour, #socialanxiety, #socialmedia, #selfimprovement, #mentalhealth, #motivation, #positivity. |

- *Parenting:* The content analysis of the posts revealed children, childcare, child welfare services, education, etc. as the label to describe mental health. Therefore, these labels are grouped under the main theme of "parenting", as they are the one who is always concerned about their child's health and welfare. Thus, the study identified that there exists a certain relationship between parenthood and mental health conditions. Usually, it can be seen as positive (motivating and guiding) and negative (abusing and comparing with others), which also depends upon the context and circumstances with which their children are positioned. For example, a post describes mental health conditions (like post-traumatic stress disorder [PSTD]) and childcare. This creates negative influence and stressful situations for the parents in preventing their child from getting such unhealthy conditions. The reason could be their child's regular food habits, lack of exercise, education and academic performance, discrimination faced at schools, or trapped in any traumatic events, etc.
- *Harassments and resulting actions*: Many kinds of literature have studied the relationship between harassments and mental health conditions, which ultimately becomes the cause for depression, self-harm, or even death (Gradus et al., 2008; Espelage and Holt, 2007; Wolff et al., 2017). This has also been found to be valid in this study, which is relating to mental health. Moreover, careful observation of the posts indicates that the present generation students are very sensitive and often display a lack of preparedness to face problems encountered in their day-to-day lives.
- *Disability types and disorder characteristics:* A post indicates that *"braininjury, PTSD, depression, mentalhealth, psychology, TBI"*. This signifies that the type of disability and disorder characteristics has a role to play in depression and other mental health conditions.
- *Health services and it's quality improvement practices:* As aforementioned, with the foreseen dimensions and causes for mental health conditions among people, users have expressed the need for healthcare processes and supporting facilities for tackling the problems of mental health. Apart from the practice of providing consultations and interventions through medical personnel, people are anticipating technology and telehealth devices into healthcare for improving health service. In

addition, people expect sentinel surveillance type of system wherein a large amount of data related to diseases and its causing agents is collected from a group of hospitals for providing quality services.

- *Mental health is a controlling mechanism:* The study identified that not every post posted by the individual about mental health was about the health condition, causalities, and healthcare facilities. However, they have also referred to the importance of school education and curriculum development, mental health awareness programs, doctors' recommendations, yoga, and other physical exercises for controlling mental health conditions. Moreover, posts even included the necessity of mental health policies and insurances for controlling this situation and improving the health condition of an individual. Like a post describing it as "*insurance, prescription drugs, pregnancy, mentalhealthcare*".
- *Sharing news and seeking/providing support*: The study has also identified several hashtags written by the people in their websites for expressing their support towards mental health or to share relevant information and news about it. These posts written using the hashtags get consolidated at one particular page (created out of hashtag), which helps in categorizing the posts and for easy search. Doing this can help the individual or decision-maker to support or act against such events or programs, which ultimately helps in controlling the situation. For example, *survived, mentalhealth, mentalillness, rape, metoo, breastcancer domesticviolencesurvivor*.

Therefore, the sentiment and the content analysis of the posts not only contributed the study in identifying the polarity and emotion values of the people but also helped in understanding what they are concerned with and expect from healthcare professionals and other stakeholders about mental health.

*Discussions*

The current study performs Twitter sentiment analysis and investigates polarity and emotion values for the keyword "mentalhealth". It also performs content analysis on the tweets and identifies specific themes which individuals are concerned and expect from healthcare professionals and other stakeholders about mental health. Upon investigation, it was indicated that the total number of positive sentiment count is more than that of negative, and people have largely expressed trust, joy, and anticipation in their tweets related to mental health. The content analysis of the tweets also revealed that people are concerned about mental health and discuss themes related to parenting, casualties, harassments, and resulting actions, disability types and disorder characteristics, health services and it's quality improvement practices, mental health controlling mechanism and hashtags for sharing news and seeking/providing support. Consolidating the findings of Twitter sentiment analysis for mental health, the following are the salient findings that can be drawn from this study.

Firstly, it was identified that people in this generation are highly sensitive or raised sensitive. This is because of the fact that the parents or peers have either learned from the mistakes and triumphs of the previous generation or have been witnessing the number of cybercrimes, harassments, and other such violations happening around them. This makes them use such information to change their lives or children's lives as society adapts. But as he grows up, he/she finds that the world is uncertain and does not work as it was told, leading to tension, anxiety, depression, or may even go to the extent of self-harming themselves. In such cases, it was noted that the teachers, educational institutions, and parents play an important role in improving their mental health awareness by speaking to them regularly, discussing their problems, and addressing them. This helps their children to develop the strength he needs to become a mentally strong adult.

Secondly, it was noted that educational institutions and other organizations should develop necessary infrastructures, personal, and facilities for timely consultations and treatment plans. As bullying and psychological harassment are considered to be the most commonly observed work-related stress among employees, which eventually develops as a health risk. In such cases, the organization has to device necessary health and safety policies, create awareness about the workplace environment, conduct training programs, cut inflexible working hours, etc.

Thirdly, it was found that individuals lack interest in treatments as they either believe that they have been stuck with the doctor or consider seeing a doctor only when there is something wrong happening with their health. To improve, the healthcare located within the vicinity should encourage evidence-based practices so to convince people about the importance of mental health. On the other hand, the organization should also consider mental health intervention as part of integrated health and well-being strategy that covers prevention, early identification, support, and rehabilitation (WHO, 2019).

Fourthly, people have specified the need for digital technology and mental health applications, which provides the necessary security and reliable data for the users, patients, doctors, and other stakeholders for making informed decisions. As it was identified that, the present generation people are more inclined towards to use of online sources for communicating health-related content than talking to their peers. Therefore, the organization can develop and equip health applications into the system for providing mental health-related services at the right times. Finally, it was said that mental health affects physical health and vice-versa. Therefore, it becomes important to equip and follow mental health strategies (such as sports and games, physical exercises, etc.) in their systems and processes to alleviate the symptoms of mental illness and other health conditions.

## 4.5. Conclusion

The purpose of this study is to improve the usefulness of mobile health applications in the Indian context. This study uses a convergent mixed method design wherein the findings from the qualitative and quantitative methods can be integrated. This research involves: i) qualitative interviews with the respondents living in the rural regions for analyzing accessibility and acceptance of mobile health; ii) qualitative interviews with the technology entrepreneurs to study the affordability of mobile health systems; iii) qualitative data extracted from social media website (i.e., Twitter) to understand peoples' sentiments about mobile health applications, social media game (BlueWhale Challenge), social media movement (MeToo movement), and mental health.

Firstly, the study investigates factors that influence the accessibility and acceptance of mobile phone technology applications for health service delivery in India. It also tries to incorporate these factors into the technology acceptance model, which can be limited to the rural Indian populations. There are clear gaps identified in the survey responses which healthcare providers and government can fill using components of the proposed model (figure 4.2). The findings from the interview conclude that people can be made aware of mHealth through doctor's recommendation, or ease of use technologies as in reproductive and child health wherein voice calls are preferred over SMS due to literacy problems in certain regions. Moreover, components such as training facilities, standard operating procedures, and central learning community research kit help frontline health workers in conducting demonstrations to people helping them in reducing the problem of trust and thereby improving its acceptance. Since most of the study respondents are of age 20-30 years, to improve the patient engagement features such as gamification can be incorporated, which supports the young person to realize the importance of health and to remain conscious.

Secondly, it has provided insights about what key stakeholders believe are important for developing mHealth systems as affordable and cost-effective. The findings suggest that despite ASOE components formation of eco-system, governmental policies, training, and support should also be undertaken by stakeholders for improving mHealth scalability among citizens. It also suggests that future evaluative study should be multi-dimensional considering data visualization, cultural factors, and trust and relationships between the healthcare provider and healthcare professionals. Importantly, government and various association reports and stakeholders have mentioned the importance of mHealth for health service delivery as long as proper infrastructure and necessary policies are in place. This leaves healthcare providers with information about what needs to be considered for developing mHealth devices.

The study also performed sentiment analysis of the social media messages and concluded the following:

Firstly, the study addressed the sentiment or opinion of the people involved in health service delivery, as it is currently facing a lot of challenges in maintaining and delivering health service at an affordable cost. The study considers peoples' perceptions or feeling about the use of mHealth applications viz. fitness app, diabetes app, meditation app, and cancer app for health service delivery. By performing the sentiment analysis for the tweets, the result shows that mHealth applications for fitness, diabetes, and meditation app appear positive for tweets polarity and emotion values. Tweets also indicate greater joyfulness and satisfaction among the people in using these apps than in using the cancer applications.

Secondly, the first phase results indicate that social media messages show negative polarity because of the number of suicidal deaths caused due to lack of awareness about the game among the people. To eradicate it, many people, through their articles, blogs, social networking sites, and newspapers are trying to convey the message regarding the causes and effects of playing the game. People have also instructed the parents, teachers, doctors, and friends, to identify and treat those users who are in a state of depression and are facing mental illness. The results of the second phase seem to be better in terms of positive sentiments because of the quick and instantaneous laws from the government across the world in removing the game, and sincere work of the police in saving lives of these people by stopping them from completing the last task of the game, thereby making the people happy and joyous.

Thirdly, for mental health, it was indicated that the total number of positive sentiment count is more than that of the negative, and people have largely expressed trust, joy, and anticipation in their posts related to mental health. The content analysis of the posts also revealed that people are concerned about mental health, and discuss themes related to parenting, casualties, harassments, and resulting actions, disability types and disorder characteristics, health services and its quality improvement practices, mental health controlling mechanism and hashtags for sharing news and seeking/providing support. The posts of the people also indicate that people need smartphones and mobile technologies to improve their mental status and health conditions. Therefore, technology entrepreneur and healthcare professionals can take this opportunity to develop and create awareness about mobile related mental health applications such that they acts as an interface between the healthcare professionals and users or patients for managing their mental health.

Thirdly, the analysis of the social media movement identified that women have largely been associated with sexual harassment and violations at their workplaces or homes. The sentiment analysis indicates positive, as the harassment once happening within the doors is now being brought into public for creating awareness, requesting support, and seeking justice towards sexual harassment and other violations. The social media messages are largely associated with trust, fear, anger, and anticipation as the frequently repeated emotion components of the sentiment analysis. It revealed that people have feared and lost trust with other individuals because of its impact on their physical and mental health. The analysis of the tweets identified various themes which are grouped under the major themes of harassment, gender, sexual penetration, women, sectors, reform movements, culture, political, health risk, story, and right time classified based on frequently repeated keywords. At this moment it is difficult to analyze the case of social media movements as it is not possible to generalize women empowerment potential of social media using secondary data in a particular time period. But the overall results from the sentiment analysis of social media movement have been found positive, and people encourage more individuals to report such crimes and offenses such that right action can be taken against the harasser.

CHAPTER 5

# QUANTITATIVE STUDY

## 5.1. Introduction

The previous section have discussed the qualitative component of the thesis in detail. To achieve the research objective of awareness level in the use of mobile health applications among citizens, this chapter has been divided into two sections. In the first section, comparative analysis has been performed to study *"the significant difference between the awareness level in the use of mobile phone for health communication and delivery, and self-managing health applications among the technical and working staffs and medical and health professionals*". In the second section, the statistical significance was confirmed considering factors influencing awareness and intention to use (ITU).

This chapter is structured as follows. Section 5.2 presents the descriptive statistics of awareness and use followed by hypothesis testing in section 5.3. Section 5.4 presents the discussion about the study results. Finally, section 5.5 concludes this chapter.

## 5.2. Descriptive Statistics of Awareness and Use

The study results present descriptive statistics and tables for participants' demographic characteristics, indicating the awareness level and use of mobile phones and apps for health service delivery.

A cross-sectional study was conducted to measure peoples' awareness and use of mobile phone technology and applications for receiving health information from March 2018 to May 2018. Participants were selected based on convenience and simple random sampling, wherein the former is used for collecting responses from the students of engineering and medical colleges and the later among respondents working in engineering and medicine. A pre-tested questionnaire (Appendix IV) was designed using existing literature (Kayyali et al., 2017; Parthaje et al., 2016; Ehteshami et al., 2013; Khatun et al., 2014; Atulomah et al., 2010) and offline focus group interviews. The focus groups consisting of two working-class individuals, three engineering college students, and two medical college students contributed to the study by suggesting questions related to familiarity or awareness about the term "mobile health", health conditions, and mobile phones used for communicating or receiving health information. Based on these suggestions, the questionnaire was modified and pre-tested offline with one doctor and two management professors of operations discipline for identifying unclear wordings, components, and structure. These questions are measured using Likert scales and includes open answer type.

A sample size of 386 was estimated from the Survey Monkey website (IAMAI., 2018; Times of India 2018; SurveyMonkey, 2018; Gho et al., 2018; Beirne et al., 2016), and the data collection was processed through online and offline modes through personal contacts and in turn asking them to send it to their contacts. Offline responses have been collected from the students of technical (193 students) and medical colleges (83 students) located in the regions of Telangana and Maharashtra (India). To achieve national representation from other states of India, online survey questionnaire was sent randomly through email requests, Facebook and LinkedIn messengers, and as WhatsApp messages to 397 health professionals and 398 technical experts working across various domains. Additionally, multiple reminders have been sent to those respondents for participating and indicating their importance in the survey.

A total of 213 responses were received online, indicating a response rate of 26.69%. Overall, a total of 489 responses have been received including offline questionnaires. After discarding incomplete questionnaires, a sample size of 409 was considered valid for this study. As the survey was conducted among students and professionals, depending upon their educational background and field of work such as software developer, production manager, healthcare consultant, nursing, para-medicine, etc., the valid responses 386 (out of 409 responses) have been grouped as “technical students and working staff” (224 respondents) and “medical students and health professionals (practitioners) including doctors and physicists” (162 respondents). The remaining 23 responses have not been included in this study as they are still pursuing their 12$^{th}$ or Pre-University Course (PUC).

Statistical analysis was performed on the data in descriptive and analytical levels using Statistical Package for Social Sciences (SPSS) software. Descriptive statistics such as frequency distributions and means were used to evaluate demographic variables and sections on awareness and use of mobile phones towards health. The compiled scores were compared across technical students and working staff, and medical students and health professionals using *p*-value, Chi-square value, and effect sizes (Phi values) were calculated.

*Demographic characteristics of the respondents*

The demographic characteristics of the respondents have been represented in table 5.1. From a total of 386 valid responses, 49.7% male respondents and 50.25% female respondents completed the questionnaire, indicating that the sample was balanced with respect to the gender distribution. Of these samples, 48.44% of respondents are of age 18-25 which is maximum, followed by 37.56% respondents of age 26-35. This indicates that the age distribution of the responses is also relatively balanced relating to mobile Internet usage rate among G20 nations (Zee Business, 2018) and the distribution of the total population (Sharma, 2017). The other demographic information of the respondents is outlined in table 5.1.

**Table 5.1:** Respondents demographic characteristics

| Characteristics | Frequency | Percentage |
|---|---|---|
| *Gender distribution* | | |
| Male | 192 | 49.74% |
| Female | 194 | 50.25% |
| *Age distribution* | | |
| 18-25 | 187 | 48.44% |
| 26-35 | 145 | 37.56% |
| 36-45 | 44 | 11.39% |
| 46-55 | 06 | 1.55% |
| > 55 | 04 | 1.03% |
| *Marital status* | | |
| Single | 302 | 78.23% |
| Married | 84 | 21.76% |
| *Education distribution* | | |
| 12th or PUC | 03 | 0.77% |
| Bachelor degree | 216 | 55.95% |
| Master degree | 149 | 38.60% |
| Doctoral degree | 18 | 4.66% |
| *Occupation distribution* | | |
| Technical students and working staff | 224 | 58.03% |
| Medical students and health professionals | 162 | 41.96% |
| *Living arrangements* | | |
| Family | 195 | 50.51% |
| Hostel | 109 | 28.23% |
| Paying Guest | 58 | 15.02% |
| Others | 24 | 6.21% |

| | | |
|---|---|---|
| *State or territory* | | |
| Andhra Pradesh | 31 | 8.03% |
| Assam | 8 | 2.07% |
| Karnataka | 54 | 13.98% |
| Telangana | 92 | 23.83% |
| Maharashtra | 85 | 22.02% |
| Madhya Pradesh | 13 | 3.36% |
| Nepal | 18 | 4.66% |
| Tamil Nadu | 34 | 8.80% |
| Uttar Pradesh | 17 | 4.40% |
| West Bengal | 6 | 1.55% |
| Kerala | 28 | 7.25% |
| *Location* | | |
| Rural | 90 | 23.31% |
| Semi-urban | 84 | 21.76% |
| Urban/town | 212 | 54.92% |
| *Smartphone availability* | | |
| iPhone | 48 | 12.43% |
| iPad | 12 | 3.10% |
| Android smartphone | 325 | 84.19% |
| Android tablet | 03 | 0.77% |
| Blackberry | 03 | 0.77% |
| Windows tablet | 03 | 0.77% |
| Windows smartphone | 06 | 1.55% |
| Basic mobile phones | 07 | 1.81% |

*Awareness about the Use of Mobile Phone for Health Communication and Delivery*

From table 5.1, we can identify that all the 386 respondents owned a mobile phone. Of these, 347 (89.89%) respondents have used mobile phones for searching health information online. This means that respondents have used mobile phones with/without Internet access to receive health materials, but when asked about the awareness and familiarity about the term “mobile health”, only 174 (45.07%) respondents have indicated that they are extremely aware and familiar.

Table 5.2 shows the list of health conditions for which respondents have used mobile phones.

**Table 5.2:** Mobile phone use for health conditions

| Health Conditions | Frequency | Percentage |
|---|---|---|
| Asthma | 28 | 7.25% |
| Blood Pressure | 41 | 10.62% |
| Cancer | 54 | 13.98% |
| Cold and Fever | 101 | 26.16% |
| Diabetes | 36 | 9.32% |
| Epilepsy | 7 | 1.81% |
| Hypertension | 35 | 9.06% |
| Itching | 14 | 3.62% |
| Kidney Disease | 33 | 8.54% |
| Menstruation | 34 | 8.80% |
| Mental Health | 36 | 9.32% |
| Obesity | 45 | 11.65% |
| Pregnancy | 18 | 4.66% |
| Skin Disease | 22 | 5.69% |
| Stress | 89 | 23.05% |

However, when indicated about the awareness level about the use of mobile phones for health-related components, the score values differ between technical students and working staff, and medical students and health professionals (Table 5.3). For example, the mean scores for measuring awareness level in the use of mobile phones for assessing and diagnosing disease conditions and medication reminders for technical students and working staff, and medical students and health professionals were 3.70 and 3.21 having a *p-value* $< 0.001$. Similarly, the *p*-value differed when analyzed for awareness of mobile phone use in locating hospital and scheduling appointments, storing patient records, doctor-stakeholders communication, and immunization programs for pregnant and lactating mothers.

The following table (Table 5.3) compares the awareness about mobile phone use for health-related components among technical students and working staff, and medical students and health professionals.

**Table 5.3:** Comparison of the awareness about mobile phone use for health-related components among technical students and working staff, and medical students and health professionals (n = 386)

| Indicators of awareness about mobile phone use for health-related components | Mean (SD) Technical students and working staff | Mean (SD) Medical students and health professionals | *p-value (2-tailed)* | Phi value | Measure of association |
|---|---|---|---|---|---|
| Creating health awareness and education like cessations etc. | 3.79 (0.95) | 3.65 (0.75) | 0.123 | 0.22 | Small effect |
| Assessing and diagnosing certain disease conditions and medication remainders. | 3.70 (0.86) | 3.21 (0.95) | 0.000* | 0.27 | Medium effect |
| Locating hospitals and for scheduling appointments | 4.13 (0.87) | 3.80 (0.76) | 0.000* | 0.34 | Medium effect |
| Medication adherence and refilling | 3.66 (0.91) | 3.48 (0.99) | 0.078 | 0.21 | Small effect |
| Storing patient records | 3.73 (0.96) | 3.22 (1.03) | 0.000* | 0.25 | Small effect |
| Doctor-stakeholders communication informing health status of the region | 3.70 (0.95) | 3.16 (0. 95) | 0.000* | 0.37 | Medium effect |
| Immunization reminders for pregnant and lactating mothers | 3.66 (0.94) | 3.41 (1.18) | 0.021* | 0.22 | Small effect |

**p-value* significant at 0.05 level

From table 5.3, since *p-value* was less than 0.05 except for health awareness and education, and medication adherence and refilling, indicating the rejection of the null hypothesis at a significance level of 5%. Therefore it can be concluded that there exists a significant difference between the awareness level among technical students and working staff, and medical students and health professionals. Based on the mean value, we can conclude that technical students and working respondents are more aware of the use of mobile phones for health utilities than medical students and health professionals.

Additionally, the impact of dependency between the responses, when calculated, revealed that the magnitude of the effect between the groups is almost medium for assessing and diagnosing disease conditions and medication reminders (0.27), storing patient records (0.25), and immunization programs for pregnant and lactating mothers (0.22) whereas its magnitude is large for locating hospitals and for scheduling appointments (0.34) and doctor-stakeholders communication informing health status of the region (0.37).

*Use of Mobile Health Applications in Health Service Delivery*

The use of mHealth applications in technical students and working staff, and medical students and health professionals are found to be 135 and 111 numbers respectively; thus, exploring the various other areas wherein respondents have used mHealth apps were self-managing of a chronic health condition such as cholesterol, heart diseases, stroke, fitness, yoga, etc. (Table 5.4).

**Table 5.4:** Comparison of the use of self-managing apps among technical students and working staff, and medical students and health professionals based on Chi-square test results (n = 386)

| **Components of mHealth apps use** | **Scale** | **Technical students and working staff** Percent (Count) | **Medical students and health professionals** Percent (Count) | ***p-value (2-tailed)*** | **Phi value** | **Measure of association** |
|---|---|---|---|---|---|---|
| Self-managing of cancer | Yes | 29.53% (114) | 9.33% (36) | 0.000* | 0.29 | Medium effect |
| | Maybe | 8.81% (34) | 7.77 (30) | | | |
| | No | 19.69% (76) | 24.87% (96) | | | |
| Self-managing of cholesterol, heart diseases, and stroke | Yes | 23.58% (91) | 11.40% (44) | 0.019* | 0.14 | Small effect |
| | Maybe | 12.69% (49) | 12.44% (48) | | | |
| | No | 21.76% (84) | 18.13% (70) | | | |
| Self-managing of chronic obstructive pulmonary disease like bronchitis, asthma | Yes | 26.68% (103) | 17.88% (69) | 0.575 | 0.05 | Small effect |
| | Maybe | 9.33% (36) | 5.96% (23) | | | |
| | No | 22.02% (85) | 18.13% (70) | | | |
| Self-managing of fitness, yoga, diet, and nutrition for obesity | Yes | 30.31% (117) | 21.76% (84) | 0.933 | 0.01 | Relatively smaller effect |
| | Maybe | 9.59% (37) | 7.51% (29) | | | |
| | No | 18.13% (70) | 12.69% (49) | | | |

**p-value* significant at 0.05 level

From the table 5.4, the interpretation of Chi-square test results, p-value, and effect sizes between technical students and working staff, and medical students and health professionals are explained below relating to the components of mHealth apps use.

*Self-managing of Cancer*

The chi-square test results for self-managing of cancer is found to be significant as *p-value* is 0.000. Hence the null hypothesis is rejected indicating that the technical students and working staff, and medical students and health professionals are independent to one another. In other words, the use of apps for the self-managing cancer app is dependent upon technical and medical related courses and practices. Moreover, to measure the impact of dependency between the responses, measures of association or effect sizes has been calculated with a “Phi” value, and in this study, this value is found to be 0.29. Thus, indicating that there is a medium magnitude of effect in the use of cancer health app, the difference between technical students and working staff, and medical students and health professionals.

*Self-managing apps of Cholesterol, Heart Diseases, and Stroke*

For self-managing apps of cholesterol, heart diseases, and stroke, the chi-square test results between the groups was found to be significant as *p-value* is 0.019. Hence the null hypothesis is rejected indicating that the two groups are independent to one another. In other words, the use of apps for self-managing of cholesterol, heart diseases, and stroke is dependent upon technical and medical related courses and practices. Moreover, the “Phi” value was found to be 0.14 indicating that there is a small magnitude of effect in the difference of health app use between technical students and working staff, and medical students and health professionals.

*Self-managing of Chronic Obstructive Pulmonary Disease (COPD)*

In this case, the chi-square test results for self-managing of COPD was found to be 0.575, indicating the failure of rejecting the null hypothesis at a significance level of 5%. Therefore, we can conclude that there is no significant association between the use of self-managing of COPD like bronchitis, asthma, etc. among technical students and working staff, and medical students and health professionals. Additionally, when the impact of dependency between the responses using effect sizes has been calculated, a “Phi” value is 0.05. Thus indicating that there exists a small magnitude of effect in the use of self-managing of COPD app difference between technical students and working staff, and medical students and health professionals.

*Self-managing of Fitness, Yoga, Diet, and Nutrition*

From the Table 5.4, we can indicate that the technical students and working staff, and medical students and health professionals were using/used self-managing apps for fitness, yoga, diet, and nutrition. When calculated statistically, the result was found to be 0.933 which is insignificant at 5% level. Hence, the null hypothesis is failed to reject indicating that the two groups are independent of one another. Therefore, we can infer that there is no significant association between the use of self-managing apps for self-managing of fitness, yoga, diet, and nutrition for obesity among technical students and working staff, and medical students and health professionals. Moreover, the "Phi" value was found to be 0.01 indicating that there is relatively smaller magnitude of effect (smaller than COPD app) in the difference of fitness, yoga, diet, and nutrition app use between technical students and working staff, and medical students and health professionals. Thus, the use of these apps is not dependent on technical and medical related courses and practices (or work).

## 5.3. Hypothesis Testing of Awareness and Intention to Use

This study intends to examine the determinants of mobile health technology, and applications use intention. The major objectives of this study is to theoretically understand the antecedents of mHealth technology and applications early adoption and address the following research questions.

(1) To what extent individual traits and product/service adoption characteristics have on mHealth technology and application awareness?

(2) To what extent individual cognitive factors, subjective norm (SN), and perceived usefulness (PU) have on the Intention to Use (ITU) mHealth technology and application?

(3) Whether there is a direct positive relationship between individual traits, product/service adoption characteristics, individual cognitive factors, SN, PU, and ITU mHealth technology and application for health?

With this questions, the study investigates:

(1) the extent to which individual characteristics/traits promotes awareness about mHealth technology and applications;
(2) the extent to which individual perception about mHealth technology and application is attributed due to their willingness to try for the services;
(3) the extent to which individual perception about mHealth technology and application is attributed due to the support from peers, family, and important people (subjective norm);
(4) whether internalization of SN and health consciousness has any effect on intention to use;
(5) whether awareness and perceived usefulness has any power over the intention to use mHealth applications and technology, as established by prior literature.

The following section provides a description of these factors and their hypotheses.

*Mobile Service Enabled Empowerment*

Mobile Service Enabled Empowerment (MSEE) refers to individuals' intrinsic motivation towards mobile services (Spreitzer, 1995). It is said that intrinsic motivation of an individual has an influence on innovative behavior and provides autonomy to solve problems which they are facing (Redmond et al., 1993; Çakar and Ertürk, 2010; Chen et al., 2014). People who are empowered may likely develop innovative actions in order to solve problems and achieve their needs (Chen et al., 2014). Moreover, prior literature has identified the existence of relationship between MSEE and PI towards mobile services. Hence, the following hypothesis has been formulated.

H1a: Mobile Service Enabled Empowerment (MSEE) has a direct positive impact on awareness of mobile health technology and application.

H1b: MSEE has a direct positive impact on personal innovativeness towards mobile services.

*Personal Innovativeness*

Personal Innovativeness (PI) refers to the willingness of an individual towards new mobile technology services (Agarwal and Prasad, 1998). It acts as an important construct in studying individual behavior towards innovation diffusion (Rogers, 1983) and marketing research (Flynn and Goldsmith, 1993). People with high innovative capabilities are likely to be aware (Lyons and Henderson, 2005) and act as information seekers about new products and services happening in their domain (Lu et al., 2005). They tend to manage themselves during uncertainties and develop positive intentions towards acceptance (Rogers, 1983). Personal innovativeness is associated with awareness about the technology and its services for mobile health services (Rai et al., 2013; Chen et al. 2014). It also influences perceived usefulness, which ultimately may lead to acceptance. For example, the worldwide web (Agarwal and Karahanna, 2000), wireless Internet services over mobile technology (Parveen and Sulaiman, 2008; Lu et al., 2005), etc. In this study, we expect there would be positive association between PI, awareness, perceived usefulness, and intention to use mobile health technology and applications. Thus, the hypotheses are proposed as:

H2a: Personal Innovativeness (PI) has a direct positive impact on awareness of mobile health technology and application.

H2b: PI has a direct positive impact on the perceived usefulness of mobile health technology and application.

H2c: PI has a direct positive impact on the intention to use mobile health technology and application.

*Subjective Norm*

Subjective Norm (SN) is the “perceived social pressure to perform or not to perform the behavior" (Ajzen, 1988). In other words, it can be said that, due to the external pressure from their relatives, peers, and friends, people may opt for a particular behavior even if they are not positive. Prior literature suggests that SN influences positively towards perceived usefulness (Ajzen, 1988; Teo, 2009; Weiz et al., 2016) and intention to use (Fishbein and Ajzen, 1975; Raza et al., 2017) technology and services (Venkatesh and Davis, 2000). Hence, the following hypotheses has been proposed:

H3a: Subjective Norm (SN) has a direct positive impact on the intention to use mobile health technology and application.

H3b: SN has a direct positive impact on the perceived usefulness of mobile health technology and application.

*Health Consciousness*

Health Consciousness (HC) refers to the individuals consiousness towards his/her own health (Dutta-Bergman, 2004; Dutta and Basu, 2008). It is believed that people who are highly conscious about health try to exercise, practice yoga, and follow a diet every day or on a regular basis to keep them fit. At the same time, they improve their knowledge related to health, disease, and food habits from various sources (Dutta-Bergman, 2004; Ahadzadeh et al., 2015). Moreover, previous literature also indicated that health consciousness influences perceived usefulness (Wahyuni and Nurbojatmiko, 2017; Ahadzadeh et al., 2015). Therefore, the hypothesis is formulated as:

H4: Health consciousness has a direct positive impact on the perceived usefulness of mobile health technology and application.

*Awareness*

Awareness about mobile health technology and applications is a new experience to many of the individuals. An individual with a high level of awareness is bound to adopt these services for managing health and diseases, i.e., more the level of awareness more the impact on purchase intention and use (Asif et al., 2018). It was identified that there exists a lack of awareness among the medical and engineering students about mobile health applications and its practices for specific health areas (Parthaje et al., 2016). Prior literature has also found that people are aware and used mobile technology for health but are unaware about its applications (Ehteshami et al., 2013; Zayapragassarazan and Kumar, 2016; Pai and Alathur, 2019). Therefore, the lack of awareness about the benefits, advantages, and disadvantages acts as a barrier to the acceptance of mobile health technology and applications. Thus, we propose our hypotheses as:

H5a: Awareness of services (AWR) has a direct positive impact on the perceived usefulness of mobile health technology and application.

H5b: AWR has a direct positive impact on the intention to use mobile health technology and application.

*Perceived Usefulness*

It refers to "the degree to which a person believes that using a particular system would enhance his/her job performance" (Davis, 1989, p. 320). Wong et al. (2014) also states it "as the belief about using the technology that would bring benefits to the user". More specifically, if people believe that using a certain technology will help them in improving job performance, then there is a high possibility of accepting it for their daily operations. As identified in the literature, this construct has a positive influence on the acceptance of products and services. We expect that to be true even for mobile health technology and applications. Therefore, accordingly, the study hypothesis is formulated as:

H6: Perceived usefulness has a direct positive impact on the intention to use mobile health technology and application.

*Research Model*

The study model presented in figure 5.1 consisted of components related to TAM (subjective norm, perceived usefulness, and intention to use), HBM (health consciousness), and individual traits (mobile service enabled empowerment and personal innovativeness) to mobile services.

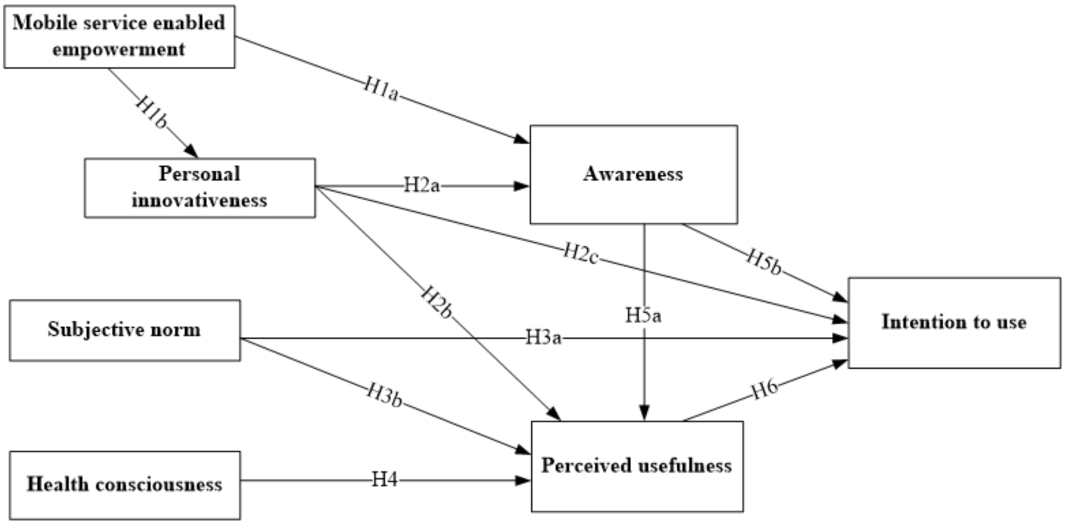



**Figure 5.3:** Research Model

The study model emphasizes on the determinants of mobile health technology, and applications use intention. The methodology adopted in this research is empirical based on the primary data collected through structured questionnaires for testing research hypothesis.

*Pre-testing of Questionnaire*

The study variables were identified from the literature review. The questionnaire was in English language and pre-tested offline with a medical practitioners, two management professors, and three students. Their suggestions pertaining to the component and structure were taken, and modifications have been done accordingly (Appendix V).

*Sample Size*

The sample size is calculated based on the number of mobile phone users or owners. In India, the total number of mobile phones users are 650 million (Iyengar, 2017). Thus, Slovin's formula (Altares et al., 2003) is used to calculate the sample size as the total population is large, and there is no idea about its behavior. Hence the minimum samples for this study should be 399.99, which is rounded off to 400. But this study considered a total sample size of 409 responses taken from both online and offline channels.

*Study Population*

The proposed research model was tested using a structured questionnaire from a random sample of mobile phone and Internet users. Hence, the mobile phone and the Internet user located in India represent the study population. It can be students, academicians, working professionals, and other general population. Since the dependent variable is the intention to use, the respondents can be the non-users, one-time users, or continual users (Chatzoglou et al., 2015) of mobile health technology and applications.

*Data Collection*

For achieving the national representation, the questionnaire was distributed in the urban locations of Bangalore, Vadodara, New Delhi, and Kolkata through personal contacts. The respondents were identified according to the age distribution from the census data of 2011. The data was also collected by posting the questionnaire link (prepared using Google docs) in the individuals' message box of mobile health applications pages available on social media (i.e., Twitter and Facebook).

The participants were explicitly informed about the importance of the responses and the future use of the data for academic purpose. Overall, 409 responses out of 512 were valid and considered for this study. The survey was carried out between December 2017 and May 2018, and the average time was calculated to be 15 minutes.

*Participants Demographics*

The demographic details of the respondents are provided in table 5.5. It was identified that gender-wise the sample was balanced with a higher number of male respondents than the female and age-wise it is skewed between the age groups of 18-25 and 26-35.

**Table 5.5:** Participants demographic characteristics

| Demographic Variable | Category | Responses | |
|---|---|---|---|
| | | Numbers | Percentage (%) |
| Gender | Male | 234 | 57.21 |
| | Female | 175 | 42.78 |
| Age | 18-25 | 213 | 52.07 |
| | 26-35 | 128 | 31.29 |
| | 36-45 | 43 | 10.51 |
| | 46-55 | 11 | 2.68 |
| | >55 | 14 | 3.42 |
| Marital Status | Single | 256 | 62.59 |
| | Married | 142 | 34.71 |
| | Others | 11 | 2.68 |
| Education Qualification | <10$^{th}$ std | 18 | 4.40 |
| | 11$^{th}$ to 12$^{th}$ std | 9 | 2.20 |
| | Bachelor degree | 214 | 52.32 |
| | Master degree | 141 | 34.47 |
| | Doctoral degree | 27 | 6.60 |

The study also revealed that over 268 (65.52%) of the respondents had used basic mobile phones features (indirect type) for seeking health information from online sources. For the multiple-choice question, respondents have largely indicated that, they have used social networking apps (128 [31.29%]), video sharing apps (74 [18.09%]), and Internet browsers (214 [52.32%]) for cold and fever, obesity, stress, and mental health, and toothache problems.

*Survey Instruments*

The items in the questionnaire were largely constructed as 5-point Likert-type scales (Appendix V). However, at some places, open answer type questions were also used seeking their perceptions and opinions about mobile health applications.

The items for the construct *mobile service enabled empowerment* was measured using five items of Spreitzer (1995). These instruments have been accepted and used in mobile banking and health service research of Donner and Tellez (2008) and Chen et al. (2014). Items for *personal innovativeness* was measured with five items adapted from the literature of Agarwal and Prasad (1998) and Rai et al. (2013) and modified slightly to fit the study context. The construct *health consciousness* was measured using five items of Dutta-Bergman (2004) scale. Items for the *subjective norm* and *perceived usefulness* has been taken from the literature of Hu et al. (2003) and Davis (1989) and incorporated suggested changes. The construct *awareness* was measured using four items of Sathye (1999) and that of *intention to use* consisted of two items taken from Bhattacherjee (2000). These items are grouped as indicated by Davis and Venkatesh (1996) such that it ensures a logical flow of ideas between the items.

*Data Analysis and Results*

The data analysis was carried out using statistical package for social science v16 and AMOS 22. The results have been presented in the following sections.

*Pilot Study*

For conducting the pilot study, a revised questionnaire was sent to 123 respondents, both online and offline. The unidimensionality of the construct was measured by performing exploratory factor analysis (EFA) using Maximum Likelihood extraction and Promax rotation method. For an initial Eigenvalue greater than 1, seven variables have been extracted with Kaiser—Meyer–Olkin (KMO) value and was found to be 0.738, which is above the acceptable value of 0.5 (Malhotra and Dash, 2011). The internal consistency of the proposed construct was measured using reliability analysis through Cronbach's alpha and found that the values are within the acceptable range of 0.7, indicating acceptance (Nunally, 1978).

*Main Study*

The main study includes the analysis performed using a two-step method (Anderson and Gerbing 1988). As a first step, Confirmatory Factor Analysis (CFA) was performed on the measurement model to ensure that the items stated for each measure represent the same construct. In the second step, the structural model was analyzed for examining hypothesized causal paths. This helps us in inferring that the proposed conceptual model designates a satisfactory fit with the data.

