Mobile Phone Diffusion and

Rural Healthcare Access in

India and China

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by

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Abstract

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Three decades of mobile phone diffusion, thousands of mobile-phone-based health projects worldwide ("mHealth"), and tens of thousands of health applications in Apple's *iTunes* store, but fundamental questions about the effect of phone diffusion on people's healthcare behaviour remain unanswered. Empirical, theoretical, and methodological gaps in the study of mobile phones and health reinforce each other and lead to simplifying assumptions that mobile phones are a ubiquitous and neutral platform for interventions to improve health and healthcare. This contradicts what we know from the technology adoption literature.

This thesis explores the theoretical link between mobile phone diffusion and healthcare access; develops and tests a new multidimensional indicator of mobile phone adoption; and analyses the effects of phone use on people's healthcare-seeking behaviour. My mixed methods research design—implemented in rural Rajasthan (India) and Gansu (China)—involves qualitative research with 231 participants and primary survey data from 800 persons.

My research yields a qualitatively grounded framework that describes the accessibility and suitability of mobile phones in healthcare-seeking processes, the heterogeneous outcomes of phone use and non-use on healthcare access, and the uneven equity consequences in this process. Quantitative analysis based on the framework finds that mobile phone use in rural India and China increases access to healthcare, but it also invites more complex and delayed health behaviours and the over-use of scarce healthcare resources. Moreover, increasing phone-aided health action threatens to marginalise socio-economically disadvantaged groups further.

I present here the first quantitative evidence on how mobile phone adoption influences healthcare-seeking behaviour. This challenges the common view that mHealth interventions operate on a neutral platform and draws attention to potential targeting, user acceptance, and sustainability problems. The framework and tools developed in this thesis can support policy considerations for health systems to evaluate and address the healthcare implications of mobile phone diffusion.

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List of Abbreviations

AIC	Akaike Information Criterion
App	Smartphone application
ASHA	Accredited Social Health Activist
BIC	Bayesian Information Criterion
BMI	Body Mass Index
CA	Capability Approach
CHC	Community Health Centre
eHealth	Electronic Healthcare Delivery
GDP	Gross Domestic Product
GIS	Geographical Information System
GPS	Global Positioning System
GSMA	Groupe Speciale Mobile Association
HH	Household
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
ICT	Information and Communication Technology
ICTD	Information and Communication Technologies and Development
IHME	Institute for Health Metrics and Evaluation
IIHMR	Indian Institute of Health Management Research
IIPS	Indian Institute of Population Studies
ITU	International Telecommunication Union
LMICs	Low- and Middle-Income Countries
mHealth	Mobile-Phone-Based Health Service Delivery
NBS	National Bureau of Statistics
NGO	Non-Governmental Organisation
OBC	Other Backward Class
PHC	Primary Health Centre
RHS	Right-Hand Side
RQ	Research Question
SC	Scheduled Caste
SIM	Subscriber Identity Module
SMS	Short Messaging Service
ST	Scheduled Tribe
TV	Television
UNICEF	United Nations Children's Fund
WHO	World Health Organization

List of Currency Symbols

£	Pound Sterling (GBP)	₹	Indian Rupee (INR)
¥	Chinese Renminbi Yuan (RMB / CNY)	$	United States Dollar (USD)

List of Frequent Terms Related to Mobile Phone Adoption and Health-Related Uses

Adoption as: Ownership	Access to a mobile phone through ownership and personal use (i.e. no shared access, no involvement of third-party users). Synonymous to "taking up," this narrow notion of adoption conventionally implies that ownership equals use.
Adoption as: Access	Access to mobile phones that is not limited to personal ownership. Includes shared ownership and joint use, borrowed access, and market access through renting. Typically disregards indirect access through third-party users.
Adoption as: Decision to Make Full Use	Conventional definition of adoption following Rogers (2003:21), typically equating the notion of adoption with "use" or "full use" (rather than the decision itself). Independent of access, but typically disregarding indirect access through third-party users.
Adoption as: Appropriation	Originating from the term to "make one's own," the anthropological concept of technology appropriation refers to societal and individual-level processes of incorporating mobile phones into the organisation of everyday life. Conceptually excludes non-users of mobile phones.
Adoption as: Utilisation	Three-dimensional conceptualisation of adoption, involving direct and indirect access, the functional breadth (extent) and frequency of use (intensity). Any form of use may appear along any form of access, e.g. daily use of mobile Internet through borrowed phones or topping up phone credit through a third party. This is the conceptual basis for the mobile phone utilisation index developed in this thesis.
Diffusion	Defined as "the spreading of something more widely," mobile phone diffusion here is an aggregate-level description of mobile phone adoption among a group of people. Mobile phone diffusion is typically measured through indicators such as mobile phone subscription numbers or mobile phone ownership per 100 people.
Health Action / Healthcare Seeking	A sequential process of remedying an illness by oneself or third parties including family members, doctors, and other actors. The health action or healthcare-seeking process begins with detecting an illness or a physical discomfort and potentially involves a wide range of sequential (and occasionally parallel) healthcare activities.
Mobile-Phone-Aided Healthcare Seeking / Phone-Aided Health Action	The individual-level incorporation of mobile phones in the process of healthcare seeking. This may pertain to one or more stages of this process, and can involve one or more activities such as calling for help or making appointments. Such phone use may also be carried out by third parties. One person may exhibit different phone-aided healthcare-seeking processes, e.g. depending on the respective health condition.
Accessibility of Mobile Phones for Healthcare Seeking	The individual-level result of interactions between different forms of mobile phone utilisation on the one hand, and the severity of that person's health condition on the other hand.
Suitability of Mobile Phones for Healthcare Seeking	The individual-level result of interactions between health actor responsiveness, viability of alternative solutions, and complementarities for phone-aided healthcare seeking.

Source: Own elaboration; selected items defined through Polgar (1963), Rogers (2003), Stevenson and Oxford University Press (2011), and Wirth *et al.* (2008).

PART I

Introduction and Background

Chapter 1

Introduction[1]

Low- and middle-income countries (LMICs) have undergone a rapid mobile connectivity transition. During the past decade, up to 630 million new subscriptions per year were added in LMICs, and these countries now account for three in four mobile phone subscriptions worldwide. Public health actors have responded to this trend with approximately 1,100 projects to date that focus on using mobile phones to improve health systems and health service delivery (according to the mobile industry association Groupe Speciale Mobile Association, GSMA, 2015). Such projects are known as "mHealth," or mobile-phone-based health service delivery. LMICs dominate the mHealth landscape, representing eight of the top-ten countries (by project count). For instance, South Africa operates 81 projects, India currently has 59 projects, and Kenya has 50 ongoing mHealth projects (GSMA, 2015). But utilising mobile phones for health does not stop at targeted projects: Apple's *iTunes* smartphone application ("app") store alone contained 84,000 health-related "apps" in May 2015,[2] and the global health app market is estimated to soar from a volume of $2.4 billion in 2013 to $26 billion by 2017 (Apple Inc., 2015; research2guidance, 2014:7). For comparison, the worldwide programme expenditures of the Bill and Melinda Gates Foundation in 2014 amounted to $4.8 billion (Bill & Melinda Gates Foundation, 2015:14).

The excitement, enthusiasm, and activity surrounding mHealth reflect common narratives that mobile technology offers near-limitless public health "potential" and "tremendous

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[1] Parts of this thesis are currently under review for publication or have been presented as conference papers. A subset of these publications was written with Dr Proochista Ariana. Notes throughout the document identify these parts and explain the specific contributions of Dr Ariana.

[2] My estimate, based on indexed items in the categories "health & fitness" and "medical."

opportunities" that should not go unharnessed (Agarwal & Labrique, 2014:230; Philbrick, 2012:6; Qiang *et al.*, 2012:15; Rodin, 2010:6; WHO, 2011:1). Moreover, the emphasis on LMICs follows aspirations to deliver health services and information more efficiently, effectively, and equitably—especially for otherwise disadvantaged groups (Anglada-Martinez *et al.*, 2015:28; Kwan *et al.*, 2013:27; van Heerden *et al.*, 2012:394).

Despite the enthusiasm, fundamental questions about the healthcare implications of mobile phone use have remained unanswered. Public health research interests in mobile phones commonly surround the design, deployment, and enabling conditions for mHealth interventions; some studies examine the direct health implications of mobile phone use (e.g. radiation, texting and driving, sleep disruption); but virtually no research explores the implications of mobile phone diffusion for access to healthcare in low-, middle-, or high-income contexts. Neither has there been a coordinated effort to build a knowledge base on the healthcare implications of rapid mobile phone diffusion, nor do we have theories to explain any such relationships. Methodological difficulties of quantifying the qualitatively rich accounts of mobile phone adoption in order to measure its impact on healthcare access sustain this knowledge gap.

In the absence of theoretical guidance and empirical experience, mHealth researchers and practitioners assume that mobile phones access is "given" among the target populations, that mobile phones do not themselves influence healthcare behaviours, and that the nature of people's mobile phone use does not change over time or during mHealth implementation processes. Mobile phones are treated as a given, neutral, and static platform for service delivery. These simplifying assumptions are problematic in light of the broader technology diffusion scholarship, which stresses the social embeddedness of technology use and its wide range of social implications. If mobile phone diffusion does affect people's healthcare behaviour, then this would challenge common narratives about mHealth service delivery and its "potential" to address health problems in LMICs.

My thesis explores the relation between mobile phone diffusion and healthcare-seeking behaviour. I will demonstrate that the emerging and partly negative healthcare consequences of mobile phone diffusion are an important yet neglected development outcome that can undermine the role of mobile phones for health service delivery in rural areas of LMICs. Rather than being neutral towards health, mobile phone use encourages health system over-utilisation, and excluded non-users can face increasing barriers to healthcare access where mobile phones diffuse rapidly.

The objective of my research is to inform theory and practice at the intersection of mobile phones and health. This speaks especially to the public health and social sciences literature around technology adoption. Development studies research suits this purpose because it is interested in the well-being and equity consequences of development processes in LMICs, and it offers an interdisciplinary, mixed methods approach to understanding the role and impacts of mobile technology for the lives of the poor. Focusing on rural areas of India and China as two low- and middle-income contexts with fast rates of mobile phone diffusion but persistent healthcare challenges, I investigate the following three research questions:

1. How is mobile phone diffusion related to access to healthcare in rural India and China?
2. Can we construct a multidimensional measure of mobile phone utilisation that explains mobile-phone-aided healthcare behaviour better than binary indicators of adoption?
3. Does mobile phone use influence access to healthcare in rural India and China?

I investigate these questions through a mixed methods research design that combines a qualitative grounded theory approach using interviews and focus groups with statistical analysis of a representative household survey. Starting with the Capability Approach as preliminary

guiding framework for analysis, I will develop my own empirically grounded framework in order to link mobile phone diffusion to healthcare access in rural India and China. Regression models and descriptive statistical methods then help to analyse the following three hypotheses quantitatively:

H1   *An index that captures mobile phone utilisation as a three-dimensional concept is a better predictor of phone-aided health action than conventional, ownership-based measures of mobile phone adoption.*[3]

H2   *Direct and indirect health-related phone use during an illness episode on average improves access to healthcare.*

H3   *Phone-aided health action exacerbates socio-economic healthcare inequities.*

My research is the first study, to my knowledge, that examines comprehensively the effects of mobile phone diffusion on healthcare access. My mixed methods approach from a social sciences perspective thereby enables me to contribute to the intersection of mobile phones and health theoretically, methodologically, and empirically.

Driven by the need to understand better the social implications of engaging with mobile technology, I contribute to the theoretical understanding of this research area through a new and empirically grounded framework that describes the healthcare-seeking effects of mobile phone diffusion in LMICs. This framework goes beyond existing approaches as it links comprehensive anthropological and sociological notions of mobile phone adoption to outcomes in healthcare as a particular domain of human development. This does not only yield a new way to articulate the relationship between phone diffusion and health behaviour. Contrary to current

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[3] I use the terms "healthcare-seeking behaviour" and "health action" interchangeably.

thought in this field, the framework also draws attention to the potential competition among and between different phone-aided and conventional healthcare solutions, to the heterogeneous healthcare-seeking behaviours of different groups of mobile phone users and non-users, and the uneven equity outcomes in this process.

Methodologically, this research offers systematic ways of capturing mobile phone adoption and healthcare-seeking behaviour. I establish and test a new index measure of mobile phone adoption that more precisely predicts people's phone-aided health action when compared to common adoption indicators. This multidimensional measure also helps to discriminate between different degrees of adoption in contexts where mobile phones have diffused widely. In addition, I employ a new technique to quantify and analyse sequential health action processes, which enables refined and more detailed insights than conventional "one-off" measures of healthcare access. The survey instruments developed for this research—together with innovative survey sampling strategies using satellite maps and digital aides—may prove useful for future research on the development impact of mobile technology.

Empirically, this research produces unique qualitative and quantitative data to understand the emergence of mobile-phone-aided health behaviours and to assess their healthcare implications. The analysis in this thesis shows that people who use mobile phones during the course of an illness are more likely to access healthcare. However, I also find that the health-related phone use during people's illnesses contributes to more complex and delayed health behaviours. In addition, mobile phone use during illnesses is linked to incommensurate demand responses in light of people's symptoms—for instance, the over-use of scarce healthcare resources for mild conditions.[4] Based on primary survey data analysis, rapid mobile phone diffusion in my field sites appears to exacerbate inequities in healthcare access. Given that this is

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[4] I use the terms "commensurability" and "alignment" interchangeably.

the first study that tests the effects of phone use on healthcare-seeking behaviour, my findings contribute to the yet nascent empirical knowledge base at the interface of mobile phone diffusion and public health.

The thesis comprises three parts, which are sub-divided into eight chapters. Part I describes the background of this thesis. Following this introduction, Chapter 2 reviews the interdisciplinary technology and mobile phone diffusion literature together with the scholarship at the interface of mobile phones and public health in order to articulate and justify the research questions. As the public health literature focuses on mHealth interventions from a medical perspective, it tends to reduce mobile phones to a given and static platform that in itself does not affect the healthcare behaviours and outcomes targeted by mHealth. This is problematic because the broader technology diffusion literature highlights the social embeddedness of technology adoption processes and the probable effect of these processes on development outcomes including health. At the same time, research at the interface of health and mobile phones faces methodological challenges similar to the technology diffusion literature, where qualitative and quantitative divides between anthropological, sociological, and economic research continue to obstruct the operationalisation of technology adoption concepts for the measurement of development impacts.

A description of my mixed methods research approach is provided in Chapter 3. I combine qualitative and quantitative research methods to overcome the aforementioned methodological divides, thereby bridging the gap between studies of technology adoption and appropriation processes on the one hand, and studies of technology impacts on the other. Because my inquiry begins with a qualitative exploration of the link between mobile phone diffusion and healthcare behaviour, I formulate in this chapter a preliminary open-ended framework for exploratory research based on the Capability Approach, which helps to articulate the position of technology in the broader analysis of development outcomes. This framework was the starting

point for the qualitative data collection, resulting in 71:46 hours of recorded interview material from 231 respondents in Gansu (China) and Rajasthan (India). The qualitative analysis resulted in a more close-ended theoretical framework that relates mobile phone diffusion to healthcare access. A subsequent phase of primary survey data collection in Rajasthan and Gansu—using innovative methods to sample 800 respondents—provided the data basis for the quantitative analysis of healthcare impacts associated with mobile phone diffusion.

Part II of this thesis contains the qualitative analysis that informs Research Question 1 on the theoretical link between mobile phone diffusion and healthcare access. I present qualitative case study evidence in Chapter 4 to demonstrate how phone-aided healthcare-seeking behaviour materialises in rural Rajasthan and Gansu, and the conditions under which this would and would not be the case. This qualitative analysis directly informs my theoretical framework, but it also offers useful empirical insights. Among others, phone-aided health action emerges in both Rajasthan and Gansu despite their different health systems, yet phone-aided behaviour rarely involves sanctioned mHealth services such as hotlines or health information services. This provides first indication of potential competition between local healthcare solutions and dedicated mHealth services.

Chapter 5 comprises the theoretical framework that resulted from my qualitative analysis. Substantiating the qualitative claims and themes through the secondary phone diffusion and healthcare-seeking literature, this chapter focuses on explaining and linking the analytical categories of the framework. The framework describes how mobile phone diffusion enters healthcare-seeking processes, but variations in mobile phone accessibility and suitability during this process create patterns of systematic exclusion and non-use. Provided that mobile phone use in personal healthcare is advantageous, already marginalised groups of individuals may be left out of healthcare access improvements, and they may face gradually growing exclusion from the health system as health workers increasingly adapt to people's phone-aided

healthcare access. I use this framework to formulate hypotheses on the relationship between mobile phone use and healthcare access.

The third and last part of the thesis tests these hypotheses quantitatively in order to inform Research Questions 2 and 3. Hypothesis 1 suggests that a three-dimensional mobile phone utilisation index is a better measure of adoption than conventional binary ownership indicators, which I test in Chapter 6 by predicting the emergence of phone-aided health action. Following the quantitative operationalisation of "mobile phone utilisation" and "healthcare-seeking processes" and a quantitative description of the field sites using the representative survey data, I present the results of multilevel logistic regression analyses. The results demonstrate that the new index measure of adoption is a better predictor of phone-aided health action, which supports Hypothesis 1 and challenges the common access and ownership focus in medical mHealth narratives.

Chapter 7 tests two further hypotheses in order to inform Research Question 3, namely that mobile phone diffusion improves healthcare access (Hypothesis 2) and that this process exacerbates socio-economic healthcare inequities (Hypothesis 3). Testing these hypotheses requires specific statistics of healthcare access that go beyond conventional measures. Based on sequential healthcare-seeking process data, I measure healthcare access (a) as provider choices during the process, (b) as the delay and number of discrete healthcare activities elapsed until a particular kind of healthcare access, and (c) as patients' demand response given their self-described symptoms. Using single- and multilevel regression models to examine the effects on healthcare access, I find that people using phones have increased access to healthcare (with some substitution across different types of healthcare providers), but that the process of accessing care is more complex and delayed compared to non-users. Health-related phone use also encourages adverse demand responses that potentially exacerbate the already problematic healthcare supply situation in the field sites.

Descriptive statistical analysis of equity patterns further indicates that increasing health-related mobile phone use can reinforce patterns of social, economic, and spatial marginalisation, although health system over-utilisation also means that some patients may be worse off with phones than without. While Hypothesis 3 on increasing inequities is largely supported by the data, Hypothesis 2 on improved healthcare is mostly refuted. My discussion of these findings will lead me to conclude that mobile phones facilitate health behaviour, but that this behaviour need not always be medically desirable owing to heuristics in health decision-making, incomplete and costly information for attaining care, and fragmented and opaque health systems.

Chapter 8 concludes by articulating the policy, methodological, and theoretical implications of this research. The potentially adverse effects of mobile phone diffusion reported in my study should not lead to the conclusion that phone access ought to be regulated, but rather that health systems require supply-sided mechanisms to govern the adaptation to changing technological environments in order to uphold and promote equitable access to healthcare. Furthermore, local assessments of healthcare-seeking behaviours with and without mobile phones can help to judge critically the necessity for mHealth interventions. Conventional, non-mHealth solutions for healthcare access and behaviour change may be preferred in some circumstances.

Methodologically, this thesis develops a range of tools for use in other studies. These tools include a cost-effective method of satellite-aided survey sampling in dispersed rural areas of LMICs; an index measure that represents variations in mobile phone adoption more faithfully than conventional indicators; and a new technique to capture and analyse sequential healthcare-seeking processes, which enables more precise and refined judgements on behavioural healthcare outcomes.

Lastly, I discuss the theoretical implications for research in the fields of public health and "information and communication technologies and development" (or ICTD). While my study challenges notions like "mobile phones for development" and "digital divides," it also offers a structured way of thinking about variations in mobile technology adoption and the ensuing implications for healthcare behaviour and equity. I also propose that future research building on this study should consider (a) the healthcare effects of specific phone-aided behaviours such as home and advice calls, (b) dynamic healthcare equity implications resulting from the interplay between mobile phone diffusion and health system adaptation, and (c) the relationship between existing local healthcare solutions versus externally introduced mHealth solutions. The overall conclusion of this thesis is that the healthcare implications of mobile phone diffusion can be detrimental, which is problematic in light of the extensive yet under-researched use of phones as a platform for health interventions.

Chapter 2

Technology Diffusion and Development:

A Thematic Literature Review and the Case of Mobile Phones and Public Health

2.1   Introduction

This thesis is a case study of mobile phones and healthcare access, situated within the broader scholarship of the social development implications of technology diffusion. Through the literature review in this chapter, I will establish the three research questions that guide the analysis in this thesis:

1. How is mobile phone diffusion related to access to healthcare in rural India and China?

2. Can we construct a multidimensional measure of mobile phone utilisation that explains mobile-phone-aided healthcare behaviour better than binary indicators of adoption?

3. Does mobile phone use influence access to healthcare in rural India and China?

Section 2.2 reviews the main research themes in the interdisciplinary literature of technology and mobile phone diffusion, highlighting the disciplinary and methodological differences between the qualitative anthropological and sociological literature on the one hand, and the quantitative sociological and economic literature on the other hand. The qualitative approaches highlight the coevolution of technology and society in which technologies are shaped and redefined by their social context, and in which technological diffusion alters social values, structures, and behaviours. This dynamic relationship means that technology diffusion can

have a broad range of implications, but qualitative studies are not normally designed to provide insights about the scale of these impacts.

The subsequent review of the quantitative literature addresses problems in numerical assessments of technology adoption. A main measurement problem is that locally grounded and multi-dimensional adoption indicators are desirable (owing to the context-dependent nature of technology adoption), but researchers commonly rely on binary measures of ownership and use. Binary measures capture insufficiently people's engagement with a technology and the ensuing development implications (as well as their distribution). Nevertheless, quantitative research has been able to produce first insights into the development effects of technology diffusion. These findings inform a range of the qualitatively hypothesised development impacts, for example in terms of changing social interaction patterns and economic activity. But knowledge gaps remain in understanding social impact, unintended consequences, and the distributional implications of technology diffusion.