A normality test was performed as suggested by Lu et al. (2005) to ensure data suitability for predetermining statistical analysis. From the data analysis, we observed fairly normal distributions for the items in terms of skewness and tolerable value (i.e., from benign to 1.0) in the case of kurtosis as it is within the accepted value suggested by Kline (2011).

The EFA was also carried out using Maximum Likelihood extraction and Promax rotation method. The results of the analysis found that all the seven variables have been extracted and KMO test value was 0.777, which is acceptable. The results indicate all the items present in a particular component correlates and represents its corresponding component. The reliability analysis was calculated and found to be more than 0.7, indicating the acceptance of study items (Nunally, 1978).

*The Measurement Model*

The confirmatory measurement model was tested for model fit, convergent, and discriminant validity (Fornell and Larcker, 1981). The model fit was assessed as suggested by (Lu et al., 2005). Since the sample size is more than 300 (considered big) and marks oversensitivity, the resulting Chi-square test value and its corresponding *p-value* can be ignored (Joreskog and Sorbom, 1993).

The other values i.e. $X^2$/df = 2.279, Normed Fit Index (NFI) = 0.901, Tucker-Lewis Index (TLI) = 0.923, Comparative Fit Index (CFI) = 0.941, Root Mean Square Residual (RMSR) = 0.0457, Root Mean Square Error of Approximation (RMSEA) = 0.056 are found within the accepted value and suggest a good fit (Hu and Bentler, 1999; Hair et al., 2010).

*Convergent Validity*

It is proved that, when the items of a construct that are theoretically related, they are actually related (Lee et al., 2006). The convergent validity is measured using the factor loading and its corresponding *p-values*. From this study, it was identified that all the items factor loading is above the cutoff value of 0.5, indicating the acceptability of construct validity (Kline, 1998). The Composite Reliability (CR) is calculated and found that the value is greater than 0.7, indicating adequate reliability (Table 5.6).

**Table 5.6:** Assessment of validity

| | CR | AVE | MSEE | PI | SN | HC | AWR | ITU | PU |
|---|---|---|---|---|---|---|---|---|---|
| **ITU** | 0.831 | 0.711 | **0.843** | | | | | | |
| **MSEE** | 0.848 | 0.652 | 0.311 | **0.807** | | | | | |
| **PI** | 0.828 | 0.617 | 0.242 | 0.508 | **0.785** | | | | |
| **SN** | 0.796 | 0.566 | -0.077 | 0.128 | 0.173 | **0.752** | | | |
| **HC** | 0.766 | 0.622 | 0.084 | 0.204 | 0.218 | 0.034 | **0.788** | | |
| **AWR** | 0.713 | 0.554 | 0.256 | 0.311 | 0.173 | 0.010 | 0.039 | **0.744** | |
| **PU** | 0.788 | 0.482 | 0.108 | 0.255 | 0.374 | 0.424 | 0.101 | 0.215 | **0.695** |

Significant at a *p-value* of 0.000
CR – composite reliability, AVE – average variance extracted, MSEE – mobile service enabled empowerment, PI – personal innovativeness, SN – subjective norm, HC - health consciousness, AWR – awareness, ITU – intention to use, and PU - perceived usefulness

The Average Variance Extracted (AVE) is the variance of the construct to that of the variance due to measurement error. In this study, the AVE values for all the constructs is greater than 0.5, except for perceived usefulness, i.e., 0.482, indicating acceptance as its composite reliability is greater than 0.6 (Fornell and Larcker, 1981). Hence, constructs convergent validity was achieved.

Table 5.6 below presents the values for reliability, validity, and factor correlational matrix with the square root of the AVE on the diagonal.

*Discriminant Validity*

Discriminant validity is proved when the constructs correlation values are not excessively high (greater than 0.85) or excessively low (lesser than 0.10) (Lu et al., 2005). It is also achieved as the diagonal values are greater than the off-diagonal values (Hair et al., 2010). This indicates that the components are not related with each other (Table 5.6).

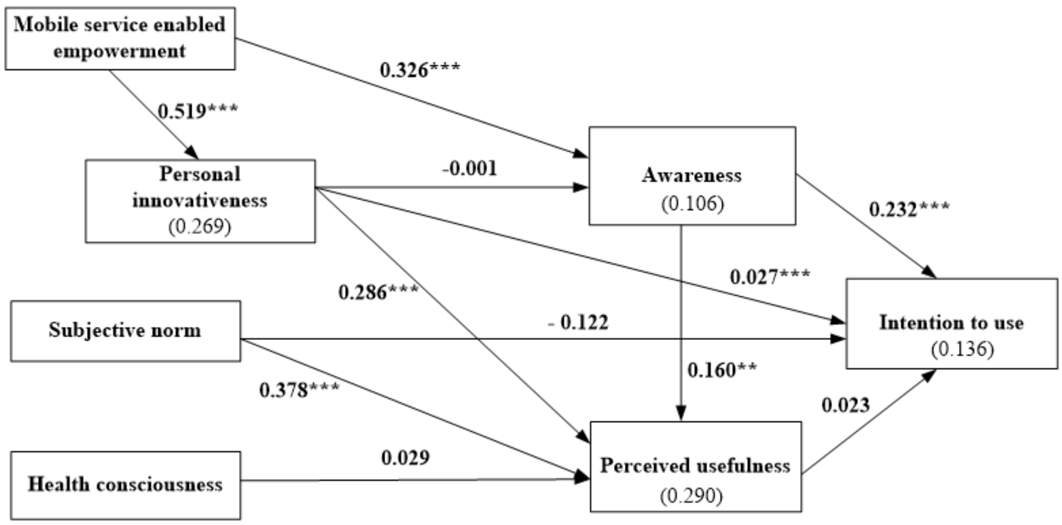
The proposed model is also tested for multicollinearity issues to observe that the data are highly intercorrelated with the independent variables. It was tested for the dependent variable 'intention to use' against MSEE, PI, SN, HC, PU, and AWR as an independent. The result found that the values for each of the variables are less than 3.3, indicating that the model is free from multicollinearity issues (Kock and Lynn, 2012).

*The Structural Model*

In this case, the relations between the constructs were tested. Here, the model fit indices were also measured and found to have an acceptable fit with X2/df = 2.287, NFI =

0.895, TLI = 0.922, CFI = 0.937, RMSR = 0.0523, RMSEA = 0.056 (Hair et al., 2010; Hu and Bentler, 1999).

Figure 5.2 depicts the results obtained from the path analysis. The values inserted on each individual paths represents the estimate of standardized regression weight. To measure the total amount of variance in the dependent variable 'intention to use' that is explained by the independent variables, 'awareness, personal innovativeness, subjective norm, health consciousness, and perceived usefulness', squared multiple correlation values is calculated (Figure 5.2).




***significance at p<0.001, **p<0.05

**Figure 5.4:** Results of the path analysis

From figure 5.2, we can observe that mobile service enabled empowerment and personal innovativeness together contributes to 10.6% of the variance in awareness. Personal innovativeness, subjective norm, and health consciousness collectively explained 29% of the variance in perceived usefulness. Finally, 13.6% of the variance in the intention to use mobile health technology and applications is explained by awareness, perceived usefulness, subjective norm, and personal innovativeness.

## 5.4. Discussions

### *5.4.1. Descriptive Statistics*

The study findings indicate that the awareness and use of mobile phones and application among the groups of technical and medical courses were moderate. However, the respondents have largely used mobile phones for assessing chronic/lifestyle illness/diseases (Asthma (7.25%), Cancer (13.98%), Diabetes (9.32%), etc.) rather than other illnesses/health conditions. This indicates that respondents are health conscious and tried finding information sources for managing menstrual cycles, preventive and chronic/lifestyle health conditions.

Regarding the awareness and familiarity about the term “mobile health” among technical students and working staff, and medical students and health professionals, only 174 respondents have indicated that they are extremely aware and familiar, out of which are 96 (55.17%) respondents are from technical courses and 78 (44.82%) respondents from medical courses. Statistically, the survey on awareness about mobile phone use for health-related components among the groups revealed that, except for health awareness and education, and medication adherence and refilling, the null hypothesis is rejected at 5% significance level. Overall, among the groups, considering the mean values, awareness rate about mobile phone use is highest among technical students and working staff, and medical students and health professionals.

Moreover, regarding the use of mobile health apps, there exists a medium effect in the use of cancer app, small effect for apps of cholesterol, heart diseases, and stroke, relatively small effect for COPD and fitness, yoga, diet, & nutrition app difference between technical students and working staff, and medical students and health professionals. This can be due to the Internet accessibility and structure of technical course curriculum equipped with industrial practices, seminars, and other technical projects making them drive towards health application awareness and use.

Similarly, the technical people working in the manufacturing and service sectors are basically health conscious as they will be continuously working from one or multiple workstation to meet the company’s targets, making them susceptible to various health conditions. Therefore, technical people usually refer to various mobile health apps to stay fit, free from mental stress and other related health behaviors like blood pressure, hypertension, etc. which was identified in this study.

> *Due to work pressure, I hardly find time to go to the gym. Therefore, I walk every day using this … applications and also follow diet plans by asking friends and doctors. (Professional working in a technical field)*

In the case of medical practitioners, the use of mobile phones for health activities is less, as they will be continuously working with real-time health cases of different patients on a daily basis and may use it to send patient health records to their peers informing health status. The doctor cited it as:

*I am aware about the use of mobile phones for maternal and child care when I was working in a healthcare center. There as a front-end support, we used to call and remind maternal women and new mothers regularly to take vaccinations and diet plans for staying healthy. At its backend, we used to record and consolidate all the vaccination details given on that particular day so as to send it to higher authorities or peers of that districts for projecting and allocating health treatment plans, etc. (Doctor)*

Moreover, they may use mobile health apps for personal use than their professional lives due to users' socio-demographic factors.

*I use … health application for tracking fitness and also I suggest the same to my patients during visits, but sometimes, people used to tell me that, they have problems in reading (language) and often face difficulties in using mobile phones (other than calling) if their son/daughter is not there at home. Therefore, I suggest them to meet once three to six months for a routine health checkup. (Doctor)*

In addition to this, most people in India even though having access to Internet prefer to visit doctor personally, and in some cases follow Ayurveda and traditional home remedies as it brings relaxation to their mind and rather than the following information through digital and/or online communities.

*The prospects are intriguing, but reliability and accuracy are severely lacking presently in health applications. Therefore, I would prefer visiting him personally rather than mobile phones. (Engineering Student)*

*I prefer first aids or home remedies if something comes up sudden (Professional working in a technical field).*

Furthermore, respondents have also expressed a positive feeling about the initiative of using mobile health and health applications for healthcare service delivery but are also waiting for evidence about behavioral outcomes and reliability.

*I am aware about mobile health services, but currently, it is still in an initial stage of managing appointments, and in later stages, if evidence gets generated, I am sure that majority of the people will go for it. I feels it's a great initiative towards the digital campaign. (Engineering Student).*

In this way, the study not only considered prior literatures in designing the questionnaires but also included questions from the focus groups interviews. Thus, the survey instrument so developed are relevant for explaining the mobile phone technology and apps awareness and use components but found to be comprehensive as per the present context. Furthermore, the study finding contributes to the body of knowledge as previous literature involving technical and medical course groups especially in the Indian context are less reported.

### *5.4.2. Hypothesis Testing*

The model proposed in this study was supported by the data chosen from the total population. The results of the path analysis have been tabulated in Table 5.7.

**Table 5.7:** Significant test results for hypothesized direct effects

| Hypothesis | Path Variables | Significance | Results |
|---|---|---|---|
| H1a | MSEE → AWR | 0.001*** | ***Supported*** |
| H1b | MSEE → PI | 0.001*** | ***Supported*** |
| H2a | PI → AWR | 0.991 | Not Supported |
| H2b | PI → PU | 0.001*** | ***Supported*** |
| H2c | PI → ITU | 0.001*** | ***Supported*** |
| H3a | SN → ITU | 0.069 | Not Supported |
| H3b | SN → PU | 0.001*** | ***Supported*** |
| H4 | HC → PU | 0.621 | Not Supported |
| H5a | AWR → PU | 0.012** | ***Supported*** |
| H5b | AWR → ITU | 0.001*** | ***Supported*** |
| H6 | PU → ITU | 0.752 | Not Supported |

***significance at $p<0.001$, **$p<0.05$
MSEE – mobile service enabled empowerment, PI – personal innovativeness, SN – subjective norm, HC - health consciousness, AWR – awareness, ITU – intention to use, and PU - perceived usefulness

The results of the path significance test (Table 5.7) indicate that MSEE had a significant positive influence on AWR. Moreover, for the sample chosen,the determinants PI, SN, and AWR had a significant positive influence on PU. Finally,the determinants PI→AWR also had a significant positive influence on ITU. The remaining paths, PI→AWR, SN→ITU, HC→PU, and PU→ITU were found to be statistically insignificant, and hence the corresponding hypotheses were rejected.

The path analysis results between MSEE and AWR (H1a) and MSEE and PI (H1b) is consistent with prior research findings (Chen et al., 2014), and indicate that MSEE has a direct positive relationship on AWR and PI towards mobile services. This result signifies that empowered people are likely to be aware and finds it meaningful to use mobile phones for healthcare service delivery as it would help them in managing problems independently by maintaining their anonymity and privacy.

The direct effects of PI and AWR (H2a) are found to be insignificant, but PI and PU (H2b) and PI and ITU (H2c) are significant at $p<0.001$. This indicates that PI does not drive individuals towards awareness but consider to be useful and may use them in managing health often or in the near future. This unexpected result obtained through this study stipulates that, even though people take a chance to explore various mobile applications, but often find difficulty in identifying the information about mobile health applications or the benefits of using it. They feel that mobile technology and applications are important for banking and other day-to-day activities but are reluctant or hesitant to use it for health-seeking and communication. This can be because of the lack of electronic health literacy, trust, and training from health professionals.

The study also finds that SN and ITU (H3a) is found to be insignificant, confirming the research works of Venkatesh et al. (2003); Chismar and Wiley-Patton (2003); Chau and Hu (2002); and Suki and Suki (2017), concluding that subjective norm has a minimal influence on use intentions and seems to work on perceptions rather than intentions when its use is not mandatory (Lu et al., 2005). Simultaneously, the results of SN and PU (H3b) is found to be significant, indicating that the people during unavoidable circumstances may suggest their important ones to improve the use perception, accomplishing and enhancing the quality of health-related tasks and goals. Similar studies have also been found in support of this result (Kim and Park, 2012; Karahanna and Straub, 1999; Beldad and Hegner, 2018).

The relationship between HC and PU (H4) is found to be insignificant and is consistent with the work of Beldad and Hegner (2018). Even health-conscious people believe that its use may help them in managing their health easily but due to their food habits and prevalence of various diseases make them anxious thereby allowing them to visit healthcare professionals personally rather than through mobile phones. This finding failed to confirm the results of previous research by Kim and Park (2012) and Chen and Lin (2018).

The study finds that the relationships between the variables AWR and PU (H5a) and AWR and ITU (H5b) are found to be significant at $p<0.05$ and $p<0.001$, respectively. This result is in line with the earlier works of Hanafizadeh and Khedmatgozar (2012) and Al-Somali et al. (2009) and indicates that awareness enhances an individual's mobile health technology and applications use intention.

Interestingly, the study identifies that the direct effects of PU and ITU (H6) is insignificant and is in line with the work of Bidmon et al. (2014). This result signifies that when it comes to use intention of mobile health technology and applications, the doctor's recommendation plays an important role rather than perceived usefulness. This is because of the fact that digital solutions which are recommended by the professionals are preferably developed according to their requirement and the chances of getting unrealistic or error results will be less. Hence, it can be concluded that higher the recommendations, more the propensity of an individual to use it for healthcare services.

### 5.5. Conclusions

India is one of the G20 nations with the largest Internet subscribers and the majority of its populations is young (age below 25 years and two-thirds less than 35 years). The study findings indicate that the rate of awareness and use of mobile health applications is highest among technical students and working staff, than medical students and health professionals. Moreover, people prefer to use mobile phone technology and applications for improving health and wellness conditions. However, due to connectivity problems, socio-demographic factors, trust, and information credibility lead to lower acceptance and adoption among people and make them prefer personal visits than through mobile interventions. Therefore, recommendations from healthcare professionals, healthcare solution providers, and the government play an important role in improving their awareness, perceptions, and for creating value among individuals, organizations, and society.

This study also intends to examine the determinants of mobile health technology, and applications use intention. From the data analysis, it was identified that personal innovativeness and awareness are the important variables which contribute to mobile health technology and applications use intention. Further, it was also identified that the opinion of people who they consider to be important, are less likely to be appreciated when it comes to health. This means that people may consider it as optional and work more with perception than intention.

This research has some important contributions. This study includes citizens' perspectives about mobile health technology and applications. It uses multiple theoretical models, and the variables are delineated from individual traits, adoption characteristics of new product or service, individual cognitive factors, health-related use behavior from the view of technology. Thus, the model formed is theorized as it appears in the present context and among Indian citizens. The study would be helpful for the decision-makers in getting some benefit by considering the study variables into practice.

*Limitations and Future Research*

The study has got certain limitations. Firstly, most of the data responses have been received from the participants living in the regions of the south of India. This can be a limit to generalize the total population's awareness about mobile health apps as most of the health application by Government of India under National Rural Health Mission was initiated in Northern states of India as phase 1. Secondly, offline respondents have been initially instructed about the importance of using mobile phones for health service delivery, and later provided questionnaires for their response. Thirdly, this study has not considered the observed changes in the peoples' health outcome in using a mobile phone for chronic/lifestyle illness and other disease conditions. This might have an influence on the data results being more reliable for awareness level than they actually have. Finally, the use of semi-structured interviews among the study respondents will provide further evidence about any specific reason and experience of using mobile health and applications. Therefore, in the future, research can be conducted by considering the factors of demography, culture, and individual health needs and consciousness influencing the awareness and use of mobile phone for health service delivery.

For hypothesis testing, the study had collected responses from four locations (specifically urban), and since India is a land with varieties of culture, traditions, and customs, its influence on the adoption of mobile health technology and applications has not been considered for this study. This might have provided a narrow scope and generalization may not be a true representation of the intention of the entire population towards the use of mobile health technology and applications. Hence, this research in the future can be extended by including samples from other states of India to study the significance of these factors on adoption. The majority of the respondents in this study are with a bachelor (52.32%) and master degree (34.47%). These constraints might also have difficulties in generalizing the findings across the level of citizens in India.

In the research model, the r-squared values for personal innovativeness, subjective norm, awareness, and health consciousness together explain only is 29% of the variance in the perceived usefulness, while that of personal innovativeness, awareness, subjective norm, and perceived usefulness is 13.6%. So, an effort should be made to consider other variables such as perceived ease of use, health severity and susceptibility, electronic health literacy, and trust for measuring the significance and variance in the use intention.

# CHAPTER 6

## SYNTHESIS, IMPLICATIONS, AND RECOMMENDATIONS

## 6.1. Introduction

The previous chapter discussed the empirical findings for the awareness and acceptance of the mobile health applications and technology through quantitative survey among the general populations, technical and working staffs and medical and health professionals located in India. This chapter will discuss the synthesis of findings, study implications, and recommendations for improving mobile health application usefulness in India.

This chapter is structured as follows. Section 6.2 presents the synthesis of findings obtained from the use of qualitative and quantitative study approaches. Section 6.3 addresses the implications of the study. Finally, section 6.4 concludes this chapter by providing recommendations for improving mobile health application usefulness.

## 6.2. Synthesis of the Study

The synthesis of the research may be discussed in the light of the qualitative (using interviews and secondary data), and quantitative (questionnaire survey) study approaches, as mentioned in chapter 3. This section discusses the synthesis of findings obtained from the study approaches that are presented in chapters 4 and 5. Specifically, subsection 6.2.1 outlines how the awareness, accessibility, acceptance, and affordability of mobile health applications' usefulness have been studied. Subsection 6.2.2 integrates the findings of the qualitative and quantitative study approaches in terms of triangulation of studies and potential ways to improve it.

### 6.2.1. Understanding and Modeling Variables

As mentioned in chapter 3 of this thesis, the overall research question is, "How to improve the usefulness of mobile health applications for health service delivery?". To answer this question both the qualitative and quantitative study approaches were employed. The qualitative study included both primary (interview-based case study) and secondary data (Twitter data) for identifying the components of awareness, accessibility, and acceptance, among rural populations, and affordability among technology entrepreneurs. The quantitative study used statistical analysis to investigate the relationships between the components identified in interviews conducted among rural regions. These two studies have been performed sequentially so as to identify the variable and survey instrument for administering a larger set of samples. This section, therefore, discusses how findings from the qualitative study and quantitative study are connected and compared in terms of measuring mobile health applications' usefulness.

Recall that the qualitative study, used for identifying the components of awareness, accessibility, and acceptance among rural populations, and affordability among technology entrepreneurs, has been analyzed by following three steps: the first step was to perform sentiment analysis and identify components from the content analysis for the data extracted from the Twitter website, the second step was to develop a grounded theory model from the interviews conducted among populations living in the rural regions, and the third step used conceptual-analytical model for identifying stakeholder views on fundamental conditions for initiating mobile health systems and desirable outcomes regarding affordability and cost-effectiveness of successful mHealth systems.

On the other hand, the quantitative data were also analyzed to investigate the direct relationships between mobile service–enabled empowerment, personal innovativeness, awareness, health consciousness, subjective norm, perceived usefulness on intention to use mobile health technology and applications. It can be seen that the steps of the qualitative and quantitative studies were corresponding to the layers of people, process, and technology, which is interacting with each other within the ecosystem, showing that the studies were framed based on similar ideas and structures. This allows the study approaches to be conducted under an overall conceptual framework. By doing so, findings obtained from the approaches will be easier to associate, validate and attain the purposes of triangulation and complementarity.

The evidence for triangulation is mainly related to the following aspect. The results of the qualitative studies showed that healthcare professionals could influence users and patients towards the use of mobile health applications across the use phases. Likewise, the empirical results of the quantitative study revealed that recommendations from the healthcare professionals and important person (subjective norm) tended to have an impact on perceived usefulness. Additionally, the qualitative interview further indicated that the level of awareness and familiarity about mobile health applications would improve the perceptions for enhancing their health conditions. Thus, it can be observed that findings obtained from both studies showed consistent evidence on the importance of subjective norm on mobile health applications' use. Prior studies on awareness and use of mobile health applications have shown the interaction between mobile service enabled empowerment and personal innovativeness (Chen et al. 2014; Rai et al. 2013), but ignored the impact of perceived usefulness. This study, therefore, contributes to the literature by providing evidence on the interaction between perceived usefulness and mobile health applications use.

Therefore, it can be observed that the use of quantitative and qualitative studies was closely integrated with each other invalidating the study findings. This improved the external validity of the overall study. As discussed in chapter 4, the results of the qualitative study have identified that people's awareness about mobile health technology and applications influences their intention to use. However, the finding from the quantitative analysis for these variables was inclined to be stable and was found to be significant. i.e., the relationship between the awareness and intention to use mobile health technology and application is found to be significant.

From the discussion of qualitative components obtained from Twitter, the presence of a causal relationship between the health consciousness, health information orientation, perceived usefulness, perceived ease of use, attitude, intention to use, and actual take-up was identified. On integrating the finding with that of interview data, it revealed a systematic process involved in the acceptance of mobile health technology and applications for Indian populations. Therefore, it would be interesting if future studies could use these models to study the significance and its interactions of the variables on the actual use of mobile health technology and applications.

The study also identified the components which are important for achieving affordable system operational effectiveness of mobile health technology and applications in India. The findings illustrated people's need and unwillingness, lack of application infrastructure, ecosystem development, governmental policies, and training and support as factors influencing successful mobile health systems. Therefore, it would be desirable to include multi-dimensional variables considering data visualization, cultural factors, trust, and relationships between users and healthcare professionals in the quantitative models. Thus, future research would consider all three levels, i.e., people, process, and technology, for studying their combined effect on mobile health technology and application acceptance and use. Indeed, the methodology adopted in this research drives through the layers of people, processes, and technology, and the integration of qualitative and quantitative study provides a rich depiction of the status of mobile health technology and applications in India.

Medical articles and other literature also claim that individuals suffering from depression and mental health issues are the reasons behind the outbreak of social media games (#Bluewhale Challenge) and social media movement (#MeToo movement). Therefore, the study incorporated sentiment and content analysis of the tweets for detecting the connection of common themes or consents surrounding social media movement and game to that of mental health. The results of BlueWhale Challenge, MeToo, and mental health, confirms that people suffering or having suffered from mental health conditions because of hoarding, harassments, and bullying at workplaces or homes have largely become the victims of Bluewhale game/self-harm or influencers in the case of MeToo movement. However, there exist certain common variables and practices that can be highlighted by these studies, and these are depicted in table 6.1.

Table 6.1: Common variables and practices identified through the Twitter sentiment analysis

| Variables / Themes | Social Media Game (BlueWhale Challenge) | Social Media Movement (MeToo) | Mental Health |
|---|---|---|---|
| Social Media | ✓ | ✓ | |
| Search Engine | ✓ | ✓ | |
| Messenger Apps | ✓ | ✓ | |
| Unsecured Websites | ✓ | ✓ | |
| Control Policies and Action | ✓ | ✓ | |
| Children | ✓ | | ✓ |
| Parents | ✓ | | ✓ |
| Schools and Education | ✓ | | ✓ |
| Loneliness | ✓ | | ✓ |
| Hoarding | ✓ | | ✓ |
| Sexual Penetration | | ✓ | ✓ |
| Disability Types | | ✓ | ✓ |
| Disorder Characteristics | | ✓ | ✓ |
| Women | | ✓ | ✓ |
| Healthcare Professionals | | ✓ | ✓ |
| Harassment | ✓ | ✓ | ✓ |

| | | | |
|---|---|---|---|
| Health Risk | ✓ | ✓ | ✓ |
| Younger People | ✓ | ✓ | ✓ |
| Suicide | ✓ | ✓ | ✓ |
| Depression | ✓ | ✓ | ✓ |
| Motivating | ✓ | ✓ | ✓ |
| ICTs and Mobile based solutions | ✓ | ✓ | ✓ |

From table 6.1, the study identified the existence of more and most common variables from the data analysis of Twitter, which have been considered and studied under four different cases depending upon its combination.

*Case i: BlueWhale Challenge, MeToo, and mental health*

The Twitter analytics of BlueWhale Challenge, MeToo, and mental health revealed that harassment, young people, suicide, depression, and motivation are the most commonly observed variables.

- *Harassment:* The content analysis of the Twitter data revealed that harassments and harm are most commonly observed across the three aforementioned studies. However, the only difference is that, in BlueWhale challenge, individuals suffering from mental health problems due to harassments or other issues have become the victims of self-harm, whereas, in MeToo, individuals who faced problems of harassments and abuse at workplaces or homes have become the influencers, and have targeted their peers by posting their experience about it on social media.
- *Health Risk:* Harassments, abuse, and violence have an influence on individuals becoming the victim of self-harm, depression, and other mental health condition. The ultimate result in all these cases will be putting their health into risk. For example, as explained in the causal loop diagram of social media game, the reason for the suicide is the influence of loneliness, depression, isolation, etc. faced by an individual.
- *Young People:* The study revealed that the younger generation people, particularly in the education and entertainment industry, have become the victim of BlueWhale game and/or MeToo because of mental health problems.
- *Depression:* It is considered a serious mental health disorder generally seen among the individuals who face the problem of sexual harassment, bullying, abuse, and

violence. In this study, it can be seen as the resultant outcome of being harassed by their peers or colleagues, which will either turn out in doing self-harm or in becoming an influencer on social media.

- *Motivating:* In this study, motivation act as a mental health recovery process wherein healthcare professionals or teachers as mentors are involved in indenting individuals suffering from mental health problems. The role of these mentors will be to get in contact with their patient or ward (mentee) on a regular basis, and to provide guidance in bringing them up and towards positive direction, like reminding them about good times, etc.
- *Information and Communication Technologies and Mobile based solutions:* Though technologies act as a medium to harass, abuse, and torment an individual, they can also be used in controlling and saving people from getting into self-harm and other severe mental health practices. Interestingly, the study revealed that sexual harassment and abuse have an influence on mental health. Individuals cited mobile-based solutions with a proper governing mechanism for early prevention, and for saving people from improper mental and physical health. For example, mobile applications used for reporting sexual harassment instantly.

*Case ii: BlueWhale Challenge and MeToo*

Consolidating the finding obtained from the BlueWhale Challenge and MeToo, we can study that; there also exist certain variables which influence an individual to suffer from harassment and become the victims of self-harm/suicide or influencers on social media. The following are the commonly identified variables:

- *Social media, search engines, messenger applications:* These variables act as a tool or a medium through which harassments are conducted, victimized, or reported. In this study, it was identified that social media forums (like Twitter) had been used to report their experiences and/or empathy, and to encourage others to seek support by targeting the tormentor, or to continue this movement. Search engines and messenger applications have also been used by the curator or admins to get in contact with individuals, and thereby to extort them to play the game of death.
- *Unsecured websites and applications:* Interestingly, it was also noted that unsecured websites and applications might also influence an individual to get

involved in sexual harassment, extorting, and abuse. For example, a cyberbully or stalker can use personal information (such as photos, locations, etc.) stored online to extort them. It was also reported that people are using unsecured websites and applications to download the game of self-harm.

- *Control policies and actions:* In this study, it was identified that, due to the enforcement of strict policies and actions against the tormentor or curator, the number of people becoming victims had reduced subsequently. Still, the governing body should continuously monitor and work on the safety and security of mobile applications and websites such that bullying can be controlled, and people can be saved from becoming the victim.

*Case iii: MeToo and Mental Health*

In the case, MeToo and mental health, the commonly identified variables are sexual penetration, disability types, disorder characteristics, women, and healthcare professionals.

- *Sexual Penetration:* The reason behind the outbreak of the MeToo movement is because of depression and mental health conditions which an individual experienced because of sexual harassment, abuse, and violations. From this study, it was identified that only the profiles of the proficient person from business, entertainment, movie industry, and politicians had been targeted. Many individuals have posted about their experiences in the social media forums against the tormentor. Some of the tweets specified that because of their mental health conditions caused by sexual penetration and harassment, they were compelled to share experiences online and make others aware of them. However, as of now, the case is still on to confirm whether it is because of any conspiracy or not.
- *Disability Types and Disorder Characteristics:* It was identified that an individual's disability type and disorder characteristics also influence mental health problems. For example, the literature defines that crime and harassments are the components of discrimination which an individual faces with a mental health problem (Williams et al., 2012). This means that because of disability discrimination, individuals often feel depressed and lonely as they are considered to be less favorable within the group. Moreover, disability discrimination is often being subjected to harassment,

which ultimately impacts their physical and mental health. Likewise, individuals possessing improper disorder characteristics (such as depressive disorder, post-traumatic stress disorder, etc.) may face the problem of harassment, abuse, and violations due to their association with a terrifying incident.

- *Women:* According to the WHO (2019), it was identified that woman predominates, and approximately 1 in 3 people in the community face mental disorders, i.e., depression, anxiety, and somatic complaints. Thus, the study findings become valid in this case, i.e., girls and women populations had been the common theme, and they largely faced mental health problems because of harassment at workplaces or at homes.
- *Healthcare professionals:* In this study, healthcare professionals act as a consultant or solution provider to solve mental health problems of an individual. Their main task is to work closely with the victims to generate evidence and support without blurring any of the body or body parts. In addition, as aforementioned, they should act vigilantly, quickly address complaints, document misconduct, and comply with healthcare-specific obligations to address problems of harassment and mental health (Morris et al., 2018). For this, they may require a smartphone application which helps them in managing these processes, and eliminating such problems.

*Case iv: Mental Health and BlueWhale Challenge*

The common variables identified in the case of mental health and BlueWhale challenge were: children, parents, schools and education, loneliness, and hoarding. These variables are discussed as follows:

- *Children:* In the case of mental health and BlueWhale challenge, school-going children and youngsters have become the victims. Since they themselves develop intrinsic motivation towards the use of mobile and smartphones for gaming, watching videos, etc. and due to their passion and addiction, they might have got acquainted with such geo-located augmented reality games and ultimately become the victim of the game. The other reason could be the depression, loneliness, bullying, or any other internal struggle faced by them in society, and within the school and college premises.

- *Parents, schools, and education:* These variables can be considered either as a catalyst in receiving mental health or in controlling the situations and saving lives. For example, parents and teaching professionals should encourage their children and ward in getting good grades and scores in their exams, rather than frequently pressuring and comparing them with their classmates, relatives, and neighbors. They should also create a healthy atmosphere so that children or students feel free to approach them and discuss the problems which they are facing. It was also identified that teaching professionals should also nurture the creative ideas of the students and encourage them in discussions and decision making. At the same time, they should make the students aware of the importance of mental health and the reason it has to be given priority. This helps them to be mentally strong. Interestingly, there were tweets suggesting the need for including physical exercises and games in their curriculum so as to balance the mental pressure caused by to their workload. Also, organizations and educational institutions should also implement strict policies and actions against ragging, harassments, and smartphone use in the campus so that the violence and self-harm can be controlled.
- *Loneliness and Hoarding:* These variables are considered to be the determinants of harassment and other violations. Therefore, parents and their peers are advised to talk to them and continuously monitor their children or ward at their homes, schools, and organizations on a regular basis. This will help us in measuring their performance and behavior. If found inappropriate, quick actions should be taken in consulting with the help of doctors and healthcare professionals such that the individuals can be prevented or saved from becoming it severe and worse.

### 6.2.2. Measuring and Reporting Variables

The previous section presented the findings of the qualitative and quantitative studies that are connected and compared in terms of understanding and modeling variables. This section focuses on the integration of findings obtained from the qualitative and quantitative studies for measuring and reporting the variables of awareness, accessibility, and affordability of mobile health technology and applications in India. As aforementioned, the integration of qualitative and quantitative findings within a single study helps in reducing the limitations and biases and provides a new approach to assess the current state of mobile health technology and applications across the layers of people, process, and technology. From the study findings, it was observed that the dynamics associated with the mobile health technology and applications in the real environment are somewhat disorganized, resulting in the sense of dissatisfaction among the stakeholders (i.e., people, healthcare practitioners, government, and the techno-entrepreneurs). Therefore, the mobile health technology and application involves consideration of multiple views for capturing perceptions of these individuals for adoption or absolute rejection of the mobile health system across the patients' use-phases. This study, therefore, uses a synthesis matrix to organize the findings and for revealing the pattern of information. The synthesis matrix consisted of the study dimensions (awareness, accessibility, acceptance, and affordability) across the rows and the perceptions of mobile health among users/patients, healthcare professionals, general population, technology entrepreneur, and social media users in the columns. The synthesis matrix has been discussed in four cases, and is explained as follows:

*6.2.2.1. Synthesis of Findings for Awareness*

The following table (table 6.2) presents the synthesis matrix for the component awareness.

**Table 6.2: Synthesis matrix for awareness**

| User/Patients in Rural Regions | Healthcare Professionals | General Population | Technology Entrepreneur | Social Media (Twitter) Users |
|---|---|---|---|---|
| • People use video applications, calling, and SMS applications for health but lack knowledge and familiarity about the term mobile health.<br>Lack of awareness about the government initiated mobile health applications. | • The ambiguity about the term exists among the medical staff.<br>• The familiarity with the term mobile health is less among the staff.<br>• Lack of awareness observed among doctors and supporting staff when asked about government initiated mobile health applications. | • The degree of awareness and familiarity about the term "mobile health" among technical students and working staff is 55.17%.<br>• Technical students and working staff used mobile phones for cold and fever (63.36%), asthma (53.57%), cancer (40.74%), diabetes | • The stakeholders (technology entrepreneur and healthcare IT developers) are aware of the term 'mobile health'. | • The sentiment analysis of fitness, diabetes, meditation, and cancer mobile health applications revealed that people are aware of fitness and diabetes applications. |

| | | | | |
|---|---|---|---|---|
| | | (55.55%), menstruation (44.11%) and stress and mental health (53.6%). | | |
| • Literacy problems for locating and identifying the right applications. | • They use mobile phones for vaccination and treatment remainders for pregnant and new mothers and for TB patients.<br>• Comparative analysis revealed that the degree of awareness and familiarity about the term “mobile health” among medical students and health professionals is 44.82%.<br>• Health professionals used mobile phones for cold and fever (36.63%), asthma (46.42%), cancer (59.25%), diabetes (44.44%), menstruation (55.88%), and stress and mental health (46.4%). | • The awareness about mobile phone use for health-related components is significant except for health awareness and education, and medication adherence, and refilling.<br>• Mobile service enabled empowerment, and personal innovativeness together contributes to 10.6% of the variance in awareness.<br>• The results of the path analysis indicate that awareness enhances an individual’s use of intention. | • They also agreed that knowledge, familiarity, and utility could be improved by keeping the doctor at the fulcrum. | • Improving awareness and familiarity about the right mobile application helps in reducing depressions and self-harm practices saving lives.<br>• Awareness about mobile phone applications helps individuals in reporting harassment and violations to the concerned authority instantly. |

From table 6.2, it can be identified that social media users and technology entrepreneurs have reported the importance of mobile health applications and services awareness for improving health literacy and conditions. However, the familiarity and awareness about the term ‘mobile health’ and government-initiated applications is still found to be lacking among the rural and general populations and healthcare professionals. It has been observed that people are using basic mobile phone applications for communicating and receiving health information. In most cases, people reported the need for a doctor or healthcare professional to improve their familiarity or recommend it to the people. The problems of literacy act as a barrier for the individuals in locating the right applications, information sources, and reporting harassment and violations. The quantitative study involving non-users, one-time users, or continual users of mobile health applications also revealed that mobile service-enabled empowerment influences awareness. This means that empowered people are likely to be aware, and find it meaningful to use mobile phones for healthcare service delivery as it would help them in managing problems independently by maintaining their anonymity and privacy. The awareness also influences the perceived usefulness and intention to use mobile health technology and applications.

*6.2.2.2. Synthesis of Findings for Accessibility*

The synthesis matrix for accessibility is presented in table 6.3. Here, the accessibility of mobile phone applications and Internet can create a positive and sometimes negative impact on the lives of the individuals. For example, through mobile applications, individuals were involved in self-harm as a part of the activity or task. Simultaneously, it can also help individuals in finding out solutions to their physical and mental health problems at the right time by maintaining their anonymity and security.

The study findings also agree that the accessibility of mobile health applications and technologies is crucial for improving the health and disease condition of the people. But the same is not true in all cases as it is dependent on the complexity of the disease. The social media users claim that the use of cancer applications would facilitate individuals in improving their health at the early stages than at later stages.

**Table 6.3: Synthesis matrix for accessibility**

| User/Patients in Rural Regions | Healthcare Professionals | General Population | Technology Entrepreneur | Social Media (Twitter) Users |
|---|---|---|---|---|
| • Difficulties in paying transportation cost as there is a lack of bus connectivity | • The nearest district hospital is more than 10 km, and people visit primary healthcare for | • People are using mobile phones and their applications for communicating and receiving | • For people living in urban and semi-urban locations, the process of | • Access to mobile cancer applications in the early stages of diagnosis can be helpful in |

| | | | | |
|---|---|---|---|---|
| towards the hospital area.<br>• Problems of literacy and health literacy, Internet and mobile phone connectivity, supportive infrastructures, and features limits itself from being accessible. | medical consultations.<br>• Power breakdowns and mobile network problems limit access and adoption of health information technology.<br>• Difficulties observed during software breakdowns as the service center is at a distant place. | health information.<br>• They have used social networking apps (31.29%), video sharing apps (18.09%), and Internet browsers (52.32%) for cold and fever, obesity, stress, and mental health, and toothache problems. | integrating the healthcare process and systems helps in reaching the patients and their feedback.<br>• Governmental regulations, like section 304, restrict doctors to access healthcare applications and technologies. | improving and saving lives.<br>• Access to various technologies and the Internet positively influences individuals in finding out solutions for health conditions and also to create and report abuse and harassment.<br>• Access to online social media blogs and websites helps in saving individuals' costs and time. |

Accessibility also depends on the availability of the network infrastructure and supporting facilities. It should also be made available in the nearest healthcare units with proper interoperability so as to avoid breakdowns and disruptions. As the majority of people are taking treatments in the primary healthcare units because of the larger travel time and improper bus connectivity contributing to the time, cost, and health risk. Therefore, the availability and accessibility of the mobile health applications infrastructure would be beneficial for them in managing and scheduling healthcare services independently.

At present, people use basic mobile phone applications for reproductive and child health programmes, Indradhanush and cessations programmes, and the 99DOTS process, signifying physical accessibility. It is suitable and beneficial for pregnant and new mothers, TB patients in treatment, vaccination, and medication reminders. Among the general population, which includes students and professionals of engineering and medicine, and academicians, the use of mobile health application is direct and restricted for searching nearby hospitals, communicating with doctors for scheduling appointments and consultations during unavoidable conditions such as weekends and at night. They have even used it for finding health information pertaining to cold and fever, obesity, stress and mental health, and toothache problems.

*6.2.2.3. Synthesis of Findings for Acceptance*

To achieve the nation's health policy objective of providing universal health coverage (WHO, 2014), digital health systems have been incorporated, making patient data accessible, reducing fraudulent systems, and insurance policies for improving accountability (Garg, 2018).

The findings of the quantitative and qualitative study agree that mobile health applications help in improving the health and service delivery; but it is crucial to understand the problems associated with the technicality and governance (Table 6.4). This has also been agreed to by the healthcare professionals and technology entrepreneurs. They have suggested considering people's need and unwillingness in developing mobile health applications and technologies. Since some of the people in the rural and urban regions have given priority to traditional homemade therapies, the technology entrepreneur should consider these factors with cultural and other demographics for mobile health acceptance.

The finding of the qualitative interview conducted in the rural region indicated that people are likely to visit the doctor personally rather than through intervention conducted via mobile phones. When enquired, they revealed the credibility of the information and the literacy in locating the right applications as the major reason. This has also been agreed to by the technology entrepreneurs. They have suggested to provide training sessions, and to promote the applications by keeping doctor at the center.

**Table 6.4:** Synthesis matrix for acceptance

| User/Patients in Rural Regions | Healthcare Professionals | General Population | Technology Entrepreneur | Social Media (Twitter) Users |
|---|---|---|---|---|
| • The credibility of the information and sources is not trustworthy.<br>• People prefer personal visits to mobile intervention. | • Indian penal code (section 304) has been imposed on doctors to restrict mobile communication for health consultations. | • Acceptance depends on the cost of the service and applications and its value for the money.<br>• The acceptance of mobile health | • People's Need and Unwillingness.<br>• Supportive governmental policies.<br>• Training and support. | • Recommendations from clinics or hospitals are preferred for accepting applications.<br>• Lack of awareness or interoperability |

| | | | | |
|---|---|---|---|---|
| • Preference given to traditional homemade therapies as a preventive and reactive approach.<br>• Recommendations from doctors are necessary for using mobile health applications.<br>• Mobile health applications and services should be cost-effective and affordable. | • People try false dialing for a 99DOTS process for eradicating TB.<br>• The negative perception of the mobile phone as it is hazardous.<br>• Mobile health technology and applications should be customized according to the need and processes.<br>• It should be approved by governing bodies, and if hand-held support and training are available. | applications also depends upon the availability of it in the nearest healthcare center.<br>• Personal innovativeness and awareness influence individuals' intention to use mobile health technology and applications. | • Ecosystem development. | issues resulted in sadness among people.<br>• People prefer meditation applications because of mindfulness and deep sound features, which are binaural in nature.<br>• The mobile health application displaying some documented symptoms can be helpful for improving health. |

The study also revealed that the applications and technologies which are available are developed and practiced in western countries, and are not suitable in the Indian scenario. This can be because of the policy of healthcare systems and/or government. The penal code (section 304) of India has been imposed restrictions on doctors not to use mobile phone during health consultations, which limits acceptance and use.

The other reason identified was mobile health applications for the TB process. Though it is available, people try false dialing practices, indicating adherence to pill taking. This has been reflected in the questionnaire study that, personal innovativeness influences intention to use. That means, people with higher innovativeness and interest in technologies are likely to use such applications when newly introduced. The social media messages, healthcare professionals, and technology entrepreneurs have also agreed about the problems of interoperability and network securities, for which necessary support should be provided by the government for improving the acceptance. The people in the urban and rural regions have also specified evidence of individual health change outcomes. For this, the database and system similar to the 99DOTS process can be maintained centrally at the district or private hospitals, which reduces patient waiting time and improve consultation time of the doctors. The concern which was identified among all the groups was the affordability of mobile health applications and technologies. People, including doctors in rural and urban areas, have agreed that cost factors influence acceptance of mobile health applications and technologies. This means that, if the cost of the device is more, then only a percentage of people (high-income group) can afford, and may use it for health activities. This will not support the desired objective. Technology entrepreneurs have taken up the affordable components, and are finding out ways to bring down the cost of individual components that need to be equipped into the main instrument for monitoring periodic health status.

#### *6.2.2.4. Synthesis of Findings for Affordability*

The synthesis of the findings for the affordability has been represented in table 6.5. Social media users believe that accessibility and affordability of the Internet and smartphone will influence connectivity and wider spread distribution. But through interviews, it was identified that affordability of the device, hardware, and software infrastructure should also be considered to be critical in improving the usefulness of mobile health applications and technologies. The social media users, may be the users of fitness applications, have recommended new and freely available applications to be effective. The people in rural and urban locations have agreed that the cost of the device and its utility are the major concerns. This can be due to the difference in their income status, which makes them think about the device cost, though it has some positive implications. Interestingly, the cost and the utility factor have also been identified in the interviews with healthcare professionals in the context of setting up of suitable infrastructures, systems, and processes.

**Table 6.5: Synthesis matrix for affordability**

| User/Patients in Rural Regions | Healthcare Professionals | General Population | Technology Entrepreneur | Social Media (Twitter) Users |
|---|---|---|---|---|
| • Difficulties in purchasing smartphones among daily wage people.<br>• The application should be cost-effective.<br>• Should provide value for the amount paid. | • Difficulties in the purchasing process for high-end technology supportive devices to store patient records.<br>• The process involved in setting up of structure, systems, and software is time-consuming as it has to go different channels for approval. | • The questionnaire survey identified that 86.5% of the people are considering factor affordability, i.e., value for the money in accepting and using mobile | • The effectiveness of an affordable system depends on technical performance, supportability, process efficiency, and affordability.<br>• Application infrastructure and affordability: i.e., the cost of the components used | • Fitness applications that are new and freely available are used in managing healthcare service and for diet practices.<br>• Accessibility and affordability of the Internet promote the wide-spread |

| | | | | |
|---|---|---|---|---|
| | Should be effective and create value for the amount paid. | health for service delivery. | in mobile health applications. | distribution and instant connectivity of information. |

This indicates that for achieving affordable system operational effectiveness, other than affordability, technical performance, supportability, and process efficiency should also be considered by software developers or technology entrepreneurs. Therefore, from the synthesis of study findings, it can be concluded that the affordability of mobile health technology and applications is also dependent upon the cost of the nested components which are required for the development.

*6.2.2.5. Synthesis of Study Findings using Rich Pictures*

The study also uses the concept of 'Rich Pictures' as suggested by Checkland and Scholes (1999) and follows discussions about the variables and their interactions associated with each of the stakeholders. The discussion and opinions about mobile health technology and applications identified through qualitative and quantitative findings have been discussed in the form of a conceptual model (figure 6.1).

The main purpose of defining is to logically deduce the problematic situation so that the company can get a clear outlook about the situation, thereby providing a base by considering it from different viewpoints. Following the storylines, it becomes apparent that mobile health technology and applications "involve complex structures, systems, and processes connected together to form a whole, and thereby showing the properties of the whole, than the properties of its component parts" (Checkland and Scholes, 1999).

From the figure 6.1, it was observed that healthcare officers (central), healthcare officers (regions), and software developers feel that the use of mobile phones or smartphones can help in achieving national health policy 2017, i.e., providing universal health coverage and delivering quality healthcare at an affordable level. Accordingly, healthcare professionals look for the support of government for providing necessary supporting facilities and infrastructure for improving accessibility. They depend on software developers to develop mobile health systems according to their need and requirement so that it fits well within the systems. As the use of mobile health technology and applications affect the health directly, people have cited the recommendations from healthcare professionals for accepting and using it in their daily lives.

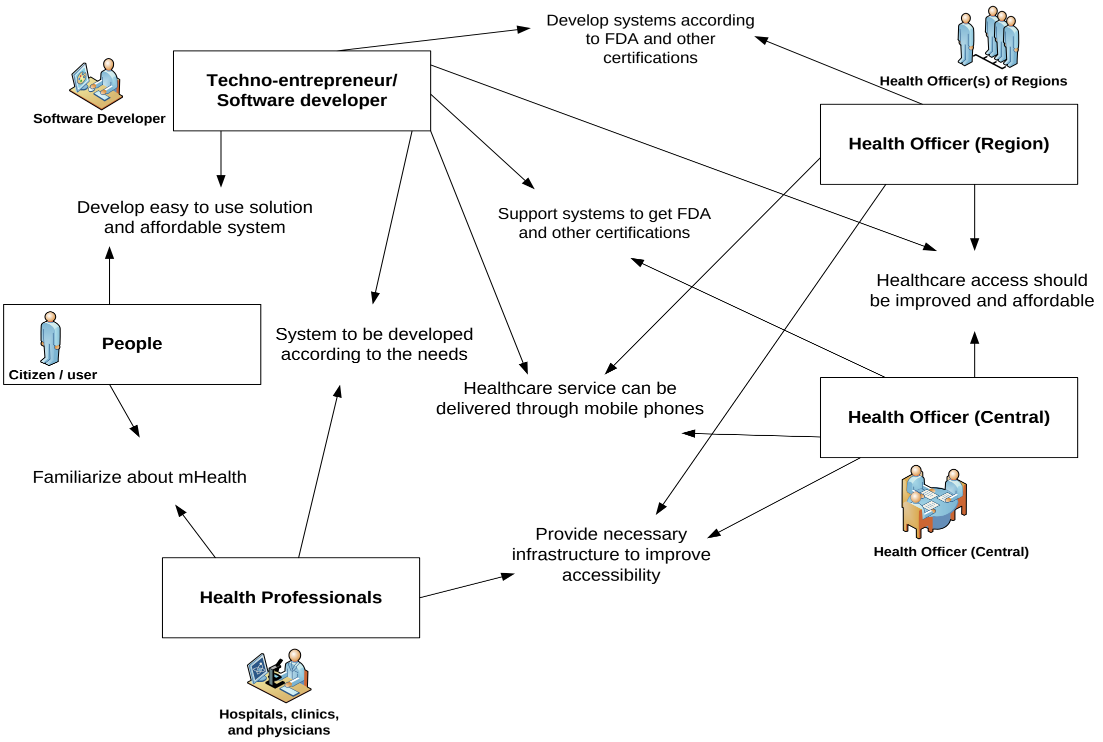



**Figure 6.1:** Rich picture of mobile health technology and application initiation and adoption

Thus, healthcare professionals play an important role in improving the level of awareness and familiarity among people and to assist them in using it for managing health and disease conditions.

Finally, software developers should work closely with the government and people in developing easy-to-use solutions, and alternately, should build a robust system architecture certified with FDA and other governing bodies to improve peoples' perceptions and trust and to support evidence-based practices. The interactions between each of the stakeholders involved in the process of initiation, development, and implementation of mobile health technology and applications have been presented in the following sections.

The interactions between the health officers (central and region) and software developers are depicted in figure 6.2.

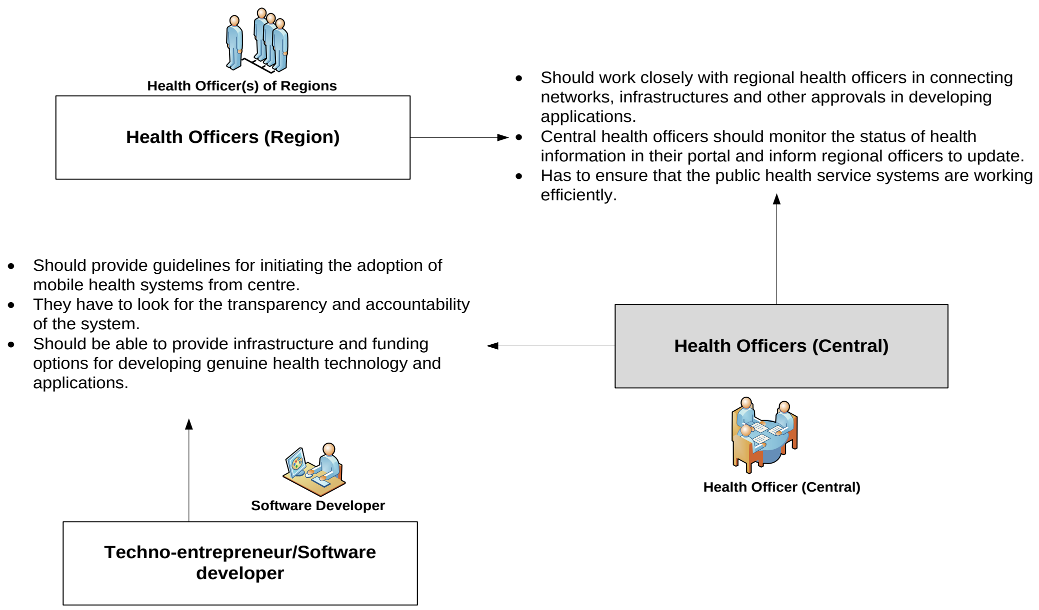



**Figure 6.2:** Rich picture explaining interactions between health officers (central and region) and software developer

It explains that the health officer (central) should support the health officer (region) and software developers initiating the use of mobile phones for health and disease conditions. They should continuously work with regional offices in improving interoperability and other facilities required for initiating mobile health solutions. In addition, they should act as a monitoring and controlling unit and observe whether the healthcare facilities are working as desired. Simultaneously, health officers (central) should work with a software developer in identifying and providing funding opportunities and to setup necessary infrastructures for designing a mobile health system that is transparent and accountable.

The interactions between health professionals, health officers (region), and software developers are depicted in figure 6.3. It can be observed that, for recommending mobile health technology and applications, the healthcare professionals should work with software developer towards customized mobile health system which is reliable and maintainable with proper utility, support, and application feature. Simultaneously, the systems and their network should also be secured, such that the patient data is protected.

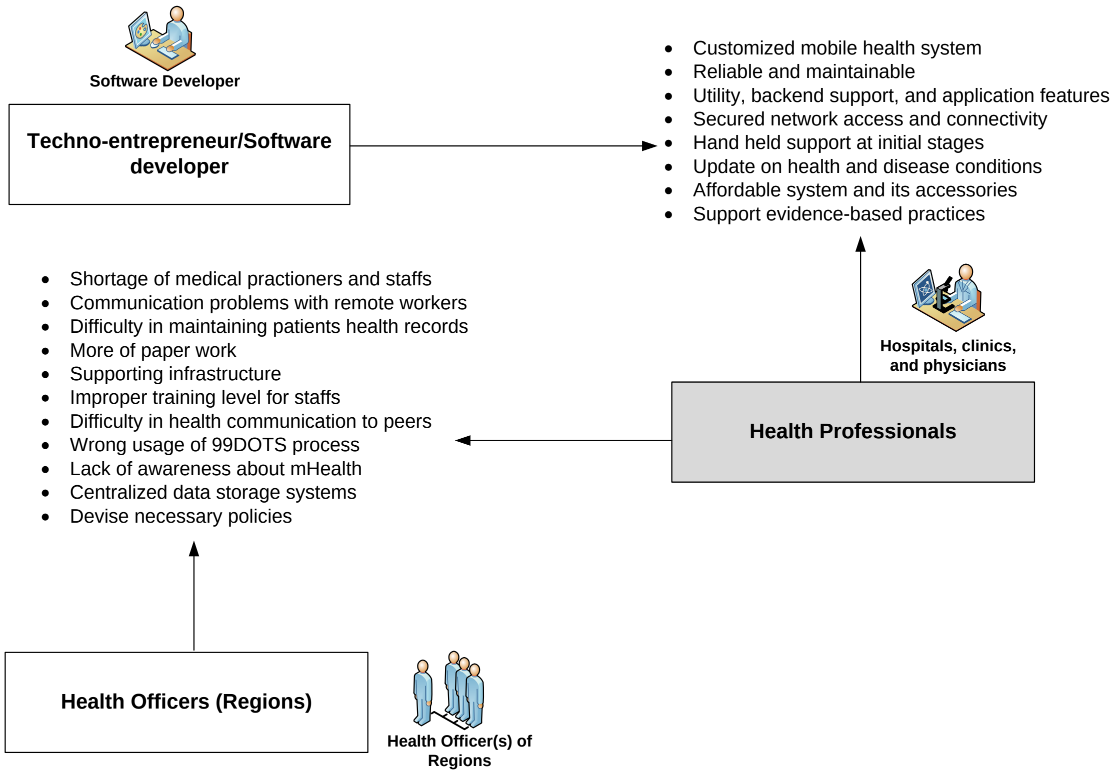



**Figure 6.3:** Rich picture explaining interactions between health professionals, health officers (region), and software developer

They should also consider the resource allocations and constraints of the health officers (regions). It was observed in the rural regions that, due to a shortage of medical practitioners and staff, a single doctor or two have to consult the health problems of the patient, which greatly influences his/her health and physical conditions over time. The same has been found in the content analysis of mental health. It mentioned, *"Doctors at high risk for depression & #Suicide, Survey says about 15% of physicians are depressed, and ...#News #MentalHealth #MentalHealthIssues #SuicidalIdeation #PhysiciansAndMentalHealth #Overstressed #DeathBySuicide*".

It was also identified that due to lack of supporting infrastructure, healthcare professionals are finding it difficult to maintain patient health records. This makes them spend extra time and energy manually writing down the prescriptions and vaccinations, which not only takes a lot amount of patient time but also is prone to errors. Interestingly, it was identified in the process of 99DOTS program, and people are advised to use mobile phones to a tollfree number as an acknowledgment for medication adherence. But people in some cases are using it wrongly probably because of lack of interest, training, and health consciousness.

The study identified that most healthcare professionals are not aware of mobile health though they use it for the 99DOTS process. Therefore, sensitization helps in improving the familiarity and uptake of applications and technology. Statistically, it was confirmed, as awareness about mobile health technology and applications influences perceived usefulness and intention to use. Upon explaining the term, they agreed about the relationships present between the awareness and intention to use, but revealed the suboptimal nature of available applications. This is because of lack of suitability and authenticity of data sources and certifications from the referral or governing bodies. They also specified the need for customized and cost-effective health applications for making it acceptable in the Indian context.

The integration of the people, technology entrepreneur and health professionals is presented in figure 6.4. It was identified that technology entrepreneurs should also consider demographic characteristics and other cultural factors of the individuals when developing mobile health technology and applications. The study also identified that empowered and health-conscious people are correctly following the instructions of the doctors for the medication (99DOTS process) and treatment adherence (maternity). They are finding it beneficial as they are easy to use and affordable solutions for health improvement.

The study finding also indicates the information and source credibility, for which the support from the healthcare professionals is required for carrying out intervention through mobile phones. For diet and fitness applications, people prefer updated health information and features of gamification and incentive schemes for providing them motivation and support towards exercise and other fitness activities.

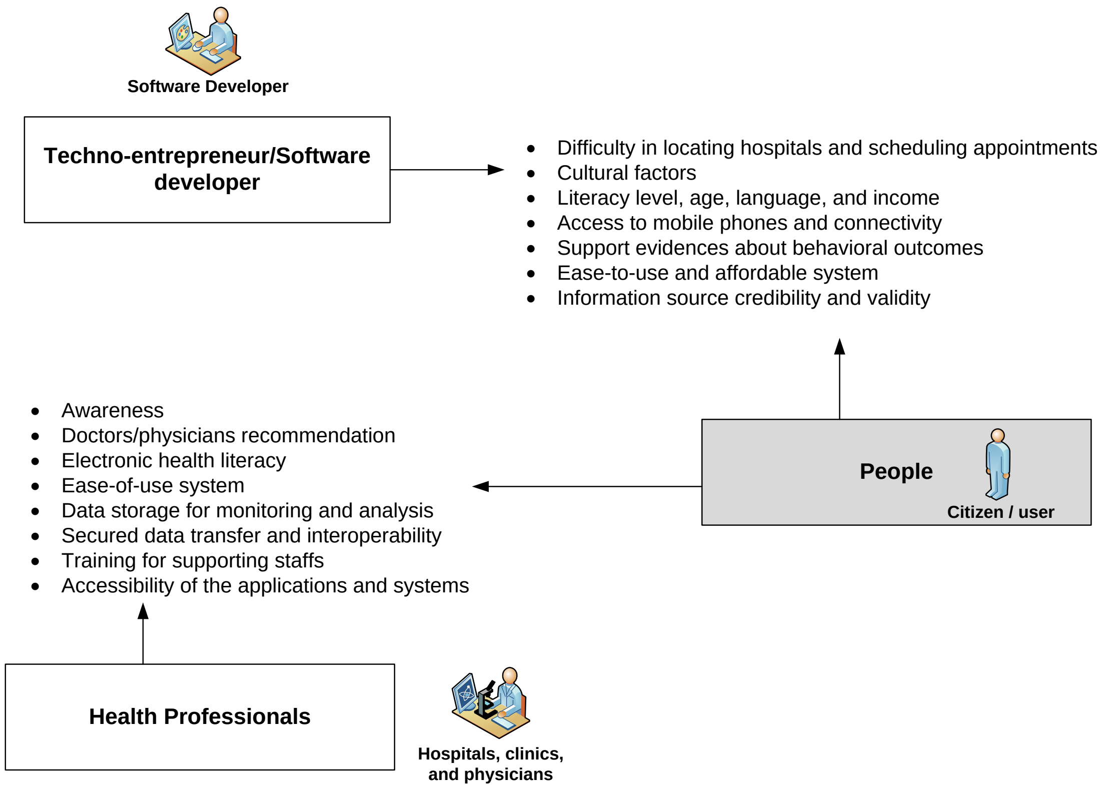



**Figure 6.4:** Rich picture explaining interactions between people, health professionals, and software developer

From healthcare professionals, people expect suitable infrastructure, staff, facilities, training, and support during improper health conditions. They also expect a recommendation from healthcare professionals in improving the awareness and in using the applications as they feared about the accessibility, information and source credibility. This result has also been confirmed statistically, as subjective norm significantly influences the perception of mobile health technology and applications for health.

The interactions from the people and that of a technology entrepreneur, people, and health officer (region) are depicted in figure 6.5.

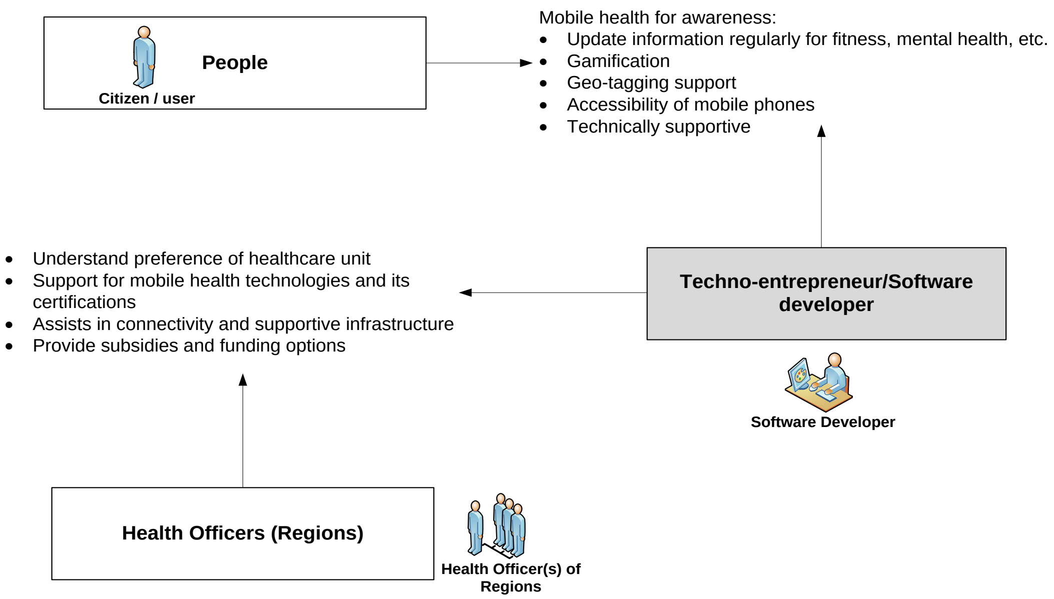



**Figure 6.5:** Rich picture explaining interactions between software developer, health officers (regions) and people

It was identified that technology entrepreneurs basically look for the support of the health officers in providing permissions for understanding the working conditions and systems of the healthcare units or towards mobile health technology and application initiations and development. It can work in terms of providing connectivity and supporting infrastructures, subsidies and funding options, which would help them in motivation and performance improvement. They also look for constant support and feedback from the users and other stakeholders regarding the degree of awareness and availability of features present in their products and services for further improvement.

## 6.3. Implications of the Study

The previous sections have discussed the findings obtained from the qualitative and quantitative studies and are connected and compared in terms of measuring and reporting variables for measuring awareness, accessibility, and affordability of mobile health and application. These findings have certain implications and recommendations for improving mobile health applications' usefulness among the people, healthcare practitioners, government, and the techno-entrepreneurs in making decisions.

To make the discussion clear, this section discusses the implications corresponding to primary qualitative and quantitative data analysis. Firstly, section 6.3.1 discusses the theoretical implications of the study, followed by practical implications in section 6.3.2. Finally, the business implications of this study are discussed in section 6.3.3.

### 6.3.1 Theoretical Implications

The usefulness of mobile health applications and technology can be improved only when people are aware of different health applications available in their mobile play stores. Moreover, as stated by Ehteshami et al. (2013), the Information Technology (IT) capabilities and awareness of needs and interest, are essential in programming optimized efficiency of IT and facilitating message transmissions. The present study was conducted to measure the awareness and use of mobile health applications among groups of technical students & working staffs, and groups of medical students & health professionals studying or working in India. However, previous literature published had also addressed mHealth awareness among college-going students of engineering and medical colleges, and the awareness results were similar (Ehteshami et al., 2013; Parthaje et al., 2016).

In most of the results relating to awareness and the use of mobile phone technologies in healthcare, among the groups, technical students and working staff have the highest awareness about the usage of medical students and health professionals. This can be due to mobile phone and Internet access, which drives technical personnel towards innovativeness, trying out new technologies, resulting in positive belief about such technologies. In addition, most of these technical students try to keep themselves up-to-date about the latest technologies, which helps them in designing and developing architecture or applications relating to mobile phones.

The use of mobile phone technology and applications in our study corresponds to a total of 63.7% of the study population. Of these, 135 (34.9%) respondents were from among technical students and working staff, and 111 (28.7%) respondents belong to medical students and health professionals. This means that medical students and health professionals were using less of mHealth apps even though they are aware of it. The reason could be inefficient and inaccurate online health information, data privacy issues, problems in identifying the right health apps, lack of trust and technology infrastructure for facilitating patients' data, and resistance to using because of socio-demographic characteristics of the respondents (such as problems of literacy, language, income, etc.).

This result was found to be consistent with another study finding that healthcare providers are reluctant to use medical devices and apps for clinical practices due to the fundamental level of quality and safety in using the apps (Ventola, 2014).

Similarly, medical students and junior doctors specified the importance of user-friendly smartphones in education, professional practices, and hospital management system and indicated about the management concern (such as return on investment, patient safety, and data privacy factors) in implementing it in their projects (Payne et al., 2012). Also, about 68.84% of the Indians live in the rural region (Chandramouli and General, 2011). The hospitals and software developers should also consider affordability factors and people's lifestyles in implementing technology, such that both will be benefitted. For example, it was found in a randomized controlled study that the smartphone application is negatively associated with the number of alcohol intakes and is not effective in reducing alcohol consumption among university students (Gajecki et al., 2014). At this instance, the mHealth application standards and interoperability should also be considered to get accurate patient data and efficient data processing units, which assists people in managing their health.

Moreover, these authors have also pointed out that investing time and money in such new technology should generate benefits to the organization in the form of Return on Investment (ROI) with patient safety and data privacy factors. In India, nearly 68.84% of the people live in the rural region (Chandramouli and General, 2011), hospitals should consider these affordability factors and people lifestyles in implementing technology such that they will also be benefitted.

Thus, in India, the improvement in mHealth awareness and use can be ensured either by building the evidence base, trust, and by removing the misconceptions about mobile phone use or through doctors' recommendations. As people tend to use mobile health applications until an authoritative and governance policy recommends it. Therefore, in our study, even-though private and government bodies are promoting mHealth platforms, the differences in the level of awareness and use can be observed across students, practitioners, and workers of technical and medical courses. In such cases, these results can equip healthcare providers and application developers to device necessary promotions strategies and support for creating awareness and making them use mobile phones and applications for day-to-day activities.

For measuring the intention to use mobile health technology and applications, the current study uses multiple theoretical models to identify the study variables. As indicated by the researchers, the use of multiple theoretical models forms a robust framework that integrates theoretical efforts supported by multiple subjects (Edmondson and McManus, 2007; Alathur et al., 2014). In the conceptualization of this model, the variables: health consciousness (Dutta-Bergman, 2004; Cho et al., 2014), subjective norm (Ajzen, 1991), perceived usefulness (Hu et al., 2003; Davis, 1989), awareness (Sathye, 1999), intention to use (Bhattacherjee, 2000; Wahyuni and Nurbojatmiko, 2017), mobile service enabled empowerment (Spreitzer, 1995; Chen et al., 2014), and personal innovativeness (Agarwal and Prasad 1998; Rai et al., 2013) are incorporated for making it complete according to the present situation. The description of these variables is given in the previous sections. Thus, by considering the relevant variables, the conceptual model so formed is theorized as it appears in the present context and among Indian citizens.

### 6.3.2 Practical and Policy Implications

The Government of India (GOI) has already initiated 'Digital India' campaign for promoting governmental services accessible to citizens electronically by creating a secure and stable digital foundation and by providing universal digital literacy for enabling various schemes like Make in India, BharatNet, etc. For this, at present, Bharat Broadband Network Limited connected 625,000 villages tthrough mobile connectivity, public Internet access program, E-Kranti- electronic service delivery, etc. Also, realizing the disparity in the population level and healthcare, and due to unprecedented achievements in mortality rate and various disease outbreaks, India's Millennium Development Goals has failed. Thus, national health policy 2017 for achieving Sustainable Development Goals (SDGs) 3 has been formulated. In addition, GOIs 'National Institution for Transforming India' (NITI) Aayog was set up for SDG 3 by using mobile health applications such as telemedicine and point of care diagnostics processes. Besides these, National eHealth Authority for regulating and monitoring electronic health exchanges and electronic health record standards has also initiated to improve accessibility and affordability of health information technologies and mHealth devices (NITI Aayog, 2017). Consequently, these applications and services create a benefit for the government and people.

In this context, the study findings help the practitioners to get feedback about their health applications so that they can operate and modify them by regularly updating the technology databases with proper diet plan, calories meter and fitness videos and meditation tunes, etc. It also helps customers/patients in delivering health care services from scheduling appointments to medication reminders, including treatments and processing of health records, which creates value for achieving satisfaction for the patients and the customers. Furthermore, these data help the company to identify their current market share with respect to their competitors which help them in devising necessary policies and strategies accordingly. Focusing on the themes related to customer perceptions and expectations along with their possible causal relationships happening within the system, helps them in increasing the visibility of their health applications, which in turn improves the returns to their stakeholders.

The findings obtained through this empirical study should be noted by the government as well as the techno-entrepreneurs in devising mHealth platforms. To improve the participation of citizens in using mobile phones for health activities or mHealth apps, the design and operating process should be as easy as that of the case of 99Dots process for TB or Khushi Baby programmes for maternal and childcare such that less educated people or any people having basic handset can record or receive their health status. In addition, it highlights the supervision and support of the government and the techno-entrepreneur through crowdsourcing agencies to monitor their health device (such as NFC necklace and stickers) for accurate data in accordance to the standard governing bodies such as Food and Drug Administration (FDA), etc. and constant feedback. Furthermore, the findings help the government in identifying and communicating medical practitioners regarding immunization or health-related programs so that they can plan for the medical training and visits for improving treatment and care. It also assists the government in initiating and designing different insurance and health policy schemes for the benefit of the people, particularly in the regions where access to health care is quite less.

As it was observed, lack of trust, social influence, and mobile literacy was found to be a major component in awareness, accessibility, and acceptance of mHealth among rural regions. The participant expects that because of many cyber-related crimes and harassment through mobile phones, the use of mobile phones for health utility should incorporate apps, and should be suggested by their doctor during visits. The governing body should take care of these cases, as the health-related data generated or recorded should be communicated to the right hands for medication or treatments, as users/patients will be directly at risk. Supportive health workers or community workers are also equally responsible for the monitoring and communicating of the health-related activities, as they act as interphase between the patients and doctors. The importance of respondents' efficacy along with motivations and willingness also plays an important role in enhancing knowledge. Connected training sessions for the subsequent use of mobile phones for health activities, in turn, helps them in maintaining health correctly in the right condition, and in creating interest with them and others through word-of-mouth.

The adoption of mHealth technology and applications plays an important role for the doctors and patients in streamlining healthcare processes to achieve the desired goal of universal health coverage. By identifying various factors influencing mHealth application and technology adoption, the healthcare professionals and other stakeholders can easily understand the ground reality and its working so that specific targets and action plans can be devised accordingly. For instance, as aforementioned, a lack of awareness could be a possible reason for its low adoption. In such cases, Dietsche (2014) concept of governance is recommended. This model considers various perspectives for achieving good governance through the dimensions of results, processes, rules, or the ability to steer (Dietsche, 2014).

The Government of India has aligned its national development goals with that of sustainable development goals with the agenda "Sabka Saath Sabka Vikas," i.e., "collective effort, inclusive growth" (United Nations, 2017). For this, they have brought in various ambitious programs such as Aadhaar (biometric identity system), national health portal, and mobile telephony as support for Digital India (D'Monte, 2016). Information and communication technology at its forefront acts as a key enabler for connecting the people across the federal systems of governance and sustainability. With the smartphones and its applications, the lifestyle of an individual has changed, and the information or services which were earlier inaccessible or required greater time and effort, have been made available within a few phases. Likewise, Ministry of Health and Family Welfare, National Health Rural Mission, etc. are in an initial phase of implementing mobile devices for controlling mortality, preventing Tuberculosis, communicable and non-communicable diseases in the near future. Thus, mHealth technology and application adoption are seen to be in the initial phase of implementation, which requires a proper framework for its governance.

This study highlights some of the important findings which healthcare organization and other stakeholders have to consider while implementing mHealth technology and applications for healthcare. Though the study identified potential adopters, it can be applied to any smartphone user wherein people have used their mobile devices for seeking and communicating information over the Internet (indirect) or through health applications (direct). It was revealed that people had used mobile phones through an indirect type of applications (such as social networking apps, video sharing apps, and Internet browsers) for cold and fever, obesity, stress and mental health, and toothache rather than the direct type of health applications. Thus, mHealth technology and applications can be effective with the help of doctors and other physicians' recommendations, promotions during physical visits, and through social media platforms. In addition, proper training and supporting mechanisms across the patients' use-phases would also help individuals and practitioners to monitor their health status oneself, thereby influencing its usefulness and actual system use.

Specifically, for technology entrepreneurs and software developers, the study findings indicate that individual characteristics towards mobile services and subjective norms should be given greater importance to attract more people towards mHealth technology and applications. The study also revealed that mHealth technology and applications should also include gamification, visual displays, easy demonstrations, and reward systems to enhance individual users to try it for managing health and service delivery. They should also work closely with the healthcare professionals and the end-users in their need identification and feedback mechanism for updating the features and components regularly. At the same time, they should also promote mHealth applications and technology through social media, conferences, and summits, and practical demonstrations in educational institutions, etc.

Therefore, the proposed model should take into consideration various components that determine the criteria for the realization of rights to health. The study supports the earlier result that, for achieving a successive solution, awareness and acceptance components should be considered which help the firms and government in reaching the patients who need medical facilities. However, as it has been observed by this study, the components such as lack of trust and subjective norms have an impact on the acceptance of mHealth. For this, as reported by researchers and scholars, there should be a learning community that needs to be established centrally for maintaining the data generated or obtained from the patients, and there should be a proper standard for the collection, transmitting, and analyzing the patients' data. In this direction, the realization of mHealth will influence and motivates people to use mobile technologies in medical utilities.

### 6.3.3 Business Implication

The important factors that play a significant role in the development of India's mobile health application and technology service industry (un)like China's e-commerce industry include economic development, the traditional business model, governmental rules and policies, and cultural differences (Yi, 2017). These components are explained in the following sub-sections.

#### 6.3.3.1. *Economic Development*

The country's economic development has an influence on the penetration of mobile health among citizens. It is said that the role of health on economic development takes place in the form of direct labor productivity and indirect incentive effect (Finlay, 2007). The former postulates that better the health, more the contribution to the labor productivity by reducing absenteeism and healthcare cost (Kahn et al., 2010) while the latter considers the need for investing healthcare cost in education which itself is an important factor for the country's economic development and forms indirect incentive effect for education (Finlay, 2007).

In India, due to uneven economic development in the northern and southern parts in terms of demographics and economic factors of the people living in the rural and urban regions, most of the health initiatives in its first phases have been taken place in the northern states. This is because of the fact that the people living in the southern part of India have higher per capita incomes and lower fertility rates than the north (Tumbe, 2017). It is also said that the urbanization rates of southern India appear to be more than northern India because of per capita income levels, growth, and migration rates (Tumbe, 2017; India Today, 2013). With respect to informal healthcare, study says that in certain states of Uttarakhand, 99% of the health-related services are provided through clinics, and private healthcare sectors are not professionally fit in their facilities impacting the quality of care (Gautham et al., 2014; Sharma and Narang, 2011). Similarly, in south India, in a region of Andhra Pradesh, 25% of the health care services are delivered through the clinic, 40% through a mobile van and 35% include both clinic and mobile service (Gautham et al., 2014). In an article, it was indicated that people of south India are oriented and conscious towards health than the north and have found a gap in health insurance coverage (Vikram, 2018). It is also highlighted that; people usually tend to go to private hospitals to seek healthcare as government health services lack quality care, accessibility, and waiting for lines (Vikram, 2018).