Section 2.3 shows that the field of mobile phones and public health in many ways reflects these difficulties. Dominated by the medical, computer, and engineering sciences, most research attention in this area is devoted to developing, deploying, and evaluating health interventions that use mobile phones as a platform ("mHealth"). Very little empirical research focuses on the ways in which mobile phone diffusion influences people's health-related behaviours. Prevailing theoretical approaches in this field do not consider the potential influences of mobile phones on health behaviour either. Interventions and theoretical models instead assume that mobile phones are neutral platforms that do not influence the outcomes that the specific mHealth interventions aim to achieve. This assumption is difficult to sustain if the aforementioned findings from the broader literature on technology diffusion can be relied on. Understanding the healthcare effects of mobile phones is therefore not only relevant for the study of the social implications of technology diffusion, but also for the theory and practice of mHealth.

My three research questions respond to these gaps, focusing on the theoretical link between phone diffusion and healthcare access (RQ1), on the methodological challenges in quantifying mobile phone adoption as a multidimensional concept (RQ2), and on the healthcare implications of mobile phone diffusion (RQ3). Development studies research is suited for this purpose because it offers an interdisciplinary and mixed methods approach to understanding the role and impacts of mobile technology for the lives of the poor. Interdisciplinarity is advantageous to complement the active research agenda on mHealth (driven by the medical, computer, and engineering sciences) with a social sciences perspective (involving social anthropology, sociology, and economics). A mixed method approach helps to bridge the gap between detecting locally emerging forms of mobile phone adoption and assessing the scale and distribution of their healthcare implications. Given the aspirations of many mHealth research projects to contribute to more equitable healthcare access especially for deprived areas of low- and middle-income countries, the case study to inform these questions will focus on rural regions of India and China as two contexts with rapid mobile phone diffusion yet persistent challenges in healthcare access.

Before I proceed with the review, a preliminary remark on the notion of technology adoption is necessary. In later parts of this thesis, I contrast the notion of mobile phone adoption as "ownership" with adoption as "utilisation" for analytical purposes. While the health literature often explicitly refers to mobile phone adoption in terms of "ownership" and "access," it is evident that very few researchers, if any, equate ownership of a mobile phone with its use. Rather, technology adoption is typically conceptualised as use: Rogers (2003)—with more than 67,000 citations the most influential publication that addresses technology and innovation

adoption (Google Inc., 2015b)—defines adoption as "a decision to make full use of an innovation as the best course of action available" (Rogers, 2003:21).[5] Although the conceptualisation of technology and its links to society and development differ across the disciplines (Williams & Edge, 1996:873), most of the authors in the following review adhere conceptually to the notion that adoption is "use" rather than "ownership" (e.g. Feder *et al.*, 1985:256; Foster & Rosenzweig, 2010:396; Torrance, 2012:869). However, my review of quantitative measurement issues will show that the empirical operationalisation of "adoption" often results in binary or one-dimensional indicators. One of the main arguments in later parts of the thesis is therefore not that ownership is somehow different from use (that much we know), but that it is possible to devise measures which more comprehensively capture the multiple facets of mobile phone utilisation. A more comprehensive measure of utilisation can help us to understand better the nature and implications of mobile phone diffusion.

2.2   A Review of (Mobile) Technology Diffusion Research

Because the case study of mobile phones and healthcare reflects some of the challenges of the study of the social implications of technology diffusion more generally, this section provides a review of the main themes in the technology diffusion literature from a development studies perspective. The thematic review includes qualitative literature from social anthropology and sociology (Section 2.2.1) and quantitative literature form sociology and economics (Section 2.2.2). A broad range of technological case studies alongside specific mobile phone studies will help to convey that, while information and communication technologies (ICTs)

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[5] The process of diffusion is one "in which an innovation [e.g. a new technology] is communicated through certain channels over time among the members of a social system" and could be assessed as "the aggregate level of use of a specific new technology within a given geographical area or a given population" (Rogers, 2003:5, 257).

such as mobile phones may be different,[6] they also share traits with more broadly conceptual-

ised technologies like roads.[7] Section 2.2.3 summarises the main themes relevant to the subse-

quent review of the health and mobile phone literature, namely the methodological tension

between qualitative and quantitative studies of technology diffusion, the challenges of opera-

tionalising mobile phone adoption in quantitative studies, and the wide spectrum of positive

and negative, intended and unintended, and social and economic impacts that emerge from

technology diffusion processes.

2.2.1   Qualitative Studies of Technology in Social Anthropology and Sociology

Qualitative research on technology and mobile phones in the areas of social anthropol-

ogy and sociology highlights the many facets of contextually conditioned mobile phone use.[8]

In addition, the review of the qualitative literature demonstrates that technology in general and

mobile phones in particular coevolve with and affect their surrounding socio-economic envi-

ronment. However, it is difficult to assess the scale and distribution of technology diffusion

impacts solely based on qualitative research.

2.2.1.1   Incorporating Technologies Into Daily Lives

A common theme in the qualitative literature is the "appropriation" of technology and

the ensuing complex forms of technological engagement. Appropriation research examines the

ways in which technologies become incorporated into people's lives and their material practice.

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[6] By referring to ICTs, I adhere to convention and mean digital, electronic information and communication tech-
nologies, rather than e.g. postal services.

[7] The presentation will focus on a wide range of "physical technologies" as objects and techniques, rather than on
"social technologies" as "ways of organising people" such as laws or hierarchies (Beinhocker, 2006:15). I will
consider these technologies in relation to their social contexts, following what is commonly referred to as the
social construction of technology (Williams & Edge, 1996:866).

[8] I consider sociological and anthropological studies of technology simultaneously as a dividing line would be
rather imprecise and both disciplines are often in conversation with each other (Eglash, 2006:333).

During this process, technology as a physical object acquires meaning and values from the culture in which they are located (Mackay & Gillespie, 1992:708). In a similar way to how different kinds of food carry different meanings, technical objects can be perceived differently across social contexts through the different values bestowed upon them (Pfaffenberger, 1992:496-497; Robbins, 1999:406-408).

Among others, appropriation research draws attention to the wide and partly unexpected range of technology uses that emerge from its incorporation into human lives. Authors report for instance of food bowls being re-defined as chimney caps to prevent rain from extinguishing stoves underneath (Gudeman, 1992:146), and identity cards being manipulated in shamanic rituals in Amazonian Ecuador in order to inflict bodily harm on other persons (Guzmán-Gallegos, 2009:215). Another example is the study by Schaniel (1988), who examined historical records of the Maori of New Zealand between 1770 and 1840. Schaniel (1988:494-495) reports that, initially only acquainted with tools made from natural materials such as stone or bone, the Maori began incorporating previously unfamiliar iron tools—handed over as gifts by Captain Cook and other explorers—into agricultural and non-agricultural production processes. This gradual process of adoption did not adhere to the originally intended application of the iron tools, however. For example, hoes were used for weeding (using a shorter handle with the Maori user customarily squatting rather than stooping), while soil continued to be dug with wooden sticks (Schaniel, 1988:495-496). The author argues that such cultural adaptation—or appropriation—can lead to unforeseen uses of technology, similar to Europeans transferring the use of Chinese gunpowder from fireworks to firearms (Schaniel, 1988:497).

But the appropriation of new technologies extends beyond their uses as "tools" as in the cases above. Cultural appropriation also means that an object acquires symbolic meaning. A commonly cited study in this context is Hebdige (2000/1988). The author examines the gendered symbolism of motor scooters, which first arose in Europe as "feminine" counterparts to

the "masculine" motor cycles (Hebdige, 2000/1988:131). Despite an initially cool reception in the UK, scooters gradually became an integral part of the fashion-conscious "mod"-subculture by the end of the 1950s (Hebdige, 2000/1988:155). The scooters' role in establishing a group identity led them to be reimagined as a symbol of affluence and aesthetics that distinguished "mods" from the motor cycle "rockers" (Hebdige, 2000/1988:156-157).[9] This case illustrates that a technological object such as a vehicle can carry significant and shifting symbolic meaning, thereby not only fulfilling a function as a tool (e.g. means of transportation) but also as a means for group cohesion and self-identification. Pfaffenberger (1992:511) interprets this process as one in which "the 'recipient' (appropriating) culture can reinterpret the transferred artifact [*sic*] as it sees fit."

Similar manifestations of appropriation processes can be observed among mobile phones and other ICTs. Many anthropologists adhere to the argument that, "the patterns of [mobile phone] usage are made up according to the social norms of the rural society" (Hahn & Kibora, 2008:102). Among the numerous examples of such localised uses of mobile phones are Horst and Miller (2006), whose ethnographic study took place in Jamaica. The authors explain how the phone becomes a token of religious identity among Jamaican Christians: "Phones can be secured on a string that says 'I ♥ Jesus' or marked by a Christian screen saver such as a cross or a Bible verse. They can also be Christianized through ringtones" (Horst & Miller, 2006:156). Similarly, Dodson *et al.* (2013) explain how mobile phone usage patterns emerge along existing social structures. The authors study female phone users in Morocco and state that, "taboos on mixed-gender communication extended across technological platforms to include phone-to-phone (voice) contact as well as text-to-text exchanges" (Dodson *et al.*, 2013:82). Other influences of local cultures on phone use are expressed, among others, in

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[9] The "rockers," however, persisted in emphasising the masculine/feminine divide between the drivers of the respective vehicles, thereby arguably reinforcing their own identity (Willis, 1978:19-21).

evolving rules of mobile phone etiquette (e.g. Medhi *et al.*, 2010:7, discuss the use of mobile phones during family meals in the Philippines). The emergence of the popular use of short messaging services (SMS) is itself the result of users' reinvention of a back-end service that was originally intended for technicians only (Fortunati, 2005:155-156). Such examples underline that local appropriation processes contribute to a broad spectrum of mobile phone uses, some of which are unforeseen.

At the same time, reinterpretation of technology has its limits and to some extent users have to navigate and negotiate original design specifications. On the one hand, this means that users can find strategies to operate phones despite apparent usability constraints. Fernández-Ardèvol (2014:126) for instance observed in urban Peru that avatar images in phone books facilitate the use among illiterate persons. Describing the lost phone of a 62-year-old woman, she states that, "Her old device was 'beautiful' with 'big buttons' and 'little cartoons' (icons) which were really useful for her to identify who to call, as she was illiterate." Likewise, illiterate users can make mobile phone calls by complementing the phone with paper phone books that are handled by third persons (Chipchase, 2006:16; Dey *et al.*, 2011:57; Ndiaye & Zouinar, 2014:275). On the other hand, user characteristics like illiteracy or old age can also limit the engagement with mobile phones, or even render them unusable altogether. Older persons often experience difficulties with complicated menus, inconveniently small display texts, and illegibly small and low-contrast text (Kurniawan, 2008:893-895; Ziefle & Bay, 2005:381-382). But where no intermediaries are present to set up and explain icons and pictograms, technical aides may be misunderstood or may even be culturally inappropriate (Chipchase, 2008:81-82). This interplay between coping strategy and constraint indicates that mobile phone adoption patterns are uneven across and within population sub-groups.

Furthermore, studies of mobile phone appropriation show that not just their usage but also access patterns are reconfigured in the process of diffusion. Bell (2005:70) argues that

shared mobile phone ownership within families in Asian countries such as Malaysia "clearly violate some Western expectations about privacy, but they map onto extant cultural patterns around sharing and notions of social solidarity beyond the individual." But access patterns extend beyond binary divisions of personal and shared use. Tenhunen (2008:519-520) for example reports that operators of "public" mobile phones in rural India do the dialling for illiterate callers, corresponding to a partial transfer of phone operation during market-based access.[10] Similar examples from high-income contexts such as Sweden, the UK, and the US demonstrate that such indirect access is not specific to LMICs (Fernández-Ardèvol, 2012:17-18; Reisdorf *et al.*, 2012:19). But indirect forms of mobile phone access have also been shown to create complications. The female participants in the study by Dodson *et al.* (2013:85) indicated problems if other phone users (especially the technologically more savvy ones; i.e. sons and husbands in this case) change settings and customise the device, thereby creating an unfamiliar use environment for others. In short, the social embeddedness of mobile technology shapes adoption patterns, but it can also create frictions in access.

The notion that "innovation [is continually modified and improved] throughout the diffusion process" captures broadly the main argument of this sub-section (Brown, 1981:174). The anthropological and sociological literature offers an abundance of evidence that the users of technology play an active part in its interpretation and application, up to a point that can be understood as "user innovation."[11] We can thus expect fundamental differences in mobile phone use across as well as within different social contexts.

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[10] Access through a third party is also referred to as "proxy use," where proxy users rely on help from "aides" who operates the devices on their behalf (Reisdorf, 2011:401). I consider this a form of indirect access in which the proxy user nonetheless "benefits" from the technology (also see Fernández-Ardèvol, 2014:123).

[11] On unexpected technological developments resulting from locally evolving innovation, see e.g. Bijker (1995:270), Cresswell (2002:182-185), and von Hippel (2010:414-415).

2.2.1.2   Coevolution of Technology and Society: Social Change and Development

One of the main arguments of the aforementioned study by Schaniel (1988:497) is that societies shape technology and not *vice versa*. However, many anthropologists and sociologists have made compelling arguments that the relationship between technology and society is co-evolving rather than unidirectional: The dynamic process of appropriation means that humans do not only continuously shape and reinterpret technology, but also that the use of technology shapes the social context.

On the local level, technological change can influence social behaviour directly. For example, the social embeddedness of technology means that seemingly simple technological interventions can upset a social setting significantly. The anthropological study of irrigation practices in Tunisian oasis communities by Bédoucha (2002) illustrates this. The local communities, supplied by a common spring, had initially chosen irrigation technologies that required them to manage jointly the water supply for the respective settlements. The irrigation technology therefore served as platform for social interaction that—for no lesser reason than survival—often helped to reconcile conflicts in light of pressing water management questions (Bédoucha, 2002:86). Under French colonial rule, the original system (a water clock) was replaced by a static divider system that made intensive, interpersonal management of water flows obsolete. It also had social repercussions. Bédoucha (2002) notes,

> The installation of a divider, which might seem a simple technical measure, was a fatal blow to el-'anâd as a functioning community; for, by removing the occasion for disputes over water, it also removed the only occasion that obliged the villages to get along, to sit down together in spite of everything. […] Because the [new] irrigation networks were independent, there was no longer the need for contact. The two groups turned their backs on each other. (Bédoucha, 2002:88)

On the one hand, the new water management technology deprived the communities of a common cause. On the other hand, it enforced new management techniques that Bédoucha (2002:104) describes as "petty accountancy," in which the micromanagement of water share allocations undermined social identity in the communities to an extent that an oasis dweller described as follows: "We are reduced to nothing [by dividing watering times by the drop], smashed to bits like our water" (Bédoucha, 2002:104). In this case, the imposition of a specific technology led to social change because social practices were linked directly to its operation.

Similar effects can be observed in seemingly "connecting" technological installations: roads. Pedersen and Bunkenborg (2012:558, 561) present an ethnographic case study of Chinese oil companies in Mongolia, characterised by a setting of mutual distrust and scepticism between Mongolian and Chinese groups. The infrastructural setup around Chinese oil exploration activities appeared to actively sustain—if not enhance—rather than reduce the distance and disconnect between the expat Chinese workers and the local Mongolian population (Pedersen & Bunkenborg, 2012:563-565). One example pertains to objections of Mongolian officials about the roads constructed by the oil company to transport its crude output from Mongolia to China for refining: The officials requested the company to redevelop the roads in order to expedite traffic flow in the sparsely populated area. The apparent rationale, so the authors, was that, "The better the roads along which the drivers were taking their loads, […] the less interaction took place between them and the Mongolians living in the area" (Pedersen & Bunkenborg, 2012:565). The roads therefore became an active instrument of managing social relationships by maintaining a desired degree of distance, or "technologies of distantiation" in the words of Pedersen and Bunkenborg (2012:563). The point here is not that technological change is necessarily detrimental to social interaction, but that its introduction can have immediate, traceable effects on a social system rather than merely its use being shaped by that system (Sillitoe, 1998:231).

The effect of technology onto society is not a one-off event following its introduction (or imposition). A broader process of coevolution between societies and technological systems is permanently at work. A compelling example is the proliferation of clocks, and the ensuing social change. Ling (2012:41-50) reviews the increasing penetration of clocks and timekeeping from the 1200s onwards, pointing out the gradual normalisation of public clock use in everyday life during the 15th century, their penetration into the home spheres with the advent of home clocks during the 18th century, and the common reliance on personal timekeeping through mass-produced watches in the 20th century. Throughout this process, increasingly many personal and social activities become coordinated "by the clock," ranging from prayers in the early years via trade and military battles to interpersonal interaction and workplace organisation. Eventually, Ling (2012:57) observes, "Clock time has become the central method for the co-ordination of society" in such a way that most societies now have a mutually agreed expectation that timekeeping is understood and adhered to by socially active members (Postill, 2002:251-252). The technology therefore begins to shape social behaviour. Daily rush hours—part of many people's everyday practice and experience—would not exist in the absence of precise and synchronised clocks as pacemakers of individual and societal processes (Munn, 1992:111-112). But the sociological and anthropological analysis of clocks is not only instructive for its illustration of socio-technological coevolution. It also highlights that technologies interact with power relationships in societies and may themselves become instruments of domination and tyranny, for example through social norms of punctuality and the orderly (or abusive) control of production processes (Munn, 1992:109; Thompson, 1967:81-86).

These three examples of water management, roads, and clocks share the emphasis on interactions between technology and society beyond appropriation and local forms of use. In line with this broad range of anthropological and sociological case studies, the qualitative literature has also shed light on the inter-relationship and coevolution of mobile phones and social

behaviour. Indeed, Ling (2012:178-179) likens the social role of mobile phones to that of clocks, arguing for instance that ignoring one's mobile phone in contemporary Western societies is as burdensome for others as ignoring clock time. And like the clock, the phone does not only become part of human routines but increasingly shapes them, for example with daily charging routines and late-night email checks (Lemola *et al.*, 2015:412). Moreover, in other work, Ling (2008b) exemplifies the effects of mobile phone use on social interaction through their role in mediating ritual practices like greetings and small talk. Such mediation, he argues, is central to the reproduction of social relationships and social cohesion (Ling, 2008b:159). However, as in the previous example of distancing roads, mobile phones, too, can become distancing technologies. Ling (2008b) addresses this point with the following observation:

> A woman walked along the platform at an Oslo subway station, texting as she walked. She walked with a slow, slightly stiff-legged gait, with her concentration clearly on her mobile phone. Occasionally she would glance up in order to navigate around people standing on the platform. […] The woman's posture and carriage were clearly closed to other potential involvements. She had adopted body language that showed her engrossment in the composition of the text message. This shielded her from the limited involvements available at a subway station. (Ling, 2008b:106)

Ling's (2008) example illustrates that phones can help the user to avoid her or his immediate social environment. At the same time, phone use can foster more intimate yet remote contacts. Claims that mobile phone use strengthens intimate and family relationships can be seen, for example, in their central role for maintaining otherwise challenging "transnational" family relationships of Jamaican phone users (Horst, 2006:147-148).

Qualitative evidence shows that mobile phones do not only alter but also redefine social relationships. Miller (2010) illustrates this through romantic relationships of Filipinos that become increasingly defined by the practice of text messaging between partners:

> In the Philippines, a relationship is not really a relationship without between 20 and 120 texts a day; this isn't an inherent capacity, but then it's not really a Filipino tradition either. It's something new. Texting has transformed what it means to be Filipino, because it has become pretty much the dominant practice of waking hours and redefined what relationships are. (Miller, 2010:112-113)

In other words, the standards and definition of a romantic relationship changed with the increasing use of mobile phones. Yet, not just the definition of the relationship between men and women may be affected by mobile phones, also the understanding and performance of their respective roles. Based on research in India, Jeffrey and Doron (2013:179) and Donner *et al.* (2008:334) for example argue that mobile phone use can influence courtship practices and women's autonomy, which can undermine (or at least threaten) established gender roles and change processes of identity building and role formation. Such processes can create a space for negotiation, but also potentially for conflict and violence (Jeffrey & Doron, 2013:167).

As these examples illustrate, technology and mobile phone use is not only socially conditioned, but it also conditions social relationships and identities. Social change is therefore likely to ensue where mobile phones diffuse widely and rapidly. The following section reviews the qualitative literature on the social and economic development implications of technology and mobile phone diffusion.

2.2.1.3   Development Implications

Given the dialectic relationship between technology and society, it seems improbable that technology diffusion invariably leads to desired development outcomes like improved economic security, education, or political participation (consider e.g. the human development index by the United Nations Development Programme, consisting of income, education, and longevity; UNDP, 2014:160-163). The qualitative literature helps to explore the broad spectrum of outcomes. Further important themes that emerge in the mobile phone literature are (a)

the limited positive impact from an international development perspective, (b) the breadth of unintended consequences, and (c) their emergence along social and demographic strata.

Development-related outcomes often ensue where technical change interacts with social change. A simple example is Klaeger (2012), who describes how hawking arises alongside a country road in Ghana. Despite the occupational hazards, the road and its passing travellers create a space for commercial activities on which the vendors subsist, free from the intervention of municipal authorities and along which new work practices arise in sync with the flows of the passing traffic (Klaeger, 2012:543, 545-547). Likewise, clock time has enabled an unprecedented degree of coordination that makes it possible to run operations such as hospitals, train lines, or national production networks (Ling, 2012:38).

However desirable it may be, there is no guarantee that technological change processes are advantageous from a development perspective (Pfaffenberger, 1992:511-512). For example, Gudeman (1992:145) illustrates how continuing innovation and technical change helps Guatemalan households to generate savings and—potentially—profits in the local markets. However, this does not leave the households better off during market transactions. Because established merchants participate in the market for profit making whereas the local households and artisan producers participate "to survive," the balance of economic power is inclined towards the former at the expense of the latter. Whereas merchants benefit from extracting rents (i.e. make profits), local households maintain their minimal standard of living despite their technical advancement.

While Gudeman (1992) provides an example of absent economic benefits in a low-income context, Murdock *et al.* (1994) highlight the case of unfulfilled educational impacts of technological change in high-income Britain in the 1980s. Their longitudinal qualitative study coincided with a 1981 government scheme that explicitly encouraged household adoption of micro-computers for educational and personal development purposes, especially in view of

children's computer use (Murdock *et al.*, 1994:142). Though many computers were procured under this rationale, Murdock *et al.* (1994:148) describe the potential competition between educational and entertainment uses as "an unequal struggle" that resolved more often than not in appropriating the computer for games rather than learning. The authors conclude that only a minority of computer users would use the technology in a way that is conducive to personal development. This minority comprises "professional and managerial strata," thereby potentially reproducing and enhancing their social status and influence, whereas the entertainment use of computers is concentrated among less advantaged social groups (Murdock *et al.*, 1994:148).[12]

Narratives of managed technical change through development initiatives often have an equally discouraging tone (Ferguson, 1994; Mosse, 2004). For example, Sillitoe (1998:233) documents the case of technical interventions in Bangladesh to tackle flooding and soil erosion. The interventions improved existing and led to the emergence of new economic activities. However, socio-economically better-off landowners were able to benefit more strongly from these developments owing to resource control and political power in the highly stratified society. Not only exacerbating inequities and marginalisation, this process also increased social conflict.

Reports of desired development outcomes alongside unintended consequences and problematic patterns of equity and marginalisation are echoed in the qualitative mobile phone literature. For example, a number of authors link mobile phones to economic development. Among them is Donner (2009:94-95), who argues that micro-coordination through mobile phones increases productivity and economic activity at the individual level, and that the mere

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[12] Similar patterns have been observed with mobile phone adoption (Rangaswamy & Cutrell, 2012:57).

"reachability" enabled through mobile phones may already have a positive influence on people's choices and economic behaviour. Other common claims are that mobile phones enhance people's sense of security and safety, while also providing better access to services (e.g. de Silva & Zainudeen, 2007:11; Gagliardone, 2015:10; Ling, 2012:115-118). Fieldwork by Burrell (2010:242-243) in Uganda showed that mobile phone diffusion enables better service access, even for people who do not own a phone.

But intended positive socio-economic implications of mobile phone diffusion are not a general rule. Recalling in-depth ethnographic fieldwork in Jamaica, Miller (2010) concludes,

> In general there was surprisingly little evidence for entrepreneurial use [of mobile phones]. Similarly in relation to obtaining employment. The general consensus was that the vast majority of jobs were accessed through social connections and patronage, and not through simply matching opportunity to qualifications. So if we had remained focused on income generation, then we would have concluded that the impact of mobile phones was disappointingly slight. (Miller, 2010:128)

Miller (2010) is not the only author who observes the low incidence or absence of expected development effects. Molony (2008:340) examined mobile phone uses in the Tanzanian context, stressing that, "Although there are times when individuals use ICT in ways that aid personal or collective development, […] mobile phones are more commonly put to a nondevelopmental [*sic*] use." Driven by conspicuous ownership rather than functional use, he argues,

> The mobile phone is an embodiment of the experience with modernity, so much so that some people will walk with a dysfunctional handset on display in an attempt to participate, if only by simulation, in the increasing practice of digital consumption. (Molony, 2008:343)

Symbolic uses of mobile phones as in this specific case are unlikely to contribute human development on a larger scale.

But absence of financial benefit need not mean absence of broader socio-economic impact. As indicated in the previous section, it is widely established in the literature that social relationships are affected by mobile phones. Horst (2006:149) indicate that affordable transnational communication enabled and facilitated by mobile phones is a platform for Jamaican family members to exchange information. Being communication technologies, this may be expected. But these social networks can also become an important safety net when crisis strikes. Indeed, Miller (2010:128-129) qualifies the previous statement to some extent by drawing attention to the important role of mobile phone communication in maintaining extensive social networks and approaching them for help. As Horst and Miller (2006:165) put it: "The cell phone is not central to making money, but it is vital to getting money."

Effects on social relationships and roles can be disruptive, positively as well as negatively. Horst (2006:154-155) stresses that increased interaction and reduced distances between interlocutors in transnational relationships can increase mutual dependence and reinforce power relations, evidenced for example by surveillance and micromanagement of the daily lives of others in family and romantic relationships. Phone-based surveillance and micromanagement through employers has also been documented for Chinese migrant workers (Wallis, 2011:480-481). Similarly, Jeffrey and Doron (2013:166) observe that, "The effects of [the mobile phone's arrival] arrival among poorer people in India have been to shake and challenge institutions of authority and both to reinforce and undermine gender roles." It may therefore be that mobile phones, though potentially liberating devices, also enable powerful parties to tighten control over others.

Such ambiguous outcomes also emerge with respect to political participation. Although information and communication technology is thought to break up existing power structures

and foster public discourses (e.g. Kreutz, 2010), this need not always be the case. The detailed case study of local radio stations in Nairobi slums in Kenya by Gagliardone (2015:2) sheds light on the nuanced outcomes where people increasingly use mobile phones for public participation. This participation is heavily geared towards a small group of recurrent callers who exhibited greater "competence" in speaking on public radio (Gagliardone, 2015:9). In addition, the state's response to the public participation was rather mixed and shaped by the ethnic composition in the respective communities (Gagliardone, 2015:11). The resulting patterns of "competence"-based public participation and ethnically conditioned state reactions point at deep-rooted sources of inequality that have the potential to reproduce rather than reduce patterns of marginalisation and disempowerment.

Overall, the qualitative sociological and anthropological literature draws attention to the potentially problematic equity implications and the unforeseen positive and negative development outcomes of technology diffusion processes. Because the interaction between the social and technological context shapes these outcomes, Venkatesh (1996:53)—a student of information technology diffusion in the US—cautions researchers to "[not] assume that what the technology can do in the household is the same as what the household wants to do with the technology." In other words, the actual forms of mobile phone use in different (e.g. developing) contexts are likely to deviate from their intended or *a priori* assumed use.

None of this may be very surprising, but the nature of qualitative analyses and the focus of the literature above make it difficult to derive conclusions about the prevalence and significance of these outcomes on a societal level. The following section reviews the quantitative economic and sociological literature that has endeavoured to do so.

2.2.2   Quantitative Studies of Technology in Economics and Sociology

Continuing the review of the empirical literature on technology diffusion and develop-ment, I now move to quantitative studies in the fields of sociology and economics. As the previous sub-sections illustrated the breadth of technology uses arising from socially condi-tioned appropriation processes, I will first examine the ways in which researchers capture tech-nology adoption and diffusion quantitatively. We will see from this description that most quan-titative indicators are unfit to represent the breadth of mobile phone uses outlined above. I then go on to review quantitative findings of the development impacts of technology and mobile phones. Despite the limited measures, a range of social and economic impacts of mobile phone diffusion become apparent, but gaps remain in our understanding of the spectrum of intended and unintended effects and their distribution across population groups and sub-groups.

2.2.2.1   Measurement Issues of Technology Adoption and Diffusion

Given the somewhat unpredictable process of technology appropriation in different so-cial contexts, it would appear intuitive that quantitative analyses of the social and economic impact of technology incorporate a variety of uses. In the following, I review five varieties of adoption measurement, namely individual- or household-level ownership indicators, measures of revealed technology usage, user-generated data, aggregate penetration and coverage indica-tors, and indices of technology use, all of which are summarised in Table 2.1. As I discuss the challenges associated with each of these approaches, the review will highlight that most indi-cators are unable to capture the breadth of adoption behaviours and instead rely on binary or one-dimensional measures.

Table 2.1. Types and Examples of Mobile Phone Adoption Indicators

Types of Indicators	Example Indicators	Sources
Ownership Indicators	Personal ownership	Kavetsos and Koutroumpis (2011); Lee and Bellemare (2013:628); Rice and Pearce (2015)
	Household ownership	Graham and Nikolova (2013); Lee and Bellemare (2013); Martin and Abbott (2011)
Revealed Use	"Owners" and "non-owners who share"	Wesolowski *et al.* (2012)
	Any calls made in last three months	de Silva *et al.* (2011)
	Any personal engagement with technology	Reisdorf (2011)
	Phone use (as channel of communication)	Palackal *et al.* (2011); Zanello *et al.* (2014)
	Usage scales (e.g. call minutes per day)	Davis *et al.* (1989); Kaba *et al.* (2009); Kwon and Chidambaram (2000)
User-Generated Data	Phone logs	Donner (2007)
	Social media activity logs	Aral *et al.* (2009); Aral and Walker (2012)
	Network operator records	Andris and Bettencourt (2014); Blumenstock and Eagle (2010); Boase and Ling (2013); Mehrotra *et al.* (2012); Miritello *et al.* (2013); Saramäki *et al.* (2014); Wesolowski *et al.* (2013)
Aggregate Penetration Data	Teledensity	Bailard (2009); Chavula (2012); Stump *et al.* (2008)
	Start of mobile network roll-out	Aker (2010); Aker and Fafchamps (2014); Bailard (2009); Jensen (2007); Muto and Yamano (2009)
Composite Indices	National-level adoption index	Bruno *et al.* (2010); Farhadi *et al.* (2012); Katz *et al.* (2014)
	Index of Internet uses	Blank and Groselj (2014)
	Mobile phone appropriation index	Lee *et al.* (2012); Wirth *et al.* (2008)
	Mobile phone personalisation index	Tossell et al. (2012)

Source: Own elaboration.

Ownership Indicators

The most basic form of adoption measurement consists of binary indicators of technology ownership. Synonymous treatment of ownership and use is not only a semantic convenience, but it features widely in research that assesses the socio-economic impact of technology (Duncombe, 2011:274; Martin & Abbott, 2011:21; May & Diga, 2015:91; Zanello, 2012:712). An example using primary survey data from LMICs is the agricultural market price study of Lee and Bellemare (2013:628), who measure adoption through a series of binary indicators of mobile phone ownership for the household, the farmer, and his or her spouse and children. In

a recent study on equity trends of mobile phone adoption in Armenia, Rice and Pearce (2015:10) rely solely on personal ownership indicators from secondary data sets. On the cross-country level, international happiness studies such as Graham and Nikolova (2013) and Kavetsos and Koutroumpis (2011) use secondary household survey data in order to test the determinants of self-described well-being. Kavetsos and Koutroumpis (2011:744) focus on "private" mobile phones for their analysis, whereas Graham and Nikolova (2013:136) rely on household mobile phone ownership (complemented with specific mobile-phone-based financial transaction use).

Binary ownership indicators are attractive for their simplicity but assume that an owned technology is also a technology in use and, conversely, that a technology not owned is also not being used. A possible motivation for these indicators is the relative ease of communicating as well as capturing them (especially in secondary data sets; Duncombe, 2011:275). Their use also appears to be linked to early yet persistent notions of the "digital divide," according to which inclusion and exclusion from ICT use were stratified along the "haves" and "have nots" (Barzilai-Nahon, 2006:270; Dewan & Frederick, 2005:299-300; Qureshi, 2014:215; Stump *et al.*, 2008).[13] In light of earlier arguments, reducing the concept of mobile phone adoption to the ownership of the device on either the personal or the household level is insufficient to understand the mechanisms that underlie potential socio-economic impacts (Duncombe, 2011:274-275; Zanello, 2012:710). While perhaps obvious, this is worth highlighting because ownership remains a common adoption indicator in quantitative analyses and we will see in later parts of this chapter that "(personal) access" is a widespread notion in the public health literature on mobile phone diffusion in LMICs.

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[13] The concept would develop later into actual engagement with ICTs together with the skills required for their operation (Barzilai-Nahon, 2006:274-275; van Dijk, 2006). Schroeder (2015:2828-2830) goes yet further and analyses digital divides between elites and the broader population in terms of technology-aided media content creation and consumption.

Revealed Use

Rather than assuming that use follows from ownership, it is often possible to capture actual use directly. This has a long tradition in the technology adoption and diffusion literature. The landmark study by Griliches (1957) involved the adoption of hybrid corn varieties in agriculture. "Acceptance" rates of the technology were measured in terms of area planted with the product. Other research on agricultural technology adoption relies on these indicators as well (Bandiera & Rasul, 2006:872-873; Conley & Udry, 2010:44). Similarly influential studies involved the diffusion of new antibiotics among doctors in Illinois by Coleman *et al.* (1957:254) and van den Bulte and Lilien (2001:1415). Pharmaceutical adoption in these studies is based on prescription records, thereby again inferring adoption from revealed use (the same strategy is pursued by Iyengar *et al.*, 2011:201).

In the area of mobile phone adoption, revealed use pertains to people's reported use over a certain period, typically based on self-reported data. These data often lead to binary user/non-user or adopter/non-adopter classifications (Karnowski *et al.*, 2011:2-4). For instance, Wesolowski *et al.* (2012:2) examine the patterns of mobile phone adoption with the help of secondary data from financial inclusion surveys in Kenya. Their identification of "users" includes people who "own" a mobile phone, and "non-owners who share a phone." Likewise, de Silva *et al.* (2011:3) measure mobile phone adoption based on whether any calls were made and received in the last three months, regardless of whether the phone was owned. Reisdorf (2011:401) examines the characteristics of Internet non-users in the UK and Sweden, who are not only defined by not having internet access. Non-users, according to her definition, can be people choosing not to use the Internet, people who discontinued Internet use, and individuals who use the Internet indirectly via third parties. Other studies have measured mobile phone use as one channel of communication alongside others such as face-to-face contact (Palackal *et al.*, 2011:397; Zanello *et al.*, 2014: Table A2).

Not all these indicators are binary. Especially in analyses using technology acceptance and other models to predict adoption, researchers apply a wider range of measures (Davis *et al.*, 1989:991; Kaba *et al.*, 2009; Kwon & Chidambaram, 2000). For example, Kaba *et al.* (2009:278) study mobile phone use in Guinea using self-completion questionnaires. The authors measure usage through the frequency of incoming and outgoing calls (starting from "0-5" calls per day) and the average time spent calling per day (starting with "less than five minutes" per day). Kwon and Chidambaram (2000:10) further include work-related and personal uses as indicators of mobile phone use.

Revealed use as an indicator of adoption is common and helps to resolve the potential incongruence between ownership and actual technological engagement. Appealing though they may be, usage measures for mobile phone adoption face difficulties in following the footsteps of other physical technologies like grain varieties and pharmaceuticals. Hybrid corn variations and medicines arguably have only few dimensions along which they can be deployed. A sack of hybrid corn seed can be a paperweight during storms and a capsule can serve as earplug if necessary. But neither is this probable, nor is it clear how such uses would affect our understanding of their socio-economic impacts (Mackay & Gillespie, 1992:702). In addition, it is possible to incorporate measures of "correct" use in order to account for variations in technology usage (Dupas, 2010:17; Oster & Thornton, 2012:1264).

The situation becomes more complicated where mobile phones and other multi-purpose technologies are concerned. As will be discussed in later parts of this section, Blank and Groselj (2014) capture 48 different activities of Internet use alone. Mobile phone appropriation patterns potentially include yet more and context-specific forms of engagement, for instance using a "calculator to know [the proper product] price before selling to the market" (Martin & Abbott, 2011:27). It is yet unresolved such how potentially complex patterns of appropriation map onto single usage measures such as "any call in the last three months" or "any shared use" (de Silva

et al., 2011:3; Wesolowski *et al.*, 2012:2). It is also possible that one-dimensional indicators bias the analysis towards intended applications of the mobile phone while potentially disregarding broader unintended and emerging uses of the technology. In addition, none of the aforementioned studies accounts for third-party use as an indirect route of technological impact. The only quantitative study that addresses third-party access refers to it as "non-use" (Reisdorf, 2011:401).

User-Generated Data

Revealed use can also be captured through data stored in the device or maintained by network operators and mobile service providers. Besides checking people's phone logs manually to understand their phone use (Donner, 2007:9), studies of mobile-phone-mediated societal behaviour that use transactional phone data from service providers are becoming increasingly common (also referred to as "big data;" Boullé *et al.*, 2014:231; Taylor & Schroeder, 2015). For instance, recent work by Aral *et al.* (2009) and Aral and Walker (2012) on peer influences in social networks using data from instant messengers and the *Facebook* social networking site has highlighted the importance of distinguishing between ownership and use of "apps" in quantitative sociological analyses. In the domain of mobile phones, examples include Andris and Bettencourt (2014), Blumenstock and Eagle (2010), Mehrotra *et al.* (2012), Saramäki *et al.* (2014), and Wesolowski *et al.* (2013). These studies typically rely on transactional mobile phone data that are stored by mobile network operators.

For example, Miritello *et al.* (2013:91) analysed nine billion voice call connections of 20 million mobile phone users in a European country to examine how people allocate their talk time across their social networks. Going beyond transactional data alone, Saramäki *et al.* (2014:942-943) used conventional questionnaires for a sample of 24 school-leaving students

who received a mobile phone for the survey. The survey data collected information about the students and their contacts, to which mobile phone call records were matched in order to study communication patterns over a period of 18 months. Blumenstock and Eagle (2010:2-3) used network operator data to draw a sample for a telephone survey based on whether a mobile phone user had made a call in the preceding three months. Obtained for 901 respondents, these data were matched subsequently with the transactional phone records, including variables like the activation date of the SIM card, maximum top-up values, and the numbers of incoming and outgoing calls.

Regarding the quality of user-generated data versus recalled responses in survey questionnaires, Boase and Ling (2013:514-515) and Blumenstock and Eagle (2010:8) highlight mismatches between the two measures. The conclusion that such "results show that self-report measures […] generally do not compare favorably [*sic*] to [transactional] log measures" subsequently appears to imply higher accuracy of user-generated data (Boase & Ling, 2013:515). This need not be the case. If previously cited studies of third-party and shared use are credible, then the data captured by the operation of a single SIM card would not map exactly onto the behaviour of one phone owner, or user, or beneficiary. In addition, user engagement with a technology extends beyond what network operators capture, for example different channels of communication via messengers such as *Skype*, in-built applications including calendars or calculators, or symbolic phone uses. Not all of these uses and channels will be relevant to understand development outcomes, but if not supplemented through qualitative research or survey data, it is difficult to disentangle, interpret, and prioritise the various uses, channels, and access patterns in user-generated data.

Aggregate Penetration Data

Some adoption-and-diffusion studies circumvent the problem of indirect access in ownership and usage indicators through regional aggregation. The most common measure in this regard is teledensity, or the number of mobile phone subscriptions per 100 inhabitants of a country or region. Such is done for instance in the cross-country regressions of Chavula (2012:15) and Bailard (2009:340) to assess the effect of mobile phone diffusion on economic growth and corruption, respectively.

On more local levels, a frequently used indicator is mobile network coverage. The most prominent example of this kind is Jensen (2007), who carried out a study of the market price effects of mobile phone diffusion in the fishing sector in three districts of Kerala, India. Using weekly market price surveys, Jensen (2007:891) juxtaposes price fluctuations against the dates at which mobile services became available in the three districts. Other studies have pursued similar approaches, linking network coverage to micro surveys in order to test the effects of mobile phone diffusion on corruption, commodity pricing, and market participation (Aker, 2010:49-50; Aker & Fafchamps, 2014:272; Bailard, 2009:342; Muto & Yamano, 2009:1889). The logic is compelling: Where no services are available, they cannot be used, and hence changes following service introduction are attributable to mobile phone adoption.

Since these indicators aggregate data on a regional level, they help to circumvent problems of indirect mobile phone use and individual-level behaviour, for example with regard to receiving market price updates. However, the problem is not solved by avoiding it: Through aggregating, it is not possible to understand how different kinds of uses contribute to the observed outcomes (e.g. Graham *et al.*, 2014:759). In addition, as in the previous case, depending on the nature of the analysis, symbolic uses or in-built phone functions such as alarm clocks and cameras may be responsible for some of the observed effects before a signal tower goes online. These may be marginal cases and will be rejected more often than not, but they may

shape the distribution and interpretation of the outcomes. In the absence of complementary micro-level data on mobile phone appropriation patterns, such considerations will be difficult.

Composite Indices

In order to account for the multidimensionality of technology adoption, a growing number of researchers has begun to construct composite indices of technology use. For instance, the recent publication by Blank and Groselj (2014) attempts a systematic assessment of Internet use in the UK using, among others, a quantitative measure of the "amount" of use that is based on an ordinal intensity scale for 48 different Internet-based activities. Among the few examples relating to mobile phones is Tossell *et al.* (2012), who develop a quantitative measure of mobile phone personalisation, and Wirth *et al.* (2008) and Lee *et al.* (2012), who conceptualize and test a quantitative scale to capture the anthropological concept of adoption-as-appropriation in the context of mobile phone use in high-income settings. To construct their index, Lee *et al.* (2012) use 85 indicators, based on survey questions like "How often do you watch videos on your cellphone [*sic*]?," "How often do you change your cellphone's ring tone?," or "How many voice calls per day do you have on your cellphone?" (Lee *et al.*, 2012:32-34). Moreover, a number of indices have been developed to study the diffusion of digital technologies on the cross-country level (Bruno *et al.*, 2010; Farhadi *et al.*, 2012:4; Katz *et al.*, 2014:34). For example, Katz *et al.* (2014:34) devised a composite "digitation index" that comprises 24 individual indicators including mobile phone penetration, SMS usage per subscriber, and Internet retail volume as a share of total retail sales.

All the micro-level examples of adoption indices are restricted to high-income contexts. In addition, although these indices are an advancement from the reductionist measures above, simplification and dimension reduction are important tasks when quantitatively measuring the

impact of technology. It would not be sensible to capture all conceivable forms of mobile phone use for this purpose ("How often in the last month have you used your phone as a torch / hammer / pendant?"). But in light of the qualitative evidence, it appears advisable to gain an understanding of local appropriation patterns before the quantitative measure is devised, or else it would impose stringent assumptions on people's behaviours that potentially result in misleading conclusions.

This review of adoption and diffusion indicators highlighted the challenges involved in the quantitative measurement of complex and context-specific mobile phone adoption processes. To some extent, this reflects challenges of technology adoption more generally, but mobile phone use is complicated by the versatility of the technical artefact compared to hybrid corn or pharmaceuticals.