Therefore, the need for the use of the mobile phone for health service delivery should be targeted to the people in the north region of India than the south as the current scenario. But the penetration and use of the Internet across Indian cities are more in the urban (182.9 million per day) region than rural (98 million per day). According to IAMAI (2014), Mumbai followed by Delhi, Kolkata and Bangalore are considered to be the highest Internet users' states in India (Mahajan, 2014). As a result, the healthcare provider's project should be coupled with the Internet service provider to identify and track such regions having poor access as mentioned above for effective delivery and use of mHealth. As most of the people are in rural regions, the healthcare providers should also focus on tailored health delivery projects like near field communication stickers of Udaipur Rajasthan as evidence for creating awareness and trust among people as easy-to-use and affordable systems.

#### 6.3.3.2. *Traditional Business Model*

The traditional business model also has an impact on health service delivery through mobile phones. Generally, humans tend to resist changes when it is imposed, and this is also true in this case. As aforementioned, in India, the prevalence of northern and southern divide, rural and urban divide, and citizen's cultural and economic factors act as a moderator for the acceptance of any technology related to health. In the traditional business model, when they fall sick, they tend to visit a family doctor for their medications, which otherwise used home prepared medicines or syrups extracted from plants. Over the years, because of the population explosion and lack of healthcare access, initiatives such as doctor field visits had come into practice wherein people still get personalized care depending upon their health condition. Later identified that countries are facing severe healthcare shortages and couldn't match up to the standards, researchers have coupled information and technological systems with health service delivery considering its access. As this system works with non-physical interactions between the users and the doctors, people resist. This resistance can be due to literacy problems wherein people don't know to read and write, or maybe because of electronic literacy, as people may not know how to use a mobile phone for receiving information, etc. especially in certain parts of rural regions and most common amongst older populations. Moreover, with the increase of many cyber-crimes and privacy issues as this system is directly connected to the individual health condition, people try to be conscious and prefer meeting doctors physically than through mobile phones due to lack of trust.

As a result, the healthcare provider should not only focus on transforming the business model but also should take into consideration people's demographic components or patient-centric solutions for initiating such systems. Simultaneously, as researchers indicated that, the acceptance of technology depends upon the creation of awareness among people. As people in India basically trust the items in its presence, the healthcare provider should, therefore, create awareness about mHealth by generating real-time evidence. Currently, from this study, we can identify that people are using mobile phones for health service delivery with an intention to receive health information as a second opinion for more acute health symptoms than chronic. Nonetheless, people try to book appointments and identify doctors, etc. through mobile health applications, which indicates that people indulge themselves in such a platform for service delivery rather than disease-specific applications.

#### 6.3.3.3. *Governmental Rules and Policies*

Realizing the benefits of health and wellness, and as a part of 'Swachh Bharat Mission,' the government of India has initiated health programs/wellness, which is celebrated on a specific day of every month. For example, last Sunday of January is celebrated as World Leprosy Eradication Day, February 4 as World Cancer Day, March 8 as International Women's Day, April 22 as Earth Day, June 21 as International Day of Yoga, etc. (NHP, 2016). These practices have been passed by the government based on the suffering of the present generation (both young and old) for a particular situation, which is due to improper food habits and lack of exercise in their busy schedules. Similarly, by considering the people's demographic profile in the rural regions, the government, through their primary healthcare center has initiated the use of mobile phone technology for reminding pregnant females and new mothers about their medications and vaccinations reducing mortality ratio. The government has also initiated the 99DOTS process for eradication and preventing TB disease among people through district healthcare centers wherein the registered patients give a missed phone call to a toll-free number, and system tracks these numbers indicating medication adherence and monitoring of their patients (IANS, 2018). Recently, under the Universal Immunization Programme (UIP) government is devising policies for providing vaccination certificates as a mandated requirement for taking admissions at schools. This has been initiated to eradicate measles-rubella and other health conditions of providing safety to the children (Govindarajan, 2017). Therefore, considering all these initiatives, the healthcare and service providers can promote their application with respect to these programs such that the vision of 2020 of Digital India and Swachh Bharat Mission can be achieved.

#### 6.3.3.4. *Cultural Differences*

India is a country with diverse cultural values, tradition, ethnicity, diversity, and languages. In most of the cases, these components have an influence in managing individuals' health and disease conditions by identifying possible causes and treatments involved in the process. For example, Lentils, which is a staple food in India often avoided for breastfeeding women as it causes gas problems, and also citrus fruits are not recommended to the women during pregnancy (Gordon et al. 1994). According to EuroMed-Info (2018), the way patients perceive patient education is found to have a profound effect on receiving information and willingness to use. They also mentioned that western countries such as the U.S. consider disease as a natural phenomenon and advocates treatment regimens for preventing it whereas, in other countries, people consider it as a supernatural phenomenon and promote prayers and other spiritual interventions as an initial step as a treatment EuroMed-Info (2018).

In the research paper, it was indicated that the female patient was experiencing anxiety resulting in somatic symptoms with autonomic instability was initially taken to temple to perform rituals and later seeks the help of psychiatrist and identified that due to family's conventional societal norms the female was experiencing this problem (Worthington and Gogne, 2011). It is also indicated in the research paper that women experiencing mental distress have oriented themselves more into magico-religious healing sites than psychiatry (Sood, 2008). Similarly, in this study, when asked about mHealth, respondents indicated that homely medications or traditional practices of visiting temples and offering prayers would spontaneously come up as a reactive solution when people in their family experience health problems. This confirms the aforementioned statements and holds well even in the present context but has been reduced over time with the generation.

These patient-centric or user data and its factors associated can be used by the healthcare providers to measure the quality of service delivered by the respective organization, which adds up in creating technical and economic value. This process of extracting the data and transforming them into money or its economic benefits can be termed as data monetization. For every organization, generating value in the form of profit after cost is important to sustain competition and growth. Therefore, data monetization will be influential and impactful for any type of business or organization. According to Najjar and Kettinger (2013), for implementing a data monetization process, the organization should require high-end network capabilities, software and hardware infrastructure with mathematical and business skills to exploit the data.

Depending on the level of capabilities and position, the company then needs to monetize the data. They have indicated that for successful data monetization process, the organization needs to create and share data that could build relationships and models, identify the gap between the current and expected level in the journey, develop contracts ensuring adherence, and nurture trust. In a research paper Li et al. (2016) studied user-generated content monetization (UGC) based on influence, the timing of contributor adoption, and impact from online social activities. They concluded that the contributor should continuously interact with the reader to factor the social activities of contributors, and the nature of the platform should be considered in designing the UGC monetization methods (Li et al., 2016).

## 6.4. Recommendations for Improving Mobile Health Applications' Usefulness in India

The previous sections have discussed several implications of this thesis in relation to intangible measurement, disclosure, and modeling. These findings have several recommendations for improving mobile health application usefulness in India and are discussed in the following sections.

The current study identified that for improving the usefulness of mHealth or health-related apps, the initiation from healthcare or the doctor would have more impact on people's participation or interest in its use. Likewise, ease of use of technology or projects like voice calls, NFC necklaces, and stickers should be encouraged among fewer literacy people, which motivate them to accept devices and in turn, improve health in the rural areas. As a result, the proposed components can be used as instruments for measuring the awareness, accessibility, and acceptance of mHealth.

Thus, improvement in the awareness and use of mHealth applications can be achieved if there exist necessary infrastructure and policy, which are at present inadequate for health application. Also, mobile health application use is directly linked to individual health. Therefore, its success depends on techno-entrepreneurs and software developers in designing apps by identifying patient diagnostic processes and treatment at hospitals and clinics. Since there is no copy-paste mechanism in healthcare, mobile health applications should be tailored to the needs of healthcare providers so that they can make their patients aware, and thereby recommend them to use health applications.

The success of mobile health applications and technology is also dependent upon evidence and patient behavioral outcomes. Thus, the development of the right ecosystem or infrastructure and the components of an affordable system overall effectiveness will ensure success. Mobile health projects in India which are currently working as pilots across cities and location should be identified and integrated, forming the central ecosystem and/or research kit. These systems with proper security and access can be helpful for the researchers, government, and other stakeholders in devising appropriate and separate policies for mobile medical technology, and application for ensuring proper governance and timely health and service delivery.

### 6.4.1. Mobile Health System Architecture

As aforementioned, this study integrates the findings, and proposes a mobile health framework from the data obtained by the author and previous works on mobile health applications and systems in India. In an interview with the IT professionals, it was identified that for developing user-generated healthcare systems, the components such as sensors, security, website servers, mobile, analytics, cloud, and professionalism with a human touch need to be considered (Figure 6.6).

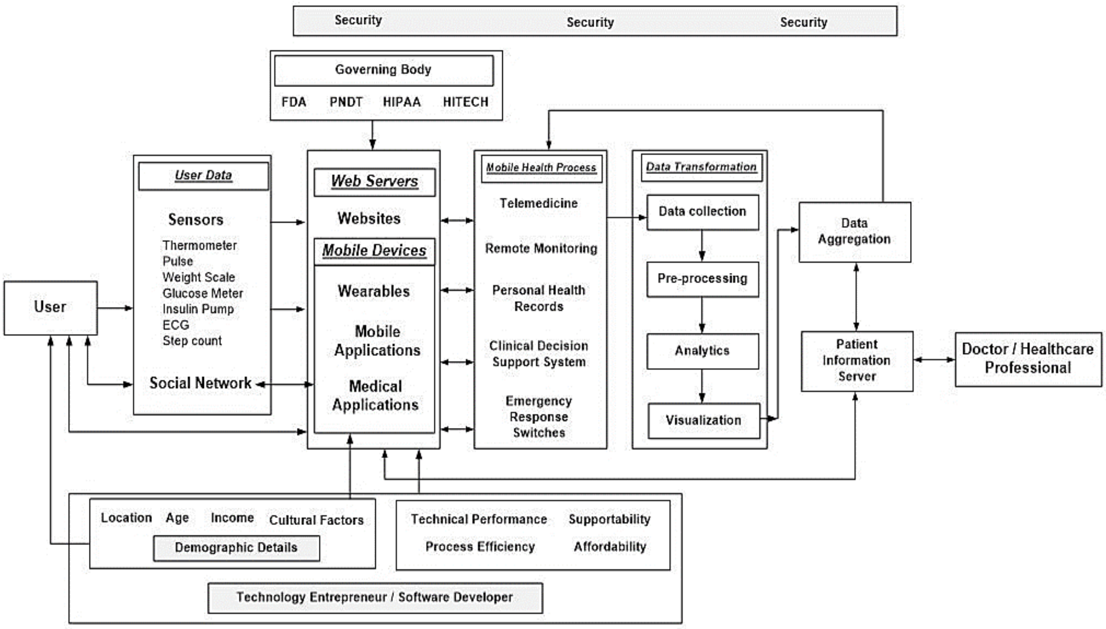



**Figure 6.6:** The proposed architecture for mobile health systems in India

The following section discusses the roles and responsibilities for each of the components indicated in the figure 6.6.

- *User Data Sources:* The data can be collected through social networks (Lin et al., 2008) and sensors (VPNHaus, 2011).
- *Web-servers and Mobile devices:* These data should be regulated and approved by the specific governing body such as U.S. Food and Drug Administration (FDA), Health Information Technology for Economic and Clinical Health (HITECH) Act, Health Insurance Portability and Accountability Act (HIPAA), and Pre-Natal Diagnostic Techniques (PNDT) such that the patient's data is secured with authentic access. Simultaneously, the device manufacturers should also consider its technical performance, supportability, process efficiency, and affordability factors for achieving affordable system effectiveness (Dallosta and Simcik, 2012). They should also consider the users' demographic details such as location, age, income, cultural factors, etc. for developing mobile health apps and services as majority of the people in India are located in rural regions.
- *Mobile Health Processes:* It includes various mobile devices for delivering health services. It acts as a channel for communicating and delivering a meaningful solution from the raw data.
- *Data Transformation:* In this stage, the raw data will undergo pre-processing, analytics, and visualizations to provide clear and easy understanding of the patient health cases suggesting medications and treatments.

Through these channels and by using various mobile health processes (telemedicine, health, and wellness, etc.), these data are transformed into a meaningful solution through analytics tools and visualizations for aggregation and storage in the patient information server. As this information is available in the cloud, it can be retrieved by the user or healthcare professional through proper authentication. This acts as support towards evidence-based practice and learning.

### 6.4.2. Governance Framework

In social science, the concept of governance has been explained with four different rules, which are dependent upon the perspective of the researchers in considering the results, processes, rules, or the ability to steer (Hyden et al. 2004). From the analysis of this study, the matrix for the governance of the digitized system in health improvement can be studied with the combination drawn from the above-mentioned dimensions (Figure 6.7).

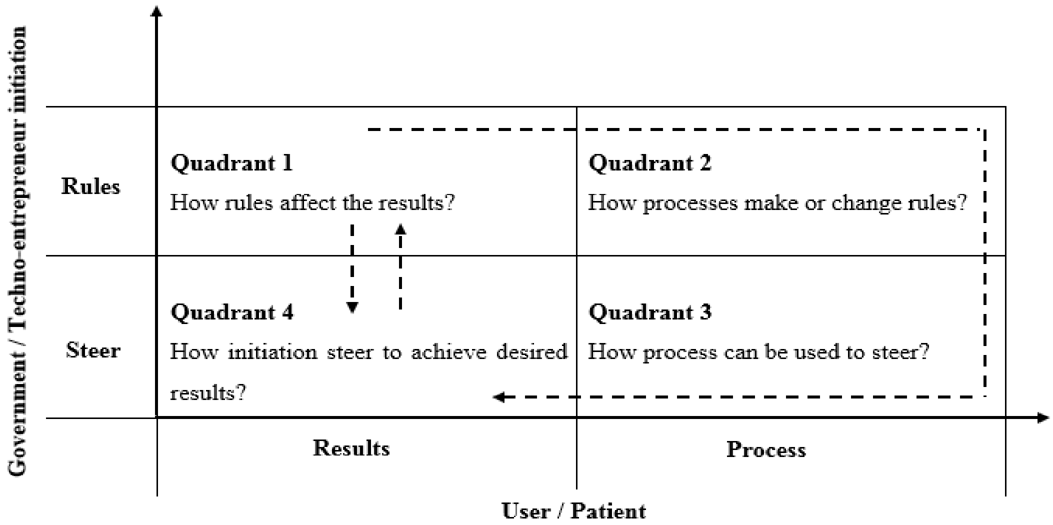



Figure 6.7: Matrix for the governance of digitalized system in health improvement

In the figure 6.7, **results** represent how the government or techno-entrepreneur initiation changes the health outcomes of the users or patients upon using mobile phones for health activities. It can be in the form of health structure (i.e., weight, fitness, diet or nutrition, lifestyle), or in saving time through the electronic record, prescription reminders, appointment scheduling, etc. **Process** refers to interactions with the user or the patient in driving rules and decisions. Since most of the respondents' concern about the mHealth application was the trust, a research kit which accommodates data about research happening in the field of mobile health through real-time examples can be used.

**Rules** are nothing but the institution and policies such as 'Digital India', which help government and techno-entrepreneur to tackle any health-related problems. For example, the 99Dots process, an initiation from the government to reduce TB and Pradhan Mantri Surakshit Matritva Abhiyan to improve the mortality ratio or Practo, for locating doctors and booking an appointment can be classified in this category. **Steer**, means to drive or control the initiation process. Example, Kushi Baby project which reduces the work of the ASHA worker to maintain a record or to provide awareness and training campaign to the people through media or personal visits.

An important aspect here is the dotted arrows connecting the quadrants. The first link from quadrant 1 to quadrant 4 (quadrant 1 ↔ quadrant 4) represents the shortest path for the initiation, which suggests how rules influence results, and are translated into actions that steer towards it. The second link from quadrant 1 to quadrant 4 through quadrants 2, 3, and 4, signifies that changing and improving rules is more difficult than predicted. Therefore, the government and the techno-entrepreneur should analyze which path they drive their process in. This helps them in governing mobile health applications.

# CHAPTER 7

# C O N C L U S I O N S

## 7.1. Introduction

This chapter comprises a summary of conclusions and empirical findings of the research study. It summarizes where the research starts; revisits the research questions, objectives, and hypothesis, and summarizes the limitation of the research. Finally, the novelty of the study is highlighted, and recommendations are made for future research.

This chapter is structured as follows. Section 7.2 presents a summary of the empirical study findings against the research objectives. Section 7.3 recapitulates the research questions and discusses the answer in the section 7.4. Section 7.5 highlights the contribution of this study. Section 7.6 presents the originality of this study and also outlines the limitations of the thesis in section 7.7. Section 7.8 offers suggestions for future research. Finally, section 7.9 concludes this chapter.

## 7.2. Summary of Empirical Study Findings

The findings of the research may be summarized in light of the research objectives, as mentioned in chapter 3. This section summarizes the results obtained from the empirical studies which were generated from the quantitative and qualitative studies presented in chapters 4 and 5. The results exhibited in this section incorporate not only the findings obtained from quantitative and qualitative studies, but also integrates the findings that were derived from the combination of multiple study approaches.

In order to make the discussion clearer and easier to understand, this section discusses the findings corresponding to all the three research objectives. Firstly, section 7.2.1 presents the findings of the quantitative study in relation to mobile health applications awareness and intention to use among respondents living in urban locations (RO1). Secondly, section 7.2.2 presents the results of the qualitative study for analyzing the accessibility and acceptance of mobile health among rural regions (RO2). Thirdly, the factors of affordability measured from an interview-based case study for developing mobile health systems and solutions (RO3) is discussed in section 7.2.3. Finally, due to the popularity of social media use, sentiment analysis of tweets was studied in section 7.2.4.

### 7.2.1. Awareness Level and Use of Mobile Health

***Research Objective 1:*** *To study the awareness level in the use of mobile health applications among citizens.*

The approach followed to achieve the main research objective of awareness level and the use of mobile health has been divided into two sections, which are supported through hypotheses. In the first section, comparative analysis has been performed to study the *significant difference* and *magnitude of effect* between the awareness level in the use of mobile phone for health communication and delivery, and self-managing of health applications (i.e., cancer, cholesterol, heart diseases, and stroke, chronic obstructive pulmonary disease, and fitness, yoga, diet, and nutrition) among technical and working staffs, medical and health professionals, and others. In the second section, the significance was confirmed for the factors influencing awareness and intention to use (ITU).

***i. A comparative study among technical and working staffs, medical and health professionals***

Based on the literature review specific to mobile health in India and with regards to its awareness level and use among various demographic groups (i.e., technical students and working staffs, medical students and health professionals, and others). Comparative data analysis has been performed on these groups, and the main findings are:

- A total of 386 valid responses are analyzed. The average age of the population was 18-25 (187) and 26-35 (145), and the majority of the participants are female (194). The study population has been grouped as technical students and working staffs (224), medical students, and health professionals (162) for testing the hypothesis. Overall, 407 respondents owned a mobile phone, and 347 respondents have used it for seeking health information related to cold and fever (101), obesity (45), blood pressure (41), diabetes (36), stress, and mental health (125), cancer (54), and hypertension (35) from online sources.
- The level of awareness about the term ‘mobile health’: only 174 respondents have indicated that they are extremely aware and familiar.

- The indicators of awareness about mobile phone use for health-related components include creating health awareness and education like cessations etc., assessing and diagnosing certain disease conditions and medication remainders, locating hospitals and for scheduling appointments, medication adherence and refilling, storing patient records, doctor-stakeholders communication informing the health status of the region, and immunization reminders for pregnant and lactating mothers.
- The components of mHealth apps use include: self-managing of cancer, self-managing of cholesterol, heart diseases, and stroke, self-managing of chronic obstructive pulmonary disease like bronchitis, asthma, and self-managing of fitness, yoga, diet, and nutrition for obesity.
- Statistically, when calculated the awareness level in the use of the mobile phone for various health-related components indicated that except for creating health awareness and education significant value was achieved at *p-value* < 0.05 and *p-value* < 0.001. Thus indicating the existence of a significant difference between the awareness levels among these groups.
- To measure the impact of dependency between the responses, effect sizes ('Phi value') have been calculated. The magnitude of effect between the awareness level in the use of the mobile phone for creating health awareness and education, medication adherence and refilling, and immunization reminders for pregnant and lactating mothers is small whereas other components have a medium effect.
- The use of mHealth apps in health service delivery releveled that except for self-managing of chronic obstructive pulmonary disease (COPD) (0.575) and fitness, yoga, diet, and nutrition for obesity (0.933), the significant value was achieved at p-value<0.05. Thus, indicating the use of self-managing health apps is dependent upon technical, medical, and other related courses and practices.
- The magnitude of effect between the components of mHealth apps use was found to be relatively small effect for self-managing of fitness, yoga, diet, and nutrition for obesity (0.01) than others among the groups.

The comparison between the groups, i.e., technical students and working staffs and medical students and health professionals indicate the hypothesis, *"There is a* *significant difference between the awareness level in the use of mobile phone for health communication and delivery, and self-managing health applications among the groups"* is achieved in all the cases except for creating health awareness and education, medication adherence and refilling, fitness, yoga, diet, and nutrition for obesity and COPD.

Moreover, the findings from the effect sizes indicate that the hypothesis, *"There is a high magnitude of effect between the awareness level in the use of mobile phone for health-related components, and mHealth apps use among the groups"*, has not been achieved completely as the effect sizes values indicate medium effect for most variables. Thus, the alternate hypothesis can be stated as, *"There is an average magnitude of effect between the awareness level in the use of the mobile phone for health-related components, and mHealth apps use among the groups."*

***ii. Hypothesis Testing for Determinants of Awareness and Intention to Use***

The hypothesis needs to be explained before proceeding further. The hypothesis was tested in a two-step method, i.e., testing the measurement model for validity and reliability through factor analysis and analyzing the structural model for hypothesis testing and model fit. It was observed that all the values are within the acceptable cut-off ranges and suggests a good model fit.

- In this study, Mobile-Service Enabled-Empowerment (MSEE) refers to intrinsic motivation that expresses individuals' cognitive assessments of mobile services. It is also said that empowered individuals believe that they have the capability of adjusting changes for solving the problem and thereby stimulating individuals to feel less constrained for fostering innovative behaviors. The direct effects of MSEE on PI and AWR (H1a) is statistically significant at $p<0.001$. Therefore, the study findings indicate that empowered people in the urban regions are more likely to be aware and finds them meaningful to use mobile phones for healthcare service delivery as it would help them confident in managing their problems independently.
- Personal Innovativeness (PI) is defined as the degree to which an individual is willing to try new mobile technology service. It was indicated that people with

innovative capabilities are active for seeking information and new ideas and often tend to handle uncertainties and develop positive intention towards acceptance. To summarize, the study identified that the respondents living in urban regions and having access to the internet have largely indicated that, they have used social networking apps (128 [31.29%]), video sharing apps (74 [18.09%]), and internet browsers (214 [52.32%]) for cold and fever, obesity, stress, and mental health, and toothache problems.

- The statistical results revealed that the direct effects of PI on awareness (H2a) were not supported and found to be insignificant whereas PI on PU (H2b) and ITU (H2c) is significant at $p<0.001$. This indicates that PI doesn't drive individuals towards awareness but consider to be useful and may use them in managing health often or in the near future. This unexpected result obtained through this study stipulates that, even though people use mobile phones for various services, they deliberately ignore health applications due to lack of interest, electronic health literacy, and source credibility. Moreover, individuals consider visiting healthcare professionals personally as it gives more mental reliefs than through digital interventions.
- Subjective Norm (SN) is defined as the "perceived social pressure to perform or not to perform the behavior". The results of SN and ITU (H3a) is found to be insignificant and can be concluded that subjective norm has a minimal influence on use intentions and seems to work on perceptions rather than intentions when its use is not mandatory. Simultaneously, the results of SN and PU (H3b) is found to be significant, indicating that the people during deteriorating health may consider their important ones to overcome their perception about its use, accomplishing and enhancing the quality of health-related tasks and goals.
- This indicates that the individuals' perception about mobile device and that of using it for health service can only be improved until an external influence such as healthcare professionals or government (through digital health programmes) recommends them to use by providing specific training programmes.
- Health Consciousness (HC) indicates that people who are interested in their health often look for different health information technology and resources from multiple sources to stay fit and healthy. The relationship between HC and PU (H4) is found to be insignificant and is consistent with the prior work. Even though health-

conscious people believe that its use may help them in managing their health easily but due to their food habits and prevalence of various diseases make them anxious thereby allowing them to visit healthcare professionals personally rather than through mobile phones.

- Awareness (AWR) is defined as the degree to which an individual is aware of and familiar with a product or services. Literatures says that awareness influences purchase intention, which in turn leads to acceptance. The study finds that the relationships between the variables AWR and PU (H5a) and AWR and ITU (H5b) are found to be significant at $p<0.05$ and $p<0.001$, respectively. This result is in line with the earlier works and indicates that awareness enhances an individual's mHealth technology and applications use intention.
- Perceived Usefulness (PU) is defined as the degree to which a person believes that using a system would enhance his or her job performance. The direct effects of PU and ITU (H6) are insignificant and are in line with the previous literature. This result signifies that when it comes to use intention of mHealth technology and applications, the doctor's recommendation plays an important role rather than perceived usefulness. This is because of the fact that digital solutions which are recommended by the professionals are preferably developed according to their requirement and the chances of getting unrealistic or error results will be less. Hence, it can be concluded that higher the recommendations, more the propensity of an individual to use it for healthcare services.
- People have also cited that they often find difficulty in identifying the right health applications as there are too many applications available in the play stores and which therefore require doctors' support in using the technologies.

### 7.2.2. Accessibility and Acceptance of Mobile Health

***Research Objective 2:*** *To analyze the accessibility and acceptance of mobile health among the rural population.*

Accessibility of mobile health implies the ability of a person, to easily access health information and services regardless of form, structure, or presentation. Similarly, acceptance includes components related to ease of use, quality of information (credibility and accuracy), and system quality (irregularities, downtimes, and availability). The verification and acceptance of mobile health services and applications have done through 60 semi-structured interviews conducted among rural populations. This process had contributed the study in generating evidence about mobile health accessibility and acceptance among people. The responses from semi-structured interviews resulted in classifying various components of accessibility on access to information, and its detailed results are presented in chapter 4. Findings related to accessibility and acceptance of mobile health may be summarized as follows:

- The demographic characteristics has identified that patients (13), caretakers/family members (38), and both (09) with a majority of female respondents and mostly homemaker with age of 21-30 years participated in the interview. Moreover, respondents speak the Kannada language (60), and only 51 of them knows to read and write. The respondents' here use mobile phones for listening to music (44) and watching videos (46) other than calling feature.
- The study used conceptual-analytical model, and the findings from the healthcare and individual perspectives were classified according to Penchansky and Thomas dimensions of access. The accessibility of the identified mobile health application has also been studied using the components of physical, suitability, and affective.
- The study identified that the healthcare observed lack of supporting infrastructures, human resource, and improper training programmes during the implementation of health information technology limits itself from being accessible. The patients/users have also agreed that problems related to language and literacy, the anxiety of using mobile phones for health, and mobile and internet connectivity will be a barrier for mobile health acceptance.
- Findings indicate that among the users and the healthcare professionals, there exists a lack of awareness about the term mobile health and applications initiated by the government. Interestingly, it was observed that healthcare professionals located in the study areas were using mobile phones for vaccination and treatment remainders for pregnant and new mothers and for TB patients. The patients/users are also aware due to ASHA workers and primary healthcare centers (during pregnancy and childbirth) or when they go to work.

- People cited that mobile phones are being used for watching health-related videos, listen to music to get relief from stress, and communicating with doctors through video apps, calling, and SMS apps. This indicates that the information available online is physically accessible to a large extent but lacks awareness. However, in some cases, there are issues observed among the respondents as the credibility of the content and language used by the sender may not be easily understood by the patients/users.
- Healthcare professionals mentioned that there are difficulties in purchasing high-end technology supportive devices to store patient records as it has to be approved by various authorities and is time-consuming. It was identified that people are not hesitant to use basic mobile phone technology for health care and preferred to use voice calls rather than SMS for medication reminders and appointment. As most of the people work on daily wages and limits them in purchasing smartphones and paid versions of applications.
- It has observed that healthcare and application accessibility plays a vital role in improving the perception of mobile health and promoting its awareness among people. The study reflects that nearly 35% of the people travel 1-5 kilometers and 61.67 % of people more than 6 kilometers from their place to reach the nearest hospitals or clinic. This has increased incurred additional pay for transportation and also lacks bus connectivity towards the hospital area. Moreover, power breakdowns and mobile network problems limit access and adoption of health information technology.
- Individuals' self-efficacy and health consciousness can influence the acceptance of mobile health applications. The mobile phone equipped with diet and yoga information can be a possible solution for improving acceptance. Some people in the study area are health conscious and are oriented towards preventive health practices such as regular health monitoring (12), healthy eating habits and exercises (23), and diet practices (like eating roti's at night times) (35).
- The significant findings are that people in the rural regions often face the problem with the healthcare facility as waiting time is more and less consultation time. They follow homemade practice their diet plans and medications (either extract of plants or spices) as suggested by their family members and relatives. They tend to resist

when proposed about mobile health. However, with the timely availability and external influence, i.e., from medical practitioners (49) and training (43), they would be likely to use mobile health applications and services specifically for an appointment and medication reminders (49 and 52), health-related messages (29), and medical counseling (28).

- The important factor which was identified during the interview was the negative perception in using the mobile phone as it is hazardous. Doctors complain about the restriction that has been imposed on them to not to use mobile phones for health services (section 304). This implies that government policies act as a barrier to mHealth practices. They also cited that in the 99DOTS process for eradicating TB people try false dialing so that the actual health outcome of an individual was inaccurate.
- In the rural region, mobile phones are used for reproductive and child health programmes (24), Indradhanush, and cessations programmes (11) and 99DOTS process (1). Its accessibility has been studied by considering the components of physical, suitability, and affective.
- The study revealed that the utility of mobile phones for health service is effective for reproductive and child health programmes. This signifies that the medium is physically and financially accessible for maternal mothers and new mothers.
- Female respondents who received treatment and vaccination reminders through mobile phone during the process of reproductive and child health programmes have been benefited. This confirms the component suitability, signifying that the medium is suitable and provide a solution to address the need. A smaller group of people indicated that they had been benefited from the fitness application.
- People agreed that they had used basic mobile phone apps for searching nearby hospitals, communicating with doctors for scheduling appointments and consultations during unavoidable conditions such as weekends and at night. This confirms affective accessibility signifying that the mobile phone has a role to play in individuals' daily life.

These findings show that the distribution of mHealth across the rural regions is still in an initial stage of service delivery and is used mainly for reproductive and child health programmes than telemedicine and 99DOTS process. These programmes are in practice at places where network and its supporting technologies are connected and available for scheduling vaccinations and conducting regular interventions. However, lack of awareness, trust, and evidence (health outcomes), primarily affects mHealth acceptance. Thus, consolidating the findings, technology acceptance model is proposed specifically for rural Indian populations. The proposed model validates the existing model of Kim et al. (2016) and incorporates components related to awareness, knowledge, and familiarity supported by components: perceived accessibility and traditional/cultural factors which are important in the Indian context.

Hence based on the findings, the hypothesis can be formulated as *"There is a moderate degree of mobile health accessibility among the rural people."* Similarly, as cited by the respondents that doctors' recommendation is required for mHealth acceptance, therefore its hypothesis can be formulated as *"subjective norm influences positively in improving the perception of mobile health among rural people."*

### 7.2.3. Affordability of Mobile Health System

***Research Objective 3:*** *To study the affordability in terms of cost to consumer and financial viability of the service provider (i.e., stakeholder or technology entrepreneur).*

Affordability is "*the degree that system performance, cost, and schedule constraints are balanced over the system life, while mission needs are satisfied in concert with strategic investment and organizational needs"*. Prior literature indicates that for achieving an affordable system overall effectiveness, the organization has to consider the components related to technical performance, supportability, process efficiency, and affordability. Therefore, this study used the conceptual-analytical model for generating the themes which are measured using 17 in-depth qualitative interviews (online and offline) with the stakeholders (such as technology entrepreneurs, software developers, and healthcare professionals) of mobile care devices, telehealth services, and home health and wellness devices. The detailed results of these components are presented in chapter 4. Findings related to the affordability of mobile health may be summarized as follows:

i. To achieve this objective, the study used four major themes for guiding the analysis and presenting the findings. Moreover, several sub-themes which are generated during the data analysis process has been recorded to these major themes. They are technical performance (application framework and payment model), supportability (reliability and maintainability), process efficiency (development, utility, backend support, and application features) and affordability (financial viability and cost-to-consumer).

ii. The technology entrepreneurs highlight the peoples' reluctance towards the use of mHealth apps for managing health because of source credibility, literacy, connectivity issues, trust, and cultural factors. Thus, the hypothesis can be postulated as *peoples' need and willingness influences stakeholders in implementing mHealth applications for health service delivery*.

iii. The major findings are that the use of mHealth for treatment and diagnosis are still in the initial phase of service delivery due to negative perception, supportive infrastructures, etc. The technical parts equipped in digital/mobile-assisted medical technologies should be considered for making mHealth and its apps affordable and cost-effective. Thus, the hypothesis can be formulated as *technical infrastructure and affordability factors influences stakeholders in implementing mHealth applications for health service delivery*.

iv. The study also reveals that the need of the healthcare professional and that of the hospital system is entirely different and requires a tailored system which can be developed through learnings from health professionals during their regular interventions.

v. The setting up of ecosystems helps stakeholders in resolving problems of data integration, information requirement, and connectivity, which assists them in informed judgment and decision making. Thus, the hypothesis can be formulated as the *development of ecosystem influences stakeholders in implementing mHealth applications for health service delivery*.

vi. The mechanism for carrying out the healthcare process and interventions using digital devices are not so precise in terms of service delivery. It was even identified that structuring of healthcare systems also influences the usability of healthcare and its apps. The governmental policies (like the Indian penal code of section 304) act as a barrier to mHealth implementation. Thus, from the findings, we can postulate hypothesis as *government policies influences stakeholders in implementing mHealth applications for health service delivery*.

vii. It has also been identified through healthcare professionals that there was a lack of support from the software solution providers during post-implementations. This leads to poorer trust resulting in unwillingness by the healthcare system for major system upgradation or long-term contract. Thus, the hypothesis can be formulated as *training and support influences stakeholders in implementing mHealth applications for health service delivery*.

Therefore, for mHealth apps and system to be affordable and cost-effective systems, the stakeholders in India should consider the aforementioned factors that eventually helps in bridging the gap of health service delivery by improving its scalability.

### 7.2.4. Sentiment Analysis of Social Media Messages

- The polarity and emotions of mHealth applications (fitness, meditation, diabetes, and cancer) among Twitter users have been studied through sentiment analysis.
- It was found that except for cancer application, there exists a positive polarity towards the fitness, diabetes, and meditation application among Twitter users. This means that people are joyous and satisfied with the launch of these applications.
- It was identified through the survey that the youth population of age 18 – 35 years had reported the use of mobile phones for mental health problems. To validate this result, sentiment analysis was carried out for the messages "#mentalhealth" posted on Twitter.
- The result indicated frequent themes related to parenting, casualties, harassments, and resulting actions, disability types and disorder characteristics, health services and it's quality improvement practices, mental health controlling mechanism, and hashtags for sharing news and seeking/providing support.
- Access to technology has brought in certain authority either to fight injustice and/or to spread hatred or violence among people. Social media is used during unexpected stressful events. It was also said that mental health has resulted in the outbreak of social media game (#Bluewhale Challenge) and social media movement (#MeToo

movement). Therefore, a comparative analysis was performed along with the messages of mental health.

- The results confirmed that people suffering or suffered from mental health conditions because of hoarding, harassments, and bullying at workplaces or homes have largely become the victim of Bluewhale game/self-harm or influencers in the case of MeToo movement.
- Largely girls and women populations have become the victims, and only the profiles of the proficient person from business, entertainment, movie industry, and politicians have been highlighted. The case is still on to confirm whether it is because of any conspiracy or not.
- Social media and Internet influences individuals in their decision making and its features such as gamification assists them in balancing positive and negative health outcomes.
- The studies revealed that Android/iOS based preventive mobile solutions would be beneficial to overcome the problem of violence and mental health and to live healthy and fit.

### 7.3. Revisiting the Research Question

This section revisits the research questions, as stated in chapter 2 and tries to answer those questions through justifications.

***Research Question:*** *How to improve the usefulness of mobile health applications for health service delivery?*

- In India, due to disparities in health resources and population levels, and unprecedented achievements in the mortality rate has resulted in the failure of India's millennium development goals.
- It influences countries economic development, numerous innovative healthcare solutions connected to the nation's sustainable development goals have been initiated.
- Mobile health, the practice of using mobile technology in healthcare systems is one such solution which is widely used in low- and medium-income countries including

India for achieving accessible and affordable healthcare systems through mobile care devices, telehealth services, etc.

- The content analysis of the mobile health applications also revealed major themes such as awareness and accessibility in their messages posted on the Twitter website. This had helped us in formulating the research question.
- The analysis of the current information for a keyword search of ‘mHealth’ in the Scopus database from the year January 2008 to 28 June 2019 revealed 7,874 published documents. By considering the literature published in the Indian context, only 441 documents are available. Of these documents, 15 documents were excluded as these documents fall into subject areas of basic sciences, economics, econometrics, and finance, achieving a total of 426 documents. This indicates that mobile health has been discussed less adequately among the Indian population.
- The analysis of the keywords specifically discussed across the topics of gender and age groups, system and software, health and disease condition, management, evidence-based practices (outcome), methods, and importance of the study connected through lines.
- This indicates that researches carried out in India indicated the need and importance of mobile health for developing countries and rural regions for specific health diseases and managing health services. They have worked upon technical systems and software and carried out various interventions for improving healthcare accessibility and supporting evidence-based practices.
- The bibliographic analysis revealed that the study had been conducted by various authors. However, mobile health applications usefulness has been discussed less adequately among general populations. This results in the need for solving the problem that stands undiminished.
- Prior literature in this domain has also indicated its importance but lack adequately with respect to people, process, and technology in the Indian context. Hence this research question was formulated and addressed according to the approach for creating value among individuals, organizations, and society.
- This approach states that, for achieving a successful solution with customers, the components such as acceptability, accessibility, affordability, and awareness needs to be considered.

Therefore, the study considered these components as research objectives and are revisited in the light of multiple case studies and questionnaire surveys across rural and urban regions and healthcare solution developers.