No quantitative adoption indicator can be perfect, but some may be more suitable than others to understand the socio-economic implications of mobile phone diffusion. Indicators that rely on ownership or one-dimensional conceptions of revealed use may work for technologies with a very limited range of applications, but they probably misrepresent the intricate and partly unpredictable adoption patterns of mobile phones. User-generated data of phone use can enable a more extensive view on technologically mediated social behaviour, but it, too, suffers from a radical reduction of usage dimensions and potential discrepancies between the users, owners, and beneficiaries of mobile phones. Aggregated usage and coverage data may be better suited to assess exhaustively the implications of phone diffusion on specific social and economic facets in a given region, but it is in itself unable to uncover heterogeneous forms of use and associated equity patterns within the region. Multidimensional adoption indices can help to rectify these issues, but the adequacy of such indices is defined by the specific context rather

than by standardised instruments. It appears reasonable to develop such indices locally in order to strike a balance between reductionism and unworkable complexity.

In all these instances, it appears advisable to ground the indicators in the local context through complementary qualitative and survey research (e.g. Porter *et al.*, 2012). In addition, while non-user behaviour is acknowledged by some sociologists (Katz, 2008:10-11; Reisdorf *et al.*, 2012:15-16), none of the measures discussed here appreciates impacts through indirect use by third parties, which is arguably an important dimension for technologies such as mobile phones that are typically associated with access challenges, a wide range of uses, and sharing arrangements (Burrell, 2010; Chipchase, 2006; Steenson & Donner, 2009). Overall, there remains tension between qualitative and quantitative approaches aiming to capture technology adoption and diffusion. The extent to which the indicators of technology adoption and utilisation map onto each other remains little explored.

2.2.2.2   Empirical Findings From the Quantitative Literature

Despite the challenging measurement, it is possible to discern impacts of ICTs and mobile phones on social and economic development outcomes. Owing to the broad range of quantitative evidence of social, economic, and political impacts emerging from the review below, we can conjecture that healthcare is probably no exception (Section 2.3 discusses this further).[14]

Among others, mobile phone diffusion has been linked to value changes on the micro level.[15] In a study among a sample of 335 female self-employed mobile phone owners in the

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[14] In recent years, a range of reviews has emerged that examines the empirical literature of mobile phone impacts from various angles. See e.g. Aker and Blumenstock (2015); Aker and Mbiti (2010); Duncombe (2011); Jensen (2010); Martin (2014); May and Diga (2015); Nakasone *et al.* (2014); Porter (2012); Walsham (2010).

[15] For macro-level political and economic effects of mobile phone diffusion, see e.g. Alozie *et al.* (2011:760); Bailard (2009:341-342); Chavula (2012:20); Farhadi *et al.* (2012:6); Graham and Nikolova (2013:138-139); Gruber and Koutroumpis (2011:402, 4011); Kavetsos and Koutroumpis (2011:750-751); Sassi and Goaied (2013:259-260).

Indian city of Chennai, Chew *et al.* (2013:12-13) for instance found that a quantitative measure of empowerment ("mattering") is linked to more intensive mobile phone use. According to the authors, this link is established by "human interaction that is facilitated by the social use of mobile phones and the perceptions associated with this use" (Chew *et al.*, 2013:13). Moreover, Bailard (2009:346-348) indicates that increasing mobile network coverage in Namibia was linked to lower levels of perceived presidential and local government corruption. These and other studies correspond to qualitative research arguments according to which the adoption of digital technology can influence social roles and values.

Quantitative research also provides limited evidence mainly from high-income contexts that diffusion and use of digital technology affect social structures (Chuang & Schechter, 2015:4.17). Based on findings from a small-scale survey among high-school graduates in the UK, Roberts and Dunbar (2011:194) argue that "the majority of an individual's communication still tends to be limited to a relatively small number of others" despite the increasing diffusion of mobile phones and social media. Saramäki *et al.* (2014:946), who substantiate this survey data with call connection records, make a similar point. The authors conclude that people have limited time to devote to the closest contacts in their social network, so that "even the efficiencies provided by some forms of digital communication (in this case, cell phones) are insufficient to alter them" (Saramäki *et al.*, 2014:946). Such conclusions have also been drawn from larger-scale research. Analysing nine billion mobile phone connections, Miritello *et al.* (2013:93-94) observe that people's time on the phone is concentrated among a small number of contacts regardless of how intensive their phone use is, and that mobile phone use does not appear to increase the size of people's core networks of close contacts. This yet sparse quantitative research suggests that mobile phone diffusion does not create wholly new network structures, but it may affect them in subtle ways by increasing the attention on one's closest contacts

(Ling, 2008b:106). Such processes may also mirror the aforementioned research on roads (Pedersen & Bunkenborg, 2012:563): Phone use connects, but it can also create distance.

Economic analyses of mobile phone diffusion in LMICs are frequently concerned with the impacts on poverty levels of the general population, farmers, and entrepreneurs (Aker & Mbiti, 2010:213-214). A prominent example is the market price study among Kerala fishermen by Jensen (2007:893), which powerfully illustrates the relationship between mobile signal access and reduced market price fluctuations. Reduced price volatility upon introduction of mobile network coverage suggests that mobile phone diffusion contributes to a reduction of producer risk and wastage (Jensen, 2007:896). Similar effects of reduced price variability following mobile network roll-out are observed in Uganda by Muto and Yamano (2009:1895) and in Niger by Aker and Fafchamps (2014:290). While predictable prices can reduce producer risks, Lee and Bellemare (2013:634, 636) find that personal phone ownership for farmers is also associated with higher received market prices for their produce. In contrast, Futch and McIntosh (2009:69-70) studied the introduction of village phone kiosks in Rwanda, which increased access to mobile communication but did not affect either prices received by farmers nor profits by the people operating the village phones. Taken together, economic analyses of the market effects of mobile phones suggest effects on prices as well as income, but these do not follow automatically.

Despite the extensive work on social, political, and economic outcomes, the quantitative literature remains limited in its analysis of equity effects. Only few studies provide first pointers in this direction. For example, based on survey research from more than 2,000 respondents across India, Tanzania, and Mozambique, Souter *et al.* (2005:79-80) find that more affluent population groups tend to value the economic and social benefits of mobile phones higher (Souter *et al.*, 2005:88-89). Combining telephone interview and network operator data, Blumenstock and Eagle (2010:7-8), too, indicate that more affluent persons use their phones

along wider network of contacts. Furthermore, the mixed methods study of young people's phone use by Porter *et al.* (2012:153) points at the gendered dimension of mobile phone use (measured as time of last access), for example with South Africa and Ghana having a higher share of female users whereas in Malawi more young men use phones. These studies suggest that different groups of adopters may experience different development-related effects, yet the evidence base remains narrow and inconclusive overall.

Going beyond general mobile phone diffusion, the broader field of "information and communication technologies and development" (ICTD, see next sub-section) focuses in particular on interventions that use mobile phones as a platform. This includes health, as we will see in Section 2.3.1, but also financial services, market information, and education. Before I conclude this review of the empirical quantitative literature, I will illustrate briefly—for completeness—the varied insights emerging from such intervention studies.

As far as mobile financial services are concerned, data by Jack and Suri (2014:219-220) suggest that the financial M-Pesa service in Kenya helps to reduce transaction costs within dispersed risk-sharing networks, thereby better cushioning service users against financial shocks. In other words, this mobile phone service in connection with people's social networks acts as an insurance in times of crisis (Jack & Suri, 2014:220). Mbiti and Weil (2011:13, 16-17) support these findings but also indicate that affluent population groups may be more likely to benefit from this service.

In the case of market information, Rashid and Elder (2009:5-8) review seven development projects aimed at improving the lives of farmers in LMICs. While some projects showed encouraging effects such as higher incomes for farmers and entrepreneurs, increased transaction efficiency, and reduced wastage, other projects experienced low service uptake and little financial net benefit for the users. Similarly, Fafchamps and Minten (2012) experimentally tested the effects of SMS-based agricultural information for 933 Indian farmers. Providing

price, crop, and weather information via SMS, the authors find no effect on farmers' producer prices, cultivation patterns, or crop losses (Fafchamps & Minten, 2012:412).

As an educational intervention, Aker *et al.* (2012) report the outcomes of an experiment in Niger in which adults were taught the operation of basic mobile phones with SMS and voice communication facilities. The experimental results show that adults who were trained in mobile phone use also achieved significantly better test scores in writing and maths (Aker *et al.*, 2012:118). However, there is no clear link between phone use and schooling achievement as studies from the US and Australia have also indicated that smartphone and information technology use can be counterproductive to student learning and conducive to "technologically-enabled dishonesty" (Academic Misconduct and Plagiarism Taskforce, 2015:10, 23; Tindell & Bohlander, 2011:5; Tossell *et al.*, 2015:722-723).

While the implications of specific mobile-phone-based interventions are mixed, they also compound the effects emanating from people's engagement with the mobile phone itself, and the associated complex adoption processes in which technologies are appropriated, interpreted, and redefined. However, it is widely acknowledged that we do not yet sufficiently understand the behaviour of mobile phones as platforms for mobile-phone-based development initiatives (Aker & Mbiti, 2010:225-227).

In short, quantitative indicators of technological use permit analyses of whether specific social and economic effects materialise in a region or society, but context-insensitive measures potentially forego information that would be critical to understand the mechanisms through which such effects unfold and how they are distributed. Ongoing research in this area has nevertheless begun to unpack the elaborate patterns of socio-economic mobile phone impact, often in correspondence with the hypothesised impacts in qualitative studies. And although these studies point out the varied positive and negative consequences that may be associated with mobile phone diffusion, knowledge gaps continue to exist with respect to social development

effects, unintended consequences, and the equity implications of technology. In addition, in light of the challenges in assessing mobile phone adoption, the further development of locally grounded adoption indicators potentially aids future research in this area. Only few mixed methods research projects have combined these elements in a single study in order to provide a holistic picture (e.g. Porter *et al.*, 2015; Porter *et al.*, 2012).

2.2.3   Synthesis of Issues

We have seen a number of issues arising in this review of technology, mobile phones, and development. Three main themes are relevant for the further analysis of the relationship between mobile phones and health. First, a natural tension exists between qualitative anthropological and sociological research that yields contextually rich and locally grounded views on mobile phone adoption-as-appropriation, and quantitative sociological and economic research that illuminates the scale of phone diffusion impacts. Only few mixed methods and interdisciplinary research projects have yet attempted to bridge the gap from emerging use to measuring developmental outcomes.

The methodological and disciplinary divisions are related to the second point, namely issues in operationalising the concept of "mobile phone adoption." Qualitative research offers rich insights into the diverse forms in which humans engage with and make sense of mobile technology, but quantitative studies necessarily have to reduce dimensions and complexity. Often this means relying on a binary measure of ownership or revealed use, but such binary indicators are repeatedly criticised for being "too narrow," "too static," and for "[hiding] the richness of the landscape" (Donner & Tellez, 2008:327; Fernández-Ardèvol, 2014:123; Karnowski *et al.*, 2011). Measuring mobile phone adoption is further complicated by potential and conceptually unresolved disconnections between the owner, the user, and the beneficiary of a mobile phone (Burrell, 2010:235). So far, the most complex indicators are used mainly to

study the drivers of mobile phone adoption, rather than its implications. How different forms of mobile phone adoption affect development outcomes and their distribution therefore remains a "black box" in the quantitative literature.

Third, although the underlying mechanisms are yet understudied, there is little debating the point that mobile technology diffusion does have social and economic impacts. The literature review hinted at various dimensions of change associated with phone and ICT diffusion, ranging from social values, roles, and structures via political participation and governance to economic implications. While some of these outcomes were anticipated or intended, many were not. Moreover, the equity implications of these changes are a pervasive theme in the qualitative literature, but quantitative research has yet to explore these in reasonable depth. Impacts and their distribution do not only matter for understanding the role of mobile phones in development contexts, but also with regard to their role as platforms for targeted development interventions. The literature review offers an abundance of evidence that mobile phones can influence some of the target outcomes of these interventions, making them "non-neutral" platforms.

My emphasis on the themes of appropriation, measurement, and impacts relates to the loosely demarcated field of information and communication technologies and development (ICTD). ICTD researchers share an interest in the use of technologies to support "development" (variously defined) in LMICs (Díaz Andrade & Urquhart, 2012:289; Duncombe, 2012:2; Flor, 2015; Heeks, 2014:2; Unwin, 2009:1).[16] As a result, most research in the area of ICTD has focused on ICT readiness and availability, the factors that drive diffusion and acceptance of technologies, and the positive development potential of technological change (Andersson &

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[16] For example, Tim Unwin's book *ICT4D* opens with the lines "This book is about how information and communication technologies (ICTs) can be used to help poor and marginalised people and communities make a difference to their lives" (Unwin, 2009:1).

Hatakka, 2013:293; Dodson *et al.*, 2012; Heeks, 2014:12; Roztocki & Weistroffer, 2014:351). Digital divides and exclusion have been a prominent theme as well, but they, too, have focused primarily on access and connectivity rather than on "higher-order" forms of exclusion that pertain to motivations, skills, effective usage of technology (May & Diga, 2015:100; Pearce, 2013:78; Robinson *et al.*, 2015; van Dijk, 2006:22).

In light of these foci and the dominating view that technologies ought to contribute to development, too little emphasis has been devoted to the social embeddedness of technology, user behaviour and different forms of use, unintended negative and positive effects of ICT diffusion, the equity implications of technological change, and the broad spectrum of consequences surrounding digital inclusion and exclusion (Ayanso *et al.*, 2013:63; Graham, 2011; Heeks, 2014:12; Sæbø & Furuholt, 2013:128-130; Wyche, 2015:2). The field is now experiencing a gradual transition towards broader research of technological and social development, a growing theoretical base, and more interdisciplinary and mixed method research that permits locally grounded conclusions (Andersson & Hatakka, 2013; Burrell & Toyama, 2009; Chib, 2015; Gagliardone, 2015; Heeks, 2009:27; Kleine, 2013; Walsham, 2013:50).

Unlike much of the ICTD literature, my research at the intersection of technology, health, and development focuses on understanding the nature of technological and social change, rather than assessing the "contribution" of a particular technology to development. Nonetheless, ICTD's increasing application of social theory can also enrich public health research on mobile phones that I will examine in the following section. The review of the public health literature will show that there is very little research on the healthcare implications of mobile phone diffusion; and that this potentially important channel of impact is routinely assumed away in the medical, computer, and engineering sciences focus on phone-based health interventions.

2.3   The Interface of Public Health and Mobile Technology

Public health is one of the domains in which the knowledge gaps of technology diffusion studies resurface. Research attention in this area focuses on the utilisation of mobile phones for health services and health system improvements. However, one of the major challenges is the limited theoretical understanding of the more fundamental relationship between mobile phone diffusion and healthcare access. As a result of our limited empirical and theoretical knowledge of this link, developers and analysts of mobile-phone-based health service delivery commonly adhere to the simplifying assumption that mobile phones are a neutral platform for delivering services (i.e. engaging with mobile phones themselves leaves the intended health outcomes of mHealth interventions unaffected). This is problematic in light of the preceding review.

In order to formulate my research questions in response to these issues, this section first introduces the popular practice of mHealth because the implications of my study relate to this kind of phone-based intervention. As I am concerned with the adoption behaviour of the general population, the review focuses on end-user-oriented interventions, rather than interventions taking place solely within healthcare organisations. Following the introduction to mHealth, I review the main research themes at the interface of mobile phones and health. This will again underline the prominence of mHealth as opposed to the comparatively marginalised research areas of emerging health-related phone uses and their health implications.[17] Because little empirical evidence exists to understand the character of mobile phones as platforms for

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[17] I will focus on behavioural healthcare consequences of phone and ICT appropriation. This excludes direct health effects associated with the device such as mobile phone radiation, exploding batteries, electrical shocks, distraction during the operation of road vehicles, or mobile phones as bacterial repositories, and indirect effects like "economic security, gender dynamics, familial relationships, and social interactions" (Ben *et al.*, 2009; Brady *et al.*, 2011; Jeffrey & Doron, 2013:212-213; Karabagli *et al.*, 2006; Karger, 2005; Mechael, 2006:144; Patrick *et al.*, 2008:178; Visvanathan *et al.*, 2011; Wang *et al.*, 2012:212; Wilson & Stimpson, 2010). For studies and reviews of health system implications, see e.g. Agarwal *et al.* (2015); Black *et al.* (2011); Buntin *et al.* (2011); Chaudhry *et al.* (2006); Durrani and Khoja (2009); Free *et al.* (2013b); Källander *et al.* (2013); Labrique *et al.* (2013).

health service delivery, the review subsequently turns to the theoretical strands in the health and mobile phone literature. It will emerge that the existing theoretical positions—explicit as well as implicit—tend not to appreciate the broad range of mobile phone adoption patterns and their possible impacts, compounding the empirical research gap. The final part of this section will therefore formulate three research questions to inform the interface of mobile technologies and health from a theoretical, methodological, and empirical perspective, using the case studies of rural India and rural China.

2.3.1   mHealth: Introduction and Overview

The majority of empirical research considering the healthcare implications of mobile phones is concerned directly or indirectly with "mHealth"—that is, examining the ways in which mobile phones can be used to improve health systems and health service delivery.[18] While recent studies have begun to move towards user engagement with mobile phones, disproportionately little attention is devoted to the emerging health-related uses of mobile phones and their healthcare implications. Given the prominence of mHealth, I will briefly outline its rationale before I review the empirical public health literature at the interface of mobile phones and health.

The health problems of LMICs are the backdrop against which many low-cost mHealth technologies are being developed (Beratarrechea *et al.*, 2014:79; Clifford *et al.*, 2008:5). Worrying health indicators persist in these regions despite progress since the establishment of the Millennium Development Goals. For example, Cutler *et al.* (2006:107) report that 30% of deaths in low-income countries occur among children below the age of five years whereas this

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[18] Based on content analyses of Scopus search results, I estimate that approximately half of the published literature on health and mobile phones addresses interventions in one way or another (Elsevier B.V., 2015). This also includes health-system-oriented interventions that are not discussed in this presentation.

is only the case for 1% of children in high-income countries. Similarly, data from the Institute

for Health Metrics and Evaluation (2012) and the World Bank (2015) indicate that residents in

LMICs die on average 20 years younger than those in high-income countries.[19] This positive

correlation between country income and health outcomes is widely recognised.[20] The worrying

aggregate health indicators in LMICS are further accentuated by within-country disparities be-

tween urban and rural areas, the latter of which are routinely described to suffer from inade-

quate health service provision, insufficient health financing, low demand for formal healthcare,

and problematic health behaviours including unhealthy levels of alcohol and tobacco consump-

tion.[21] For example, Chaudhury *et al.* (2006:91-92) study the supply of healthcare in terms of

health worker absenteeism across Bangladesh, India, Indonesia, Peru, and Uganda, finding that,

across these five countries, health worker absentee rates are on average 35%, and often pres-

ence at work is no guarantee that work is actually carried out.

mHealth is a response to the persistent healthcare challenges and inequities in high- as

well as low- and middle-income countries, considering the rapid growth of mobile connectivity

around the world (Anglada-Martinez *et al.*, 2015:28; Kwan *et al.*, 2013:27; van Heerden *et al.*,

2012:394). The recent decade has witnessed a surge of low-cost applications that are designed

to use mobile devices as a platform for health service delivery. By making use of mobile phone

functions such as voice communication, SMS, mobile broadband, or additional software and

"apps" installed on the phone, these mobile health technologies cover a broad spectrum of

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[19] Population-weighted average using 2010 country-level Global Burden of Disease data and World Bank country classifications and population data.

[20] See e.g. Barnes *et al.* (2009); Bloom *et al.* (2010:31-32); Bloom *et al.* (2004); Deaton (2007:22); McKeown (1979:92-107); Preston (1975:235); Pritchett and Summers (1996); Sachs and Commission on Macroeconomics and Health (2001:23-40); World Bank (1993:17-21).

[21] For evidence on these points, see e.g. Banerjee *et al.* (2004:949); Banerjee and Duflo (2011:55); Cutler *et al.* (2006:109); Das and Hammer (2004:960); Das *et al.* (2008:102); Dow *et al.* (1997:19-22); Dupas (2011:426-429); Kremer and Glennerster (2011:273-276); Kyaing *et al.* (2005:15); Mwabu (2007:3314); WHO (2013c:39, 144-153).

services that involve end users as well as providers of healthcare services (Free *et al.*, 2013a:2).

Patient-centred solutions include remote disease management, public health information pro-

vision, or diagnosis services among others.[22] For instance, remote diagnosis is enabled through

hotlines that link patients to doctors for advice on medical conditions (Atun & Urganci,

2006:13-14; Bunn *et al.*, 2005:956; Ivatury *et al.*, 2009:130).

Popular awareness of mHealth emerged in 2009.[23] While a recent review indicated that

only 11% of ICTD publications between 2000 and 2010 were health-related (Gomez *et al.*,

2012:67), mHealth has received wider interest from outside the development community and

in fact has produced three times as many news items than ICTD between 2005 and 2015 (see

Figure 2.1 for the evolution of media supply and demand on ICTD and mHealth as determined

by *LexisNexis* and *Google Trends*). Given the combination of persistent health problems in

rural developing areas, the widespread use of mobile phones, and the diversity of emerging

low-cost health technologies, "technology optimists" have dominated the public media (Lupton,

2014:1345), emphasising the transformative potential of mobile phones and their utilisation

through mhealth applications in the provision of health services.[24]

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[22] For specific examples and case studies, see Atun and Sittampalam (2006); Deglise *et al.* (2012); Free *et al.* (2013a); Friederici *et al.* (2012); Krishna *et al.* (2009); Labrique *et al.* (2013); LaPlante and Peng (2011); Mendoza *et al.* (2013); van Velthoven *et al.* (2012); WHO (2011). Applications that involve phone use only on the provider side include, for example, decision support systems, disease surveillance, or inventory management. See Free *et al.* (2013b), Leslie *et al.* (2011:94-111), and Qiang *et al.* (2012:36) for further examples.

[23] Popular interest is based on "mhealth" news items captured in the *LexisNexis* database, which amounted to 13 globally in 2008, 172 in 2009, and 671 in 2010 (Reed Elsevier (UK) Ltd., 2015). The following media statistics are based on data from *LexisNexis* and *Google Trends* (Google Inc., 2015c). Keyword searches for ICTD include "ICTD," "ICT4D," "ICT for development," and "information and communication technology/ies for development;" mHealth searches were limited to "mhealth" and "m-health."

[24] Based on keyword searches, 45% of the 10,778 reported news items in *LexisNexis* between 2009 and 2015 had a positive tone, compared with 30% exhibiting cautious wording. Keywords including variants of "revolutionising," "opportunity," "harnessing," and "transforming" for optimistic wording; and variants of "threat," "danger," and "challenge" for cautious wording. However, keyword searches of this kind are at best indicative of tone, as they would also (incorrectly) capture "an opportunity to ruin health systems with mHealth" and "mHealth to solve all global healthcare challenges."

Although the overall tone of the public media on mHealth is optimistic, criticism and

caution are also mounting, increasingly involving concerns regarding the lack of evidence, the

scale-up of pilot projects, interoperability and coordination of scattered projects, user charac-

teristics and contextual factors influencing effectiveness and side-effects of projects, and the

mHealth "hype" and its techno-centric orientation.[25] In 2012, Uganda had halted their imple-

mentation of mHealth projects altogether for need of better coordination among the existing

projects (Republic of Uganda, 2012).

Figure 2.1. Popular Demand and Supply of Media Reports on mHealth and ICTD
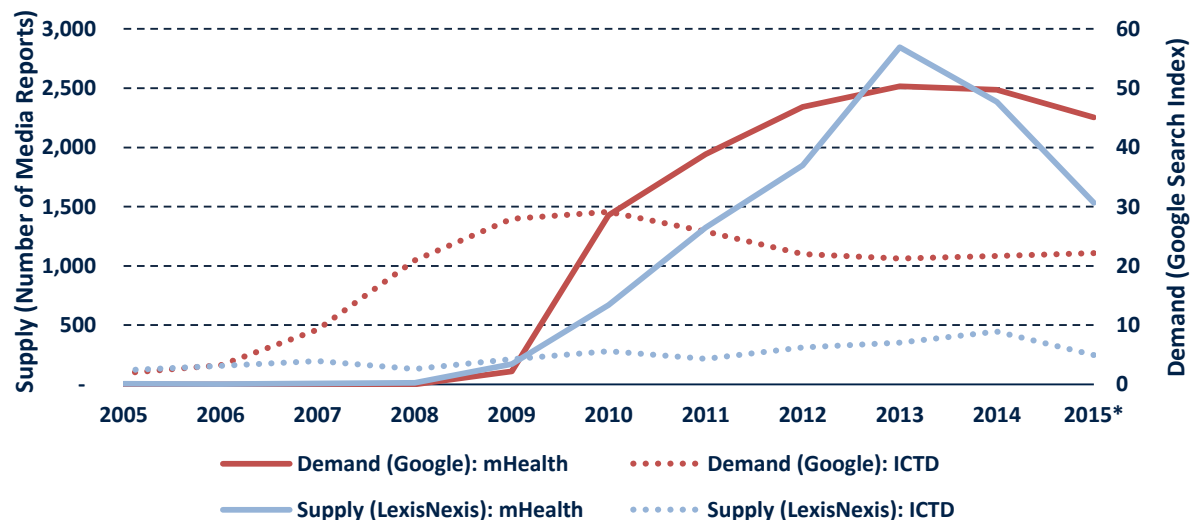
Source: Own illustration, based on Google Inc. (2015c) and Reed Elsevier (UK) Ltd. (2015).
* 2015 data until 13 August.
Notes. *LexisNexis* database including all languages and all news sources, searching terms in headlines, by-lines, and body of news items. "ICTD" including related terms "ICT4D," "ICT for development," and "information and communication technology / technologies for development" (due to syntax and Boolean logic, the phrase "ICT and development" would also yield results for "ICT development"). *Google Trends* search index as annual un-weighted average of weekly data. Data is reported as relative index of worldwide search intensity over time (un-disclosed formula). ICTD in Google search index reported as "topic" rather than individual term, yielding more inclusive results. For example, index scores in July 2015: ICTD (topic) – 30; "ICTD" (single term) – 5; "ICT4D" (single term) – 9. First positive index scores for "ICTD" in January 2009 and "ICT4D" in October 2007.

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[25] See Bastawrous and Armstrong (2013:140); Chib *et al.* (2015); Deglise *et al.* (2012: "Conclusion"); Fjeldsoe *et al.* (2009:171); Free *et al.* (2013a:40); Free *et al.* (2013b:23); Friederici *et al.* (2012:55); Kahn *et al.* (2010:254); Kaplan (2006:10); Krishna *et al.* (2009:238); Lewis *et al.* (2012:337); Mechael and Donner (2013:13); Piette *et al.* (2012); PricewaterhouseCoopers (2012:6); Qiang *et al.* (2012:15); The PLoS Medicine Editors (2013); Tomlinson *et al.* (2013); van Heerden *et al.* (2012); Wei *et al.* (2011:47); WHO (2011:66).

Emerging from the broader field of telemedicine, academic interest in mHealth began to grow around 2005.[26] Analogous to the higher popular interest in mHealth compared to ICTD, mHealth has also accounted for more than twice as many academic publications during the period from 2005 to 2015 (Elsevier B.V., 2015). A main driver of this mismatch is the wider interest of the medical sciences in the field of mHealth, dominating it with 56% of all 1,630 mHealth publications whereas their share in the ICTD literature is only 3.4% of 760 publications. The main disciplinary backgrounds of ICTD publications are instead the computer and social sciences (77% and 27%, respectively), the latter of which play only a subordinate role in mHealth research (38% computer sciences, 6% social sciences research). The broader intersection of "mobile phones and health" is even more strongly concentrated among the medical sciences (65% of 7,092 publications). The disciplinary focus on medical, computer, and engineering sciences at the intersection of mobile phones and health is linked to a very specific research agenda that emphasises mHealth design, experimental tests of intervention effectiveness, and physical health impacts, rather than the social and behavioural dimensions of mobile phones and healthcare (Chib *et al.*, 2015:30). I will explore this point further in the following review of empirical studies and theoretical approaches in this research field.

2.3.2   Empirical Research on Mobile Phones and Health

I begin my review of the literature at the intersection of mobile phones and health with a thematic overview of the empirical research. Four partly overlapping research themes emerge

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[26] According to the *Scopus* database, 2005 was the first year with two-digit publications on "mhealth" or "m-health;" the three-digit mark was surpassed in 2011 (Elsevier B.V., 2015). Unlike the public media, academic publications tend to be more cautious in tone. 13% of the existing 1,630 mHealth-related publications use optimistic language in title, abstract, or keywords, whereas 20% are cautious in tone. In terms of disciplinary composition, the 760 ICTD publications comprise 76.6% computer sciences, 27.4% social sciences, 9.9% engineering sciences, and 3.4% medical sciences. The 1,630 mHealth publications comprise 56.3% medical sciences, 37.7% computer sciences, 28.0% engineering sciences, and 6.4% social sciences. The 7,092 mobile phone and health publications comprise 65.4% medical sciences, 19.2% computer sciences, 16.7% engineering sciences, and 6.8% social sciences.

from the literature and include, in descending order of research volume, (a) the design and evaluation of mobile-phone-based health interventions, (b) mobile phone usage and access patterns to inform the barriers and equity implications of mHealth interventions, (c) emerging health-related uses of mobile phones, and (d) the health-related implications of mobile phone diffusion. While many questions in this literature surround mHealth interventions, the review will draw attention to one puzzling research gap: the study of healthcare implications of people's mobile phone use. This is not a trivial niche as the previous review of technology adoption highlighted. In the worst case, negative healthcare-related effects of mobile phone diffusion could undermine the very rationale of delivering healthcare services through mobile phones. The fact that very little is known about such outcomes is therefore rather problematic. Nevertheless, let us start the review with the most common research theme at the intersection of mobile phones and healthcare.

The vast majority of the literature focuses on the design and experimental evaluation of phone-based health interventions. With at least at least 60 systematic reviews and reviews of reviews summarising studies with patient-focused mHealth services, there is little that I could contribute with my own summary. In the broadest terms, this mHealth literature points at modestly optimistic results from experimental trials in low-, middle-, and high-income countries. For example, a review of systematic reviews by Mbuagbaw *et al.* (2015:7) reports that text message reminders increase compliance with medication regimes and treatment adherence for HIV/AIDS patients. In contrast, findings for behaviour change interventions are more mixed (Hall *et al.*, 2014:3). Virtually all systematic reviews in this field call for more evidence from randomised controlled trials and the consideration of privacy issues,[27] and few also raise the

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[27] A selection of recent reviews that make this claim and focus on LMICs includes Al Dahdah *et al.* (in press:4), Beratarrechea *et al.* (2014:80), Bloomfield *et al.* (2014:8), Cole-Lewis (2013), Hall *et al.* (2015:412), Hall *et al.*

need for studies examining political, structural, and equity implications of mHealth; the relationship of mHealth vis-à-vis "traditional" healthcare provision; and contextually sensitive qualitative research on mHealth implementation.[28] At the same time, the lack of "evidence" especially from LMICs is cited repeatedly as a shortcoming in mHealth research (Hall *et al.*, 2015:411; Seko *et al.*, 2014:600). Almost half of all mHealth studies originate from the US and the UK and more than 90% from high-income countries overall (Elsevier B.V., 2015). The most prominent low- and middle-income origins are India and China, accounting for 4% and 3% of the mHealth publications worldwide (Elsevier B.V., 2015).

A second popular though less voluminous research theme is the study of phone access and user behaviour to understand facilitating factors for mHealth interventions. Part of these studies discuss the targeting and potential acceptance of mHealth among specific target groups given their use of ICTs.[29] For example, McInnes *et al.* (2013) reviewed the literature on US homeless persons' mobile phone and ICT use. Based on findings of somewhat widespread ownership and use, the authors argue "that homeless populations in the United States may also be potential beneficiaries of interventions using these relatively low-cost technologies" (McInnes *et al.*, 2013:e22). However, as parts of the homeless population do not have mobile phones, the authors also advocate that this "priority issue" be addressed through the free provision of smartphones for homeless people (McInnes *et al.*, 2013:e22). Other, less common

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(2014:9), Mbuagbaw *et al.* (2015:15), Noordam *et al.* (2011:624), Steinhubl *et al.* (2015:5), and Tamrat and Kachnowski (2012:1100).

[28] Al Dahdah *et al.* (in press:5); Aranda-Jan *et al.* (2014:11-12); Chib *et al.* (2015:30); Hall *et al.* (2014:9); Higgs *et al.* (2014:181-184); Jennings and Gagliardi (2013:8); Mbuagbaw *et al.* (2015:5-6); Peiris *et al.* (2014:680, 688); Steinhubl *et al.* (2015:4-5).

[29] For example DeSouza *et al.* (2014); Friederici *et al.* (2012:57); Guo *et al.* (2015:667); Jack and Mars (2014:5); Jain *et al.* (2015:34); Jang-Jaccard *et al.* (2014:501); Kamis *et al.* (2015:10); Kaplan (2006:9); Mechael and Donner (2013:8-9); Osborn (2013:105-106); Piette *et al.* (2012:368); Rai *et al.* (2013); Samal *et al.* (2010:126-127); Tran *et al.* (2015:13); Zurovac *et al.* (2013).

publications in this area stress the potential equity implications for specific mHealth interventions and the industry more generally, resulting from different degrees of mobile phone access and ownership as well as social, demographic, and economic factors such as illiteracy, old age, and poverty.[30] For example, Wesolowski *et al.* (2012:5) examine the differences between mobile phone ownership and sharing patterns using secondary survey data from Kenya, arguing that mHealth interventions need to be responsive to socio-economically shaped patterns of phone ownership and access. Overall, this comparatively recent strand of the literature is more receptive to underlying patterns of mobile phone adoption (although often based on reduced measures like ownership and access) and the resulting or potential equity implications thereof. Concerns about user and non-user behaviour in these studies also contribute to a higher share of qualitative and mixed methods publications in this area.

The third strand in the user-centred literature on mobile phones and healthcare departs further from the mHealth theme and examines the health-related behaviours emerging from mobile phone and ICT diffusion. This part of the empirical literature is yet more likely to involve qualitative as well as social research. Qualitative studies in this theme relate to anthropological and sociological research of mobile phone diffusion that had started to document locally emerging health-related uses of mobile phones before the term mHealth became popular. With her ethnographic study in Egypt, Mechael (2006, 2008) has been one of the first authors who dedicated a sole project to the health-related uses of mobile phones. She documented, among others, the coordinated use of mobile phones to summon emergency services and to put hospitals on stand-by in response to a major bus accident (Mechael, 2006:121-122, 128-129). Neither needed the phones to be owned by the person calling for help (e.g. the phone of an accident victim), nor was the coordinating person necessarily involved in the accident in any

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[30] For example Benjamin (2013:72); Higgs *et al.* (2014:182); Jennings and Gagliardi (2013); Jennings *et al.* (2015:346); Lupton (2014:1353); Noordam *et al.* (2011:624); van Heerden *et al.* (2012:394).

way (e.g. delegating the task to remote but more experienced family members). Similar trends

emerge from the in-depth ethnographic accounts by Horst and Miller (2006) in Jamaica and

Burrell (2010:242-243) in Uganda. Another example is the emerging use of mobile phones for

pornography consumption, as documented by Day (2014:184) in Sierra Leone and Glik *et al.*

(2014:8) in Senegal. Other commonly documented activities are talking about illnesses on the

phone and accessing health information via mobile broadband, both of which could affect

healthcare-seeking behaviours.[31] These and other qualitative accounts provide information on

the richness of behaviours emerging in the context of mobile phone diffusion and their relation

to other health-related practices such as information seeking (e.g. Ahmed *et al.*, 2014:14-15).

Quantitative studies in this theme provide a sense of the extent of such behaviours. For

instance, a forthcoming publication by Hampshire *et al.* (in press:39) presents survey results

among 4,626 people between the ages of 8 and 25 years in Ghana, Malawi, and South Africa,

demonstrating that 35% used a mobile phone for their own and 31% for someone else's illness

in the twelve months preceding their survey. In contrast, Khatun *et al.* (2014) report that only

1.9% of 2,581 surveyed patients in Bangladesh contacted a health provider through a phone

whereas the vast majority of interaction takes place face-to-face. Among the public health lit-

erature, the emergence of phone-related health behaviours mainly appears to justify further

phone-aided healthcare solutions (e.g. Hampshire *et al.*, in press:25-26; Khatun *et al.*, 2014:9;

Labrique *et al.*, 2012).

The fourth and least developed theme in the empirical literature is concerned with the

health-related implications of phone use. Evidence on health behaviour impacts is yet more

diffuse and often limited to speculation. Especially qualitative studies reflect the more general

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[31] See Doron (2012:421); Fernández-Ardèvol (2013:16); Muessig *et al.* (2015); Oreglia (2013:170); Tenhunen
(2008:519-520).

challenges of assessing the social impacts of technology diffusion. For example, whereas emergency uses of mobile phones are typically understood to be advantageous for healthcare access, certain "social" (or anti-social) forms of mobile phone use may in fact generate risks to people's health. An extreme example is mobile phones' instrumental role in terrorist attacks, for instance in India (Jeffrey & Doron, 2013:205-208). Mobile phone diffusion can also create anxieties and mental stress as spouses become better able to coordinate extra-marital affairs (Mechael, 2006:154). In addition, even if phone users access health information, there is no guarantee that this information comes from a qualified source (Horst & Miller, 2006:139-140). Yet, while all these claims are plausible and grounded in qualitative empirical data, these studies have yet to establish to what extent these mobile phones adoption patterns change health behaviour and outcomes.

Quantitative and mixed method health outcome studies complement and extend the scope of the qualitative evidence. On the macro level, analyses have for example linked investments in and diffusion of mobile technology and other ICTs to higher life expectancy (e.g. Bankole *et al.*, 2011:10). Cross-country micro-level data analysis has furthermore provided quantitative support for the anxiety claim, finding that increasing personal mobile phone ownership is associated to higher stress levels (Graham & Nikolova, 2013:136). Moreover, a review of studies mainly from high-income countries by Livingstone and Smith (2014:642-643) provides only mildly supportive evidence for the aforementioned qualitative studies' concerns about the adverse consequences of adolescents' pornography consumption (enabled through pre-loaded content on the device or becoming available through mobile broadband), but stronger negative implications for other potentially phone-enabled behaviours such as "cyberbullying." The authors also stress the difficulty of comparing ICT-related harm to the kinds of harm inflicted in the absence of ICT (Livingstone & Smith, 2014:642). However, the general impression from the literature review is that most quantitative studies examining the health

effects of mobile phone use are linked to direct effects, for instance posture problems, sleep deprivation, or driving accidents as a result of phone use (Bailin *et al.*, 2014; Berolo *et al.*, 2011; Melton *et al.*, 2014; Ming *et al.*, 2006; Trudeau *et al.*, 2012). There is no study I am aware of that attempts to understand the effects of mobile phone diffusion on healthcare access behaviour or preventive health practices.

Having progressed from mHealth design and evaluation as the most common to health behaviour outcomes of phone use as the least common theme, a few observations are in order. Firstly, the focus on experimental evidence of interventions and the interest in physical and psychological health implications reflects the general composition of this field, being dominated by the medical, computer, and engineering sciences. Secondly, the research interest in patterns of mobile phone adoption and their social implications has grown only very recently, with the majority of publications emerging from 2013 onwards. Thirdly, it is surprising that the social and healthcare implications of phone diffusion have received so little research attention, given that (a) there is widespread evidence of health-related phone uses (Hampshire *et al.*, in press: Table 7), (b) researchers lament the absence of evidence about emerging behaviours and their outcomes (Al Dahdah *et al.*, in press:4), (c) other researchers call for more education and regulation in the area of digital media use (Bailin *et al.*, 2014:616; Buhi *et al.*, 2009:110; Day, 2014:187), and (d) yet others would go as far as arguing that "the more technology is used, the less advantageous it is for one's health" (Melton *et al.*, 2014:516). However, studying the impacts of mobile phone diffusion at this interface is also a challenge in light of the systemic, social, and dynamic nature of technology adoption; and the conventional focus on randomised controlled trials in public health that make such measurement difficult, if not impossible.

In summary, the empirical research agenda at the intersection of mobile phones and health is focused primarily on quantitative and experimental studies of the effectiveness of

mHealth and its enabling conditions. Where researchers analyse emerging behaviours in relation to phone and ICT diffusion, these analyses either stop short of measuring impacts or devote attention to direct health effects such as injuries or stress. However, as I illustrated in Section 2.2, the social implications of mobile phone diffusion are neither trivial nor irrelevant. Although people have been shown to incorporate mobile technology in their health-related behaviours in a variety of contexts, we do not know much about the healthcare implications of these behaviours. On the one hand, a better understanding of healthcare behaviour would be relevant to understand the role of mobile phone diffusion in health as an important dimension of human development. On the other hand, if mobile phone diffusion does have health-related development impacts (which it plausibly has), this may affect the way mHealth is conceived. If effects were positive, some mHealth interventions could be considered redundant because the phone itself would fulfil the purpose of mHealth already. If mobile phones were overwhelmingly detrimental to healthcare, questions could arise whether it is sensible to propose mobile-phone-based interventions to improve healthcare and equalise access. While this is an empirical shortcoming, the next section discusses whether theories in this area are able to rectify the problem by considering underlying technology adoption processes.

2.3.3   Theoretical Perspectives

The previous section established that most research in the area of mobile phones and public health concerns phone-based mHealth interventions, whereas very little research attention is devoted to the healthcare effects of mobile phone diffusion, especially from a social sciences perspective. In addition, the rapid pace of technical development means that many trialled mHealth solutions are prone to be overtaken or obsolete within a short time period (Anglada-Martinez *et al.*, 2015:28). Neither of these points would be problematic if researchers had a comprehensive theoretical toolkit that enables them to articulate the mechanisms, effects,

and distributional consequences of mobile phone diffusion prior to designing and deploying mHealth solutions. For example, an mHealth study by van Olmen *et al.* (2013:4) points out the "potential effect of providing participants with a regular mobile phone" for diabetes care and therefore equip their control group with mobile phones as well. However, the absence of further theoretical engagement with the role of the mobile phone in this study is symptomatic for the wider field of mHealth research whose neglect of theory, mechanisms of change, and their equity implications has been flagged repeatedly (Chib, 2013:70; Chib *et al.*, 2015:30; Cole-Lewis, 2013:38-39; Hall *et al.*, 2014:9; Higgs *et al.*, 2014:183; Jennings & Gagliardi, 2013:9; Peiris *et al.*, 2014:680; Riley *et al.*, 2011:65). This is not to say that the field as a whole is a-theoretical. But the following review will show that the existing theories, though useful in understanding the mechanisms underlying the desired effects in a specific intervention, are insufficient to understand the healthcare outcomes of mobile phone diffusion more generally, and whether and under which circumstances these should be desirable.

Behaviour change theory—often based on information-seeking models and theories of planned behaviour—is probably the most common approach in ICT-based health information delivery (Mohr *et al.*, 2014; Riley *et al.*, 2011:65; Webb *et al.*, 2010). Such models examine the channels and determinants that guide people's actions and that shape the patterns of information access (Ajzen, 1991; Bandura, 1991; Wilson, 1999). Applied to digital technologies and healthcare, they help to inform the determinants of intended and actual health information access and the factors to be met for successful information service delivery (e.g. Walsh *et al.*, 2015:6). For example, Batchelor *et al.* (2015:8118) combine theories of planned behaviour with models of information seeking to understand how people identify health information and how they subsequently make healthcare decisions. Insights from these frameworks are in turn used to inform the design and development of health interventions, for example the timing of messages and their specific content (Riley *et al.*, 2011:66). However, a shortcoming of these

approaches in the field of mHealth is that they focus on the informational value provided by the intervention itself, thus examining how the desired behaviour changes can be induced among the target population. This ignores locally emerging patterns of technology use and thereby treats the mobile phone as platform for information delivery as given and static.