### 7.4. The Answer to Research Question

During the exploration of the preliminary study, it was identified that Indians are insufficiently active and are living a sedentary lifestyle. This can have a high impact on individuals' health condition on a longer run. Some of these can be overweight, diabetes and heart disease, cancer, mental health problems, etc. It emerged that various mobile health applications can be beneficial in improving the goals of sustainable development by improving health literacy, healthcare service access, and to reduce the burden of disease through awareness. It also became apparent that the use of mobile health in healthcare service can help peoples and technology entrepreneurs in developing effective solutions to gain instant healthcare access and right treatment. The need for the patient-centered healthcare ecosystem was achieved through layers of people, process, and technology interacting with each other within the ecosystem for improving mobile health applications usefulness in India. Also, it was concluded that the use of a mixed method was appropriate for this study as it helped to develop a framework with the help of rich secondary and primary data. The main conclusion identified from this study are summarized as follows:

- Perception and user experience of mobile health applications (fitness, meditation, diabetes, and cancer) among the citizens have been studied through Twitter sentiment analysis and found that except for cancer application there exists a positive polarity towards the fitness, diabetes, and meditation application among the users or people. This means that people are joyous and satisfied with the launch of these applications.
- As has been identified in the questionnaire survey that 125 peoples have reported the use of mobile phones for mental health problems, among others. As a greater number of the youth population of age 18 – 35 years are involved in the questionnaire survey, to validate this result, sentiment analysis was carried out for the messages "#mentalhealth" posted on the Twitter.

- The result indicates that people are concerned about mental health and discuss themes related to parenting, casualties, harassments, and resulting actions, disability types and disorder characteristics, health services and it's quality improvement practices, mental health controlling mechanism and hashtags for sharing news and seeking/providing support.
- As medical articles and other literature also claim that individuals suffering from depression and mental health issue are the reasons behind the outbreak of social media game (#Bluewhale Challenge) and social media movement (#MeToo movement). Therefore the study incorporated sentiment and content analysis of its tweets for detecting common themes or consents surrounding social media movement and game to that of mental health.
- The results of these analyses confirmed that people are suffering or suffered from mental health conditions because of hoarding, harassments, and bullying at workplaces or homes have largely become the victim of Bluewhale game/self-harm or influencers in the case of MeToo movement.
- Interestingly, the study also revealed that girls and women populations had become the victim, and only the profiles of the proficient person from business, entertainment, movie industry, and politicians have been highlighted. However, the case is still on to confirm whether it is because of any conspiracy or not.
- It can be inferred from the findings that, social media and internet influences individuals in their decision making and its features such as gamification assists them in balancing positive and negative health outcomes. However, it was also identified that people are simultaneously searching for Android/iOS based preventive mobile solutions to overcome the problem of violence and mental health and to live healthy and fit.
- As has been identified in the qualitative study that individuals' motivation towards mobile services could influence the awareness and use of mobile health applications and services. This has been supported by the findings of the quantitative study that mobile service-related factors influence individuals' awareness and use of mobile health applications.
- Interview respondents have indicated that recommendation from doctors or healthcare professionals is very important in improving their perception of using

mobile health applications for health services. The quantitative study provided evidence in line with these findings. Specifically, it was found that subjective norm positively influences the perceived usefulness of mobile health application, and individuals generally work with perceptions rather than intentions when its use is not mandatory.

- The study respondents indicated that since they have problems in reading and writing, which limit itself from information-seeking practices which otherwise may influence them towards awareness about mobile health applications and services. This result has also been verified through statistical analysis and found that personal innovativeness has a direct positive impact on the intention to use mobile health applications and services.
- A large number of respondents indicated that the literacy of searching for health information from online sources is not just sufficient for using mobile health applications. However, the credibility and validity of information sources should also be considered. This result was found to be true with the technology entrepreneurs who needed customized applications.
- Interview respondents have also stressed upon the factor "affordability" when asked about their willingness to use health applications. It has been included in the questionnaire survey and found that 86.5% of the people have strongly agreed. They are thus indicating that people in rural regions and urban locations are also considering affordability in accepting and using mobile health for service delivery.
- Therefore, this study also considers affordability as a major component for achieving a successful solution. For this, data were considered from direct observations and 17 in-depth interviews involving healthcare professionals, technology entrepreneurs, and software developers working in this domain.
- Based on the existing models of affordability and by using an inductive approach, the codes emerged has been organized as per a priori themes. These themes include technical performance, supportability, process efficiency, and affordability as a fundamental condition for initiating mobile health systems.
- These themes, when analyzed further found that people's need and unwillingness, lack of application infrastructure, ecosystem development, governmental policies,

and training and support as factors influencing successful mobile health systems in India.

## 7.5. Contribution of this Study

The previous section discusses the summary of the research findings by recapitulating the research questions and objectives. This section stresses the contribution of this thesis and has been divided into three sections, specifically addressing the contribution of this study to theory, methodology, and practice.

### 7.5.1. Theoretical Contribution

- Prior literature in mobile health had used multiple theoretical assumptions which are often unclear with respect to accessibility and acceptance. Therefore, this study contributes to the existing theoretical model by identifying accessibility and acceptance components from previous literature, contexts, and interviews among rural regions. Thus, the model so formed is considered to be important in bringing the complete investigation of components related to accessibility and acceptance.
- The qualitative studies, as aforementioned, contributes by extending technology acceptance model and by incorporating awareness, knowledge and familiarity, perceived accessibility, and traditional/cultural factors which are considered to be important in the Indian context.
- The sentiment analysis of mobile health applications contributes theoretically through a causal loop diagram for understanding the complexities associated with accessibility and acceptability of mobile health application among the citizens, healthcare, patients, and application developers.
- The sentiment analysis of '#MeToo movement' and '#Bluewhale Challenge' also contributed theoretically to the study in identifying and establishing the interrelationships between the factors associated with the mental health of an individual.
- In the questionnaire survey, the hypothesized model was developed from the literature and theories of individual traits and adoption characteristics, technology acceptance, and health beliefs. Thus, the model so formed makes it comprehensive in the present context and among Indian citizens.

### 7.5.2. Methodological Contribution

- The sentiment analysis of Twitter data contributes methodologically to the study in identifying factors associated with mobile health awareness, accessibility, and acceptance. It also supported the study in understanding whether social media movement (#MeToo movement) and game (#Bluewhale Challenge) has any impact on the mental health of an individual.
- The use of convergent mixed methodology with triangulation also supported the study in integrating qualitative and quantitative data findings through the layers of people, process, and technology which is considered to be important in improving the mobile health applications usefulness in India.
- The use of rich picture diagram also contributes methodologically to the study in modeling case studies pertaining to patient-centered healthcare ecosystem and capturing the richness of information across people, healthcare professionals, software developers, and government.

### 7.5.3. Practical Contribution

The practical contribution of this research includes capturing important insights from the analysis of secondary and primary data values.

- Secondary data analysis revealed that social media influences positively (creating awareness and gathering support) and negatively (spreading hatred and discontent) on the individual's mental health. So, the use of mobile health applications can be used either to report harassments and violence or to receive counseling from healthcare professionals by protecting their privacy and anonymity.
- It also supported the study in understanding individuals' perceptions of mobile health applications. However, it can also be used by healthcare professionals and the application developers as a feedback mechanism which assists them in designing and improving their health applications.
- The primary data from the interviews revealed that mobile health-related initiatives should be connected to citizens through a recommendation from healthcare professionals. This implies that for effective implementations, emphasis should be

placed on understanding the concept of governance, which is framed according to results, processes, rules, ability to steer.

- The case study also revealed that healthcare professionals and techno-entrepreneur should also need to identify peoples' need and unwillingness and consider technical components, governmental policies, and training and support. This will persuade other individuals and patients to use mobile health services and applications for managing health.

### 7.6. The Novelty of this Study

The originality of this thesis has been discussed, verified, and judged according to the guidelines mentioned by Philips and Pugh (1994).

- *Carrying out empirical work that has not been done before*

  The present research is basically exploratory. In this study, an architectural framework and ecosystem suitable for Indian population have been designed and proposed. This has not been done previously. Secondly, there are no published articles in this domain, which are studied through the layers of people, process, and technology.

- *Reinterpreting an existing theory, maybe in a different context*

  This study interprets the research questions through the layers of people, process, and technology by measuring the components related to usefulness, i.e., awareness, accessibility, acceptance, and affordability. However, in the area of mobile health, there is a lack of theoretical concept which specifically addresses all these components in a single theory. Therefore, this study also claims novelty in the use of multiple theoretical models for achieving the objectives of this research.

- *Trying out something in this country which has previously only been done in other countries*

  Although mobile health applications is not a new domain, the analysis of various components and proposal of the ecosystem and architectural framework, particularly for Indian context is a novel one. This study also considers novelty in integrating primary and secondary data approaches to design questionnaire surveys and interviews for the purpose of identifying and understanding the complexities associated with the mobile health system in India.

- *Taking a particular technique and applying it to a new area*

  Some of the techniques which are well known has been used in this study, as mentioned below.

  i. *Causal loop diagram* being popular in understanding and visualizing the interrelationships in the form of causal links (positive and negative) and causal loops (balancing and reinforcement) has been applied for studying the adoption of mobile health in India.
  ii. *Rich pictures* have been applied in the healthcare sector and found to be still valid. It is also used in this study for modeling the mobile health system and for capturing the richness of information across people, healthcare professionals, software developers, and government.
  iii. *Twitter sentiment analysis* has been found to be successful in predicting poll results and vaccinations for a particular region. The same has been tested for mobile health applications, social media movement, and games. It was found that people are joyous and satisfied with the launch of these mobile health applications, and however, for social media movement and games has an influence on the mental health of an individual.

- *Adding to knowledge in a way that has not previously been done before*

  The approach for analyzing the content of the tweets extracted from Twitter websites and finding out the significance of the components identified will definitely be a novel one for the future researchers in the field of mobile health for exploring new possibilities in the facets of mobile health research.

## 7.7. Limitations of this Thesis

The previous section discussed the potential contribution of this thesis with respect to extant literature and knowledge. However, like others, this thesis may also suffer from limitation. Following are some of the limitation observed in this thesis.

- The tweets extracted for mobile health applications, BlueWhale Challenge, MeToo, and mental health was random and therefore, might not be representative and may vary with time.
- There might be a chance of missing out relevant messages or tweets as we have used only one keyword (unigram) to extract the tweets. For example, in the case of social media game ‘BlueWhale’, we have extracted the tweets by limiting our search strategy to bluewhalechallenge. Thus, missing out tweets related to keywords: curatorfindme, suicidegame, imwhale, etc.
- During the Twitter sentiment analysis for mobile health applications and BlueWhale Challenge, it was observed that tweets were classified as ‘unknown’ among polarity and emotion values. This can be due to the type of lexicon (as we have not validated the lexicon) or use of different writing styles such as @pplications, not good, etc. in the tweets.
- In the qualitative part of this study, problems have been identified in accessing targeted interviewees due to the sensitivity of the topic, time, and other financial constraints. Moreover, during the interview process, some respondents are very cautious in providing detailed information which may have an influence on reducing the reliability of the study results.
- Furthermore, due to participants’ anxiety about confidentiality, interview responses have been handwritten, and therefore, further data analysis was dependent on these handwritten notes, which may limit itself in such a situation.
- Even though actions have been taken to reduce the bias imposed by the researcher, his knowledge, background, and experiences may have some influence on the research processes such as the selection of the sample, conducting interviews, and data analysis.
- In the quantitative part of this study, most of the data responses have been received from the participants living the regions of the south of India as this can be a limit to generalize the total population’s awareness about mobile health.
- In addition, offline respondents have been initially instructed about the importance of using mobile phones for health service delivery, and later provided questionnaires for their responses. Hence this may have some influence on the results of mobile health awareness.

- Furthermore, this study has not considered any observed changes in the people health in using a mobile phone for health and other disease conditions. Thus, it might have an influence on the data results being more reliable for awareness level than they actually have.

### 7.8. Suggestions for Future Research

The previous sections have discussed the contribution to the thesis and also specifies thesis limitations. This section, therefore, provides several avenues that can be undertaken as a part of future research:

- The use of lexicon for performing the sentiment analysis can be created and validated for the various contents and words such that the analysis performed using it can be more specific and meaningful.
- The Twitter sentiment analysis of mobile health applications has been considered in this study to understand the user perception of health applications in service delivery. However, sentiment analysis of specific diseases and technology solutions can be studied in detail to understand the impact of social media on the individual and their family members towards health and wellness.
- The study also showcases, the content analysis of the tweets for BlueWhale Challenge, mental health, and MeToo for understanding the key themes which individuals are concerned about. However, these studies can be further explored by classifying the content according to the frequency and hashtags for statistically validation and hypothesis testing.
- Accessibility of mobile health in-terms of the digital divide and the medical divide needs to be researched as it has not been embraced in this study.
- The framework of mobile health awareness and use can be extended by including variables such as participants' demographic factors, trust, technology anxiety, environmental concerns, and behavioral control to measure its significance.
- For the study, factors of health, mobile service, and individual cognitions have been considered and analyzed. However, awareness about specific health utilities and its use for health information seeking behavior and communication can also be included to measure its significance.

- In India, to support digitization, most of the healthcare professionals are using mobile phones for health services. The framework used in this thesis can be further validated by including more case studies involving application users and developers using qualitative comparative analysis such that the results will be more accurate.

## 7.9. Conclusions

The aim of this study is to improve the usefulness of mobile health applications usefulness for health service delivery in India. The study employed the use of qualitative (using primary and secondary data) and quantitative (primary questionnaire survey) study approaches for examining the relationships across the layers of people, process, and technology. The use of multiple study approaches or mixed methodologies enables triangulation of the study findings for comparing and validating the result towards the overall conceptual framework. This chapter concludes by summarizing the major findings leading to revisiting and answering the research questions, significant study contribution, and the limitation of this study. Suggestions for future work have been proposed to close the gaps and to keep enriching the study domain.

# REFERENCES

Ababtain, A. F., Almulhim, D. A. and Househ, M. S. (2013). “The state of mobile health in the developing world and the Middle East.” In *International Conference on Informatics, Management and Technology in Healthcare (ICIMTH),* Athens, Greece,190, 300-302.

Abro, M. M. Q., Khurshid, M. A. and Aamir, A. (2015). “The use of mixed methods in management research.” *Journal of Applied Finance and Banking*, SCIENPRESS Ltd, 5(2), 1-8.

Agarwal, R. and Karahanna, E. (2000). “Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage.” *MIS Quarterly*, 24(4), 665-694.

Agarwal, R. and Prasad, J. (1998). “A conceptual and operational definition of personal innovativeness in the domain of information technology.” *Information Systems Research*, 9(2), 204-215.

Ahadzadeh, A.S. and Sharif, S.P. (2017). “Online Health Information Seeking among Malaysian Women: Technology Acceptance Model Perspective”. *SEARCH*, 9(1), 47-70.

Ahadzadeh, A.S., Sharif, S.P., Ong, F.S. and Khong, K.W. (2015). “Integrating health belief model and technology acceptance model: an investigation of health-related internet use.” *Journal of Medical Internet Research*, 17(2), e45, 1-17.

Aitken, M. and Lyle, J. (2015). “Patient adoption of mHealth: use, evidence and remaining barriers to mainstream acceptance.” *Parsippany, NJ: IMS Institute for Healthcare Informatics*, https://www.iqvia.com/-/media/iqvia/pdfs/institute-reports/patient-adoption-of-mhealth.pdf (Jan. 18, 2017).

Ajay, V. S., Jindal, D., Roy, A., Venugopal, V., Sharma, R., Pawar, A., Kinra S, Tandon, N. and Prabhakaran, D. (2016). “Development of a Smartphone-Enabled Hypertension and Diabetes Mellitus Management Package to Facilitate Evidence-Based Care Delivery in Primary Healthcare Facilities in India: The mPower Heart Project.” *Journal of the American Heart Association*, 5(12), e004343, 1-16.

Ajzen, I. (1988). “Attitudes, Personality, and Behavior.” *Mapping Social Psychology Series*, Dorsey Press, Chicago.

Alam, M. Z., Hoque, M. R., Hu, W. and Barua, Z. (2020). "Factors influencing the adoption of mHealth services in a developing country: A patient-centric study." *International Journal of Information Management*, 50, 128-143.

Alathur, S., Vigneswara Ilavarasan, P. and Gupta, M.P. (2014). "Determinants of citizens' electronic participation: insights from India", *Transforming Government: People, Process and Policy*, 8(3), 447-472.

Alderfer, C. P. (1969). An empirical test of a new theory of human needs. *Organizational Behavior and Human Performance*, *4*(2), 142-175.

Al-Ghamdi, A., Al Harbi, D., Alarfaj, N., Al Hajri, A., Almarashdeh, I., Alsmadi, M., Alshabanah, M. and Alrajhi, D. (2019). "Developing and Implementing a Web-Based Platform for Skills and Knowledge Exchange." *International Journal of Scientific Research in Science and Technology*, 6(3), 562-573.

Alnemer, K. A., Alhuzaim, W. M., Alnemer, A. A., Alharbi, B. B., Bawazir, A. S., Barayyan, O. R. and Balaraj, F. K. (2015). "Are health-related tweets evidence based? Review and analysis of health-related tweets on twitter." *Journal of Medical Internet Research*, 17(10), e246, 1-6.

Al-Somali, S. A., Gholami, R. and Clegg, B. (2009). "An investigation into the acceptance of online banking in Saudi Arabia", *Technovation*, 29(2), 130-141.

Altares, P. S., Copo, A. R. I., Gabuyo, Y. A., Laddaran, A. T., Mejia, L. D. P., Policapio, I. A., Sy, E. A. G., Tizon, H. D. and Yao, A. M. S. D. (2003). "Elementary statistics: a modern approach"., *Rex Bookstore Inc.,* Philippines.

Ammenwerth, E., and De Keizer, N. F. (2016). "Publishing health IT evaluation studies." *Evidence-Based Health Informatics: Promoting Safety and Efficiency Through Scientific Methods and Ethical Policy. Studies in Health Technology and Informatics*, 222, 304-311.

Anderson, J. C. and Gerbing, D. W. (1988). "Structural equation modeling in practice: A review and recommended two-step approach.", *Psychological Bulletin*, 103(3), 411-423.

Aranda-Jan, C. B., Mohutsiwa-Dibe, N. and Loukanova, S. (2014). “Systematic review on what works, what does not work and why of implementation of mobile health (mHealth) projects in Africa.” *BMC Public Health*, 14(1), 188, 1-15.

Asif, M., Xuhui, W., Nasiri, A. and Ayyub, S. (2018). “Determinant factors influencing organic food purchase intention and the moderating role of awareness: A comparative analysis.” *Food Quality and Preference*, *63*, 144-150.

Atluri, V., Rao, S., Rajah, T., Schneider, J., Thibaut, M., Varanasi, S. and Velamoor, S. (2015). “Unlocking Digital Health: Opportunities for the mobile value chain.” *Telecommunications, Media, and Technology*, McKinsey & Company, New York.

Atulomah, N. O., Olanrewaju, M. F., Amosu, A. M. and Adedeji, O. (2010). “Level of awareness, perception and screening behavior regarding prostate cancer among men in a rural community of Ikenne Local Government Area, Nigeria.” *Primary Prevention Insights*, *2*, 11-20.

Austin, P. C. (2002). “Bayesian extensions of the Tobit model for analyzing measures of health status.” *Medical Decision Making*, 22(2), 152-162.

Australian Government. (2019). Assessing Financial Viability. Australian Government-Department of Finance. https://www.finance.gov.au/government/procurement/buying-australian-government/assessing-financial-viability (Apr. 12, 2019).

Ayanso, A. and Lertwachara, K. (2015). “An analytics approach to exploring the link between ICT development and affordability.” *Government Information Quarterly*, 32(4), 389-398.

Balakrishnan, R., Gopichandran, V., Chaturvedi, S., Chatterjee, R., Mahapatra, T. and Chaudhuri, I. (2016). “Continuum of Care Services for Maternal and Child Health using mobile technology–a health system strengthening strategy in low- and middle-income countries.” *BMC Medical Informatics and Decision Making*, 16(1), 84, 1-8.

Banerjee, A., Bhawalkar, J. S., Jadhav, S. L., Rathod, H. and Khedkar, D. T. (2012). “Access to health services among slum dwellers in an industrial township and surrounding rural areas: a rapid epidemiological assessment." *Journal of Family Medicine and Primary Care*, 1(1), 20-26.

Banerjie, M, (2017). "'I Have Come Back': Engineering Student Saved from Blue Whale Suicide Game." https://www.ndtv.com/india-news/i-have-come-back-engineering-student-saved-from-blue-whale-suicide-game-1743126 (Feb. 3, 2019).

Bang, A. T., Bang, R. A. and Reddy, H. M. (2005). "Home-based neonatal care: summary and applications of the field trial in rural Gadchiroli, India (1993 to 2003)." *Journal of Perinatology*, 25, S108-S122.

Bassi, A., John, O., Praveen, D., Maulik, P. K., Panda, R. and Jha, V. (2018). "Current Status and Future Directions of mHealth Interventions for Health System Strengthening in India: Systematic Review." *JMIR mHealth and uHealth*, 6(10), e11440, 1-17.

Basu, A. and Dutta, M. J. (2008), "The relationship between health information seeking and community participation: The roles of health information orientation and efficacy." *Health Communication*, 23(1), 70-79.

Bauer, A. M., Rue, T., Keppel, G. A., Cole, A. M., Baldwin, L. M. and Katon, W. (2014). "Use of mobile health (mHealth) tools by primary care patients in the WWAMI region Practice and Research Network (WPRN)." *The Journal of the American Board of Family Medicine*, 27(6), 780-788.

Beirne, G. C., Westerway, S. C. and Ng, C. K. C. (2016). "National survey of Australian sonographer knowledge and behaviour surrounding the ALARA principles when conducting the 11–14-week obstetric screening ultrasound." *Australasian Journal of Ultrasound in Medicine*, 19(2), 47-55.

Beldad, A. D. and Hegner, S. M. (2018). "Expanding the Technology Acceptance Model with the Inclusion of Trust, Social Influence, and Health Valuation to Determine the Predictors of German Users' Willingness to Continue using a Fitness App: A Structural Equation Modeling Approach". *International Journal of Human–Computer Interaction*, 34(9), 882-893.

Beratarrechea, A., Lee, A. G., Willner, J. M., Jahangir, E., Ciapponi, A. and Rubinstein, A. (2014). "The impact of mobile health interventions on chronic disease outcomes in developing countries: a systematic review." *Telemedicine and e-Health*, *20*(1), 75-82.

BenMessaoud, C., Kharrazi, H. and MacDorman, K.F. (2011). "Facilitators and barriers to adopting robotic-assisted surgery: contextualizing the unified theory of acceptance and use of technology", *PloS one*, 6(1), e16395, 1-11.

Bhan, N., Madhira, P., Muralidharan, A., Kulkarni, B., Murthy, G. V. S., Basu, S. and Kinra, S. (2017). "Health needs, access to healthcare, and perceptions of ageing in an urbanizing community in India: a qualitative study." *BMC Geriatrics*, 17(1), 156, 1-11.

Bhattacharya, S., Kumar, A., Kaushal, V. and Singh, A. (2018). "Applications of m-Health and e-Health in Public Health Sector: The Challenges and Opportunities." *International Journal of Medicine and Public Health*, 8(2), 56-57.

Bhattacherjee, A. (2001), "Understanding information systems continuance: an expectation-confirmation model." *MIS Quarterly*, 25(3), 351-370.

Bhavnani, S. P., Sola, S., Adams, D., Venkateshvaran, A., Dash, P. K., Sengupta, P. P., Bhavnani S, Ryan, T., Narula, J., Thomas, J. and Lang, R. (2018). "A randomized trial of pocket-echocardiography integrated mobile health device assessments in modern structural heart disease clinics." *JACC: Cardiovascular Imaging*, 11(4), 546-557.

Bhutia, D. T. (2014). Protein energy malnutrition in India: the plight of our under five children. *Journal of Family Medicine and Primary Care*, 3(1), 63-67.

Bidmon, S., Terlutter, R. and Röttl, J. (2014), "What explains usage of mobile physician-rating apps? Results from a web-based questionnaire", *Journal of Medical Internet Research*, 16(6), e148, 1-20.

Blaikie, N. (2000). Designing Social Research, Polity, Cambridge.

Blaikie, N. (2007). Approaches to social enquiry: Advancing knowledge. Polity, Cambridge.

Bohlen, J. M., Beal, G. M., and Rogers, E. M. (1957). “The diffusion process.”, Special Report. 24. Iowa State College, http://lib.dr.iastate.edu/specialreports/24 (May 31, 2019).

Boruff, J. T. and Storie, D. (2014). “Mobile devices in medicine: a survey of how medical students, residents, and faculty use smartphones and other mobile devices to find information.” *Journal of the Medical Library Association: JMLA*, 102(1), 22-30.

BPL Lifephone Plus (2017). “BPL LifePhone Plus, a revolutionary Mobile Healthcare Solution.” http://www.bpllifephoneplus.com/#/ (Mar 8, 2017).

Bradley, R. (2009). “Comment—Defining health insurance affordability: Unobserved heterogeneity matters.” *Journal of Health Economics*, 28(1), 255-264.

Brands, B. (2017). “*Taking charge during a terrorist attack: Implementing awareness”*. https://www.internationalairportreview.com/article/33526/taking-charge-terrorist-attack-implementing-awareness/ (Mar. 18, 2018).

Broach, R. B., Geha, R., Englander, B. S., DeLaCruz, L., Thrash, H. and Brooks, A. D. (2016). “A cost-effective handheld breast scanner for use in low-resource environments: a validation study.” *World Journal of Surgical Oncology*, 14(1), 277, 1-6.

Broens, T., Van Halteren, A., Van Sinderen, M. and Wac, K. (2007). “Towards an application framework for context-aware m-health applications.” *International Journal of Internet Protocol Technology*, 2(2), 109-116.

Brown, D. (2018). “19 million tweets later: A look at #MeToo a year after the hashtag went viral.” https://www.usatoday.com/story/news/2018/10/13/metoo-impact-hashtag-made-online/1633570002/, (Dec. 21, 2018).

Brusse, C., Gardner, K., McAullay, D. and Dowden, M. (2014). “Social media and mobile apps for health promotion in Australian Indigenous populations: scoping review.” *Journal of Medical Internet Research*, *16*(12), e280, 1-15.

Bryant, J. and Oliver, M. B. (2009). “Media effects: Advances in theory and research.” *Routledge Communication Series*, Routledge, New York.

Bryman, A. (2012). “Social research methods.” Oxford University Press, United States.

Bryman, A. (2016). *Social research methods*. *Oxford University Press*, United States.

Burrell, G. and Morgan, G. (2017). “Sociological paradigms and organisational analysis: Elements of the sociology of corporate life.” Routledge, London.

Çakar, N. D. and Ertürk, A. (2010). “Comparing innovation capability of small and medium-sized enterprises: examining the effects of organizational culture and empowerment”, *Journal of Small Business Management*, 48(3), 325-359.

Cao, X., Wang, F. and Zheng, Z. (2012). “The experimental research on E-learning instructional design model based on cognitive flexibility theory.” *Physics Procedia*, 25, 997-1005.

Centeno, D. (2009). “Nurtured Emotional Evolution among the Ifaluk. Apathy and Prophecies.” https://astrowipe.wordpress.com/2009/07/03/nutured-emotional-evolution-among-the-ifaluk/ 2009, (Jul. 20, 2017).

Central Intelligence Agency. (2019). “The World Factbook.” https://www.cia.gov/library/publications/the-world-factbook/fields/354rank.html (Apr. 23, 2019).

Chaamwe, N. and Bwalya, E. (2013). “An Investigation into Strategies Aimed at Reducing ICT Costs at the Bank of Zambia.” *International Business Management*, 7(3), 182-190.

Chan, K. L. and Chen, M. (2019). “Effects of social media and mobile health apps on pregnancy care: meta-analysis.” *JMIR mHealth and uHealth*, *7*(1), e11836, 1-13.

Chan, N. L. and Guillet, B. D. (2011). “Investigation of social media marketing: how does the hotel industry in Hong Kong perform in marketing on social media websites?.” *Journal of Travel & Tourism Marketing*, 28(4), 345-368.

Chandra, P. S., Sowmya, H. R., Mehrotra, S. and Duggal, M. (2014). “‘SMS” for mental health–Feasibility and acceptability of using text messages for mental health promotion among young women from urban low income settings in India.” *Asian Journal of Psychiatry*, 11, 59-64.

Chandramouli, C. and General, R. (2011). Census of India 2011. *Provisional Population Totals. New Delhi: Government of India*. http://censusindia.gov.in/2011-prov-results/paper2/data_files/india/paper2_1.pdf (Oct. 12, 2018).

Chatterjee, S., Kar, A. K. and Gupta, M. P. (2018). "Success of IoT in smart cities of India: An empirical analysis." *Government Information Quarterly*, 35(3), 349-361.

Chaturvedi, C. (2016). "Inventing Medical Devices: A Perspective from India." Notion Press.

Chatzoglou, P., Chatzoudes, D. and Symeonidis, S. (2015). "Factors affecting the intention to use e-Government services." In *2015 Federated Conference on Computer Science and Information Systems (FedCSIS),* IEEE.1489-1498.

Chau, P. Y. and Hu, P. J. (2002). "Examining a model of information technology acceptance by individual professionals: An exploratory study." *Journal of Management Information Systems*, 18(4), 191-229.

Chaumartin, F. R. (2007). "UPAR7: A knowledge-based system for headline sentiment tagging." In *Proceedings of the 4th International Workshop on Semantic Evaluations*, Association for Computational Linguistics, 422-425.

Checkland, P. and Scholes, J. (1990). "Soft System Methodology in Action." *John Wiley & Sons Ltd.*, Chichester, England.

Chen, J., Cade, J. E. and Allman-Farinelli, M. (2015). "The most popular smartphone apps for weight loss: a quality assessment." *JMIR mHealth and uHealth*, 3(4), e104, 1-20.

Chen, H., Chai, Y., Dong, L., Niu, W. and Zhang, P. (2018). "Effectiveness and appropriateness of mHealth interventions for maternal and child health: systematic review." *JMIR mHealth and uHealth*, *6*(1), e7, 1-12.

Chen, L., Rai, A. and Krishnan, G. (2014). "Consumer Awareness and Use of Mobile Health Services in India: An Urban–Rural Comparison Study", *Thirty Fifth International Conference on Information Systems*, Auckland.

Chen, M. F. and Lin, N. P. (2018). "Incorporation of health consciousness into the technology readiness and acceptance model to predict app download and usage intentions." *Internet Research*, 28(2), 351-373.

Chen, Y. (2011). "Understanding technology adoption through system dynamics approach: A case study of RFID technology." In *2011 IFIP 9th International Conference on Embedded and Ubiquitous Computing*, IEEE. 366-371.

Chetty, K., Liu, Q., Wenwei, L., Josie, J., Gcora, N. and Shenglin, B. (2017). "Bridging the digital divide: measuring digital literacy." http://www.g20-insights.org/policy_briefs/bridging-digital-divide-measuring-digital-literacy/ (Sept. 08, 2017).

Chew, C. and Eysenbach, G. (2010). "Pandemics in the age of Twitter: content analysis of Tweets during the 2009 H1N1 outbreak." *PloS one*, 5(11), e14118, 1-13.

Chib, A., Cheong, Y. J., Lee L. C. L., NG Chiah H. C., Tan C. K., Kameswari, V. L. V. (2012). "The hope of mobile phones in Indian rural healthcare." *Journal of Health Informatics in Developing Countries*, 6(1), 406-421.

Chin, S. O., Keum, C., Woo, J., Park, J., Choi, H. J., Woo, J. T. and Rhee, S. Y. (2016). "Successful weight reduction and maintenance by using a smartphone application in those with overweight and obesity." *Scientific Reports*, 6, 34563, 1-8.

Chismar, W. G. and Sonja W. (2003). "Does the extended technology acceptance model apply to physicians." In *Proceedings of the 36th Annual Hawaii International Conference on System Sciences, 2003* (HICSS'03). 6, IEEE. Hawaii, US. 160-167.

Cho, J., Park, D. and Lee, H.E. (2014). "Cognitive factors of using health apps: systematic analysis of relationships among health consciousness, health information orientation, eHealth literacy, and health app use efficacy." *Journal of Medical Internet Research*, 16(5), e125.

Cho, J., Quinlan, M. M., Park, D. and Noh, G.Y. (2014). "Determinants of adoption of smartphone health apps among college students." *American Journal of Health Behavior*, 38(6), 860-870.

Collis, J. and Hussey, R. (2013). "Business research: A practical guide for undergraduate and postgraduate students." *Macmillan International Higher Education,* Red Globe Press, Palgrave Macmillan, New York.

Cosmides, L. and Tooby, J. (2000). "Evolutionary psychology and the emotions." *Handbook of emotions,* 2(2), 91-115.

Cousins, S. (2018). "A New Way to Detect Breast Cancer." https://www.nytimes.com/2018/08/28/opinion/detect-breast-cancer-developing-countries-asia.html. (Mar. 6, 2019).

Creswell, J. W. (1994). "Research design: Qualitative and quantitative approaches." *Thousand Oaks,* CA: Sage.

Creswell, J. W., Klassen, A. C., Plano Clark, V. L. and Smith, K. C. (2011). "Best practices for mixed methods research in the health sciences." *Bethesda (Maryland): National Institutes of Health,* 2013, 541-545.

Culnan, M. J. (1984). "The dimensions of accessibility to online information: Implications for implementing office information systems." *ACM Transactions on Information Systems (TOIS),* 2(2), 141-150.

Cummings, D., Oh, H. and Wang, N. (2010). "Who needs polls? Gauging public opinion from Twitter data." Unpublished manuscript, December 2017.

Cunningham, P. J. and Felland, L. (2013). "Environmental scan to identify the major research questions and metrics for monitoring the effects of the Affordable Care Act on safety net hospitals." Center for Studying Health System Change. 1-34.

Curtis, L. (1920). "Papers Relating to the Application of the Principle of Dyarchy to the Government of India: To which are Appended the Report of the Joint Select Committee and the Government of India Act, 1919." Clarendon Press.

Dagger, T. S., Sweeney, J. C. and Johnson, L. W. (2007). "A hierarchical model of health service quality: scale development and investigation of an integrated model." *Journal of Service Research*, 10(2), 123-142.

Dainton, M. and Zelley, E. D. (2017). "Applying communication theory for professional life: A practical introduction." Sage publications.

Dallosta, P. and Simcik, T. (2012). “Designing for Supportability: Driving Reliability, Availability, and Maintainability.” *In Defense AT&L: Product Support*, 34–38.

Dasgupta, A. and Deb, S. (2008). “Telemedicine: A new horizon in public health in India.” *Indian Journal of Community Medicine: Official Publication of Indian Association of Preventive & Social Medicine*, 33(1), 3-8.

Davis, D. F., Golicic, S. L. and Boerstler, C. N. (2011). “Benefits and challenges of conducting multiple methods research in marketing.” *Journal of the Academy of Marketing Science*, 39(3), 467-479.

Davis, F. D. (1989), “Perceived usefulness, perceived ease of use, and user acceptance of information technology.” 13(3), *MIS Quarterly*, 319-340.

Davis, F.D. 1993, “User acceptance of information technology: system characteristics, user perceptions and behavioral impacts.” *International Journal of Man-Machine Studies*, 38(3), 475-487.

Defense Acquisition University. (2018). Affordable System Operational Effectiveness (ASOE) Model. https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=63db32bb-5ca2-4862-92bf-80c51021a36c/ (Jul. 03, 2018).

Delgado, C., Upton, D., Ranse, K., Furness, T. and Foster, K. (2017). “Nurses’ resilience and the emotional labour of nursing work: An integrative review of empirical literature.” *International Journal of Nursing Studies*, 70, 71-88.

Delgado, M. (2017). “How to Make an App: From Brainstorm to Launch.” https://clutch.co/app-developers/resources/how-to-make-an-app. (Jul. 03, 2018).

Deloitte. (2015). “2015 health care outlook India.” https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/gx-lshc-2015-health-care-outlook-india.pdf (Jul. 03, 2018).

DeSouza, S. I., Rashmi, M. R., Vasanthi, A. P., Joseph, S. M. and Rodrigues, R. (2014). “Mobile Phones: The Next Step towards Healthcare Delivery in Rural India?”, PloS ONE, 9(8): e104895, 1-9.

Dey, N., Ashour, A. S. and Bhatt, C. (2017). “Internet of things driven connected healthcare.” In *Internet of things and big data technologies for next generation healthcare*, Springer, Cham, 3-12

Dhawan, A. (2015). “2015 health care outlook India.” *Deloitte Touche Tohmatsu Limited*, 1-4.

Dietsche, E. (2014). “‘Good Governance’ of the Extractive Resources Sector: A Critical Analysis”, PhD Dissertation, University of Dundee. https://discovery.dundee.ac.uk/ws/files/5473036/Dietsche_phd_2014.pdf (Apr. 09, 2019).

D'Monte, L. (2016). “The long road to Digital India.” https://www.livemint.com/Opinion/9byO3lgHLz1KcbtCWgPw0I/The-long-road-to-Digital-India.html (Apr. 09, 2019).

Dogra, V. and Hegde, S. K. (2018). Transforming Ailing Primary Care in India: A Healing Touch. *International Journal of Health Systems and Implementation Research*, 2(2), 23-29.

Donner, J. and Tellez, C. A. (2008), “Mobile banking and economic development: Linking adoption, impact, and use”, *Asian Journal of Communication*, 18(4), 318-332.

Duggal, R. (2001). Evolution of health policy in India. *Centre for Enquiry into Health and Allied Themes*, New Delhi.

Dutta-Bergman, M. J. (2004), “Primary sources of health information: Comparisons in the domain of health attitudes, health cognitions, and health behaviors.” *Health Communication*, 16(3), 273-288.

Dwivedi, Y. K., Shareef, M. A., Simintiras, A. C., Lal, B. and Weerakkody, V. (2016). “A generalised adoption model for services: A cross-country comparison of mobile health (m-health).” *Government Information Quarterly*, 33(1), 174-187.

Edmondson, A.C. and McManus, S.E. (2007), “Methodological fit in management field research.” *Academy of Management Review*, 32(4),1246-1264.

Edura Wan Rashid, W. and Kamaruzaman Jusoff, H. (2009). "Service quality in health care setting." *International Journal of Health Care Quality Assurance*, 22(5), 471-482.

Ehteshami, A., Hachesu, P. R., Esfahani, M. K. and Rezazadeh, E. (2013). "Awareness and using of medical students about mobile health technology in clinical areas." *Acta Informatica Medica*, 21(2), 109-112.

Eisenhardt, K.M. and Graebner, M.E., 2007. "Theory building from cases: Opportunities and challenges." *The Academy of Management Journal*, 50(1), 25-32.

Epstein, R. M., Fiscella, K., Lesser, C. S. and Stange, K. C. (2010). "Why the nation needs a policy push on patient-centered health care." *Health Affairs*, 29(8), 1489-1495.

Espelage, D. L. and Holt, M. K. (2007). "Dating violence & sexual harassment across the bully-victim continuum among middle and high school students." *Journal of Youth and Adolescence*, 36(6), 799-811.

EuroMed-Info (2018). "How culture influences health beliefs". https://www.euromedinfo.eu/how-culture-influences-health-beliefs.html/#wrap (Mar. 24, 2018).