Related to these frameworks assessing determinants of information identification, technology acceptance models have been applied to mHealth to understand the usage intentions from a technological (rather than health) starting point (Or & Karsh, 2009:551; Rai *et al.*, 2013). Technology acceptance models link usage intentions to indicators of "perceived usefulness" and "perceived ease of use" (Davis, 1989:320). Although these models were developed to study technology diffusion processes in organisations, they have also found application for user-oriented ICT-based health interventions (Guo *et al.*, 2013; Or & Karsh, 2009). For example, Guo *et al.* (2015:667) expand the technology acceptance model with perceived health risks associated to mHealth use in order to predict adoption intentions. The authors find for instance that women's and older persons' perceptions of health risks could render their attitudes towards mHealth solutions more favourable. As the name implies, studies using this framework examine the driving factors for users to "accept" a given new technology, not whether it is reasonable to introduce such a technology given users' existing patterns of technological engagement. In addition, by being centred on the technology rather than health, technology acceptance models in healthcare are susceptible to disregarding the broader landscape of health behaviours as well as the nature and impacts of alternative solutions (as e.g. indicated by Glik *et al.*, 2014:8; Lucas, 2008:2130).

A third group of models applied to mHealth and the health-related uses of mobile phones more broadly are "success factor" frameworks. These frameworks attempt to explain how to realise successful interventions and desired uses of mobile technologies. For example, Arul Chib and colleagues apply an "ICT value chain" approach to healthcare, which highlights

the roles of ICT as "opportunity producer," "enhancer of capabilities," "social enabler," and "knowledge generator," which can be realised once a set of economic, technological, socio-cultural, and infrastructural "barriers" are overcome (Chib *et al.*, 2008:350-351; Rajivan *et al.*, 2005:125).[32] Another approach has been proposed by Vassilev *et al.* (2015) following a realist review of the mHealth literature. The authors name three mechanisms through which ICT-based interventions can succeed: if they appreciate peer relationships between patients and other actors, if they integrate well into people's lives and routines, and if they draw attention to the patient's symptoms and health issues (Vassilev *et al.*, 2015:3). Lastly, in a grounded framework built on qualitative fieldwork in Egypt, Mechael (2006) suggests that, following the "domestication" of mobile phones into people's everyday lives, phone-related health benefits are maximised through their intermeshing with complementary technologies and service net-works like fixed phone lines, transportation, and medical services (Mechael, 2006:193-199). Although these frameworks appreciate "domestication" processes (Mechael, 2006), stress the need to fit people's lifestyles (Vassilev *et al.*, 2015), or explore distributional patterns of mHealth interventions (Chib *et al.*, 2013), all these approaches start with the normative premise that more technology use is unproblematic for health and desirable once a set of "barriers" is overcome.

Fourthly, an often implicit but nonetheless powerful theory in the study of mobile phones and health is the assumed effect of mobile technology on transaction costs and infor-mation deficits for patients. In the area of patient health, transaction costs refer to the direct and indirect costs incurred in accessing and utilising health products, services, or information. Information deficit arguments pertain to the perceived lack of information and knowledge

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[32] While the authors apply this model to health-worker-oriented interventions, a related framework (the "extended technology-community-management model") has been applied to user-centred interventions (Chib & Komathi, 2009:331; Chib *et al.*, 2013:27).

among the target groups that mobile phones as ICTs can ameliorate. Both arguments are closely related as, for example, Micevska (2005:58) argue that "the costs of [health] information acquisition will fall and individual health will presumably improve [through mobile technologies]" when compared to alternative means such as postal networks or face-to-face interaction, and Dammert *et al.* (2014:158) claim that "mobile phone service[s] could facilitate the diffusion of knowledge and best practices, reduce transaction costs, and improve the delivery of public services." Though implicit, the facilitating logic of technology is compelling and widespread in healthcare contexts. Higgs *et al.* (2014:184) observe that, "Most mHealth interventions are driven by a focus on transmission of information as the primary intervening variable without sufficiently exploring change mechanisms." Despite its appeal, transaction cost and information deficit arguments are problematic because their one-dimensionality cannot capture the wide range of implications resulting from mHealth interventions and mobile phone adoption more generally. This allows very little space to consider scenarios in which technology may be detrimental to health behaviour, healthcare access, or health outcomes.

Lastly, a broader but sparsely represented group of arguments pertains to critical sociological and anthropological theories of technology-aided health service provision. This emerging strand, however undeveloped it may still be, is a direct response to the mHealth literature's lacking attention of the broader social and cultural factors that condition mobile phone use and people's and societies' engagement with the technology (Greenhalgh *et al.*, 2013:87; Lupton, 2012:239-240). Themes therein include, for example, the reconfiguration of roles, identities, and trust relationships between and among patients and doctors; processes of dis-/empowerment, surveillance, and resistance; and the representation of health and care more generally (Andreassen, 2011:526; 2012:91; Greenhalgh *et al.*, 2013:87; Lupton, 2012:233-234; 2014:1351-1352; Lupton & Jutel, 2015:134; Purkayastha *et al.*, 2013:4223). The critical theory approach to mobile phones and healthcare therefore corresponds to the criticism I voiced above.

At the same time, "critical theory" is less a theory than a broad and yet to be firmly established set of themes of sociological analysis. In addition, given its emergence from the social sciences that are notably underrepresented in the study of mobile phones and health, the permeation of critical research within applied mHealth research is virtually non-existent and unlikely to be developing rapidly in the near future.

Taken together, this outline of the existing theoretical strands in the mobile-phones-and-health literature demonstrates that the lack of empirical knowledge about the healthcare consequences of mobile phone diffusion is not compensated by established theoretical positions to guide the research and practice in this field. In the absence of theoretical guidance and empirical evidence, theory and practice have to make simplifying assumptions. mHealth studies using behaviour change theories, technology acceptance models, technological "success factor" frameworks, or transaction cost and information deficit arguments are all prone to treating mobile phone use as given or, if anything other than neutral, as desirable. Where mobile phone use is made explicit, it is understood as a barrier to successful service implementation, or it may influence the patterns of service uptake. Only critical theory approaches—which are scantly represented in the literature—appreciate that mobile phones may be more than a neutral or desirable platform for service delivery, potentially affecting the very outcomes that mHealth interventions are aspiring to attain. But they do not yet offer a theoretical and methodological toolkit that could easily diffuse to the dominating medical, computer, and engineering sciences. Therefore, the gap in the theoretical treatment of mobile phones and health exacerbates the research gap in the empirical literature of the healthcare implications of mobile phone diffusion.

2.3.4   Research Questions for a Case Study of Cell Phones and Health in India and China

Research at the interface of health and mobile phones is very active and motivated by the desire to realise more equitable healthcare in low- and middle-income countries. Thousands

of interventions are ongoing and hundreds are being evaluated alongside continuing demands for a larger, rigorous evidence base. While such enthusiasm is encouraging, it is also problematic. The preceding review has shown that technologies such as mobile phones neither leave their diffusion contexts unaffected, nor do they remain static throughout this process. But this is exactly the assumption reproduced in the dominant theoretical approaches that tend to treat mobile phones as given, static, and neutral. It is thus important to foster a more nuanced understanding of the link between mobile phones and healthcare as one domain of human development. It is difficult to sustain the equity and impact justifications of mHealth interventions if we can neither appreciate nor conceptualise the healthcare consequences of mobile phones (which are unlikely to diffuse evenly), and how these consequences positively or negatively affect the viability of the mHealth projects worldwide.

The point here is not that mobile phones are necessarily bad for health behaviour, but that we do not have any evidence on this issue and that we lack an analytical tool to guide us through the thought process. Although anthropological, sociological, and economic research can potentially inform this topic, this requires an interdisciplinary and mixed method research approach that helps to link locally emerging forms of mobile phone use with the nature and scale of their healthcare-related impacts, provided these exist. It appears plausible to commence such a project in rural areas of LMICs, which are not only focal for the mHealth industry, but which also conventionally face the most worrying healthcare challenges. Examining the case study of mobile-phone-mediated healthcare behaviour in rural India and China—the two most salient LMICs in the mobile phone and health literature (Elsevier B.V., 2015)—I therefore investigate three research questions.

Firstly, I examine the theoretical connection between mobile phones and healthcare access in order to provide a basis for systematic analysis and hypotheses on the implications of

mobile phone diffusion in rural India and China. I limit myself to healthcare access (rather than e.g. preventive behaviour) in order to focus the scope of the analysis:

1. How is mobile phone diffusion related to access to healthcare in rural India and China?

Secondly, a methodological question arises. Especially the medical literature emphasises the "ubiquitous" access in relation to the claimed advantages of mobile phone diffusion for mHealth service delivery and health-related uses (e.g. Hampshire *et al.*, in press:25-26; Kwan *et al.*, 2013:27; McInnes *et al.*, 2013:e22). At the same time, the literature review highlighted the shortcomings of conceptualising "technology adoption" as a binary measure, be it access, ownership, or one-dimensional use. This suggests that "adoption" could be measured better as a multidimensional concept that acknowledges, for example, different ways of accessing and utilising the device (e.g. Burrell, 2010:235). While part of the question is what such a "utilisation" measure would look like in a healthcare context, one way to examine its suitability vis-à-vis conventional binary indicators is to link it to the local emergence of healthcare-related mobile phone uses (e.g. phone calls with local doctors):

2. Can we construct a multidimensional measure of mobile phone utilisation that explains mobile-phone-aided healthcare behaviour better than binary indicators of adoption?

Lastly, the empirical question remains as to whether and how mobile phone diffusion actually affects healthcare behaviours. If it does, it would mean that mobile phone diffusion has social development implications in the area of health, but it would also complicate the

existing conceptualisation of mHealth as operating on a neutral platform. The third research question therefore asks:

3. Does mobile phone use influence access to healthcare in rural India and China?

Acknowledging the context-dependent nature of mobile phone use and healthcare behaviour, I will carry out a comparative case study in order to identify factors and effects that may vary and that may be stable across distinct social, cultural, and economic settings. With the focus on India and China, I include a low- and a middle-income country that have experienced rapid mobile phone diffusion in recent years: Between 2005 and 2013, 40% of the growth of mobile connectivity in LMICs worldwide was due to these two countries (ITU, 2015a, 2015b). In 2013, at the time when this study was developed, India and China together accounted for 2.1 billion mobile phone subscriptions, or every one in three subscriptions around the globe. Both countries together had four times as many subscriptions as the entire African continent. Statistics such as these indicate that India and China have undergone rapid development in mobile connectivity. In light of such diffusion trends, they represent interesting cases to analyse and contrast the ways in which rural residents engage with mobile technology, and how they solve healthcare problems with or without mobile phones. In addition, analyses and comparisons of India and China have long since interested researchers, not only because of their geopolitical significance but also due to the mutual interest of these countries into each other's development experiences (Drèze & Sen, 2002:14-15; Kaplinsky, 2011:201). I will discuss the selection of the specific field sites in Section 3.3. A review of the existing mobile phone adoption literature in India and China is provided as context in Appendix 1.

2.4   Chapter Summary

My literature review highlighted the empirical and theoretical research gap on the implications of mobile phone diffusion on people's healthcare behaviour. This research gap is important because the social and healthcare implications of mobile phone diffusion remain unclear, and because disproportionate attention is being devoted to phone-based solutions that strive to improve health but assume to operate on a platform that itself does not affect healthcare outcomes. Only a small volume of social sciences research has been carried out in this area, and this body of literature still lacks a unified language and tools to establish its claims more firmly.

The lack of knowledge on the healthcare implications of mobile phone diffusion also reflects a broader problem in the study of the social implications of technology diffusion, namely the conceptualisation and measurement of the notion of "adoption," commonly defined as the "decision to make full use" of a technology (Rogers, 2003:21). While perhaps more straightforward for technological objects with a narrow range of possible uses such as medicines and hybrid seed (Coleman *et al.*, 1957; Griliches, 1957), what adoption means with regard to "multi-purpose" technologies like mobile phones remains somewhat unclear (Kleine, 2013:8). Although research at the intersection of mobile phones and health has a strong motivation for equitable access to healthcare, a more fundamental yet unresolved question is how different forms of technology adoption reflect on the realisation and distribution of development-related impacts.

I therefore investigate questions related to the theoretical link between mobile phones and healthcare access, the conceptualisation and measurement of mobile phone adoption in this context, and the implications of health-related mobile phone use for people's access to healthcare. I focus on India and China as two prominent cases in the literature that have experienced rapid mobile phone diffusion but continue to face healthcare challenges in rural areas

(see Section 3.3. for details). I employ a mixed method research design to address common methodological and disciplinary divisions in the study of mobile phones and health in particular, and technology diffusion more generally. In the following chapter, I explain my research design and methodology in order to answer the research questions.

Chapter 3

A Mixed Method Approach to Building and Testing

a Framework of Mobile Phone Diffusion and Healthcare Access

3.1   Introduction

In response to the persistent methodological divides in the study of mobile phones and development, I combine qualitative and quantitative approaches in order to answer three research questions:

1. How is mobile phone diffusion related to access to healthcare in rural India and China?

2. Can we construct a multidimensional measure of mobile phone utilisation that explains mobile-phone-aided healthcare behaviour better than binary indicators of adoption?

3. Does mobile phone use influence access to healthcare in rural India and China?

Qualitative methods in this research are part of a grounded theory approach to build a new framework that is able to explain the relationship between mobile phones and healthcare access. In order to guide this exploratory enquiry, I started from a preliminary framework based on Sen's Capability Approach (CA), helping me to articulate the notion of technology in the context of development processes. Mobile phones are conceptualised as socially embedded, transformative and generative objects in a setting where people's perceptions of a good life may be at odds with externally imposed notions of well-being. Being abstract and open-ended, this framework was the starting point for a grounded and closed-ended framework of mobile phones and healthcare access from which I derived hypotheses for quantitative testing. These

hypotheses pertain to measures of mobile phone adoption as possible predictors of health-related mobile phone use, and to the process impact and the associated distributional implications of such mobile phone use:

H1   *An index that captures mobile phone utilisation as a three-dimensional concept is a better predictor of phone-aided health action than conventional, ownership-based measures of mobile phone adoption.*

H2   *Direct and indirect health-related phone use during an illness episode on average improves access to healthcare.*

H3   *Phone-aided health action exacerbates socio-economic healthcare inequities.*

I use quantitative methods to test these hypotheses, drawing on district-level representative survey data that I collected from 800 rural dwellers in my field sites. Aside from the quantitative hypotheses, the qualitative fieldwork also informed the survey instrument, critical indicators of mobile phone use and health behaviour used in the analysis, and the interpretation of the quantitative findings.

The present chapter focuses on the design of my mixed methods approach, explaining and justifying the choice and integration of the qualitative and quantitative methods employed to answer the research questions (Section 3.2). I will argue that their combination enables me to leverage each method's individual strengths by generating an intimate understanding of people's perceptions and behaviours in the context of mobile technology (qualitative) and by enabling judgements about the prevalence and significance of these behaviours on the population level (quantitative). As this research examines the cases of rural Rajasthan and rural Gansu, I justify their choice in Section 3.3 as two socio-economically distinct low- and middle-income

contexts that, however, have similarities in terms of healthcare access challenges, mobile phone penetration, and relative economic performance within the respective countries. Section 3.4 subsequently explains the Capability Approach as initial framework that guided the qualitative data collection. This framework is useful for this purpose because it does not assume an automatic link between mobile phones and healthcare and it permits the emergence of negative as well as positive outcomes. In order to deliver on these promises, however, a substantial portion of the section is concerned with a theoretical discussion of technology and its role in development processes. In the following Section 3.5, I outline how qualitative methods helped me to build a closed-ended theoretical framework on the abstract foundation of the CA. The description will address the data collection methods, the processes of sampling and interviewing, and the analysis processes. Section 3.6 explains how the qualitative work is integrated into the development of the survey questionnaire development, and the survey design that I implemented in Rajasthan and Gansu. Because the analytical strategy of the quantitative analysis follows from the qualitative analysis, I explain measurement issues and analysis techniques in the quantitative Chapters 6 and 7. In addition, I discuss methodological limitations after each qualitative and quantitative analysis in the respective empirical chapters.

3.2   The Mixed Methods Research Design

As the previous chapter outlined, qualitative anthropological and sociological research draws attention to the complexity of human-technology interaction, and quantitative economic and sociological research focuses on the extent and effects of technology adoption. Whereas qualitative research faces challenges in establishing the prevalence and population impacts of technology use, quantitative research designs typically fail to incorporate the nuances of technological engagement into their analysis. Such divides can be overcome through mixed qualitative and quantitative research designs that have a long tradition in the field of international

development but that have only recently begun to penetrate other areas of health and social sciences research (e.g. Moore, 1974; Myrdal, 1973; Oxford Editorial Board, 1996; Shaffer, 2013; Tashakkori & Creswell, 2008:4). I adopt such a mixed methods research design and explain in this section the current state of mixed method research in the literature, my rationale for choosing such an approach, the specific research design of this thesis, and methodological and philosophical challenges that mixed methods research continues to face.

Mixed methods research can be defined as "[combining] elements of qualitative and quantitative research approaches (e.g. use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration" (Johnson *et al.*, 2007:123). This practice of linking qualitative and quantitative methods aims to overcome the limitations of each individual method in order to attain a more comprehensive understanding of the social phenomena under study (Howe, 2012:90; Johnson *et al.*, 2007:122; O'Cathain *et al.*, 2007:5; Poteete *et al.*, 2010:5). The logic of mixed methods researchers is that method selection follows directly from the research questions and objectives, rather than from innate philosophical views (Johnson & Onwuegbuzie, 2004:16; Shaffer, 2013:280).[33]

The practice of mixed method research is becoming increasingly accepted in the domain of public health. In the past, methodological approaches of medical and social scientists had often collided (Baum, 1995:460). It was only from the 1990s onwards that this field experienced increasing openness towards qualitative and mixed methods (Baum, 1995:461; Bergman, 2010:173; Bryman, 2008:604-606; Creswell, 2009:102; Payne, 2006:174; Pope & Mays, 1995:44). Evidence for this can be found in the increasing volume of published research

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[33] Note the emphasis on "researcher" rather than "research." A specific project by a mixed method researcher or research team may be mono-method if this is the most appropriate way of answering the research question.

and research proposals that are classified as "mixed method" (Curry *et al.*, 2013:119). For example, Plano Clark (2010:432) reports that the number of mixed method research projects funded by the US National Institutes of Health increased from 1 in 1997 to 60 in 2007. Some even go as far as labelling this trend a "quiet revolution" in the health sciences (O'Cathain, 2009:3), although it mirrors a development towards mixed methods research that can also be found in the ICTD literature and the social sciences more broadly (Alise & Teddlie, 2010:115; Gomez & Day, 2013:311).

Mixed method research comprises a wide range of designs. Based on Creswell *et al.* (2008:68-69), Leech and Onwuegbuzie (2009:267-268), and Teddlie and Tashakkori (2009:141), these designs can be classified by purpose (e.g. exploratory, explanatory, triangulation), the degree of method integration (partially or fully along the research process), temporal implementation of the methods (simultaneous, sequential), and the relative emphasis of each method in the research design (equal, dominant). In this thesis, I use an exploratory mixed methods research design that links qualitative and quantitative methods sequentially and that does not give precedence of one method over the other. Figure 3.1 illustrates the design: A first qualitative stage serves to develop a grounded framework of mobile phone use and healthcare access, from which I derive hypotheses for quantitative testing using descriptive and inferential statistical methods. The hypotheses to be tested pertain to Research Questions 2 and 3—that is, the measurement of adoption and the effects of mobile-phone-aided healthcare seeking. The qualitative analysis thus informs both the quantitative research approach and the interpretation of the quantitative findings.

Figure 3.1. Schematic Depiction of Research Design
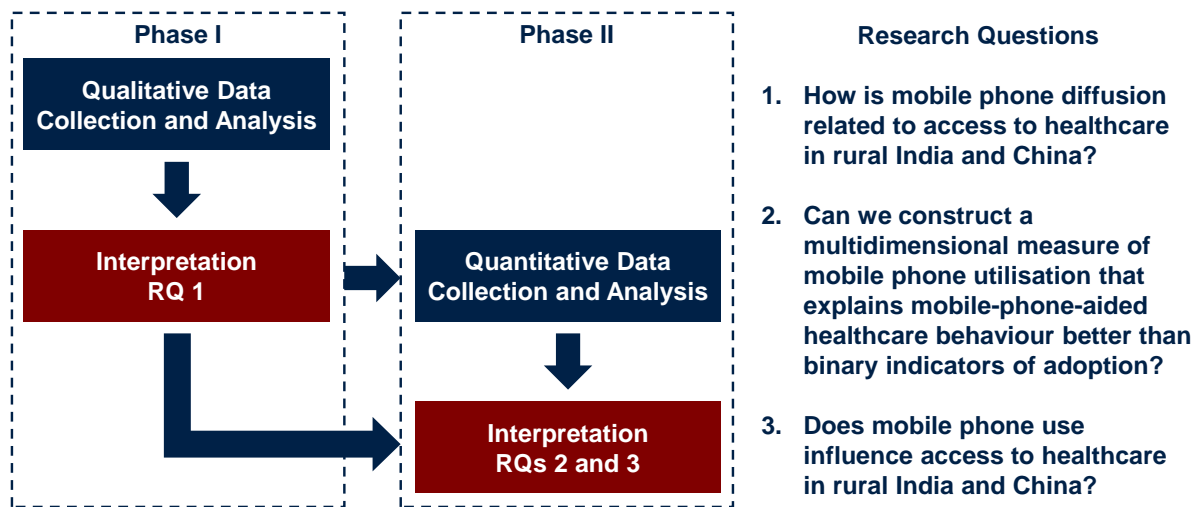
Source: Own illustration, adapted from Creswell *et al.* (2008:69).
Note. RQ is Research Question.

I derived my design and methods from the research questions as follows. One of the main intentions of this research is to explore the under-studied interface of mobile phones and health, which faces limited theorisation and sparse empirical evidence regarding the healthcare consequences of mobile phone diffusion. Given the limited existing research in this area, the exploratory nature of all three research questions favours qualitative research in order to understand the nature of people's interaction with mobile technology and whether and how mobile phones permeate their health behaviour. Long-term participant observation and ethnographic methods would be ideal to understand such intimate processes (Angrosino, 2007). However, neither temporal nor financial scope of the DPhil research project permitted such endeavours (at least not in connection with other methods). A second-best option is interview-based qualitative research in which respondents express their healthcare experiences with and without mobile phones. Thematic analysis of semi-structured interview and group responses can then help to inform the categories of the theoretical framework and their linkage. Section 3.5 explains this qualitative approach in detail.