Fagenson, E. A. (1992). "Mentoring—Who needs it? A comparison of protégés' and nonprotégés' needs for power, achievement, affiliation, and autonomy." *Journal of Vocational Behavior*, 41(1), 48-60.

FDA. (2019). Digital Health. https://www.fda.gov/medical-devices/digital-health (Mar. 24, 2018).

FDA. (2019). "Examples of Mobile Apps for Which the FDA Will Exercise Enforcement Discretion." http://www.fda.gov/MedicalDevices/DigitalHealth/MobileMedicalApplications/ucm368744.htm/ (Mar. 27, 2018).

Feseha, G. and Gerbaba, M. (2012). "Intimate partner physical violence among women in Shimelba refugee camp, northern Ethiopia." *BMC Public Health*, 12(1), 125, 1-10.

Finlay, J. (2007), “The role of health in economic development”, *Program on the Global Demography of Aging. PGDA Working Paper*, No. 21, 1-34.

Fishbein, M. and Ajzen, I. (1975), “Belief, attitude, and behavior: An introduction to theory and research”, *Reading, Mass.: Addison Wessley*. Boston.

Fisher, D. K., Norvell, J., Sonka, S. and Nelson, M. J. (2000). “Understanding technology adoption through system dynamics modeling: implications for agribusiness management.” *The International Food and Agribusiness Management Review*, 3(3), 281-296.

Flynn, L.R. and Goldsmith, R.E. (1993), “A validation of the Goldsmith and Hofacker innovativeness scale”, *Educational and Psychological Measurement*, 53(4), 1105-1116.

Fornell, C. and Larcker, D. F. (1981), “Evaluating structural equation models with unobservable variables and measurement error”, *Journal of Marketing Research*, 18(1), 39-50.

Forrest, J. I., Wiens, M., Kanters, S., Nsanzimana, S., Lester, R. T. and Mills, E. J. (2015). “Mobile health applications for HIV prevention and care in Africa.” *Current Opinion in HIV and AIDS*, 10(6), 464-471.

Fox, S. (2019). “Trying times: domestication of healthcare technologies amidst challenging dynamic contexts.” *Social Theory & Health*, 17(3), 1-16.

Frappier, M., Matwin, S., and Mili, A. (1994). “Maintainability: Factors and Criteria.” *Software Metrics Study, Tech. Memo. 1,* Canadian Space Agency, St-Hubert, Canada.

Free, C., Phillips, G., Galli, L., Watson, L., Felix, L., Edwards, P., Patel, E. and Haines, A. (2013). “The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review.” *PLoS medicine*, 10(1), e1001362, 1-26.

Freud, S. (2018). *The collected works of Sigmund Freud* (Vol. 1). *Library of Alexandria*, Ptolemaic Kingdom.

Gabarron, E., Dorronzoro, E., Rivera-Romero, O. and Wynn, R. (2019). "Diabetes on Twitter: A Sentiment Analysis." *Journal of Diabetes Science and Technology*, 13(3), 439–444.

Gajecki, M., Berman, A. H., Sinadinovic, K., Rosendahl, I. and Andersson, C. (2014). "Mobile phone brief intervention applications for risky alcohol use among university students: a randomized controlled study." *Addiction science & clinical practice*, 9(1), 11, 1-12.

Gallacher, L., and Morris, H. (2012). "ITIL Foundation Exam Study Guide." John Wiley & Sons Inc. United States.

Gallego, M.D., Bueno, S. and Noyes, J. (2016), "Second Life adoption in education: A motivational model based on Uses and Gratifications theory." *Computers & Education*, 100, 81-93.

Ganesan, A. N., Louise, J., Horsfall, M., Bilsborough, S. A., Hendriks, J., McGavigan, A. D., Selvanayagam, J. B. and Chew, D. P. (2016). "International mobile-health intervention on physical activity, sitting, and weight: the Stepathlon cardiovascular health study." *Journal of the American College of Cardiology*, 67(21), 2453-2463.

Gangopadhyay, J. (2016). "The Trials of India's Aging Population." https://thediplomat.com/2016/10/the-trials-of-indias-aging-population/ (Apr. 05, 2018).

Garai, A. (2011). "Role of mHealth in rural health in India and opportunities for collaboration." In *Background reading prepared for ICCP Technology Foresight Forum: Developments in Mobile Communication*, Paris, 1-5.

Garner, M., Ning, Z. and Francis, J. (2012). "A framework for the evaluation of patient information leaflets." *Health Expectations*, 15(3), 283-294.

Gautam, A. (2014). "Top Microblogging sites list with high pr and best." http://mywptips.com/top-microblogging-sites-list/, last accessed (Dec. 07, 2018).

Gautham, M., Shyamprasad, K.M., Singh, R., Zachariah, A., Singh, R. and Bloom, G. (2014), "Informal rural healthcare providers in North and South India." *Health Policy and Planning*, 29(1), i20-i29.

Gegenhuber, T. K. and Bauer, R. (2017). “An Organization with Many Faces: A Crowd-based Venture's Versatility in Resource Mobilization.” In *Academy of Management Proceedings,* 2017(1), Academy of Management, Briarcliff Manor, NY.

Germanakos, P., Mourlas, C. and Samaras, G. (2005). “A mobile agent approach for ubiquitous and personalized eHealth information systems.” In *Proceedings of the Workshop on'Personalization for e-Health'of the 10th International Conference on User Modeling (UM'05). Edinburgh,* 67-70.

Gibson, B. A., Ghosh, D., Morano, J. P. and Altice, F. L. (2014), “Accessibility and utilization patterns of a mobile medical clinic among vulnerable populations.” *Health & Place,* 28, 153-166.

Gilbert, S. S., Thakare, N., Ramanujapuram, A. and Akkihal, A. (2017). “Assessing stability and performance of a digitally enabled supply chain: Retrospective of a pilot in Uttar Pradesh, India.” *Vaccine,* 35(17), 2203-2208.

Ginguld, M., Renet, F., Personnaz, A., David, Y. B. and Sinha, A. (2010). “The AirJaldi Bandwidth Maximizer (BwM) - Proving Concept, Demonstrating potential and Viability”. ISIF ASIA.

Gioia, D.A., Corley, K.G. and Hamilton, A.L. (2013). “Seeking qualitative rigor in inductive research: Notes on the Gioia methodology.” *Organizational Research Methods,* 16(1), 15-31.

Glanz, K., Rimer, B.K. and Viswanath, K. (2008). “Health Behavior and Health Education: Theory, Research, and Practice.” Jossey-Bass - A Wiley Imprint, San Francisco, CA.

Global Health Observatory [GHO] data, (2015). “World Health Statistics 2015.” https://www.who.int/gho/publications/world_health_statistics/2015/en/ (Dec. 23, 2018)

Global Innovation Index. (2019). “Global Innovation Index”. https://www.globalinnovationindex.org/about gii#reports (Apr 23, 2019).

Goel, V., Venkataraman, A. and Schultz, K. (2018). “After a Long Wait, India’s #MeToo Movement Suddenly Takes Off.” https://www.nytimes.com/2018/10/09/world/asia/india-sexual-harassment-me-too-bollywood.html, (Dec. 07, 2018).

Goh, Z. Y., Lee, P. Y., and Lai, Y. F. (2019). “Patterns of fruit and vegetable intake and physical activity among community-ambulant patients in Singapore: A cross-sectional study.” *Proceedings of Singapore Healthcare*, 28(1), 10-18.

Golechha, M. (2015). “Healthcare agenda for the Indian government.” *The Indian Journal of Medical Research*.” 141(2), 151-153.

Gordon, S., Evans, D., Shapiro, N. B. and Patel, U. (1994). “Asian Indian Culture: Influences and Implications for Health Care.” 1-8.

Govindarajan, V. (2017). “Tamil Nadu makes vaccinations mandatory for school students, but parents still have safety concerns”. https://scroll.in/pulse/840298/tamil-nadu-makes-vaccinations-mandatory-for-school-students-but-parents-still-have-safety-concerns (Mar. 26, 2018).

Gradus, J. L., Street, A. E., Kelly, K. and Stafford, J. (2008). “Sexual harassment experiences and harmful alcohol use in a military sample: Differences in gender and the mediating role of depression.” *Journal of Studies on Alcohol and Drugs*, 69(3), 348-351.

Grafton, J., Lillis, A. M. and Mahama, H. (2011). “Mixed methods research in accounting.” *Qualitative Research in Accounting & Management*, 8(1), 5-21.

Green, E. C. and Murphy, E. (2014). “Health belief model.” *The Wiley Blackwell Encyclopedia of Health, Illness, Behavior, and Society*, John Wiley & Sons, Ltd. 766-769.

Griffiths, P. E. (2004). “Is emotion a natural kind?.” In R. C. Solomon (Ed.), Thinking about feeling: Contemporary philosophers on emotions, *Oxford University Press*, New York, 233–249.

Grix, J. (2002). “Introducing students to the generic terminology of social research.” *Politics*, 22(3), 175-186.

Gross, M. (2013). “Governance in Health Care.” *Atlantic Institute for Market Studies Commentary*, 1-3.

Guerra-Reyes, L., Christie, V. M., Prabhakar, A., Harris, A. L., and Siek, K. A. (2016). “Postpartum health information seeking using mobile phones: Experiences of low-income mothers.” *Maternal and Child Health Journal*, *20*(1), 13-21.

Gupta, A. (2014). “For digital India, innovation, research and technology to play a major role. *The Economic Times*.” https://economictimes.indiatimes.com/for-digital-india-innovation-research-and-technology-to-play-a-major-role/articleshow/34171292.cms/ (Jun. 27, 2018).

Gupta, D. (2011). Science and Modern India: An Institutional History, c. 1784-1947: Project of History of Science, Philosophy and Culture in Indian Civilization, Volume XV, Part 4, 15, *Pearson Education,* India.

Gupta, I. and Bhatia, M. (2019). “The Indian Health Care System.” https://international.commonwealthfund.org/countries/india/ (Oct. 13, 2018).

Gutwin, C. and Greenberg, S. (2002). "A Descriptive Framework of Workspace Awareness for Real-Time Groupware". *Computer Supported Cooperative Work (CSCW)*, **11** (3–4): 411–446.

Hahn, H. P. (2004). “Global goods and the process of appropriation.” In P. Probst & G. Spittler (eds) Between Resistance and Expansion: Explorations of Local Vitality in Africa, Münster, Germany: LIT Verlag, 213-231.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E. and Tatham, R. L. (2010), “Multivariate Data Analysis (7th ed.)”, *Upper Saddle River*, Pearson Prentice Hall, New Jersey.

Hanafizadeh, P. and Khedmatgozar, H. R. (2012), “The mediating role of the dimensions of the perceived risk in the effect of customers’ awareness on the adoption of Internet banking in Iran.” *Electronic Commerce Research*, 12(2), 151-175.

Hancock, K. E. (1993). 'Can Pay? Won't Pay?' or Economic Principles of 'Affordability'. *Urban studies*, *30*(1), 127-145.

Harikumar, J. S (2018), “Ready reckoner: head to ‘afterflood.in’ for your post-flood dos and don’ts”, https://www.thehindu.com/sci-tech/technology/internet/ready-reckoner-head-to-afterfloodin-for-your-post-flood-dos-and-donts/article24862473.ece (Mar. 26, 2018).

Health and Family Welfare. (2017). Karnataka Integrated Public Health Policy 2017. https://www.karnataka.gov.in/hfw/kannada/Documents/Karnataka_Integrated_Public_Health_Policy_2017.PDF (Jun. 12, 2018).

Healthenablr (2017). “Healthenablr: Home.” https://www.healthenablr.com/home (Mar. 8, 2017).

HelpAge India. (2015). “State of Elderly in India 2014.” https://ruralindiaonline.org/resources/state-of-elderly-in-india-2014/ (Jun. 19, 2019).

Henshaw, E. J. and Freedman-Doan, C. R. (2009). “Conceptualizing mental health care utilization using the health belief model.” *Clinical Psychology: Science and Practice*, 16(4), 420-439.

Holden, M. T. and Lynch, P. (2004). “Choosing the appropriate methodology: Understanding research philosophy.” *The Marketing Review*, 4(4), 397-409.

Holeman, I., Cookson, T. P. and Pagliari, C. (2016). “Digital technology for health sector governance in low and middle income countries: a scoping review.” *Journal of Global Health*, 6(2), 1-11.

Holla, B., Viswanath, B., Neelaveni, S., Harish, T., Kumar, C. N. and Math, S. B. (2013). “Karnataka state telemedicine project: Utilization pattern, current, and future challenges.” *Indian Journal of Psychological Medicine*, 35(3), 278-283.

Hölzel, L. P., Ries, Z., Dirmaier, J., Zill, J. M., Kriston, L., Klesse, C., Härter, M. and Bermejo, I. (2015). “Usefulness scale for patient information material (USE)-development and psychometric properties.” *BMC medical informatics and decision making*, 15(1), 34, 1-8.

Hooda Nandal, A. and Singla, M.L. (2019), "Investigating the impact of metaphors on citizens' adoption of e-governance in developing countries: An empirical study." *Transforming Government: People, Process and Policy*, 13(1), 34-61.

Hoque, R. and Sorwar, G. (2017). "Understanding factors influencing the adoption of mHealth by the elderly: An extension of the UTAUT model." *International Journal of Medical Informatics*, 101, 75-84.

Hsieh, H. F. and Shannon, S. E. (2005). "Three approaches to qualitative content analysis". *Qualitative Health Research*, *15*(9), 1277-1288.

Hu, L. T. and Bentler, P. M. (1999), "Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives." *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1-55.

Hu, P.J.H., Clark, T.H. and Ma, W.W. (2003), "Examining technology acceptance by school teachers: a longitudinal study", *Information & Management*, 41(2), 227-241.

Huesch, M. D., Galstyan, A., Ong, M. K. and Doctor, J. N. (2016). "Using social media, online social networks, and internet search as platforms for public health interventions: a pilot study." *Health Services Research*, *51*(S2), 1273-1290.

Hurt, K., Walker, R. J., Campbell, J. A. and Egede, L. E. (2016). "mHealth interventions in low and middle-income countries: a systematic review." *Global Journal of Health Science*, *8*(9), 183-193.

Hussain, M., Zaidan, A. A., Zidan, B. B., Iqbal, S., Ahmed, M. M., Albahri, O. S. and Albahri, A. S. (2018). "Conceptual framework for the security of mobile health applications on android platform." *Telematics and Informatics*, 35(5), 1335-1354.

Hyden, G., Hydén, G., Mease, K. and Mease, K. (2004). "Making sense of governance: empirical evidence from sixteen developing countries." *Lynne Rienner Publishers*.

IAMAI (2018). "Media Inner | IAMAI." https://www.iamai.in/media/details/5007 ( Jun. 30, 2018).

IANS. (2018). "How a phone call is saving lives of TB patients in India", http://www.financialexpress.com/lifestyle/health/how-a-missed-call-is-saving-lives-of-tb-patients-in-india/1109207/ (Mar. 26, 2018).

Ifinedo, P. (2016), “Applying uses and gratifications theory and social influence processes to understand students' pervasive adoption of social networking sites: Perspectives from the Americas.” *International Journal of Information Management*, 36(2), 192-206.

India Brand Equity Foundation (IBEF). (2018). “Healthcare Industry in India. https://www.ibef.org/industry/healthcare-india.aspx/ (Jul. 13, 2018).

India CSR network (2018), “CSR of GAIL: A Mobile Medical Van Launched in Giridih, Jharkhand”, http://indiacsr.in/csr-gail-mobile-medical-van-launched-giridih-jharkhand/ (Sept. 4, 2018).

India Today (2013), “North India vs South India: Who is doing better? Report says South India”, https://www.indiatoday.in/india/north/story/north-india-vs-south-india-who-is-doing-better-report-says-south-india-162101-2013-05-07 (Mar. 23, 2018).

International Diabetes Federation. (2018). “Diabetes facts & figures”. https://www.idf.org/aboutdiabetes/what is diabetes/facts figures.html (Apr. 23, 2018).

International Telecommunication Union. (2018). “ICT Development Index”. https://www.itu.int/net4/ITU D/idi/2017/index.html (Mar. 24, 2018).

IQVIA (n.d). “Impact of Digital Health Grows as Innovation, Evidence and Adoption of Mobile Health Apps Accelerate.” https://www.iqvia.com/en/newsroom/2017/11/impact-of-digital-health-grows-as-innovation-evidence-and-adoption-of-mobile-health-apps-accelerate (May. 09, 2018)

Istepanian, R., Laxminarayan, S. and Pattichis, C.S. (2006). “M-health.” Springer Science+ Business Media, Incorporated, New York.

Iyengar R. (2017). “India poised for smartphone revolution”. Cable News Network. http://money.cnn.com/2017/09/26/technology/india-mobile-congress-market-numbers/index.html. (Apr. 06, 2018).

Jacobs, B., Ir, P., Bigdeli, M., Annear, P. L. and Van Damme, W. (2011). "Addressing access barriers to health services: an analytical framework for selecting appropriate interventions in low-income Asian countries", *Health Policy and Planning*, 27(4), 288-300.

Jagdish, V. (1981). "Reorganization of health auxiliaries in India." *Tropical doctor*, 11(1), 44-46.

Jain, N., Singh, H., Koolwal, G. D., Kumar, S. and Gupta, A. (2015). "Opportunities and barriers in service delivery through mobile phones (mHealth) for severe mental illnesses in Rajasthan, India: a multi-site study." *Asian Journal of Psychiatry*, 14, 31-35.

James, R. (2014). "ICT's participatory potential in higher education collaborations: Reality or just talk." *British Journal of Educational Technology*, 45(4), 557-570.

Jamir, L., Nongkynrih, B. and Gupta, S. K. (2013). "Mobile health clinics: Meeting health needs of the urban underserved." *Indian Journal of Community Medicine: Official Publication of Indian Association of Preventive & Social Medicine*, 38(3), 132-134.

Janz, N. K. and Becker, M. H. (1984). "The health belief model: A decade later." *Health Education Quarterly*, 11(1), 1-47.

Jayakrishnan, T., Jeeja, M. C., Kuniyil, V. and Paramasivam, S. (2016). "Increasing out-of-pocket health care expenditure in India-due to supply or demand." *Pharmacoeconomics*, 1(105), 1-6.

Jha, D., Gupta, P., Ajay, V. S., Jindal, D., Perel, P., Prieto-Merino, D., Jacob, P., Nyong, J., Venugopal, V., Singh, K. and Goenka, S. (2017). "Protocol for the mWellcare trial: a multicentre, cluster randomised, 12-month, controlled trial to compare the effectiveness of mWellcare, an mHealth system for an integrated management of patients with hypertension and diabetes, versus enhanced usual care in India." *BMJ Open*, *7*(8), e014851, 1-8.

Johnson, G. (2017). "Theories of Emotion | Internet Encyclopedia of Philosophy." http://www.iep.utm.edu/emotion/ (Jul. 20, 2017).

Joo, J. and Sang, Y. (2013), “Exploring Koreans’ smartphone usage: An integrated model of the technology acceptance model and uses and gratifications theory.” *Computers in Human Behavior*, 29(6), 2512-2518.

Jöreskog, K. G. and Sörbom, D. (1993), “LISREL 8: Structural equation modeling with the SIMPLIS command language.” Scientific Software International. Hillsdale, Erlbaum, NJ.

Joseph, N., Grover, P., Rao, P. K. and Ilavarasan, P. V. (2017). “Deep analyzing public conversations: Insights from Twitter analytics for policy makers.” In *Conference on e-Business, e-Services and e-Society,* Springer, Cham, 239-250.

Jurka, T., (2012). “Sentiment: Tools for sentiment analysis.” *R package version 0.1, Recuperado de http://goo. gl/oxASCV*. (Sep. 06, 2018).

Kaewta, S. and Chutima, P. (2014). “Improvement of project portfolio management in an information technology consulting company.” In *IOP Conference Series: Materials Science and Engineering,* 58(1), 012012. IOP Publishing, 1-7.

Kahn, J. G., Yang, J. S. and Kahn, J. S. (2010). “‘Mobile’health needs and opportunities in developing countries.” *Health Affairs*, 29(2), 252-258.

Kaldate, S. (1962). “Urbanization and disintegration of rural joint family.” *Sociological Bulletin*, 11(1-2), 103-111.

Källander, K., Tibenderana, J. K., Akpogheneta, O. J., Strachan, D. L., Hill, Z., ten Asbroek, A. H., Conteh, L., Kirkwood, B.R. and Meek, S. R. (2013). “Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low-and middle-income countries: a review.” *Journal of Medical Internet Research*, *15*(1), e17, 1-13.

Kang, C., Tomkow, L. and Farrington, R. (2019). “Access to primary health care for asylum seekers and refugees: a qualitative study of service user experiences in the UK.” *British Journal of GeneralPractice*, 69(685), bjgp19X701309, e537-e545.

Kanter, R. M. and Kim, J. J. (2019). “Piramal e-Swasthya (C): A New Name, Bigger Scope, and Public-Private Partnerships.” Harvard Business School Supplement 320-012.

Kappal, R., Mehndiratta, A., Anandaraj, P. and Tsanas, A. (2014). "Current Impact, Future Prospects and Implications of Mobile Healthcare in India." *Central Asian Journal of Global Health,* 3(1), 1-15.

Karahanna, E. and Straub, D.W. (1999), "Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs." *MIS Quarterly,* 23(2), 183–214.

Karahanna, E., Straub, D.W. and Chervany, N.L. (1999). "Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs." *MIS Quarterly,* 23(2), 183-213.

Katz, E., Blumler, J. G. and Gurevitch, M. (1973). "Uses and gratifications research." *The Public Opinion Quarterly,* 37(4), 509-523.

Kayyali, R., Peletidi, A., Ismail, M., Hashim, Z., Bandeira, P., & Bonnah, J. (2017). Awareness and Use of mHealth Apps: A Study from England. *Pharmacy*, *5*(2), 33, 1-14.

Kearney, A. T. (2010). "Mobile Health, Who Pays?." *GSMA,* London, UK.

Kedar, M. S. (2015). "Digital India: New way of Innovating India Digitally." *International Research Journal of Multidisciplinary Studies*, 1(4), 34-49.

Keikhosrokiani, P., Mustaffa, N., Zakaria, N. and Baharudin, A. S. (2019). "User behavioral intention toward using mobile healthcare system." In *Consumer-Driven Technologies in Healthcare: Breakthroughs in Research and Practice,* IGI Global, 429-444.

KelpHR. (2018). "Advantages and disadvantages of PoSH Act 2013." https://www.kelphr.com/blogs/advantages-and-disadvantages-of-posh-act/# (Dec. 21, 2018).

Khatun, F., Hanifi, S. M. A., Iqbal, M., Rasheed, S., Rahman, M. S., Ahmed, T., Hoque, S., Sharmin, T., Khan, N.U.Z., Mahmood, S.S. and Peters, D. H. (2014). "Prospects of mHealth services in Bangladesh: recent evidence from Chakaria." *PLoS One,* 9(11), e111413, 1-9.

Khatun, F., Heywood, A. E., Ray, P. K., Bhuiya, A., and Liaw, S. T. (2016). "Community readiness for adopting mHealth in rural Bangladesh: a qualitative exploration. *International Journal of Medical Informatics*, 93, 49-56.

Kibria, A., Mancher, M., McCoy, M. A., Graham, R. P., Garber, A. M., and Newhouse, J. P. (2013). "Variation in health care spending: target decision making, not geography." National Academies Press.

Kim, C., Mirusmonov, M. and Lee, I. (2010). "An empirical examination of factors influencing the intention to use mobile payment." *Computers in Human Behavior*, 26(3), 310-322.

Kim, J. and Park, H. A. (2012), "Development of a health information technology acceptance model using consumers' health behavior intention." *Journal of Medical Internet Research*, 14(5), e133, 1-14.

Kim, S., Gajos, K.Z., Muller, M. and Grosz, B.J. (2016). "Acceptance of mobile technology by older adults: a preliminary study", in MobileHCI '16 *Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services,* Florence, Italy, ACM. 147-157.

King, D., Ramirez-Cano, D., Greaves, F., Vlaev, I., Beales, S. and Darzi, A. (2013). "Twitter and the health reforms in the English National Health Service." *Health Policy*, 110(2-3), 291-297.

Kishore, K. (2017). "Development Cost of Health and Fitness Mobile App." https://www.octalsoftware.com/blog/cost-of-developing-a-health-fitness-mobile-app/ (Aug. 03, 2018).

Klasnja, P. and Pratt, W. (2012). "Healthcare in the pocket: mapping the space of mobile-phone health interventions." *Journal of Biomedical Informatics*, 45(1), 184-198.

Kleinman, N. J., Shah, A., Shah, S., Phatak, S. and Viswanathan, V. (2016). "Impact of the Gather mHealth system on A1C: primary results of a multisite randomized clinical trial among people with type 2 diabetes in India." *Diabetes Care*, 39(10), e169-e170.

Kline, R. B. (1998), "Software review: Software programs for structural equation modeling: Amos, EQS, and LISREL", *Journal of Psychoeducational Assessment*, 16(4), 343-364.

Kline, R. B. (2011), "Methodology in the Social Sciences. Principles and practice of structural equation modeling (3rd ed.)." Guilford Press, New York, US.

Kock, N. and Lynn, G. (2012), "Lateral collinearity and misleading results in variance-based SEM: An illustration and recommendations", *Journal of the Association for Information Systems*, 13(7), 546-580.

Koh, K. C., Wan, J. K., Selvanathan, S., Vivekananda, C., Lee, G. Y. and Ng, C. T. (2014). "Medical students' perceptions regarding the impact of mobile medical applications on their clinical practice." *Journal of Mobile Technology in Medicine*, 3(1), 46-53.

Korkontzelos, I., Nikfarjam, A., Shardlow, M., Sarker, A., Ananiadou, S. and Gonzalez, G. H. (2016). "Analysis of the effect of sentiment analysis on extracting adverse drug reactions from tweets and forum posts." *Journal of Biomedical Informatics*, 62, 148-158.

Kothari, C. R. (2004). "Research methodology: Methods and techniques." New Age International Publishers, New Delhi.

Kotlo, A., Muragundi, P. M., Ligade, V. S. and Udupa, N. (2015). "Regulation of the mobile medical apps in India: Need of the hour." *Current Pharma Research*, 5(4), 1600-1606.

Krishna, S. and Madon, S. (2004). "The Digital Challenge: Information Technology in the Development Context (Voices in Development Management)." Ashgate Publishing Company, Brookfield, VT, USA.

Krishnan, M. (2017). "Need to redefine healthcare in India." https://health.economictimes.indiatimes.com/news/industry/need-to-redefine-healthcare-in-india/57654613/ (Jul. 18, 2018).

Kruk, M. E. and Freedman, L. P. (2008). "Assessing health system performance in developing countries: a review of the literature." *Health Policy*, 85(3), 263-276.

Kushi Baby, (2015). “Tying It All Together.” https://wearablesforgood.com/tying-it-all-together/ (Jul. 18, 2018).

Lakhiwal, A. and Kar, A. K. (2016). “Insights from Twitter analytics: modeling social media personality dimensions and impact of breakthrough events.” In *Conference on e-Business, e-Services and e-Society,* Springer, Cham, 533-544.

Lam, S. S. (1997). “SERVQUAL: A tool for measuring patients' opinions of hospital service quality in Hong Kong.” *Total Quality Management*, 8(4), 145-152.

Langley, A. (1999). “Strategies for theorizing from process data.” *Academy of Management Review,* 24(4), 691-710.

Lassen, N. B., Madsen, R. and Vatrapu, R. (2014). “Predicting iphone sales from iphone tweets.” In *2014 IEEE 18th International Enterprise Distributed Object Computing Conference,* IEEE. 81-90.

Lee, Y. and Moon, M. (2016). “Utilization and content evaluation of mobile applications for pregnancy, birth, and childcare.” *Healthcare Informatics Research*, *22*(2), 73-80.

Lee, A., Sandvei, M., Asmussen, H. C., Skougaard, M., Macdonald, J., Zavada, J., Bliddal, H., Taylor, P.C. and Gudbergsen, H. (2018). “The development of complex digital health solutions: Formative evaluation combining different methodologies. “*JMIR Research Protocols*, 7(7), e165, 1-10.

Lee, G. and Kwak, Y. H. (2012). “An open government maturity model for social media-based public engagement.” *Government Information Quarterly,* 29(4), 492-503.

Lee, J. and Rho, M. J. (2013). “Perception of influencing factors on acceptance of mobile health monitoring service: a comparison between users and non-users.” *Healthcare Informatics Research*, 19(3), 167-176.

Lee, M.K., Cheung, C.M., Sia, C.L. and Lim, K.H. (2006), “How positive informational social influence affects consumers' decision of Internet shopping?”, In *Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06),* 6, 155a, IEEE. United States, 1-10.

Lemaire, J. (2011). “Scaling up mobile health: Elements necessary for the successful scale up of mHealth in developing countries. Geneva: Advanced Development for Africa.” https://www.k4health.org/toolkits/mhealth-planning-guide/scaling-mobile-health-elements-necessary-successful-scale-mhealth-developing-countrie-0 (Feb. 23, 2017).

Levy, D. (2012). “Consumers Are Ready to Adopt Mobile Health Faster than the Health Industry is Prepared to Adapt, Finds PwC Study on Global mHealth Adoption.” http://www.pwc.in/press-releases/global-mhealth-adoption.html (Jan. 31, 2017).

Li, D., Goh, K. Y. and Heng, C. S. (2016). “Monetizing User-Generated Content in FinTech: An Empirical Study of a Social Investing Site.” *In Proceedings of the 37th International Conference on Information Systems*, Dublin, Ireland.

Lim, S., Xue, L., Yen, C.C., Chang, L., Chan, H.C., Tai, B.C., Duh, H.B.L. and Choolani, M., 2011. “A study on Singaporean women's acceptance of using mobile phones to seek health information.” *International Journal of Medical Informatics*, 80(12), e189-e202.

Lim, S.S. (2016). “Asymmetries in Asian families’ domestication of mobile communication.” In *Mobile Communication and the Family*, Springer, Dordrecht, 1-9.

Lin, C. F., Chen, J. Y., Shiu, R. H. and Chang, S. H. (2008). “A Ka band WCDMA-based LEO transport architecture in mobile telemedicine.” In: Martinez, L., and Gomez, C. (Eds.), *Telemedicine in the 21st Century*, Nova Science Publishers, USA, 187–201.

Lin, C. P. and Anol, B. (2008). Learning online social support: an investigation of network information technology based on UTAUT. *CyberPsychology & Behavior*, 11(3), 268-272.

Liu, B. (2010). “Sentiment analysis: A multi-faceted problem.” *IEEE Intelligent Systems*, 25(3), 76-80.

Liu, B. (2012). “Sentiment analysis and opinion mining.” *Synthesis Lectures on Human Language Technologies*, 5(1), 1-167.

Liu, C. and Haseltine, W. (2016). “The Singaporean Health Care System.” https://international.commonwealthfund.org/countries/singapore/ (Jun. 10, 2018).

Liu, C., Zhu, Q., Holroyd, K. A. and Seng, E. K. (2011). “Status and trends of mobile-health applications for iOS devices: A developer's perspective.” *Journal of Systems and Software*, 84(11), 2022-2033.

Long, K. M., McDermott, F. and Meadows, G. N. (2018). “Being pragmatic about healthcare complexity: our experiences applying complexity theory and pragmatism to health services research.” *BMC Medicine*, 16(1), 94, 1-9.

Lopez, A. D., Mathers, C. D., Ezzati, M., Jamison, D. T. and Murray, C. J. (2006). “Global burden of disease and risk factors.” The World Bank, Washington, DC.

Lu, J., Yao, J. E. and Yu, C. S. (2005), “Personal innovativeness, social influences and adoption of wireless Internet services via mobile technology.” *The Journal of Strategic Information Systems*, 14(3), 245-268.

Lu, J., Yu, C.S., Liu, C. and Yao, J.E. (2003). “Technology acceptance model for wireless Internet.” *Internet Research*, 13(3), 206-222.

Lupton, D. (2013). “The digitally engaged patient: Self-monitoring and self-care in the digital health era”, *Social Theory & Health*, 11(3), 256-270.

Lutz, C. A. (2011). “Unnatural emotions: Everyday sentiments on a Micronesian atoll and their challenge to Western theory.” University of Chicago Press, Chicago, IL, US.

Lwin, M. O., Vijaykumar, S., Fernando, O. N. N., Cheong, S. A., Rathnayake, V. S., Lim, G., Theng, Y. L., Chaudhuri, S. and Foo, S. (2014). “A 21st century approach to tackling dengue: Crowdsourced surveillance, predictive mapping and tailored communication.” *Acta Tropica*, 130, 100-107.

Lyons, B. and Henderson, K. (2005), “Opinion leadership in a computer-mediated environment.” *Journal of Consumer Behaviour: An International Research Review*, 4(5), 319-329.

Ma, Q. and Liu, L. (2005). "The role of Internet self-efficacy in the acceptance of web-based electronic medical records." *Journal of Organizational and End User Computing (JOEUC)*, 17(1), 38-57.

Maclennan, D. and Williams, R. (1990). "Affordable housing in Britain and the United States." Joseph Rowntree Foundation, York.

Mahajan, A. C (2014). "Internet users in India: Mumbai tops, followed by Delhi and Kolkatta". Dazeinfo. https://dazeinfo.com/2014/11/05/internet-users-india-mumbai-tops-followed-delhi-kolkatta/ (Mar. 23, 2018).

Malhotra, N. and Dash S. (2011), "Marketing research – An applied orientation." (6th ed.). *Dorling Kindersley (India) Pvt. Ltd*., Licensees of Pearson Education in South Asia.

Malvey, D. M. and Slovensky, D. J. (2017). "Global mHealth policy arena: status check and future directions". *mHealth*, 3, 41, 1-10.

Marchal, B., Van Belle, S., De Brouwere, V., Witter, S. and Kegels, G. (2014). "Complexity in health: consequences for research & evaluation." *FEMHealth discussion paper*, 1-33.

Markets and Markets. (2017). "mHealth Solutions Market." https://www.marketsandmarkets.com/Market-Reports/mhealth-apps-and-solutions-market-1232.html (Feb. 22, 2018).

Mars, M. and Scott, R. E. (2010). "Global e-health policy: a work in progress." *Health Affairs*, 29(2), 237-243.

Marshall, A., Medvedev, O. and Antonov, A. (2008). "Use of a smartphone for improved self-management of pulmonary rehabilitation." *International Journal of Telemedicine and Applications*, 2008, 1-6.

Martyn, J. (1964). "Bibliographic coupling." *Journal of Documentation*, 20(4), 236-236.

Maslow, A. and Lewis, K. J. (1987). "Maslow's hierarchy of needs." *Salenger Incorporated*, 14, 987.

Mayer, R. E. (2003). “Elements of a science of e-learning.” *Journal of Educational Computing Research*, 29(3), 297-313.

Mayes, T. and de Freitas, S. (2007). “Learning and e-learning: the role of theory.” In *Rethinking pedagogy for a digital age*. Routledge. 33-45.

Mazumdar-Shaw, K. (2018). “Leveraging affordable innovation to tackle India's healthcare challenge.” *IIMB Management Review*, 30(1), 37-50.

McCreadie, M. and Rice, R. E. (1999). “Trends in analyzing access to information. Part I: cross-disciplinary conceptualizations of access.” *Information Processing & Management*, 35(1), 45-76.

McGregor, J. (2018). “How #MeToo is reshaping employment contracts for executives.” https://www.washingtonpost.com/business/2018/10/31/how-metoo-is-reshaping-employment-contracts-executives/?noredirect=on&utm_term=.867069ac41d3 (Dec. 21, 2018).

Mehta, P. (2019). “Progress of Health Services in India after Independence.” http://www.economicsdiscussion.net/articles/progress-of-health-services-in-india-after-independence/2297 (Jul. 07, 2018).

Mengesha, G.H. and Garfield, M.J. (2019). “A contextualized IT adoption and use model for telemedicine in Ethiopia.” *Information Technology for Development*, 25(2), 184-203.

*mHealth*. (2017). “*HIMSS*.” http://www.himss.org/library/mhealth (Jan. 18, 2017).

Mills, A. (2014). “Health care systems in low-and middle-income countries.” *New England Journal of Medicine*, 370(6), 552-557.

Ministry of Health and Family Welfare Government of India. (2014). “Framework for Implementation National Health Mission 2012 – 2014.” http://www.cghealth.nic.in/nhmcg/Informations/NHM/NRH_Framework_for_Implementation__08-01-2014.pdf (Jun. 21, 2019).

Ministry of Health and Family Welfare. (2017). “Governrnent of India MCTS.” http://nrhm-mcts.nic.in/. (Feb. 21, 2019).

Ministry of Health and Family Welfare. (2017). “NIKSHAY- A web-based solution for monitoring of TB patients”. http://nikshay.gov.in/AboutNikshay.htm (Aug. 15, 2017).

Ministry of Health with Family Welfare. (2017). “National Strategic Plan for Tuberculosis Elimination 2017-2025.” *Central TB Division, Directorate General of Health Services*, New Delhi. 1-109.

Mishra, S., Trikamji, B., Singh, S., Singh, P. and Nair, R. (2013). “Historical perspective of Indian neurology.” *Annals of Indian Academy of Neurology*, 16(4), 467-477.

Modi, D., Gopalan, R., Shah, S., Venkatraman, S., Desai, G., Desai, S. and Shah, P. (2015). “Development and formative evaluation of an innovative mHealth intervention for improving coverage of community-based maternal, newborn and child health services in rural areas of India.” *Global Health Action*, 8(1), 26769, 1-14.

Mohamed, A.H.H., Tawfik, H., Al-Jumeily, D. and Norton, L. (2011). “MoHTAM: A technology acceptance model for mobile health applications.” In *2011 Developments in E-systems Engineering*, IEEE. 13-18.

Mohammad Mosadeghrad, A. (2013). “Healthcare service quality: Towards a broad definition.” *International Journal of Health Care Quality Assurance*, 26(3), 203-219

Moher, D., Liberati, A., Tetzlaff, J. and Altman, D. G. (2009). “Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement.” *Annals of Internal Medicine*, 151(4), 264-269.

MoHFW. (2009). “The National Health Bill (working draft).” http://www.prsindia.org/uploads/media/Draft_National_Bill.pdf (Oct. 13, 2018).

Moorman, C. and Matulich, E. (1993). “A model of consumers' preventive health behaviors: The role of health motivation and health ability.” *Journal of Consumer Research*, 20(2), 208-228.

Moreno, R. and Mayer, R. (2007). “Interactive multimodal learning environments.” *Educational Psychology Review*, 19(3), 309-326.

Morgan, G. and Smircich, L. (1980). “The case for qualitative research.” *Academy of Management Review*, 5(4), 491-500.

Morris, F. C., Hoerner, J. and Smith, K. (2018). “4 ways to address the #MeToo era in health care.” https://www.healio.com/gastroenterology/practice-management/news/online/%7B4d01cda5-0d75-471e-80d2-ade0e7a94d82%7D/4-ways-to-address-the-metoo-era-in-health-care, (Nov. 21, 2018).