While the qualitative work helps to articulate the theoretical link between mobile phones and healthcare access from the bottom up, it is not suitable to make judgements about the prevalence of phone-aided behaviour within a given population, about the relative importance of predictors such as phone ownership or utilisation, or about the size of any impact of phone use on healthcare access. Descriptive and inferential quantitative methods are better suited to make such statements. Ideally, this would involve a large-scale field experiment in which people randomly engage in mobile phone use during an illness, for instance by selectively deactivating their mobile network connection. Aside from the possible violations of ethical norms in such an experiment, the social embeddedness of technology use imposes obstacles to individual- or community-level randomisation in experimental trials. Alternatively, long-term panel data on the individual level would enable assessments of behavioural and healthcare access changes alongside the increasing diffusion of mobile phones, while controlling for unobserved individual-specific effects (Wooldridge, 2010:281-285). However, DPhil research restrictions make such long-term data collection efforts infeasible as well. Conversely, existing panel data sets from India and China were not designed to study mobile phone use and healthcare access with the intricate level of detail that is desirable for this research (Desai & Vanneman, 2015; Desai *et al.*, 2008; Hannum *et al.*, 2011). The next-best option for a quantitative assessment therefore is to collect primary cross-sectional survey data, and to infer population-level patterns of phone-aided health action on this basis.[34] This is the quantitative approach pursued in this thesis, and Section 3.6 outlines the survey instrument as well as sampling and implementation procedures. The specific analysis techniques are discussed closer to their actual application in the quantitative Chapters 6 and 7.

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[34] The challenges arising from choosing second-best research methods to answer the research questions are discussed as limitations in the empirical discussion, Sections 4.6, 6.5, and 7.4.1.

The qualitative and quantitative approaches in this thesis are linked sequentially, beginning with the qualitative part to establish a grounded framework and derive hypotheses, which are subsequently being tested quantitatively. The data collection phases took place separately because it was necessary to first analyse the qualitative data in order to inform the quantitative survey questionnaire. For example, the qualitative insights informed the conceptualisation and operationalisation of a three-dimensional mobile phone utilisation index that enables more precise prediction of phone-aided health action. In addition, the interpretation of the quantitative findings is aided by the qualitative research, providing a more contextualised and nuanced understanding of the study results.

Qualitative and quantitative approaches are therefore combined in a synergetic manner, utilising the strengths of each approach (Onwuegbuzie & Leech, 2005:384; Teye, 2012:380). The qualitative approach employs purposive maximum variance sampling to attain information saturation, and it uses grounded theory techniques based on thematic analysis in order to capture an exhaustive set of themes from the perspective of the rural resident. In the quantitative leg of the study, I draw a larger sample from my field sites using systematic cluster random sampling in order to test statistically the predictors and effects of phone-aided health action, thereby making inferences to the population of my sites on the district level. This mixed methods approach enables me to integrate theory generation and testing (Teddlie & Tashakkori, 2009:33). Qualitative analysis alone would be unsuitable to make inferences about frequencies and effects for the field site populations, and the quantitative analysis would be based on inappropriately simplistic assumptions and/or context-insensitive survey instruments without the preceding qualitative exploratory phase (Teddlie & Tashakkori, 2009:189-190).

Despite these advantages, the research design faces challenges related to quality judgements and fundamental philosophical viewpoints. The linkage of qualitative and quantitative methods requires a broader set of indicators to judge the quality of the research (see Table 3.1

for an illustrative selection of indicators). Qualitative research is typically judged by credibility, confirmability, transferability, dependability, transparency, relevance to users, and reflexivity (Lincoln & Guba, 1985:328; O'Cathain, 2010:534). In contrast, common quality criteria for quantitative research are validity, reliability, replicability, generalisability, transparency, appropriateness, and intelligibility (Bryman *et al.*, 2008:265; Lincoln & Guba, 1985:300; O'Cathain, 2010:533-534).

   To some extent, it is necessary to abide by these separate quality standards for qualitative and quantitative research (Curry *et al.*, 2013:121-122). For instance, considerations about the power-relationships between researcher and respondents may not only vary across different study populations, but also across different methods that introduce proximity (qualitative) or distance (quantitative) between these parties (Mayoux, 2006:117; Teye, 2012:388-389). However, the mixed method community apply additional criteria specific to their research (Bryman *et al.*, 2008:268; Heyvaert *et al.*, 2013:314; Teddlie & Tashakkori, 2009:301-302). O'Cathain (2010:541-544) provides an extended list of such mixed method research quality criteria, covering the eight domains of planning quality, design quality, data quality, interpretive rigor, inference transferability, reporting quality, synthesisability, and utility (see Table 3.1 for examples). Although this list subsumes some of the quality criteria of the individual methodological strands, it will be necessary in this thesis to not only explain method integration at each step of the research process, but also to transparently describe the qualitative and quantitative methods in their conventional manner in order to permit quality judgements for the reader.

Table 3.1. Quality Criteria and Examples: Qualitative, Quantitative, Mixed Method Research

Qualitative Research	Quantitative Research	Mixed Method Research
Credibility *Prolonged engagement with respondents*	**Validity** *Control variables to rule out alternative explanations*	**Planning quality** *Justification for mixed method research*
Confirmability *Reflexive journal*	**Reliability** *Standardised survey question wording*	**Design quality** *Design is appropriate for addressing research question*
Transferability *"Thick," contextualised description to enable considerations on transfer to other contexts*	**Replicability** *Detailed description of data analysis strategy*	**Data quality** *Detailed description of each method and its role*
Dependability *Authentication of research process through third party*	**Generalisability** *Randomisation*	**Interpretive rigor** *Transparent link of findings to respective method*
Transparency *Explicit framework and method of analysis*	**Transparency** *Benefits and limitations of statistical methods*	**Inference transferability** *Transferability to other contexts*
Relevance to users *Actively involve participants*	**Appropriateness** *Congruence between research question and method*	**Reporting quality** *Integrated reporting to go beyond each method's analysis*
Reflexivity *Discussion of research limitations*	**Intelligibility and relevance** *Significance of findings in society*	**Synthesisability** *Use of quality criteria for inclusion in systematic reviews*
		Utility *Results useful for policy makers*

Source: Own elaboration, compiled from Bryman *et al.* (2008), Lincoln and Guba (1985:301-327), O'Cathain (2010:541-544).

The application of combined quality standards also raises fundamental questions as to whether this is indeed feasible and consistent in light of the underlying philosophical motivations of these guidelines (Alise & Teddlie, 2010:115; Lincoln & Guba, 1985:300-301). It can be argued that quantitative researchers tend to follow a positivist epistemology and an objectivistic ontology, while the world views of qualitative research reflect constructivism, connected with an interpretivist epistemology (Burns, 2000:3; Neuman & Biga, 2006:151; Sullivan, 2001:99). Referred to as "purist" stances that champion mono-method approaches of academic enquiry, some authors maintain that the combination of different methodological approaches is infeasible because the underlying philosophical positions cannot be reconciled

(Onwuegbuzie & Leech, 2005:376). And there are indeed reports of mixed methods research projects failing because of power struggles as well as fundamental and unresolvable disagreements between researchers with different methodological backgrounds (Curry *et al.*, 2012; Lunde *et al.*, 2013).

There are at least three possible responses to the "incompatibility" argument from a mixed methods perspective. Firstly, the successful application of mixed method research projects in the past suggests that the combination of qualitative and quantitative approaches is indeed possible and yields useful insights. For example, Brown (2000) exploits the complementarities between household, community, and technical surveys with photographic record analysis and focus group interviews in order to broaden and triangulate her research findings. Likewise, Lampietti (2000) uses ethnographic research in order to inform the design of a quantitative household survey to understand people's willingness-to-pay for malaria prevention. In light of feasible applications, mixed method researchers have repeatedly argued that the claimed irreconcilability of qualitative and quantitative approaches is counterproductive (Bergman, 2010:173; Bryman, 2008:604-606; Creswell, 2009:102; Payne, 2006:174), or have gone as far as claiming that "mono-method research is the biggest threat to the advancement of the social sciences" (Onwuegbuzie & Leech, 2005:375). Though we may disagree on the gravity of such utterances, the findings generated through mixed method research suggest that its application can at least be useful to understand the phenomenon in question.

Secondly, the boundary between qualitative and quantitative approaches is not necessarily as clear as the notation suggests (Johnson *et al.*, 2007:117). It makes a difference whether one refers to "quantitative methods" as data collection and analysis techniques or as a methodology to which certain philosophical stances are intrinsically connected. For example, Sandelowksi argues that a research project can combine qualitative grounded theory and experiments from a positivist perspective, or that quantitatively analysed survey data can be interpreted

through a constructivist lens (Johnson *et al.*, 2007:121; Sandelowski, 2014:4). The terms "qualitative" and "quantitative" can therefore be misleading and their juxtaposition against "mixed methods" enforces the reproduction of a somewhat artificial and imprecise divide.[35]

Thirdly, and related to the previous point, while a positivist or constructivist researcher may rely on a particular set of methods that corresponds to his or her world view, the reverse is not necessarily true (Onwuegbuzie & Leech, 2005:376). I argue that the claimed irreconcilability between approaches rests on the level of research philosophy rather than method choice. It is easier to argue that thematic and statistical analysis can together inform a research question than to harmonise philosophical views that (a) objective truth is discoverable and that (b) it is merely a mental construct (Teddlie & Tashakkori, 2009:85). In line with this argument, researchers have proposed alternative philosophical viewpoints that are consistent with the use of mixed method research designs. The most prominent among these is the "pragmatist" view that focuses on the potential outcomes of the research processes and judges the value of the means accordingly (Johnson & Onwuegbuzie, 2004:16-17). In other words—and this is seen as justification for applying mixed method research—a research method is suitable if it contributes to answering a research question, given its specific strengths and weaknesses. At the same time, it is argued that this outcome-oriented approach obscures rather than solves epistemic puzzles, to the extent that pragmatism is being understood as "anti-philosophy" (Johnson & Onwuegbuzie, 2004:18). An ontological stance that helps to inform this debate and that is compatible with philosophical pragmatism is "realism" (Maxwell & Mittapalli, 2010:152). Realism itself is a heterogeneous approach, but it tends to emphasise the existence of a tangible real world onto which theories and empirical knowledge are merely projected and therefore are

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[35] I adhere to the classification of "qualitative," "quantitative," and "mixed method" research because of notational conventions, treating them as sets of techniques.

never fully objective (Maxwell & Mittapalli, 2010:153). This resonates with pragmatist research that tends to avoid perfect, certain, or absolute claims and thus helps to put it on a sounder epistemological foundation (Johnson & Onwuegbuzie, 2004:18; Mertens, 2012:256).

My rationale for combining qualitative and quantitative techniques in this study can be described as consistent with such a pragmatic realist stance. In the process of applying qualitative and quantitative methods to answer my research question, I aim to utilise the strengths and to minimise the limitations of each method, but I do not intend to uncover an absolute truth or a general law of mobile phone use. At best, the analysis will yield patterns that are consistent with people's behaviour in the field sites, but further research would be necessary to establish whether any such patterns are present beyond rural India and rural China (whose selection as field sites is explained in the following section).

3.3   Site Selection in India and China

In order to inform the link between mobile phones and healthcare access, I study rural India and rural China as two socio-culturally distinct contexts with fast mobile phone diffusion but also with persistent healthcare challenges. The comparative case study was chosen to identify factors and effects that may vary and that may be stable across distinct social, cultural, and economic settings. Fieldwork took place from September to December 2013 (qualitative phase) and from August to October 2014 (quantitative phase). The study sites in Rajasthan and Gansu are depicted in Figure 3.2. This section explains the rationale and process of their selection. More detailed field site descriptions including technology diffusion patterns and the epidemiological contexts follow in the qualitative Section 4.2 and in the quantitative Section 6.3.

Figure 3.2. Fieldwork Locations in Gansu (China) and Rajasthan (India)
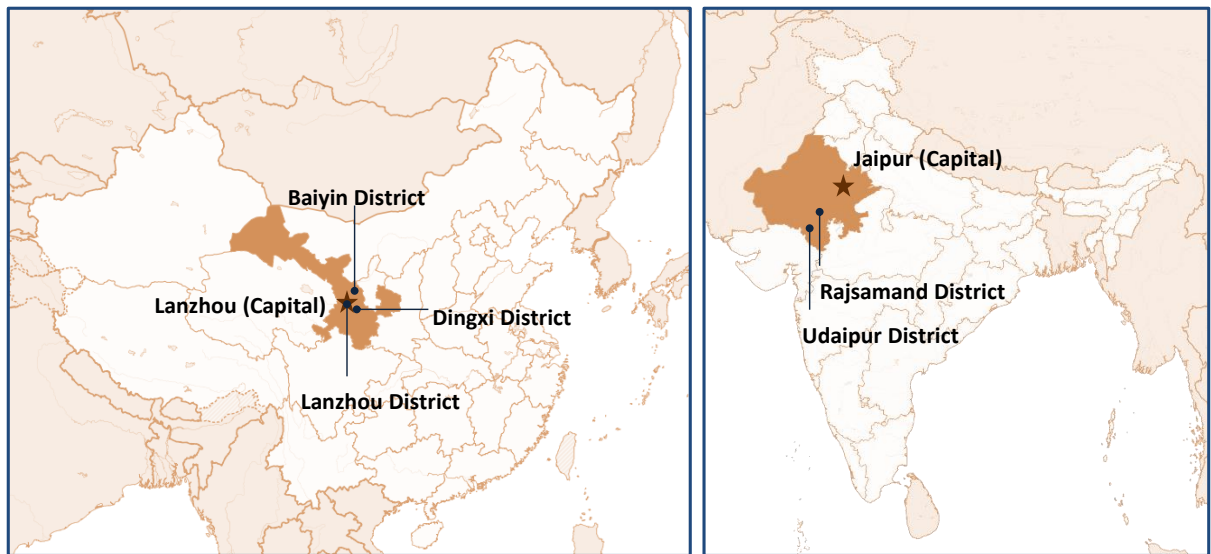
Source: Adapted from Wikimedia Commons (2013), map copyright by Joowwww (Rajasthan) and TUBS (Gansu).

I focus the analysis on the Indian state of Rajasthan and the Chinese province of Gansu. Both are among the poorest regions in their respective countries, with the majority of the population living in rural areas. The logic of my field site choice is that, if mobile health technology is hoped to improve the living conditions for the rural poor, then this exploratory analysis should also focus on the behaviours of the poorest parts of the population. However, a clear implication of this choice is that my research does not permit overarching statements for these countries as a whole: both states' gross domestic income is approximately 40% below their national averages (China Marketing Research, 2014; Datanet India, 2014; IMF, 2015); literacy rates are worse than their national averages as well (Government of India, 2011:34; WHO & Ministry of Health P.R. China, 2013:31); and with a rural population share of 63% in Gansu and 75% in Rajasthan, both regions are well above the national rates of 49% in China and 69% in India (Government of India, 2011:1; NBS, 2011). In addition, Gansu fares somewhat better than Rajasthan in typical healthcare indicators: the numbers of doctors and hospital beds per 1,000 people in Gansu are seven times as high as in Rajasthan, despite the fact that the Rajasthan figures are slightly above the Indian average (China Marketing Research, 2014; Datanet

India, 2014; NBS, 2011). Moreover, state-level averages at the time of the survey suggested that phone diffusion was broadly similar in both regions, with 74 mobile subscriptions per 100 persons 2012 (Rajasthan) and 2013 (Gansu; ISI Emerging Markets, 2012; ISI Emerging Markets, 2013). Overall, the structural differences in healthcare infrastructure and the somewhat higher economic development indicators in Gansu are factors that potentially influence the observations and conclusions on mobile phone use for health in these different contexts.

My field sites within Rajasthan and Gansu are rural areas of Udaipur and Rajsamand (Rajasthan) and of Baiyin, Lanzhou, and Dingxi (Gansu).[36] The selection of the field sites was purposive, considering (a) mobile phone diffusion and economic status in relation to state averages, (b) compatibility of geographic conditions of the rural sites across Rajasthan and Gansu, (c) accessibility of rural dwellers, (d) availability of research partners to facilitate community access, and (e) considerations of political stability and personal safety (e.g. excluding unmarked border regions to Pakistan in Rajasthan and autonomous regions in Gansu). Secondary household survey data from the regions facilitated the district selection. The latest available survey data was the Indian District-Level Household and Facility Survey in Rajasthan (2007-2008), and the Human Resources for Health in Rural China Survey in Gansu (2010-2011; IIPS, 2010; Liu & Ariana, 2012). Appreciating the mismatch of the data periods, the somewhat outdated information for Rajasthan, and the only limited data available for Gansu, the selected districts represented average or below-average household mobile phone ownership (see Figure 3.3). In addition, both Rajasthan and Gansu offer vast topographical diversity ranging from deserts via semi-arid plains to mountainous areas (Gansu is situated at a higher altitude than Rajasthan). The selected field sites were chosen to fall into hilly and mountainous areas with

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[36] Better highway infrastructure enabled geographically more extensive coverage in Gansu within the given resources. The Rajasthan field sites fall into what is described conventionally as the "tribal belt" with a larger population share of Scheduled Tribe groups.

sparse rural settlements that tended to be more difficult to access. Because of the challenging

terrain in both sites, also the density of healthcare providers was low and concentrated in distant

urban centres.

Figure 3.3. Average Household Phone Ownership in Field Sites
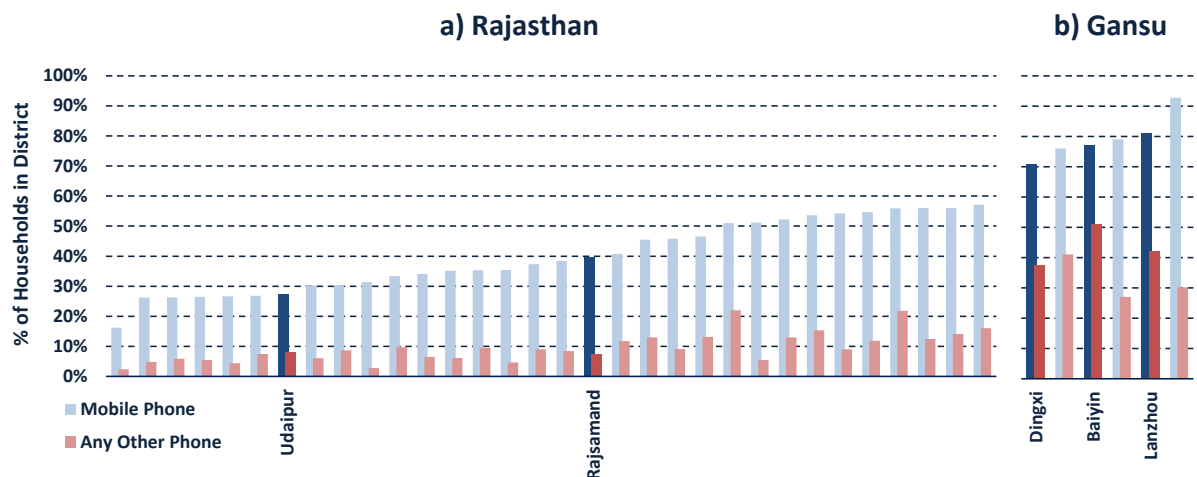
Source: Own illustration, based on IIPS (2010); Liu and Ariana (2012).
Notes. Based on latest available household data at time of research design development. Rajasthan data from 2008, based on 40,052 households. Gansu data from 2011, based on 582 households. Rajasthan data representative and weighted using household weights. Gansu data only available for 6 out of 14 prefectures, data on county level, no sample weights provided.

Across the selected districts, I chose purposively a representative set of eight sub-dis-

tricts per country, aided by local facilitators and resource persons familiar with the sites. Cri-

teria for selection included relative economic development, remoteness, and healthcare access.

The village selection within these sub-districts followed different strategies for the qualitative

and the subsequent survey data collection. For the qualitative work, village sampling was pur-

posive in order to attain maximum diversity with the aim of information saturation. Community

access in Rajasthan was particularly challenging as a Western researcher. This meant that the

village selection and access in the first research stage in Rajasthan was facilitated by the local

non-governmental organisation (NGO) Seva Mandir, which has been carrying out extensive

community-based activities for 45 years in now 700 villages across the districts of Udaipur and

Rajsamand (Seva Mandir, 2015). Such institutional assistance was not required for the Gansu

leg of the qualitative research, where available maps and administrative sub-district data facil-

itated the site selection. In contrast to the purposive village selection in the qualitative phase,

the subsequent survey involved the random selection of villages across the eight sub-districts

in each country, stratified by the distance to urban centres in order to ensure that both remote

and more central villages are represented in the sample. Details on the sampling strategies are

presented in the qualitative and quantitative sections of this chapter.

In summary, the main factors for the site selection are the rapidly increasing teledensity

and the geopolitical significance of India and China; the relatively poor economies and health

systems of rural Rajasthan and Gansu; the comparable topographies and the availability of local

partners in the selected districts; and the economic and spatial variety of the sub-districts within

the chosen locations. In the remaining sections, I explain the central tenets of the qualitative

and quantitative approaches.

3.4   Preliminary Framework: Technology and Health in the Capability Approach[37]

My starting point for the qualitative enquiry into mobile phones and healthcare access

was Amartya Sen's Capability Approach (CA). The CA is originally a normative framework

to evaluate the quality of human life and the process of development (Robeyns, 2006:352).[38] It

places emphasis on people as ends rather than means of development, where development is

understood as an expansion of humans' ability and freedom to live the life they value (Stewart

& Deneulin, 2002:64). But the CA does not only offer a perspective on how "development"

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[37] I presented a modified and extended version of this section at the Human Development and Capability Associ-
ation Annual Conference 2014, 2-5 September 2014 (Haenssgen & Ariana, 2014). Proochista Ariana contributed
to this paper through her initial conception of technology as conversion factors.

[38] Two main strands of the CA exist. Sen's version focuses on human development, whereas the strand developed
by Martha Nussbaum places more emphasis on social justice and human dignity. I chose to rely on Sen's version
due to it greater flexibility and versatility.