Mousavi, S. and Bossink, B.A. (2017). “Firms’ capabilities for sustainable innovation: The case of biofuel for aviation.” *Journal of Cleaner Production*, 167, 1263-1275.

Müller, A. M., Alley, S., Schoeppe, S. and Vandelanotte, C. (2016). “The effectiveness of e-& mHealth interventions to promote physical activity and healthy diets in developing countries: a systematic review.” *International Journal of Behavioral Nutrition and Physical Activity*, 13(1), 109, 1-14.

Müthing, J., Brüngel, R. and Friedrich, C. M. (2019). “Server-focused security assessment of mobile health apps for popular mobile platforms.” *Journal of Medical Internet Research*, 21(1), e9818, 1-17.

Mutingi, M. (2014). “System dynamics of information technology adoption in a complex environment.” *International Journal of Industrial and Systems Engineering*, 17(1), 78-97.

Myers, D. G. (2010). “Myers' psychology for AP.” Worth Publishers, MacMillan USA.

Nagar, R., Venkat, P., Stone, L. D., Engel, K. A., Sadda, P. and Shahnawaz, M. (2018). “A cluster randomized trial to determine the effectiveness of a novel, digital pendant and voice reminder platform on increasing infant immunization adherence in rural Udaipur, India.” *Vaccine*, 36(44), 6567-6577.

Nagarajan, S. (2018). “Kerala floods how doctors and support staff came to the rescue.” https://www.thehindu.com/news/national/kerala/kerala-floods-how-doctors-and-support-staff-came-to-the-rescue/article24790532.ece (Nov. 28, 2018).

Nahar, P., Kannuri, N. K., Mikkilineni, S., Murthy, G. V. S. and Phillimore, P. (2017). “mHealth and the management of chronic conditions in rural areas: a note of caution from southern India.” *Anthropology & Medicine*, 24(1), 1-16.

Najjar, M. S. and Kettinger, W. J. (2013). “Data Monetization: Lessons from a Retailer's Journey.” *MIS Quarterly Executive*, 12(4), 213-225.

National Health Policy. (2015). “Draft, Ministry of Health and Family Welfare Government of India. 2015.” http://www.mohfw.nic.in/showfile.php?lid=3014 (Jun. 26, 2018).

National Health Portal of India [NHP]. (2016), “Gateway to Authentic Health Information”, http://www.nhp.gov.in/mobile-app. (Jan. 31, 2019).

National Rural Health Mission (2016), “Mother and Child Tracking System (MCTS).” http://apps.nic.in/apps/government/mother-and-child-tracking-system-mcts (Aug. 15, 2017).

Natsoulas, T. (1987). “The six basic concepts of consciousness and William James's stream of thought.” *Imagination, Cognition and Personality*, 6(4), 289-319.

Neiger, B. L., Thackeray, R., Burton, S. H., Giraud-Carrier, C. G. and Fagen, M. C. (2013). “Evaluating social media’s capacity to develop engaged audiences in health promotion settings: use of Twitter metrics as a case study.” *Health Promotion Practice*, 14(2), 157-162.

Neter, E. and Brainin, E. (2012). “eHealth literacy: extending the digital divide to the realm of health information.” *Journal of Medical Internet Research*, *14*(1), e19, 1-10.

NHP (2016). “Health programme/wellness.” https://www.nhp.gov.in/healthprogramme/health-wellness-calendar (Mar. 26, 2018).

NHP (2016). “Committees and Commissions.” https://www.nhp.gov.in/miscellaneous/committees-and-commissions (Oct. 09, 2018).

NHP. (2016). Ministry of Health & Family Welfare. http://164.100.158.44/index1.php?lang=1&level=1&sublinkid=6471&lid=4270 (Jun. 29, 2018).

NHSRC. (2018). “National Health Systems Resource Centre- Technical Support Institute with National Health Misssion”. http://nhsrcindia.org/ (Jun. 29, 2018).

Nicholls, D. (2005). “System reliability toolkit.” Reliability Information Analysis Centre. Utica, N.Y.

Nichols, M. (2003). “A theory for eLearning.” *Educational Technology & Society*, 6(2), 1-10.

Nickerson, R., Austreich, M. and Eng, J. (2014). “Mobile technology and smartphone apps: A Diffusion of innovations analysis.” *Twentieth Americas Conference on Information Systems*, Savannah, 1-12.

Niëns, L. M., Van de Poel, E., Cameron, A., Ewen, M., Laing, R. and Brouwer, W. B. F. (2012). “Practical measurement of affordability: an application to medicines.” *Bulletin of the World Health Organization*, 90(3), 219-227.

NIHFW. (2015). “Bhore Committee 1946”. https://www.nhp.gov.in/bhore-committee-1946_pg (Apr. 23, 2019).

NITI Aayog. (2017). “National eHealth Authority (NeHA).” Government of India. Accessed: https://www.nhp.gov.in/national_eHealth_authority_neha_mtl. (May. 13, 2018).

Noesgaard, S. S. and Ørngreen, R. (2015). “The Effectiveness of E-Learning: An Explorative and Integrative Review of the Definitions, Methodologies and Factors That Promote e-Learning Effectiveness.” *Electronic Journal of E-learning*, 13(4), 278-290.

Ntaliani, M., Costopoulou, C. and Karetsos, S. (2008). “Mobile government: A challenge for agriculture.” *Government Information Quarterly*, 25(4), 699-716.

Nugent, C.D., Finlay, D., Davier, R., Donnelly, M., Hallberg, J., Black, N.D. and Craig, D. (2011). “Remote healthcare monitoring and assessment.” *Technology and Health Care*, 19(4), 295-306.

Nunnally, J. C. (1978), “Psychometric theory”, 2nd Edition, McGraw-Hill Book Company, New York.

Nussbaum, M. (2004). "Emotions as Judgments of Value and Importance." In R. C. Solomon (Ed.), Thinking about feeling: Contemporary philosophers on emotions. Oxford University, New York, 183–199.

Oberoi, S., Gupta, V. K., Chaudhary, N. and Singh, A. (2016). "99 DOTS." *International Journal of Contemporary Medical Research, 3*(9), 2760-2762.

O'Cathain, A., Murphy, E. and Nicholl, J. (2007). "Why, and how, mixed methods research is undertaken in health services research in England: a mixed methods study." *BMC health Services Research*, *7*(1), 85, 1-11.

Oliga, J. C. (1988). "Methodological foundations of systems methodologies." *Systems Practice*, 1(1), 87-112.

Opinion Lexicon, (2019). "Opinion Mining, Sentiment Analysis, and Opinion Spam Detection." https://www.cs.uic.edu/~liub/FBS/sentiment-analysis.html#lexicon/ (May. 17, 2019).

Organization for Economic Co-operation and Development [OECD]. (2017). "Mobile Technology-Based Services for Global Health and Wellness: Opportunities And Challenges", https://www.oecd.org/sti/ieconomy/Summary-Mobile-Health-Oct2016.pdf (May. 31, 2019).

O'Sullivan, D. (2014). mHealth: improving accessibility and quality of life – a pilot survey of patients and carers. https://alexwyke.wordpress.com/2014/05/21/mhealth-improving-accessibility-and-quality-of-life-a-pilot-survey-of-patients-and-carers/ (Mar. 17, 2017).

Pagolu, V. S., Reddy, K. N., Panda, G., and Majhi, B. (2016). "Sentiment analysis of Twitter data for predicting stock market movements." In *2016 international conference on signal processing, communication, power and embedded system (SCOPES),* IEEE. 1345-1350.

Pai, R. R. and Alathur, S. (2018). "Assessing mobile health applications with twitter analytics." *International Journal of Medical Informatics*, *113*, 72-84.

Pai, R. R. and Alathur, S. (2019), “Mobile Health System Framework in India”, In *20th Annual International Conference on Digital Government Research,* ACM. 186-195.

Pai, R. R. and Alathur, S. (2019). “Assessing Awareness and Use of Mobile Phone Technology for Health and Wellness: Insights from India.” *Health Policy and Technology,* 8(3), 221-227.

Pan, J. (1999). “Software reliability.” *Dependable Embedded Systems,* Carnegie Mellon University, 18, 1-14.

Panetta, K. (2017). “Top Trends in the Gartner Hype Cycle for Emerging Technologies, 2017 - Smarter with Gartner.” *Smarter With Gartner*. http://www.gartner.com/smarterwithgartner/top-trends-in-the-gartner-hype-cycle-for-emerging-technologies-2017/ (Feb. 22, 2018).

Panko, R. (2017). “How Much Does It Cost to Develop an App: 2017 Survey.” https://clutch.co/app-developers/resources/cost-build-mobile-app-survey/ (Jul. 13, 2018).

Panksepp, J. (2004). “Affective neuroscience: The foundations of human and animal emotions.” Oxford University Press.

Pantoja, T., Opiyo, N., Lewin, S., Paulsen, E., Ciapponi, A., Wiysonge, C. S., Herrera, C. A., Rada, G., Penaloza, B., Dudley, L. and Gagnon, M. P. (2017). “Implementation strategies for health systems in low-income countries: an overview of systematic reviews.” *Cochrane Database of Systematic Reviews*, (9), 1-78.

Parthaje, P. M., Unnikrishnan, B., Thapar, R., Kumar, N., Panikulam, E. J., Geroge, E., Pai, P., Kulkarni, V., Holla, R., Darshan, B. B., Kumar, A., Mehta, R. and Jay, R. (2016), “Perceptions and knowledge toward mobile-health among the college going students in Coastal South India.” *Journal of Natural Science, Biology, and Medicine*, 7(1), 75-79.

Parveen, F. and Sulaiman, A. (2008), “Technology complexity, personal innovativeness and intention to use wireless internet using mobile devices in Malaysia.” *International Review of Business Research Papers*, 4(5), 1-10.

Patel, B. N. (2016). "The State Practice of India and the Development of International Law: Dynamic Interplay Between Foreign Policy and Jurisprudence." Martinus Nijhoff Publishers.

Pathak, A. and Kumar, D. (2017). "Telehealth in India: helping to achieve health for all." *Veterinary Record*, 180(23), 572-573.

Paul, M. J. and Dredze, M. (2011). "You are what you tweet: Analyzing twitter for public health." In *Fifth International AAAI Conference on Weblogs and Social Media (ICWSM)*, 265-272.

Payne, K. F. B., Wharrad, H. and Watts, K. (2012). "Smartphone and medical related App use among medical students and junior doctors in the United Kingdom (UK): a regional survey." *BMC Medical Informatics and Decision Making*, 12(1), 121, 1-11.

Penchansky, R., and Thomas, J. W. (1981). "The concept of access: definition and relationship to consumer satisfaction." *Medical care*, 19(2), 127-140.

Pereira, A., Marins, F., Rodrigues, B., Portela, F., Santos, M. F., Machado, J., Rua, F., Silva, A., and Abelha, A. (2015). "Improving quality of medical service with mobile health software." *Procedia Computer Science*, 63, 292-299.

Perianes-Rodriguez, A., Waltman, L. and van Eck, N. J. (2016). "Constructing bibliometric networks: A comparison between full and fractional counting." *Journal of Informetrics*, 10(4), 1178-1195.

Pfammatter, A., Spring, B., Saligram, N., Davé, R., Gowda, A., Blais, L., Arora, M., Ranjani, H., Ganda, O., Hedeker, D., and Reddy, S. (2016). "mHealth intervention to improve diabetes risk behaviors in India: a prospective, parallel group cohort study." *Journal of Medical Internet Research*, 18(8), e207, 1-9.

Pharmasecure (2017). "Patient Engagement and Insights – PharmaSecure™ – Anti-Counterfeiting, Identification, and Brand Protection Solutions." http://www.pharmasecure.com/patient-engagement-and-insights (Feb. 02, 2018).

Philips, E. and Pugh, D. S. (1994). "How to get a PhD." Open University Press, Buckingham.

Piramal Swasthya. (2019). Accessible, Affordable, Available Healthcare. http://www.piramalswasthya.org/innovations/ (Mar. 23, 2019).

Piscopo, M. (2018). "IT Charging Policy. Project Management Docs." http://www.projectmanagementdocs.com/project-documents/it-charging-policy.html#axzz5CM7ZRKOY/(Apr. 11, 2018).

Planning Commission. Government of India. (2008). "Eleventh Five-Year Plan 2007-12 (Vol. II: Social Sector)". http://planningcommission.nic.in/plans/planrel/fiveyr/11th/11_v2/11th_vol2.pdf (Apr. 23, 2019).

Planning commission. Government of India. (2013). "Twelfth Five Year Plan (2012-2017): Social Sectors". III. SAGE Publications. http://planningcommission.gov.in/plans/planrel/12thplan/pdf/12fyp_vol3.pdf (Apr. 23, 2019).

Planning commission. Government of India. (2019). "9th Five Year Plan (Vol-1)". http://planningcommission.gov.in/plans/planrel/fiveyr/9th/vol1/v1c1-2.htm (Apr. 23, 2019).

Planning commission. Government of India. (2019). "Health". http://planningcommission.nic.in/plans/planrel/fiveyr/10th/volume2/v2_ch2_8.pdf (Apr. 23, 2019).

Prabhakaran, D., Jha, D., Prieto-Merino, D., Roy, A., Singh, K., Ajay, V. S., Jindal, D., Gupta, P., Kondal, D., Goenka, S. and Jacob, P. (2019). "Effectiveness of an mHealth-based electronic decision support system for integrated management of chronic conditions in primary care: the mWellcare cluster-randomized controlled trial." *Circulation*, 139(3), 380-391.

Prema, C. and Sudhakar, J. C. (2009). "Internet Banking Acceptance–An Extended Technology Acceptance Model." *RVS Journal of Management*, 2(1), 110-118.

PricewaterhouseCoopers. (2012). "Consumers Are Ready to Adopt Mobile Health Faster than the Health Industry is Prepared to Adapt, Finds PwC Study on Global mHealth Adoption.” https://www.pwc.in/press-releases/global-mhealth-adoption.html. (Feb. 21, 2019),

PricewaterhouseCoopers. (2017). “How mHealth can revolutionise the Indian healthcare industry.” https://www.pwc.in/assets/pdfs/publications/2017/how-mhealth-can-revolutionise-the-indian-healthcare-industry.pdf. (Feb. 21, 2019)

Prinja, S., Nimesh, R., Gupta, A., Bahuguna, P., Thakur, J. S., Gupta, M. and Singh, T. (2016). “Impact assessment and cost-effectiveness of m-health application used by community health workers for maternal, newborn and child health care services in rural Uttar Pradesh, India: a study protocol.” *Global Health Action*, 9(1), 31473, 1-12.

Priya S. L, (2017). “Teacher Saves Teenager from the Clutches of Blue Whale Challenge in Rajasthan.” https://www.thebetterindia.com/117617/teacher-saves-teenager-from-clutches-of-blue-whale-challenge-rajasthan/ (Feb.031, 2019).

Project Management Institute. (2015). “A Guide to the Project Management Body of Knowledge.” 5th Edition. Newtown Square, Pennsylvania, USA.

Qiang, C. Z., Yamamichi, M., Hausman, V., Altman, D. and Unit, I. S. (2011). “Mobile applications for the health sector.” *Washington: World Bank*, *2*. http://documents.worldbank.org/curated/en/751411468157784302/pdf/726040WP0Box370th0report00Apr020120.pdf (Feb. 21, 2019).

Raghu, A., Praveen, D., Peiris, D., Tarassenko, L. and Clifford, G. (2015). “Engineering a mobile health tool for resource-poor settings to assess and manage cardiovascular disease risk: SMARThealth study.” *BMC medical Informatics and Decision Making*, 15(1), 36, 1-15.

Rahi, S., Ghani, M., Alnaser, F. and Ngah, A. (2018). “Investigating the role of unified theory of acceptance and use of technology (UTAUT) in internet banking adoption context.” *Management Science Letters*, 8(3), 173-186.

Rai, A., Chen, L., Pye, J. and Baird, A. (2013), “Understanding determinants of consumer mobile health usage intentions, assimilation, and channel preferences.” *Journal of Medical Internet Research*, 15(8), e149, 1-23.

Rajasekar, S. P., Philominathan, P. P. and Chinnathambi, V. (2013). "Research methodology." arXiv. *arXiv preprint physics/0601009,* 1-20.

Ramachandran, D., Canny, J., Das, P. D. and Cutrell, E. (2010). Mobile-izing health workers in rural India. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems,* Atlanta, Georgia, USA, ACM. 1889-1898.

Ramayah, T., Taib, F. and Ling, K. P. (2006). "Classifying users and non-users of internet banking in Northern Malaysia." *The Journal of Internet Banking and Commerce*, 11(2), 1-13.

Rao, S. R. (1973). "Lothal and the Indus civilization." Asia Publishing House, New York.

Rastegar-Mojarad, M., Ye, Z., Wall, D., Murali, N. and Lin, S. (2015). "Collecting and analyzing patient experiences of health care from social media." *JMIR Research Protocols*, 4(3), e78.

Rauch, S. and Foa, E. (2006). "Emotional processing theory (EPT) and exposure therapy for PTSD." *Journal of Contemporary Psychotherapy*, 36(2), 61-65.

Raza, S. A., Umer, A. and Shah, N. (2017), "New determinants of ease of use and perceived usefulness for mobile banking adoption." *International Journal of Electronic Customer Relationship Management*, 11(1), 44-65.

Reddick, C.G. and Zheng, Y. (2017), "Determinants of citizens' mobile apps future use in Chinese local governments: An analysis of survey data." *Transforming government: people, process and policy*, 11(2), 213-235.

Redmond, M. R., Mumford, M. D. and Teach, R. (1993), "Putting creativity to work: Effects of leader behavior on subordinate creativity." *Organizational Behavior and Human Decision Processes*, 55(1), 120-151.

Reid, S. C., Kauer, S. D., Khor, A. S., Hearps, S. J., Sanci, L. A., Kennedy, A. D. and Patton, G. C. (2012). "Using a mobile phone application in youth mental health: An evaluation study." *Australian Family Physician*, 41(9), 711.

Renaud, K. and Van Biljon, J. (2008). "Predicting technology acceptance and adoption by the elderly: a qualitative study", In *Proceedings of the 2008 annual research* *conference of the South African Institute of Computer Scientists and Information Technologists on IT research in developing countries: riding the wave of technology*, Wilderness, South Africa, ACM, 210-219.

Rescue Kerala (2018), "Initiative by Government of Kerala, Kerala State IT Mission and IEEE Kerala Section." https://www.keralarescue.in/ (Sep. 04, 2018).

Research2Guidance (2017). "mHealth App Economics 2017 Current Status and Future Trends in Mobile Health." *How digital intruders are taking over the healthcare market*, Berlin, Germany, 1-26.

Research2guidance. (2016). *mHealth Economics 2016 – Current Status and Trends of the mHealth App Market*. 1-31.

Reynolds, N. R., Satyanarayana, V., Duggal, M., Varghese, M., Liberti, L., Singh, P., Ranganathan, M., Jeon, S. and Chandra, P. S. (2016). "MAHILA: a protocol for evaluating a nurse-delivered mHealth intervention for women with HIV and psychosocial risk factors in India." *BMC Health Services Research*, 16(1), 352, 1-9.

Richard, L., Furler, J., Densley, K., Haggerty, J., Russell, G., Levesque, J. F. and Gunn, J. (2016). "Equity of access to primary healthcare for vulnerable populations: the IMPACT international online survey of innovations." *International Journal for Equity in Health*, 15(1), 64, 1-20.

Ristau, R. A., Yang, J. and White, J. R. (2013). "Evaluation and evolution of diabetes mobile applications: key factors for health care professionals seeking to guide patients." *Diabetes Spectrum*, 26(4), 211-215.

Ritchie, J., Lewis, J., Nicholls, C.M. and Ormston, R. (2013). *"Qualitative research practice: A guide for social science students and researchers."* NatCen, Sage.

Rodrigues, R., Bogg, L., Shet, A., Kumar, D. S., and De Costa, A. (2014). Mobile phones to support adherence to antiretroviral therapy: what would it cost the Indian National AIDS Control Programme?. *Journal of the International AIDS Society*, *17*(1), 19036, 1-8.

Rodrigues, R., Poongulali, S., Balaji, K., Atkins, S., Ashorn, P. and De Costa, A. (2015). "'The phone reminder is important, but will others get to know about my illness?' Patient perceptions of an mHealth antiretroviral treatment support intervention in the HIVIND trial in South India." *BMJ Open*, *5*(11), e007574, 1-10.

Rogers, E. (1983). "Diffusion of innovations." Third Edition. The Free Press. NY, New York.

Rogers, E. M. (2010). "Diffusion of innovations." Simon and Schuster.

Rogers, E.M. (2003). "Diffusion of innovations." Free Press. *New York*, *551*.

Rosenstock I. M. (2005). "Why People Use Health Services." *The Milbank Quarterly*, *83*(4), 1-32,

Rosenstock, I. M. (1974). "The health belief model and preventive health behavior." *Health Education Monographs*, 2(4), 354-386.

Ruggiero, T. E. (2000). "Uses and gratifications theory in the 21st century." *Mass communication & Society*, 3(1), 3-37.

Ryan, R. and Raducha-Grace, T. (2009). "IT Financial Management: The Business of IT. *The Business of IT: How to Improve Service and Lower Costs*." Inform IT. Pearson. http://www.informit.com/articles/article.aspx?p=1397671/ (Apr. 11, 2018).

Saadi, M.R., Ahmad, S.Z. and Hussain, M. (2017), "Prioritization of citizens' preferences for using mobile government services: The analytic hierarchy process (AHP) approach." *Transforming Government: People, Process and Policy*, 11(3), 476-503.

Saha, D. and Lewis, M. R. (2016)." Practices of healthcare personnel working in primary health centres of Udupi district of India about using mobile phones for health information management." *International Journal of Management and Applied Science*, 2(6). 148-151.

Saif, H., He, Y. and Alani, H. (2012). "Alleviating data sparsity for twitter sentiment analysis." *2nd Workshop on Making Sense of Microposts*, CEUR Workshop Proceedings (CEUR-WS. org), Lyon, France, 1-9.

Salathé, M., and Khandelwal, S. (2011). "Assessing vaccination sentiments with online social media: implications for infectious disease dynamics and control." *PLoS computational biology*, *7*(10), e1002199, 1-7.

Sandhu, J. S. (2011). “Opportunities in Mobile Health. Stanford Social Innovation Review.”, *Stanford University*. https://ssir.org/articles/entry/opportunities_in_mobile_health (Feb. 22, 2018).

Sangamnere, B. S. and Srinivas, C. K. (2015). “Innovative Business Practices for Inclusive Growth and Sustainable Development in India Case Study on" Piramal Swasthya" a Connected Health CSR.” *PARIDNYA-The MIBM Research Journal*, 3(1), 30-37.

Santos-Trigo, M., Suaste, E. and Figuerola, P. (2015). “Technology and tools appropriation in medical practices.” In *Encyclopaedia of Information Science and Technology, Third Edition*, IGI Global, 5633-5640.

Sarker, S. and Wells, J.D. 2003, “Understanding mobile handheld device use and adoption”, *Communications of the ACM*, 46(12), 35-40.

Sathye, M. (1999), “Adoption of Internet banking by Australian consumers: an empirical investigation”, *International Journal of Bank Marketing*, 17(7), 324-334.

Saunders, M., Lewis, P. and Thornhill, A. (2012). “Research methods for business students.” *6th Edn.*, Harlow, England.

Saurman, E. (2016). “Improving access: modifying Penchansky and Thomas’s theory of access.” *Journal of Health Services Research & Policy*, 21(1), 36-39.

Saurman, E., Lyle, D., Perkins, D. and Roberts, R. (2014). “Successful provision of emergency mental health care to rural and remote New South Wales: an evaluation of the Mental Health Emergency Care–Rural Access Program.” *Australian Health Review*, 38(1), 58-64.

Scally, G. and Donaldson, L. J. (1998). “Clinical governance and the drive for quality improvement in the new NHS in England.” *BMJ*, 317(7150), 61-65.

Schnall, R., Rojas, M., Bakken, S., Brown, W., Carballo-Dieguez, A., Carry, M., Gelaude, D., Mosley, J.P. and Travers, J. (2016). “A user-centered model for designing consumer mobile health (mHealth) applications (apps).” *Journal of Biomedical Informatics*, 60, 243-251.

Scholl, J., Syed-Abdul, S., and Ahmed, L. A. (2011). “A case study of an EMR system at a large hospital in India: challenges and strategies for successful adoption.” *Journal of Biomedical Informatics*, 44(6), 958-967.

SDGF. (2018). “Millennium Development Goals.” http://www.sdgfund.org/mdgs-sdgs (Sep. 03, 2018).

Sedarati, P. and Baktash, A. (2017). “Smart Glasses Adoption in Smart Tourism Destination: A Conceptual Model Smart Glasses Adoption in Smart Tourism Destination.” In *ENTER 2017 Conference on Information and Communication Technologies in Tourism. Research notes*, 1-5.

Seethamraju, R., Diatha, K. S. and Garg, S. (2018). “Intention to use a mobile-based information technology solution for tuberculosis treatment monitoring–applying a UTAUT model.” *Information Systems Frontiers*, 20(1), 163-181.

Sen, G. (2012). “Universal Health Coverage in India: A long and winding road.” *Economic and Political Weekly*, 45-52.

Sengupta, R. (2013). “Sustainable and inclusive innovations in health care delivery: a business model perspective.” *GIZ India & CII-ITC Centre of Excellence for Sustainable Development*, https://gita.org.in/Attachments/Reports/giz2013-en-healthcare-india.pdf. New Delhi.

Severin, J. W. and Tankard, J. W. (2001). “Communication Theory: Origin, Methods, and Uses in The Mass Media.” Addison Wesley, Logman Inc, New York.

Seyal, A. H., Noah, A. R., Ramlie, R. and Rahman, A. A. (2015). “A preliminary study of students’ attitude on m-learning: an application of technology acceptance model.” *International Journal of Information and Education Technology*, 5(8), 609-614.

Sharma, J. K. and Narang, R. (2011). “Quality of healthcare services in rural India: the user perspective.” *Vikalpa*, 36(1), 51-60.

Sharma, M. (2017). “India’s burgeoning youth are the world’s future.” https://www.livemint.com/Opinion/2WSy5ZGR9ZO3KLDMGiJq2J/Indias-burgeoning-youth-are-the-worlds-future.html (May 09, 2018).

Sharma, M., Banerjee, B., Ingle, G. K., and Garg, S. (2017). "Effect of mHealth on modifying behavioural risk-factors of non-communicable diseases in an adult, rural population in Delhi, India." *mHealth*, 3, 42, 1-9.

Sherpa, D. (2016). "A study on developing a mHealth solution as an alternate recording and reporting system for Auxiliary nurse midwives in Udaipur district of Rajasthan". Doctoral dissertation, Yale University.

Shet, A., Arumugam, K., Rodrigues, R., Rajagopalan, N., Shubha, K., Raj, T., D'souza,G. and De Costa, A. (2010). "Designing a mobile phone-based intervention to promote adherence to antiretroviral therapy in South India." *AIDS and Behavior*, 14(3), 716-720.

Sheth, J. and Sisodia, R. (2012). "The 4 A's of marketing: Creating value for customer, company and society." Routledge.

Shields-Zeeman, L., Pathare, S., Walters, B. H., Kapadia-Kundu, N. and Joag, K. (2017). "Promoting wellbeing and improving access to mental health care through community champions in rural India: the Atmiyata intervention approach." *International Journal of Mental Health Systems*, 11(1), 6, 1-11.

Shiple, D. (2012). "Enterprise mHealth Strategy." *Divergent*, https://www.slideshare.net/dshiple/chime-divurgent-m-health-strategy-college-live-15438167 (Mar. 31, 2018).

Siddiqui, T. R., Ghazal, S., Bibi, S., Ahmed, W. and Sajjad, S. F. (2016). "Use of the health belief model for the assessment of public knowledge and household preventive practices in Karachi, Pakistan, a dengue-endemic city." *PLoS Neglected Tropical Diseases*, 10(11), e0005129, 1-15.

Silva, B. M., Rodrigues, J. J., Canelo, F., Lopes, I. M. and Lloret, J. (2019). "Towards a cooperative security system for mobile-health applications." *Electronic Commerce Research*, 19(3), 629-654.

Silva, B. M., Rodrigues, J. J., de la Torre Díez, I., López-Coronado, M. and Saleem, K. (2015). "Mobile-health: A review of current state in 2015." *Journal of Biomedical Informatics*, 56, 265-272.

Silverstone, R. and Haddon, L. (1996). “Design and the domestication of information and communication technologies: Technical change and everyday life.” In: Mansell, Robin and Silverstone, Roger, (eds.) *Communication by Design: The Politics of Information and Communication Technologies*. Oxford University Press, Oxford, UK, 44-74.

Simmons, O. G. (1958). “Social status and public health.” *Social Science Research Council, Pamphlet*, 13, New York.

Singh, A. R. and Singh, S. A. (2004). “The goal: health for all the commitment: all for health.” *Mens sana monographs, 2*(1), 97-110.

Singh, P., Sawhney, R. S. and Kahlon, K. S. (2018). “Sentiment analysis of demonetization of 500 & 1000 rupee banknotes by Indian government.” *ICT Express*, 4(3), 124-129.

Sinha, R. K. and Varghese, R. (2015). “Perception of health care professionals towards mHealth application.” *Journal of the Thai Medical Informatics Association*, 1(2), 105-116.

Sinnenberg, L., Buttenheim, A. M., Padrez, K., Mancheno, C., Ungar, L. and Merchant, R. M. (2017). “Twitter as a tool for health research: a systematic review.” *American Journal of Public Health*, 107(1), e1-e8.

Sinnenberg, L., DiSilvestro, C. L., Mancheno, C., Dailey, K., Tufts, C., Buttenheim, A. M., Ungar, L., Schwartz, H., Brown, D. and Asch, D. A. (2016). “Twitter as a potential data source for cardiovascular disease research.” *JAMA Cardiology*, 1(9), 1032-1036.

Small, H. (1973). “Co-citation in the scientific literature: A new measure of the relationship between two documents.” *Journal of the American Society for Information Science*, 24(4), 265-269.

Sofaer, S. and Firminger, K. (2005). “Patient perceptions of the quality of health services.” *Annual Review of Public Health*, 26, 513-559.

Sondaal, S. F. V., Browne, J. L., Amoakoh-Coleman, M., Borgstein, A., Miltenburg, A. S., Verwijs, M. and Klipstein-Grobusch, K. (2016). “Assessing the effect of mHealth interventions in improving maternal and neonatal care in low-and middle-income countries: a systematic review." *PloS One*, 11(5), e0154664, 1-26.

Sood, A. (2008). "Women's Pathways to Mental Health in India." *UCLA: Center for the Study of Women*. https://escholarship.org/uc/item/0nd580x9 (Mar. 24, 2018).

Soriant. (2018). "Financial Viability: What You Need to Know. Soriant - Accelerating healthcare support services." https://www.sorianthealthcare.com/financial-viability-what-you-need-to-know/ (Apr. 12, 2018).

Spreitzer, G. M. (1995), "Psychological empowerment in the workplace: Dimensions, measurement, and validation", *Academy of Management Journal*, 38(5), 1442-1465.

Squires, J. E., Moralejo, D. and LeFort, S. M. (2007). "Exploring the role of organizational policies and procedures in promoting research utilization in registered nurses." *Implementation Science*, 2(1), 17, 1-11.

Srivastava, S. C. and Shainesh, G. (2015). "Bridging the Service Divide Through Digitally Enabled Service Innovations: Evidence from Indian Healthcare Service Providers." *MIS Quarterly*, 39(1), 245-267.

Srivastava, V. (2018). "India's Growing Healthcare Burden has a Solution at 'Home'." BW Businessworld. http://businessworld.in/article/India-s-Growing-Healthcare-Burden-has-a-Solution-at-Home-/30-01-2018-138737/ (Feb. 21, 2018).

StatCounter. (2017). "India amongst world leaders in use of mobile to surf the internet." http://gs.statcounter.com/press/india-amongst-world-leaders-in-use-of-mobile-to-surf-the-internet (Feb. 21, 2018).

Statista. (2019). "Internet usage in India - Statistics & Facts." https://www.statista.com/topics/2157/internet-usage-in-india/ (Feb. 06, 2019).

Steinhubl, S. R., Muse, E. D. and Topol, E. J. (2015). "The emerging field of mobile health." *Science Translational Medicine*, 7(283), 1-12.

Stephen, A. T., and Galak, J. (2010). The complementary roles of traditional and social media publicity in driving marketing performance. *Fontainebleau: INSEAD working paper collection*. 1-40.

Steup, M. (2005). “Epistemology”. In *The Stanford encyclopedia of philosophy.* Edited by: Zalta, E. N. http://plato.stanford.edu/entries/epistemology/ (Dec. 21, 2017).

Strauss, A. and Corbin, J.M. (1990). *Basics of Qualitative Research: Grounded theory procedures and techniques*. Sage Publications, Inc.

Suciu, G., Suciu, V., Martian, A., Craciunescu, R., Vulpe, A., Marcu, I., Halunga, S. and Fratu, O. (2015). “Big data, internet of things and cloud convergence–an architecture for secure e-health applications.” *Journal of Medical Systems*, 39(141), 1-8.

Suki, N. M. and Suki, N. M. (2017), “Flight ticket booking app on mobile devices: Examining the determinants of individual intention to use”, *Journal of Air Transport Management*, 62, 146-154.

SurveyMonkey. (2018). “Sample Size Calculator.” https://www.surveymonkey.com/mp/sample-size-calculator/ (Jun. 3, 2018).

Sweileh, W. M. (2019). “A bibliometric analysis of health-related literature on natural disasters from 1900 to 2017.” *Health Research Policy and Systems*, 17(1), 18, 1-11.

Sykes, T.A., Venkatesh, V. and Gosain, S. (2009). “Model of acceptance with peer support: A social network perspective to understand employees' system use”, *MIS Quarterly*, 33(2), 371-393.

Tabish, S. A. (2001). “Hospital and health services administration: principles and practice.” Oxford University Press, USA.

Tariq, S. and Woodman, J. (2013). “Using mixed methods in health research.” *JRSM Short Rep*. 1-8.

Technopak Healthcare Outlook. (2012). “Mother and Child Care.” Technopak Advisors Pvt. Ltd. Gurgaon, 1-13.

Teddlie, C. and Tashakkori, A. (2009). “Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences.” Sage, London.

Teddlie, C. and Yu, F. (2007). “Mixed methods sampling: A typology with examples.” *Journal of* Mixed Methods Research, 1(1), 77-100.

Telecom Regulatory Authority of India (2012). "Telecom sector in India: A decadal profile. New Delhi: Government of India." http://main.trai.gov.in/sites/default/files/NCAER--Report08june12.pdf. (Nov.1, 2018).

Telecom Regulatory Authority of India, (2018). "Telecom Subscription Data as on 31st March, 2019." https://main.trai.gov.in/sites/default/files/PR_No.40of2019.pdf (Dec.21, 2018).

Tenney, E. R., Poole, J. M. and Diener, E. (2016). "Does positivity enhance work performance?: Why, when, and what we don't know." *Research in Organizational Behavior*, 36, 27-46.

Teo, T. (2009). "Modelling technology acceptance in education: A study of pre-service teachers", *Computers & Education*, 52(2), 302-312.

Tess, P. A. (2013). The role of social media in higher education classes (real and virtual)–A literature review. *Computers in Human Behavior*, 29(5), A60-A68.

Tewari, A., Kallakuri, S., Devarapalli, S., Jha, V., Patel, A. and Maulik, P. K. (2017). "Process evaluation of the systematic medical appraisal, referral and treatment (SMART) mental health project in rural India." *BMC Psychiatry*, 17(1), 385, 1-13.

The Commonwealth Fund. (2016). "Health System Features." https://international.commonwealthfund.org/features/. (Mar. 23, 2018).

The World Bank. (2018). "Rural population (% of total population)." https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=IN (Jun. 18, 2018).

The World Bank. (2018). The World Bank in India. https://www.worldbank.org/en/country/india/overview (May. 03, 2018).

Thomas, S. V. (2009). "The National Health Bill 2009 and afterwards." *Annals of Indian Academy of Neurology*, 12(2), 79.

Thurston, M. and Thurston, A. (2010). "The accessibility of health information for blind and partially sighted people." *RNIB, Edinburgh*.

Times of India (2018). “Mobile internet users in India seen at 478 million by June: IAMAI.” https://timesofindia.indiatimes.com/business/india-business/mobile-internet-users-in-india-seen-at-478-million-by-june-iamai/articleshow/63533860.cms (Jun. 30, 2018).

Tiwari, R. (2018). “What to expect in 2019: The new language of politics.” https://indianexpress.com/article/explained/narendra-modi-rahul-gandhi-lok-sabha-elections-sabarimala-entry-gender-rights-metoo-ram-temple-5512545/, (Nov. 21, 2018).

Torgan, C. (2009). “The mHealth Summit: Local and Global Converge - Kinetics. Kinetics.” http://caroltorgan.com/mhealth-summit/ (Jan. 24, 2018).

TRAI (2018). “Telecom Regulatory Authority of India 20 Glorious Years (1997-2017) New Delhi.” http://www.trai.gov.in/release-publication/reports/telecom-subscriptions-reports (Feb. 21, 2018).

Trainor, K. J., Andzulis, J. M., Rapp, A. and Agnihotri, R. (2014). “Social media technology usage and customer relationship performance: A capabilities-based examination of social CRM.” *Journal of Business Research*, 67(6), 1201-1208.

Tse, D. K., Belk, R. W. and Zhou, N. (1989). “Becoming a consumer society: A longitudinal and cross-cultural content analysis of print ads from Hong Kong, the People's Republic of China, and Taiwan.” *Journal of Consumer Research*, 15(4), 457-472.

Tumbe, C (2017), “The North-South urban paradox”, https://m.dailyhunt.in/news/india/english/the+indian+economist-epaper-indecono/the+north+south+urban+paradox-newsid-65696279 (Mar. 23, 2017).

Tuttle, P. and Bobinis, J. (2013). “Specifying Affordability.” In *INCOSE International Symposium. 23*(1), 662-676.

U.S. Mission India. (2014). “Fact Sheet: U.S.-India Science and Technology, Innovation, and Health Cooperation.” https://in.usembassy.gov/fact-sheet-u-s-india-science-and-technology-innovation-and-health-cooperation/ (Jun. 29, 2018).

United Nations. (2017). “Voluntary National Review Report- On Implementation of Sustainable Development Goals.” https://sustainabledevelopment.un.org/content/documents/15836India.pdf (Apr. 09, 2019).

United Nations. (2019). “E Government Development Index (EGDI)”. https://publicadministration.un.org/egovkb/en us/Data Center (Apr.23, 2019).

UNPAN (2014). Governance Asia-Pacific Watch: The Regional Cooperation Office for City Informatization. (155), http://workspace.unpan.org/sites/internet/Documents/GAPW%20155%E6%9C%88%E5%88%8A.htm (Jan.03, 2019).

van Eck, N. J. and Waltman, L. (2009). “How to normalize cooccurrence data? An analysis of some well-known similarity measures.” *Journal of the American Society for Information Science and Technology*, 60(8), 1635-1651.

van Eck, N. J. and Waltman, L. (2013). “VOSviewer manual.” *Leiden: Univeristeit Leiden*, *1*(1), 1-28. https://www.vosviewer.com/documentation/Manual_VOSviewer_1.5.4.pdf (Aug. 27, 2019).

van Gaans, D. and Dent, E. (2018). “Issues of accessibility to health services by older Australians: a review.” *Public Health Reviews*, 39(1), 20, 1-16.

Van Oostendorp, H., Breure, L. and Dillon, A. (2005). “Creation, use, and deployment of digital information.” Routledge, New York.

Varshney, U. (2014). “Mobile health: Four emerging themes of research.” *Decision Support Systems*, 66, 20-35.

Velu, GSK. (2017). “Make in India- a dream or reality. https://health.economictimes.indiatimes.com/health-files/make-in-india-a-dream-or-reality/2068/ (Jun. 27, 2018).

Venkat, P. G. (2016). “Intermediate Assessment of The Khushi Baby Crct: Implementation Of A Novel Mhealth Solution For Vaccination Record Keeping In Rural Udaipur, Rajasthan, India.” Public Health Theses. Yale University.

Venkatesh, V. (1999). “Creation of favorable user perceptions: Exploring the role of intrinsic motivation”. *MIS Quarterly*, 23(2), 239-260.

Venkatesh, V. and Bala, H. (2008). “Technology acceptance model 3 and a research agenda on interventions.” *Decision Sciences*, 39(2), 273-315.

Venkatesh, V. and Davis, F. D. (2000). “A theoretical extension of the technology acceptance model: Four longitudinal field studies.” *Management Science*, 46(2), 186-204.

Venkatesh, V. and Davis, F.D. (1996), “A model of the antecedents of perceived ease of use: development and test.” *Decision sciences*, 27(3), 451-481.

Venkatesh, V., Morris, M. G., Davis, G. B. and Davis, F. D. (2003), “User acceptance of information technology: Toward a unified view.” *MIS Quarterly*, 27(3), 425-478.

Ventola, C. L. (2014). Mobile devices and apps for health care professionals: uses and benefits. *Pharmacy and Therapeutics*, 39(5), 356-364.

Vikram Kumar (2018). “The New Indian Express”, http://www.newindianexpress.com/nation/2018/feb/05/south-india-beats-north-in-health-insurance-1768424.html (Mar. 23, 2018).

Vital Wave Consulting (2009). “mHealth for Development: The Opportunity of Mobile Technology for Healthcare in the Developing World.” United Nations Foundation, Vodafone Foundation. p. 9. https://web.archive.org/web/20121203014521/http://vitalwaveconsulting.com/pdf/2011/mHealth.pdf (Apr. 9, 2019).

VPNHaus. (2011). Part 1, Conversation with Martin Rosner on Security Aspects of Continua Health Alliance Architecture. https://vpnhaus.ncp-e.com/2011/conversation-with-martin-rosner-on-security-aspects-of-continua-health-alliance-architecture-part-1/. (Mar. 13, 2018).

Vrangbaek K, (2016). “The Danish Health Care System.” https://international.commonwealthfund.org/countries/denmark/. (Sep. 07, 2018).

Wagner, K. (2014). “How Mobile Health Is Changing Care Delivery. Leadership+.” HFMA Learning Solutions, Inc. https://www.hfma.org/leadership/mobilehealth/ (Apr. 09, 2019).

Wahyuni, R. (2017). “Explaining acceptance of e-health services: An extension of TAM and health belief model approach.” In *2017 5th International Conference on Cyber and IT Service Management (CITSM)*, Bali, IEEE. 1-7.

Walsh, I. and Renaud, A. (2017). “Reviewing the literature in the IS field: Two bibliometric techniques to guide readings and help the interpretation of the literature.” *Systemes D'information Management*, 22(3), 75-115.

Walther, J. B. (1996). “Computer-mediated communication: Impersonal, interpersonal, and hyperpersonal interaction.” *Communication Research*, 23(1), 3-43.

Wang, J., Yao, N., Shen, M., Zhang, X., Wang, Y., Liu, Y., Geng, Z. and Yuan, C. (2016). “Supporting caregivers of children with acute lymphoblastic leukemia via a smartphone app: a pilot study of usability and effectiveness.” *CIN: Computers, Informatics, Nursing*, 34(11), 520-527.

Wang, W. T. and Liu, C. Y. (2005). “The application of the technology acceptance model: A new way to evaluate information system success.” In *Proceedings of the 23rd International System Dynamics Conference*, Boston, Massachusetts, USA.

Wang, Y.S., Wu, M.C. and Wang, H.Y. (2009). “Investigating the determinants and age and gender differences in the acceptance of mobile learning.” *British Journal of Educational Technology*, 40(1), 92-118.

Warschauer, M. (2011). “A literacy approach to the digital divide.” *Las mulialfabetizaciones en el espacio digital.* Ediciones Aljibe, Malaga, Spain.

Weiz, D., Anand, G. and Ernst, C. P. H. (2016), “The influence of subjective norm on the usage of smartglasses”, In *The drivers of wearable device usage*, Springer, Cham, 1-11.

West, D. M. (2015). “Using mobile technology to improve maternal health and fight Ebola: A case study of mobile innovation in Nigeria.” *In Center for Technological*

*Innovation at Brookings*, The Institute for Peace and Security Studies (IPSS) gathered a group of experts for a workshop on AfSol, 19, 308-312.

Whitehead, C. M. (1991). From need to affordability: an analysis of UK housing objectives. *Urban Studies*, *28*(6), 871-887.

Whiting, A. and Williams, D. (2013), “Why people use social media: a uses and gratifications approach”, *Qualitative Market Research: An International Journal*, 16(4), 362-369.

Williams, A., Helm, H. and Clemens, E. (2012). “The effect of childhood trauma, personal wellness, supervisory working alliance, and organizational factors on vicarious traumatization.” *Journal of Mental Health Counseling*, 34(2), 133-153.

Wolff, J. M., Rospenda, K. M. and Colaneri, A. S. (2017). “Sexual harassment, psychological distress, and problematic drinking behavior among college students: an examination of reciprocal causal relations.” *The Journal of Sex Research*, 54(3), 362-373.

Wong, C. A., Sap, M., Schwartz, A., Town, R., Baker, T., Ungar, L. and Merchant, R. M. (2015). “Twitter sentiment predicts Affordable Care Act marketplace enrollment.” *Journal of medical Internet Research*, 17(2), e51, 1-8.

Wong, C. K., Yeung, D. Y., Ho, H. C., Tse, K. P. and Lam, C. Y. (2014), “Chinese older adults’ Internet use for health information”, *Journal of Applied Gerontology*, 33(3), 316-335.

Woodward, A., Fyfe, M., Handuleh, J., Patel, P., Godman, B., Leather, A., and Finlayson, A. (2014). Diffusion of e-health innovations in ‘post-conflict’settings: a qualitative study on the personal experiences of health workers. *Human Resources for Health*, 12(1), 22, 1-10.

World Bank, (2019). “Data for India, Lower middle income.” https://data.worldbank.org/?locations=IN-XN (Jun. 11, 2018) (May 31, 2019).

World Health Organization [WHO]. (2014), “Health Systems Governance for Universal Health Coverage”, https://www.who.int/universal_health_coverage/plan_action-hsgov_uhc.pdf (Mar. 26, 2018).

World Health Organization [WHO]. (2015). "Health in 2015: from MDGs, millennium development goals to SDGs, sustainable development goals." World Health Organization. http://www.who.int/iris/handle/10665/200009. (Oct. 21, 2018).

World Health Organization [WHO]. (2015). "Summary report of systematic reviews for public health emergency operations centres." https://apps.who.int/iris/bitstream/handle/10665/197379/9789241509787_eng.pdf (Mar. 24, 2018).

World Health Organization [WHO]. (2019). "Global Health Observatory (GHO) data". https://www.who.int/gho/mortality_burden_disease/life_tables/en/ (May. 09, 2019).

World Health Organization [WHO]. (2019). "Global Health Observatory (GHO) data". https://www.who.int/gho/mental_health/suicide_rates/en/ (May. 09, 2019).

World Health Organization [WHO]. (2019). "Mental health in the workplace." https://www.who.int/mental_health/in_the_workplace/en/ (May. 09, 2019).

World Health Organization [WHO]. (2019). "Millennium Development Goals (MDGs)". https://www.who.int/topics/millennium_development_goals/about/en/ (Oct. 09, 2018).

World Health Organization [WHO]. (2019). "National Health Policy". http://www.searo.who.int/india/topics/nationalhealthpolicy/en/ (Oct. 09, 2018).

World Health Organization [WHO]. (2019). "Gender and women's mental health." https://www.who.int/mental_health/prevention/genderwomen/en/ (Oct. 18, 2019).

World Health Organization [WHO]. (2019). "What do we mean by availability, accessibility, acceptability and quality (AAAQ) of the health workforce?." https://www.who.int/workforcealliance/media/qa/04/en/ (Jul. 08, 2019).

World Health Organization [WHO]. "mHealth: New horizons for health through mobile technologies." *Observatory*, 3, 66–71.

World Vision (2020), "Sponsor a Child." https://www.worldvision.in/WaysToGive/emergency-relief.aspx?code=23707#scrolltop (Feb. 05, 2020).

Worrall, L. (2016). "From conference paper to journal article: The long and winding road." *The Electronic Journal of Business Research Methods*, 14(1), 3-7.

Worthington, R. P. and Gogne, A. (2011). "Cultural aspects of primary healthcare in India: A case-based analysis." *Asia Pacific Family Medicine*, 10(1), 8.

Xiong, X., Zhang, Z., Ren, J., Zhang, J., Pan, X., Zhang, L., Gong, S. and Jin, S. (2018). "Impact of universal medical insurance system on the accessibility of medical service supply and affordability of patients in China." *PloS One*, 13(3), e0193273, 1-.

Yadav, N., DeBello, J. E., Gallardo, C. and Jackson, S. T. (2018). Gaming Projects for Cognitive Testing in an Undergraduate Mobile Healthcare Technology Course. In *2018 IEEE Frontiers in Education Conference (FIE),* San Jose, CA, USA, IEEE. 1-8.

Yaros, A., Stein, T., Bernstein, S., Waron, M.G. and Cohen, E., VMware Inc. (2015). "Methods and systems for detection and analysis of cost outliers in information technology cost models." U.S. Patent Application 14/169,724.

Yasmeen, A. (2013). "35,000 ASHA workers to get mobile phones to promote health schemes." The Hindu. http://www.thehindu.com/news/national/karnataka/35000-asha-workers-to-get-mobile-phones-to-promote-health-schemes/article5314685.ece (Aug. 15, 2017).

Yi, L. (2017). "National report on e-commerce development in China." *United Nations Industrial Development Organization (UNIDO),* Working Paper Series 16/2017.

Yin, R. (2008). "*Case study research: Design and methods".* Thousand Oaks, CA: Sage.

Young, L. (2018). "What to look for in mental well-being apps." https://medicalxpress.com/news/2018-10-mental-well-being-apps.html/ (Dec. 21, 2018).

Yu, D., Parmanto, B. and Dicianno, B. (2019). “An mHealth App for Users with Dexterity Impairments: Accessibility Study.” *JMIR mHealth and uHealth,* 7(1), e202, 1-14.

Zallman, L., Nardin, R., Sayah, A. and McCormick, D. (2015). “Perceived affordability of health insurance and medical financial burdens five years in to Massachusetts health reform.” *International Journal for Equity in Health*, 14(1), 113.

Zayapragassarazan, Z. and Kumar, S. (2016), “Awareness, knowledge, attitude and skills of telemedicine among health professional faculty working in teaching hospitals”, *Journal of Clinical and Diagnostic Research: JCDR*, 10(3), JC01–JC04.

Zee Business. (2018). “Internet users in India likely to top 500 million by June 2018.” http://www.zeebiz.com/technology/news-internet-users-in-india-likely-to-top-500-million-by-june-2018-37570 (Feb. 21, 2018).

Zelle, M. (2007). “Increasing Profitability with Tivoli IT Financial Management Products*.” IBM Corporation*.

Zhang, X., Yu, P., Yan, J. and Spil, I. T. A. (2015). “Using diffusion of innovation theory to understand the factors impacting patient acceptance and use of consumer e-health innovations: a case study in a primary care clinic.” *BMC Health Services Research*, 15(1), 71.

Zhen, J. S., and Mansori, S. (2012). “Young female motivations for purchase of organic food in Malaysia.” *International Journal of Contemporary Business Studies*, 3(5), 61-72.

Zurovac, D., Talisuna, A. O. and Snow, R. W. (2012). Mobile phone text messaging: tool for malaria control in Africa. *PLoS Medicine*, 9(2), e1001176, 1-6.

# APPENDIXES

**Appendix I: Consent Form for Participation in Interview Research**

**National Institute of Technology Karnataka, Surathkal**

**Consent Form for Participation in Interview Research**

I volunteer to participate in a research study conducted by Rajesh R. Pai from NITK Surathkal. I understand that this study is designed to gather information about the mobile health applications usefulness for health service delivery in India.

1. I have been given sufficient information about this research project. The purpose of my participation as an interviewee in this study has been explained to me and is clear.
2. My participation in this interview is voluntary, and I am free to withdraw at any time without giving any reason. In addition, if I am uncomfortable to answer any particular question or questions, I am free to decline or end the interview. If I decline to participate or withdraw from the study, it will not be disclosed.
3. I understand that notes will be written during the interview and the responses will be tape-recorded. The extracts from the interview will be kept as confidential and used only for the academic purpose.
4. I have read and understood the explanation provided to me, I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

______________________________

Participant's Signature

______________________________

Signature of the witness

______________________________

Signature of the Investigator

## Appendix II: Interview Guide for Accessibility and Acceptance of Mobile Health

### Accessibility and Acceptance of Mobile Health

Interview questions measuring awareness, accessibility, and acceptance of mobile health among rural people.

| Interview Questions |
|---|
| ***Health Consciousness and Health Information Orientation*** |
| I do everything I can in order to stay healthy? |
| I actively try to prevent disease and illness? |
| It is very important that I am in the healthiest condition possible? |
| I make a point to read and watch/listen stories about health? |
| I really enjoy learning about health issues? |
| I need to know about health issues so I can keep myself and my family healthy? |
| Before making a decision about my health, I find out everything about this issue? |
| When I take medicine, I try to get as much information as possible about its benefits and side effects? |
| ***Accessibility*** |
| Do you know how to access a mobile application? |
| Do you know how to make a voice call without others help? |
| Do you know to type and send messages through mobile phones? |
| Do you know how to access the internet using mobile phones? |
| Have you used the internet to search the health information online? |
| Do you have knowledge about any self-care technologies (from home)? |
| Have you used mobile phones to call doctor regarding appointment or counseling or treatment during illness or any health-related problems? |
| ***Awareness*** |
| Aware of mHealth apps like mDiabetes, mCessation, NHP Indradhanush, etc. from the government? |
| Aware of mobile apps for exercises, meditation, etc.? |
| Aware about use of mobile phones in Reproductive and Child Health (RCH) programmes? |

| |
|---|
| Have you heard about telemedicine? |
| Have you heard about 99dots for TB? |
| ***Perceived take-up and Acceptance*** |
| Are you willing to get medical counseling through mobile phones? |
| If you were to receive a message or call reminder about the appointment as in maternal and childcare or RCH from your doctor, whether you will respond? |
| If you were to receive a message or reminder about the medication as in RCH from your doctor whether you will respond back? |
| Are you willing to give time for mobile-based health services like tips for staying healthy and others? |

## Appendix III: Interview Guide for Measuring Affordability of Mobile Health

### Affordability of Mobile Health

***Interview Guide***

**Introduction:**

Advancement in the information and communication technology has created opportunities for the healthcare organizations to transform traditional systems of service delivery to more of digitally enabled technologies for providing health care access towards preventive, acute and chronic health conditions. It is therefore not surprising that, these technologies and applications such as mobile care devices, tele-health, and home health and wellness, has gained certain level of acceptance across rural and urban populations of developing and developed countries.

India which is the world's second largest populated country contributing to a greater probability of people being getting exposed to various health symptoms and disease conditions are currently influencing the Indian economy. Firstly, this can be due to the scarcity of health practioners and hospital infrastructure in rural and difficulties in locating right doctors, hospital waiting lines, etc. among Tier 1 cities. Secondly, the lost productivity and increase in cost due to unhealthy lifestyles/large drop-off from prescribed therapy/late diagnosis influences issues of affordability among people. Thirdly, the distinction between the privatization and public (or government) operated health care centres because of lack of facilities has also increased the out-of-pocket expenditure per episode of inpatient and outpatient care has increased by 11.4% and 9.5% CAGR between 2004 and 2014.

Under the Prime Minister initiatives of **"Digital India and Vision 2020",** there would be a transformation in healthcare sector so that "**poorest of the poor will receive healthcare".** Moreover, many technology entrepreneurs (software developers) and doctors often speak about the importance of digital technologies changing the healthcare sector of India and to the digital India programme.

**Questions:**

1. As a techno-entrepreneur/doctors, how would you develop your **mobile health environment** considering the major areas such as ***innovations for underserved, market and policy, and care for health and disease conditions***?
2. What **business driver** strategy you prefer towards the government initiative of Digital India and poorest of the poor will receive healthcare (affordability)? Please describe.

   ***(e.g., healthcare reforms considering economic factors, accountable care organisations, patient centered medical homes, value-based purchasing, demand for services, profit margin understanding in the relevant industry, maturity level and the capacity of business to supply)***
3. What **health driver** strategy you prefer towards the initiative? Please describe.

   ***(e.g., keep patient out of the system, capitation (RoI), drive for cost reduction, geographical barriers, and aging populations)***
4. What **technology driver** strategy you prefer towards the initiative? Please describe.

   ***(e.g., smaller, better, faster, and cheaper technologies (hardware and software cost, labor cost, depreciation and acquisition charges (including relative value of entity and tenders or potential supplier scale), project portfolio management systems); smartphones or touchpads, expanding wireless and mobile networks (regulations and policies), standalone personal health apps and devices (level of complexity, its security and privacy), easy dissemination via play stores, and affordability (cost and net benefits).***
5. Literatures suggests that use of **context-aware and data visualization** health applications in mobiles could improve the rate of adoption for certain mhealth features and improve user experience and acceptance through value creation in terms of recoding number of steps walked, period tracker etc.
6. To what extent did participation in Digital India and Vision 2020 advanced or hindered the implementation of mobile phone application development for health service. ***(Cost absorbed by business unit, government or nonprofit organisation as a line item for budget.)***

7. What strategies, interventions, tools, etc., would you recommend be sustained and/or scaled up? Can you please provide me a justification for your response? ***(Staff turnover? Lack of key support? Lack of technical assistance?)***
8. Reports says mobile battery backup will be less when we use health apps for service delivery and people say that mobile phones are hazardous to health, so what is your takeup on this?
9. What would be the barriers you have encountered during the initiation and development process of mHealth platform in/for India? Please list.
10. What do you think about mobile health project had/have on the improving the health service delivery in the regions and community? ***Increased use of services by youth? Increased knowledge of youth friendly services by clinic staff? Changes to the clinic(s) to make them more youth friendly?***
11. The total download in app stores is 10000, therefore, what would be your benchmarking strategies for improving the awareness and accessibility of mobile health among the population of India? ***(For targeting and segmenting, promoting and marketing, training, and service)***.
12. Can you give me more details about the components which you are going to consider while setting up the budgets (for maintenance, staffs, software and hardware? Market research and analytics or review survey? Analysis of reviews in the app stores? Any others?
13. What recommendations do you have towards mobile health technology and application services for considering it as an affordable device or technology in this market scenario and future?
14. Is there anything more you would like to add?

## Appendix IV: Questionnaire Survey for Descriptive Study

# National Institute of Technology Karnataka, Surathkal

This is a research project undertaken at NITK Surathkal to study the use of mobile phone technologies in health service delivery. As you may be aware that healthcare sector which is currently facing a lot of service delivery challenges due to lack of medical infrastructure and facilities have started promoting the use of mobile health applications (apps) for making it accessible and affordable to the people. These apps enable individuals to self-care or interact with doctors for treating chronic diseases or for scheduling appointments, medication reminders, etc. through multiple mediums dependent upon individual convenience and interactions. As a part of this research, I am conducting a survey and have identified you as one of the important respondents, considering that you have used mobile phones and its apps for accessing health information. These results will be insightful for this study. For the purpose, I request you to kindly spare some of your valuable time to answer this questionnaire. On the basis of pre-test, it is estimated that it will take maximum of 10 minutes.
I assure that all responses provided by you will be kept as confidential and used only for the academic purpose. If you are interested - upon an email request- I am happy to share the survey results with you.

**RAJESH R. PAI**
Mail: pairajesh.m@gmail.com

---

**QUESTIONNAIRE**

**Mobile phones and tablets are used in communicating health information with/without application software's (apps) downloaded from 'internet or app stores'?**

| **1. I own mobile phone/smartphone or tablet with the operating system:** | | | |
|---|---|---|---|
| iPhone | iPad | Android Smartphone | Android Tablet |
| Blackberry | Windows Tablet | Windows Smartphone | Basic mobile phones |

| **2. When I need health-related information, I will try to receive it from:** | **Very infrequent** | **Infrequent** | **Not sure** | **Frequent** | **Very frequent** |
|---|---|---|---|---|---|
| Family or friends | 1 | 2 | 3 | 4 | 5 |
| Doctors/nurses | 1 | 2 | 3 | 4 | 5 |
| Social networking sites (Facebook, Twitter, Tumblr, etc.) | 1 | 2 | 3 | 4 | 5 |
| Television | 1 | 2 | 3 | 4 | 5 |
| Newspapers, magazines, books | 1 | 2 | 3 | 4 | 5 |
| Internet and health applications | 1 | 2 | 3 | 4 | 5 |

**3.** I used mobile phones to search health related material online? **(Yes / No/ Maybe)**

**4.** I have/had used mobile phones for health condition(s):

| | | | | | |
|---|---|---|---|---|---|
| Asthma | Cancer | Stress | Diabetes | Obesity/fat | Other____________ |
| Blood Pressure | Menstruation | Cold & Fever | Tooth Problems | Not Used or Referred | |

| **Please indicate your level of awareness about the use of mobile phone for receiving health information** | | | | | |
|---|---|---|---|---|---|
| **5.** I am aware about the term 'mobile health' prior (before) to this study | Not at all aware | Slightly aware | Somewhat aware | Moderately aware | Extremely aware |
| **6.** I am familiar about the term 'mobile health' | Not at all familiar | Slightly familiar | Somewhat familiar | Moderately familiar | Extremely familiar |

| **Strongly Disagree (SD) Disagree (D) Neutral (N) Agree (A) Strongly Agree (SA)** | | | | | |
|---|---|---|---|---|---|
| **7. I am aware that mobile phones are used in/for** | SD | D | N | A | SA |
| Creating health awareness and education like cessations etc. | 1 | 2 | 3 | 4 | 5 |
| Assessing and diagnosing certain disease conditions and medication remainders etc. | 1 | 2 | 3 | 4 | 5 |
| Locating hospitals and for scheduling appointments | 1 | 2 | 3 | 4 | 5 |
| Medication adherence & refilling through pharma websites | 1 | 2 | 3 | 4 | 5 |
| Storing patient records | 1 | 2 | 3 | 4 | 5 |
| Doctor-stakeholders communication in informing health status of the locality | 1 | 2 | 3 | 4 | 5 |
| Reminding pregnant and lactating mothers about immunization | 1 | 2 | 3 | 4 | 5 |

| **8. I have seen and/or heard about mobile health applications through:** | | | | | |
|---|---|---|---|---|---|
| Family, friends or colleagues | Social media | Ads in mobile app or phone | Online videos or Websites like WebMD | Articles | Advertisements in TV |
| Electronic Mail (Email) | Public transportation | Billboards & Coupons | Healthcare centre | I don't remember | Not Seen or Heard about it |

| | | | | | |
|---|---|---|---|---|---|
| **9.** I hear people talking about mobile health app | **Never** | **Occasionally** | **Sometimes** | **Often** | **Very often** |

| 10. I downloaded / currently use apps for getting health information related to: | Yes | No | Maybe |
|---|---|---|---|
| Self-managing of cancer | 1 | 2 | 3 |
| Self-managing of cholesterol, heart diseases, & stroke | 1 | 2 | 3 |
| Self-managing of chronic obstructive pulmonary disease like bronchitis, asthma | 1 | 2 | 3 |
| Self-managing of fitness, yoga, diet, & nutrition for obesity | 1 | 2 | 3 |

| | | | | |
|---|---|---|---|---|
| **11.** Total number of health apps available on my device is | 0 | 1 | 2 | More than 2 |

**Kindly provide some information about your background**

| | | | | | |
|---|---|---|---|---|---|
| **Gender** | Male | Female | Prefer not to say | | |
| **Age** | 18–25 | 26–35 | 36–45 | 46–55 | >55 |
| **Education** | <=10th | 10+2 / PUC | Bachelor's degree | Master's degree | Doctoral Degree |
| **Course** | **Engg. /Medical/Nursing etc.:** | | | | |
| **Work status** | Student | Technical staff | Healthcare professional | Retired | Others |
| **Marital status** | Single | Married | Others | | |
| **Living arrangements** | Hostel | Family | Paying Guest | Others | |
| **Language you prefer in smartphone or tablet** | | | | | |
| **In which state or territory do you belong to?** | | | | | |

Please add anything you would like to share about use of mobile phone technologies and applications for health conditions and healthcare services:

________________________________________________________________

**Thank you for participating in this important survey!! I really appreciate your valuable time spent for this.**

## Appendix V: Questionnaire Survey for Hypothesis Testing

## National Institute of Technology Karnataka, Surathkal

This is a research project undertaken at NITK Surathkal to study the use of mobile phone technologies in health service delivery. As you may be aware that healthcare sector which is currently facing a lot of service delivery challenges due to lack of medical infrastructure and facilities have started promoting the use of mobile health applications (apps) for making it accessible and affordable to the people. These apps enable individuals to self-care or interact with doctors for treating chronic diseases or for scheduling appointments, medication reminders, etc. through multiple mediums dependent upon individual convenience and interactions.

As a part of this research, I am conducting a survey and have identified you as one of the important respondents, considering that you have used mobile phones and its apps for accessing health information. These results will be insightful for this study. For the purpose, I request you to kindly spare some of your valuable time to answer this questionnaire. On the basis of pre-test, it is estimated that it will take maximum of 10 minutes.

I assure that all responses provided by you will be kept as confidential and used only for the academic purpose. If you are interested - upon an email request- I am happy to share the survey results with you.

**RAJESH R. PAI**
Mail: pairajesh.m@gmail.com

---

**QUESTIONNAIRE**

| 1. When I need information about health (for example, cold and fever, obesity, stress, mental health, and toothache problems), I will try to receive it from: | Yes | No | Maybe |
|---|---|---|---|
| Family or friends | 1 | 2 | 3 |
| Doctors/nurses | 1 | 2 | 3 |
| Social networking sites (Facebook, Twitter, Tumblr, etc.) | 1 | 2 | 3 |
| Television | 1 | 2 | 3 |
| Newspapers, magazines, books | 1 | 2 | 3 |
| Internet and health applications | 1 | 2 | 3 |

**Mobile phones and tablets are used in communicating health information with/without application software's (apps) downloaded from 'internet or app stores'?**

| 2. I own mobile phone/smartphone or tablet with the operating system: | | | |
|---|---|---|---|
| iPhone | iPad | Android Smartphone | Android Tablet |
| Blackberry | Windows Tablet | Windows Smartphone | Basic mobile phones |

| **Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A), Strongly Agree (SA)** | SD | D | N | A | SA |
|---|---|---|---|---|---|
| **3.** Living life in the best possible health is very important to me | 1 | 2 | 3 | 4 | 5 |
| **4.** Eating right, exercising, and taking preventive measures will keep me healthy for life | 1 | 2 | 3 | 4 | 5 |
| **5.** My health depends on how well I take care of myself | 1 | 2 | 3 | 4 | 5 |
| **6.** I actively try to prevent disease and illness | 1 | 2 | 3 | 4 | 5 |
| **7.** I do everything I can to stay healthy | 1 | 2 | 3 | 4 | 5 |

| | **SD** | **D** | **N** | **A** | **SA** |
|---|---|---|---|---|---|
| **8.** I would always find ways to experiment with mobile technology and apps services if I hear about it | 1 | 2 | 3 | 4 | 5 |
| **9.** Among my families, friends, and peers, I am usually the first to try or use mobile tech and apps services | 1 | 2 | 3 | 4 | 5 |
| **10.** When it comes to try or use of mobile technology and application services, I will be hesitant | 1 | 2 | 3 | 4 | 5 |
| **11.** I like to take a chance to explore with new mobile tech and apps services. | 1 | 2 | 3 | 4 | 5 |

| | **SD** | **D** | **N** | **A** | **SA** |
|---|---|---|---|---|---|
| **12.** Use of mobile tech and apps services is important to fulfill my needs | 1 | 2 | 3 | 4 | 5 |
| **13.** Use of mobile tech and apps services assists me to control on taking care of my problems | 1 | 2 | 3 | 4 | 5 |
| **14.** Use of mobile tech and apps services supports me to independently choose how to take care of my problems | 1 | 2 | 3 | 4 | 5 |
| **15.** Use of mobile tech and apps services influence me to feel confident about my capacity to take care of my problems | 1 | 2 | 3 | 4 | 5 |

| | **SD** | **D** | **N** | **A** | **SA** |
|---|---|---|---|---|---|
| **16.** Use of mobile health technology and apps improves the quality on the work I do | 1 | 2 | 3 | 4 | 5 |
| **17.** Use of mobile health technology and apps is advantageous in managing my health | 1 | 2 | 3 | 4 | 5 |
| **18.** Use of mobile health technology and/or apps is useful in managing my health daily | 1 | 2 | 3 | 4 | 5 |
| **19.** Use of mobile health technology and apps is beneficial to me | 1 | 2 | 3 | 4 | 5 |
| **20.** Use of mobile health technology and apps will make it easier to manage my healthcare | 1 | 2 | 3 | 4 | 5 |

| **I could think of using mobile technology and apps for health information** | SD | D | N | A | SA |
|---|---|---|---|---|---|
| **21.** If I had used similar apps before | 1 | 2 | 3 | 4 | 5 |
| **22.** If there are software manuals for reference | 1 | 2 | 3 | 4 | 5 |
| **23.** If I get some time to try it out | 1 | 2 | 3 | 4 | 5 |
| **24.** If I can afford it financially | 1 | 2 | 3 | 4 | 5 |
| **25.** If it is available in the hospital nearby my place | 1 | 2 | 3 | 4 | 5 |

| **Please indicate your level of awareness about the use of mobile phone for receiving health information** | | | | | |
|---|---|---|---|---|---|
| **26.** I am aware about the term 'mobile health' prior (before) to this study | Not at all aware | Slightly aware | Somewhat aware | Moderately aware | Extremely aware |
| **27.** I am familiar about the term 'mobile health' | Not at all familiar | Slightly familiar | Somewhat familiar | Moderately familiar | Extremely familiar |

| | **SD** | **D** | **N** | **A** | **SA** |
|---|---|---|---|---|---|
| **28.** I receive sufficient information about mobile tech and apps for health | 1 | 2 | 3 | 4 | 5 |
| **29.** I receive sufficient information about the benefits of mobile tech and apps for health | 1 | 2 | 3 | 4 | 5 |
| **30.** I receive sufficient information of using mobile tech and apps for health | 1 | 2 | 3 | 4 | 5 |
| **31.** I never received information about mobile technology and apps for health from hospitals, doctors, etc. | 1 | 2 | 3 | 4 | 5 |
| | SD | D | N | A | SA |
| **32.** Individuals who encourage my behaviour think that I should use mobile tech and apps for health | 1 | 2 | 3 | 4 | 5 |
| **33.** Individuals who are essential to me think that I should use mobile technology and apps for health | 1 | 2 | 3 | 4 | 5 |
| **34.** My colleagues/classmates think that I should use mobile technology and apps for health | 1 | 2 | 3 | 4 | 5 |
| **35.** My friends think that I should use mobile technology and apps for health | 1 | 2 | 3 | 4 | 5 |
| **36.** My peers (family, friends, doctors, etc.) think that I should use mobile technology and apps for health | 1 | 2 | 3 | 4 | 5 |
| | SD | D | N | A | SA |
| **37.** I will use mobile tech and apps for managing health in future | 1 | 2 | 3 | 4 | 5 |
| **38.** I plan to use mobile tech and apps for managing health often | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| **39.** I am aware of mobile health apps (name of app) | | | | | |
| **40.** I use mobile health apps (name of app) | | | | | |
| **41.** Given a chance I would prefer to use health apps related to: | | | | | |
| **42.** How would you describe the overall opinion about mobile health apps? | Extremely favorable | Favorable | Somewhat favorable | Not at all favorable | I have not heard |

**<u>Kindly provide some information about your background</u>**

| | | | | | |
|---|---|---|---|---|---|
| **Gender** | Male | Female | Prefer not to say | | |
| **Age** | 18–25 | 26–35 | 36–45 | 46–55 | >55 |
| **Education** | <=10$^{th}$ | 10+2 / PUC | Bachelor's degree | Master's degree | Doctoral Degree |
| **Course** | **Engg. /Medical/Nursing etc.:** | | | | |
| **Work status** | Student | Technical staff | Healthcare professional | Retired | Others |
| **Marital status** | Single | Married | Others | | |
| **Living arrangements** | Hostel | Family | Paying Guest | Others | |
| **Language you prefer in smartphone or tablet** | | | | | |
| **In which state or territory do you belong to?** | | | | | |

| I use mobile phones and/or its apps for: | Never | Rarely | Sometimes | Often | Always |
|---|---|---|---|---|---|
| Playing games | 1 | 2 | 3 | 4 | 5 |
| Booking tickets and Travel | 1 | 2 | 3 | 4 | 5 |
| Reading news and Books | 1 | 2 | 3 | 4 | 5 |
| Social networking (Facebook, LinkedIn, etc.) | 1 | 2 | 3 | 4 | 5 |
| Health & Lifestyle | 1 | 2 | 3 | 4 | 5 |
| Education | 1 | 2 | 3 | 4 | 5 |
| Banking | 1 | 2 | 3 | 4 | 5 |
| Listening to music and video on YouTube | 1 | 2 | 3 | 4 | 5 |

Please add anything you would like to share about use of mobile phone technologies and applications for health conditions and healthcare services: ___________________________

**Thank you for participating in this important survey!! I really appreciate your valuable time spent for this.**

# B I O–D A T A

**Rajesh R. Pai**
Department of Humanities and Management,
Manipal Institute of Technology,
Manipal - 576104
Ph: +91 9663559700
Mail id**:** pairajesh.m@gmail.com / rajesh.pai@manipal.edu

## WORK EXPERIENCE

**Assistant Professor |** Manipal Institute of Technology, Manipal
Year: 2012 - Present

**Assistant Professor |** Srinivas School of Engineering, Mukka, Surathkal
Year: 2011 - 2012

## EDUCATION QUALIFICATION

**Ph.D. Research Scholar** | National Institute of Technology Karnataka, Surathkal
Research Area: Mobile Health Systems — Year: 2016 - Present

**Master of Technology (M.Tech.)** | Manipal Institute of Technology, Manipal
Specialization: Engineering Management — Year: 2009 - 2011
University: Manipal Academy of Higher Education

**Bachelor of Engineering (B.E.)** | Moodlakatte Institute of Technology, Kundapura
Specialization: Mechanical Engineering — Year: 2005 - 2009
University: Visveswaraiah Technological University, Belgaum

## PUBLICATIONS ACCEPTED

1. Pai, R. R., & Alathur, S. (2018). Assessing mobile health applications with twitter analytics. *International Journal of Medical Informatics*, *113*, 72-84.
2. Pai, R. R., & Alathur, S. (2019). Assessing Awareness and Use of Mobile Phone Technology for Health and Wellness: Insights from India. *Health Policy and Technology*. *8*(3), 221-227.
3. Pai, R. R., & Alathur, S. (2019). Social Media Games: Insights from Twitter Analytics. *International Journal of Web-Based Communities*. *16*(1), 34-50.

4. Pai, R. R., & Alathur, S. (2019). Determinants of Individuals' Intention to Use Mobile Health: Insights from India. *Transforming Government: People, Process and Policy*. *13*(3/4), 306-326.

5. Pai, R. R., & Alathur, S. (2019, March). Social Media and Mental Health: Insights from Twitter Analytics. In Achutha Menon Centre Public Health Conference (AMCCON) 2019 - Thiruvananthapuram.

6. R Pai, R., & Alathur, S. (2019, June). Mobile Health System Framework in India. *In 20th Annual International Conference on Digital Government Research*. (pp. 186-195). ACM.

7. Pai, R. R., & Alathur, S. (2020). Women Empowerment Through Social Media: Insights from #MeToo India. *In ICT Analysis and Applications*. (pp. 387-395). Springer, Singapore.

8. Pai, R. R., & Alathur, S. (2020, April). Determinants of Mobile Health Application Awareness and Use in India: An Empirical Analysis. (Accepted for presentation and publication in the proceedings of the 13th International Conference on Theory and Practice of Electronic Governance (ICEGOV2020). 23 – 25 September 2020, Athens, Greece.

9. Pai, R. R., & Alathur, S. Predicting Mobile Health Technology Acceptance by the Indian Rural Community: A Qualitative Study. *International Journal of Electronic Government Research (IJEGR).* (Accepted).

**PUBLICATIONS UNDER REVIEW**

1. Pai, R. R., & Alathur, S. A Review of Mobile Health Applications and its Use Phases.

2. Pai, R. R., & Alathur, S. Mobile Health Systems Affordability in India: Perspectives of Stakeholders.

3. Pai, R. R., & Alathur, S. Sentiment Analysis for Mental Health on Twitter.

4. Pai, R. R., & Alathur, S. Bibliometric Analysis and Methodological Review of Mobile Health Services and Applications in India.

5. Pai, R. R., & Alathur, S. Mobile Health Intervention and Covid-19 Pandemic Outbreak: Insights from Indian Context.

**EXTRA - CURRICULAR ACTIVITIES**

Participated in various camps held under National Scouts and Guides.

Participated in Industrial visits and workshops held at MIT Manipal and NITK Surathkal.

Represented the Cricket and Volleyball team at college level.

**AWARDS AND RECOGNITIONS**

Awarded "Rajyapuraskara" in Scouts in the year 2003.

**PERSONAL PROFILE**

| | |
|---|---|
| Name: | : Rajesh R. Pai |
| Gender: | : Male |
| Date of Birth | : 28 November 1987 |
| Marital Status | : Married |
| Address | : 6-4-12, Harishchandra Marg, Beedinagudde, Udupi - 576101 |
| Nationality | : Indian |

**DECLARATION:**

I hereby declare that the above-mentioned information is correct up to my knowledge and I bear the responsibility for the correctness of the above-mentioned particulars.

**Date**: 29 May 2020

**Place**: Manipal **Rajesh R. Pai**