(and health therein) is understood. It also provides a platform for articulating the role of technology in development processes (Andersson & Hatakka, 2013:288; Ariana & Guevarra, 2011; Heeks & Molla, 2009:33-40). Normative analyses of technology under the CA investigate for instance how technology-related development processes would be deemed valuable from an individual perspective (Birdsall, 2011; Johnstone, 2007). Beyond normative analysis, variations of the framework have been applied to exploratory analysis that would, for example, study the link between technology, human development, and economic growth (Ranis & Zhao, 2013:468-469). However, there is no agreed notion of how technology should be conceptualised in the CA (Andersson *et al.*, 2012:1). This section therefore examines the position of technology within the Capability Approach in order to guide the qualitative enquiry.

The CA is not the only framework that can be applied to the conceptualisation of technology in health and development. Other possible frameworks include structuration theory, actor-network theory, or technological affordances (Gaver, 1991; Giddens, 1984; Latour, 2005). For instance, an affordances focus would draw attention to the way in which the use of technological objects would emerge through the interaction of their design specifications and human perceptions (Gaver, 1991:79-80). Structuration theory as the interplay between individual-level agency and societal-level structures may be applied to individual technology uses that result from health system and societal configurations (Jones & Karsten, 2008:150). And Latour's actor-network approach could point to the activities that humans "delegate" to technology and the purposes that this could fulfil (e.g. to absolve one from taking responsibility for an undesired outcome; Latour, 2005:70-71; Scott-Smith, 2014:33-34). However, one of the main advantages of the CA over these theories is its inbuilt focus on development outcomes such as health, which in themselves are value-sensitive. In addition, the open-ended nature of the CA lends itself well to the generation of interview questions and tentative analytical categories to prepare the qualitative research (Merriam, 2009:70; Zheng, 2009:74). At the same

time, the CA and the aforementioned theories are not necessarily incompatible. In fact, different versions of the CA often incorporate streams from these and other theories (e.g. Oosterlaken, 2013:148). For example, the choice framework by Kleine (2013) as a derivative of the Capability Approach situates technology use within a dialectic of structure and agency that resembles Giddens's approach.

This section has two parts. I first explain the main elements of the CA and highlight the inconsistencies and omissions of existing notions of technology in this framework. In the second part, I develop a consistent approach to technology within the CA language as a starting point for my qualitative investigation. The conceptual and methodological implications of choosing this framework are discussed at the end of this section.

3.4.1 Basic Elements of the Capability Approach

The Capability Approach has been analysed and discussed from many angles. As a complete review would be redundant in light of extensive works like Robeyns (2005), I summarise here only the main elements before I discuss existing notions of "technology" in the framework. The main elements are inputs, capabilities, conversion factors, functionings, and agency (depicted in Figure 3.4).

Figure 3.4. Basic Elements of the Capability Approach
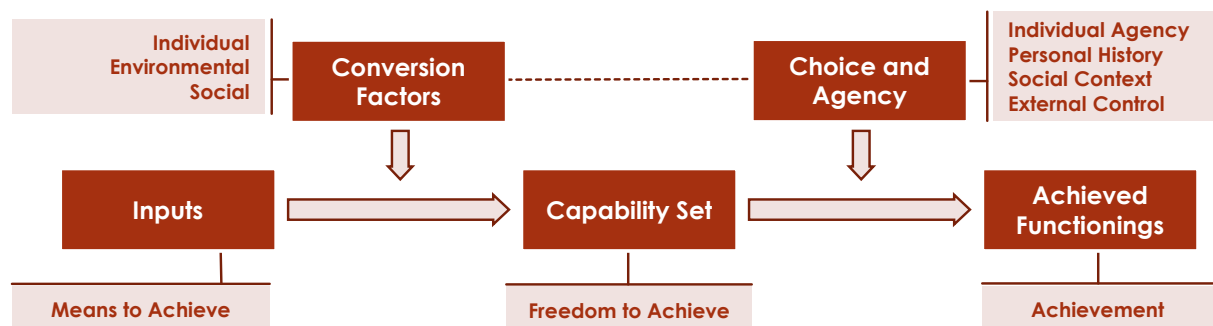
Source: Own illustration, adapted from Robeyns (2005:98).

Inputs are the means through which humans can achieve the lifestyles they value (Sen, 1992:36): Inputs as material or immaterial goods and services generate "characteristics" that satisfy needs, for example calories and micro-nutrients (characteristics) of foodstuffs (inputs) contributing to nourishment (valued outcome; Sen, 1981:24-26). In the case of health, specific inputs include the presence of doctors and nurses ("human resources for health"), hospitals and emergency services ("health infrastructure"), or health-related information.

Inputs are necessary for attaining valued life courses, which are represented by the capability space. Each capability forms a constituent element of a life that is worth living. Described as "doings" and "being" that people value and "have reason to value" (Sen, 1992:40), capabilities are articulated through critical reflection on the question, "What is a valuable life?" (Ibrahim, 2011:10-11; Kleine, 2013:44, Note 43; Sen, 1999:293; 2004:52 and Note 13). A wider capability set includes more life choices and therefore implies an improved "freedom to choose" the life one wants to live (Sen, 1992:39-40). Although the framework emphasises individual and collective reflection to arrive at valued capabilities, some options can be considered valuable in themselves regardless of whether people perceive them as subjectively important. Bodily and mental health is an example, where individuals are almost certainly better off if they can attain these, *ceteris paribus* (Ariana & Naveed, 2009:239; Sen, 2004:55). However, while these intrinsic elements would contribute to one's well-being, it is not clear *a priori* whether a person would actually choose to pursue them given other choices and constraints.

The translation of inputs into capabilities is context specific. For example, equal levels of food will be of different use for children, adults, pregnant women, people who suffer from diarrhoea, or disabled persons (Sen, 1985:199; 2004:47). Sen accounts for these variations between individuals and groups with interrelated "conversion factors" (Basu & Lòpez-Calva, 2011:176; Crocker, 1992:595-596; Robeyns, 2005:97; Sen, 1992:33; 1999:70-71). The defining feature of conversion factors is their *transformative* nature, blocking, filtering, or enhancing

the characteristics generated by inputs. Three different classes are typically considered in the literature: individual (e.g. metabolism), social (e.g. norms and customs), and environmental (e.g. climate) conversion factors (Ariana & Naveed, 2009:234; Robeyns, 2011: "Conversion factors", Para. 1).

Whereas capabilities represent the life *possibilities* that are open to individuals, functionings describe the lifestyles that they choose to pursue (however, not all these choices are observable from an external perspective). Capabilities and functionings therefore share valuable "beings" and "doings" as constituent elements, but functionings reflect what people chose to "achieve" (Alkire, 2005a:2; Kleine, 2010:679; Sen, 1992:39). For instance, an undernourished person may have chosen that state through fasting (Sen, 1992:50).

People's agency and decision-making processes influence the transition from the capability set to specific functionings. Agency addresses people's ability to bring about change on their own, "whether or not these achievements are connected to one's own well-being" (Alkire, 2002:6).[39] This means that personal objectives or obligations may be at odds with people's physical integrity, for example when participating in demonstrations or engaging in risky sports (Alkire, 2005a:3; Sen, 1985:203). This process of goal setting and pursuit involves deliberate decisions that are influenced by the personal history and characteristics of the person (Crocker, 2008:11; Robeyns, 2005:98). Also external influences can interfere with this process, potentially biasing, misleading, or even manipulating persons. This can happen by experiences or context shaping "frames of reference" (Sherif, 1935:52-53), but criteria and routines of decision-making may also be influenced directly, for example by advertising, peer pressure, or power relationships (Ariana & Naveed, 2009:238). At the same time, social norms, religious practices, and local knowledge can also act as helpful mediators and guide decision-making to

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[39] Agency can also permit paternalistic intervention, as long as external control achieves what people would have chosen—except for acting on one's own (Alkire, 2005b:121; Crocker, 2008:10-12).

such an extent that "some people might find them very enabling and supporting" (Robeyns, 2005:101-102). The local context can therefore influence both conversion factors and people's agency, as is indicated by the dotted line connecting these two categories in Figure 3.4.

Overall, this framework draws attention to the values and choices, but also to trade-offs and contextual constraints involved in attaining desired life options, for instance in the case of health. But the reader will have noticed that "technology" does not appear in any of the original CA categories. The notion has only been added later through normative analyses of what technology ought to achieve in development, applied frameworks that evaluate technologies' role in development processes, and discussions of value-sensitive technology design in the domain of engineering.[40] Existing conceptualisations take four different shapes if translated back into the abstract CA framework (Figure 3.5).[41]

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[40] These three approaches are not mutually exclusive. For examples of applied frameworks, see Gigler (2011) and Kleine (2013). For normative discussion of technology, see Coeckelbergh (2010) and Smith *et al.* (2011). For technology design using the CA, see Oosterlaken (2013) and van den Hoven (2012).

[41] My starting point is the use of the CA as an analytical rather than a normative framework in order to guide my exploratory qualitative enquiry of human-technology interaction (rather than to e.g. prescribe courses of action; Martins, 2007:42). Many of the authors below follow a normative approach and would probably disagree with this procedure, neither would they necessarily describe themselves in the way that I categorise them within the abstract version of the CA. The point here is not to prove these authors wrong, but rather to harmonise the existing notions of technology as they arise in the numerous variations of the CA within Sen's original framework as the most abstract level of analysis. Inconsistency in Sen's abstract version of the CA does not imply an inconsistent argument in the original writing.

Figure 3.5. Conceptions of Technology in the Capability Approach Literature

a) Technology as Input

b) Technology Affecting Conversion Factors

c) Technology Affecting Conversion Factors and Agency

d) Technology Affecting Conversion Factors, Agency, and Inputs
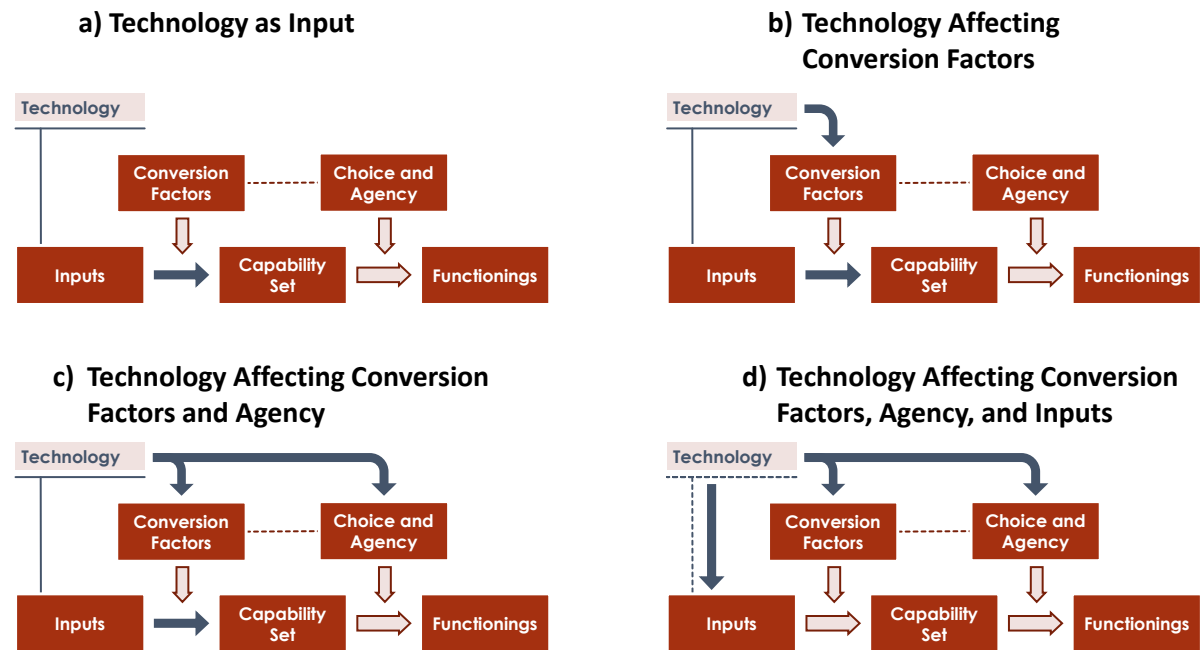
Source: Own illustration, adapted from Robeyns (2005:98).

The majority view of technology and the CA is that technology is an input that enables capabilities (Alkire, 2005a:4; May *et al.*, 2014:17; Oosterlaken, 2009:94; Robeyns, 2005:99; Sen, 2010:2). This is also the narrowest conception: Technology is "used" alongside other inputs such as food in order to exploit its particular characteristics (Figure 3.5, Panel a). This view of technology has been extended to include interactions between technology inputs and conversion factors (Johnstone, 2007:79-80; Oosterlaken, 2009:95-99; 2013:219; Oosterlaken & van den Hoven, 2011:65). The principal difference to the previous stance is the potential bidirectional relationship between conversion factors and technology inputs (Panel b). Panel c represents a group of authors who more strongly emphasise that technology (especially ICT) coevolves with values and choice processes (Coeckelbergh, 2011:86; Zheng, 2009:77; Zheng

& Stahl, 2011:78). Lastly, applied CA frameworks underline the transformative nature of (information and communication) technology akin to conversion factors, as illustrated in Panel d (Gigler, 2004; Kleine, 2013; Miroro & Adera, 2014).[42]

All these different notions agree on a special emphasis of technology in the CA. Should this attention result from technology as a special kind of input, or because the idea of "technology" is fundamentally different from the idea of "inputs?" Until now, "technology as a special input to expand human capabilities" has been the intuitive starting point for almost all technology-augmented capability frameworks. This assumes that technology carries characteristics that are necessary to attain valuable life choices, but such interpretations are either too narrow or incompatible with the concept of inputs in the CA. A narrow conceptualisation of technology as an input like any other may be justifiable on definitional grounds, but it would encourage neglecting the plausible relation between technical objects and other inputs and to conversion factors. Conversely, the more complex notions blur the distinction between inputs and other analytical categories in the CA. If we are satisfied that technical objects behave in the same way as conversion factors, how can we reconcile this with their common depiction as inputs?

3.4.2 Defining Technical Objects and Technological Conversion Factors

In order to harmonise the varying perspectives, it is useful to revisit the question whether technology is indeed fundamentally different from the notion of inputs.

Some CA scholars state that technology, be it an isolated technical object or the sum of all technical artefacts, interacts or coevolves with the larger social context (Oosterlaken, 2011:429). Likewise, Brynin and Kraut (2006:6) suggest that the technology surrounding us can reconfigure our goals. The authors exemplify this with the study by Turkle (1995), who

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[42] These frameworks tend to use variations of the sustainable livelihoods approach (DFID, 1999).

documents how individuals start creating and negotiating different identities on the Internet (Turkle, 1995:258-262). Yet, the idea of coevolution between humans and objects is not unique to technology. Anthropologists like Miller (2010:53) describe how *all* objects (material as well as immaterial, e.g. laws) influence our interaction with the world. If this applies to all objects around us, it is not clear whether technology should receive any fundamentally different treatment in the CA. We could argue either that technology should remain an input alongside others, or that all inputs should have their relationships to conversion factors and human agency redefined.

Other arguments in favour of a special place of technology face similar complications. For example, if it is argued that technology enhances cognitive functions such as calculation and reasoning (Johnstone, 2007:79), then how do we judge evidence linking the intake of calories and nutrients to the ability to carry out physical and cognitive tasks (Dasgupta, 1997:11-15; Falkingham *et al.*, 2010; Hoyland *et al.*, 2009)? Lawson (2010:216-217), who discusses the nature of technical versus other objects, might reply that technical objects are distinct because they are not consumed in the process of enabling such functions, unlike food in the preceding example.[43] However, because Lawson (2010) argues in terms of the expansion of human ability rather than human capabilities (the latter of which is a wider concept), his point does not unambiguously distinguish technical objects within the analytical concept of "inputs" in the CA. He specifically argues that "toys" are not technical objects despite their durable nature because the toys' contribution to human ability persists in their absence as they help develop "hand to eye co-ordination […] along with an understanding of how objects function, break, etc." (Lawson, 2010:217). While the argument is sensible, a technical object within the

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[43] He argues that the effects of technical activities are transient rather than permanent, thereby distinguishing them from food. My previous argument undermines his point, as food "inputs" yield transient effects on human cognition, or at least rectify the adverse effects of acute malnutrition.

CA cannot be distinguished from other "inputs" in this way because toys also enable transient states of "being entertained" that could fall under the definition of "capability." Therefore, although existing arguments in favour of a distinction between technical objects and other "inputs" make reasonable claims about the nature of technical objects with particular attributes, the arguments suggest that technical objects broadly fulfil the same purposes as other inputs within the CA (i.e. a direct expansion of human capabilities).

Is technology then yet another input? I argue that its linkage to the social context renders technology strikingly inseparable from other inputs. In addition, it is plausible that technology *as a physical object* carries characteristics that directly enhance human capabilities, just like any other input. Stirrat (1989:109) reports the case of Sri Lankan fishermen who acquire TV sets despite being disconnected from the power grid, and water tanks that never store water. The technically defunct TV sets arguably fulfilled valued capabilities of "identifying with a desired social group" or served as a "work of art" that represents the purchaser's labour and aspirations (Gell, 1986:114-115; Stirrat, 1989:109). But while the symbolic and aesthetic characteristics of technical objects are undeniable (Fortunati, 2005:156-157), technology only considered in this generative capacity (i.e. the object as bearer of characteristics) behaves fundamentally in the same way as other inputs in the CA.

We may be reluctant to concede that the satisfaction of aesthetic desires is the main feature of technical objects. Instead, they are distinct from other physical objects because they modify the characteristics of *other* inputs. The argument that technology directly extends human abilities suggests that it enables humans to do other things better (Lawson, 2010:216-217). A similar argument is made by van den Hoven (2012:35), who describes the nature of technical objects as "agentive amplifiers," which behave like conversion factors that alter the characteristics (e.g. nutritional content) of other inputs (e.g. food) by modifying them directly (e.g. through a cooking stove) or through their combination (e.g. through a recipe).

I argue that this modification of other inputs is what sets technical objects apart from other "input objects" within the CA. In the words of Oosterlaken (2011:428), technical objects have a "dual nature." Yet whereas Oosterlaken (2011:428) refers to this dual nature as "both a social and a material one," my notion of duality pertains to a "generative" dimension of technical objects as bearer of characteristics like other objects, and a "transformative" dimension that influences the characteristics of other objects. In this transformative dimension, technical objects fulfil functions that are otherwise the domain of conversion factors, namely moderating the translation of other inputs into valued capabilities. This transformative dimension defines objects as technical artefacts in my framework.

If we accept that technical items have a dual nature that generates characteristics and modifies the characteristics of other inputs, it leaves open the question as to how an object acquires transformative qualities. I maintain that these qualities are not intrinsic to the object but assigned to it within the socio-technological context.[44]

That the context defines the technology has been shown in situations where people re-interpret and re-configure existing technologies. Rogers (2003:244) cites the case of Punjabi farmers who acquired tractors for agricultural work—yet because the local technological knowledge only related to the use of bullocks, the maintenance of tractors reflected the care they gave to their animals. Consequently, they covered the tractors with blankets to keep them warm during winter at the risk of overheating and machine breakdown. In a similar vein, Lansing (1987:339) reports the case of a complex yet effective irrigation system using a network of "water temples" in Bali, which was not even recognised ("indeed invisible") as an irrigation technology by Western agricultural consultants. In short, what counts as technical

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[44] This does not exclude the possibility that the "affordances" of a technical object influence the way in which humans engage it.

object and how it relates to other inputs depends on its socio-technological context (Pfaffenberger, 1992:497).

In line with Lemonnier (1986:154), I therefore argue that technical objects are the vehicles of a larger socio-technological system of techniques that "[brings] into play materials, sequences of action, 'tools' (including the human body), and a particular knowledge. This latter is at the same time know-how, manual skills, procedures, but also […] a set of cultural representations of 'reality.'" Technical objects acquire their transformative nature from the socio-technical environment, and their role is defined in relation to it. In this sense, I concur with the idea that a technical object is different from an ordinary input, because they are used on behalf or as extensions of the human body in the translation of inputs' characteristics into valued capabilities. This may involve a transient extension of bodily and cognitive human ability as the aforementioned authors argued (Johnstone, 2007:80; Lawson, 2010). However, for the distinction to other "inputs" within the CA, the transformative dimension is decisive.

The socio-technological context is not limited to the knowledge to define an object as a technical object. In his theory of innovation diffusion, Rogers (2003:229-233, 240-244) suggests that this context further pertains to "complementary assets" that enable the successful use of a new technology (e.g. electricity grids or mobile network infrastructure), but also alternative ways of solving problems (thereby defining the "relative advantage" of a technology). This points at the importance of technology as a class of conversion factors in the CA.

An approach to technological conversion factors that considers the larger socio-technological system to include the complete set of problem-solving knowledge in a given society (see Ariana & Guevarra, 2011; Heeks & Molla, 2009:34, for early versions of this conceptualisation) conforms with the view "that human existence is already a human-technological existence" described by Coeckelbergh (2011:86). Along the same lines, Johnstone

(2012:86) maintains that "the use of technology in society as a whole can also affect our capabilities independently of our own use," for example as we are enabled to "eat a varied diet all year round because of high-tech agriculture and refrigerated transport." In other words, at any point in time, humans will have an array of tools and techniques at their disposal, which will influence the conversion of given inputs in different ways.

Defined in this way, it is possible to reconcile the different perspectives presented in the previous section. All objects serve as inputs as long as they carry characteristics required for attaining valued capabilities. What makes technical objects special is their transformative nature, thereby modifying the characteristics of other inputs in the same way that conversion factors do. Technical objects such as phones or roads can have these two natures at the same time. The technological environment defines technical objects and comprises the complete set of technological knowledge in a society. Technology as a class of conversion factors shares the features of other (e.g. individual or environmental) conversion factors, namely the influence on the translation of inputs into valued capabilities and the interaction with other conversion factors. The incorporation of technical objects and technological conversion factors is illustrated in Figure 3.6.

Figure 3.6. A Technology-Augmented Capability Approach
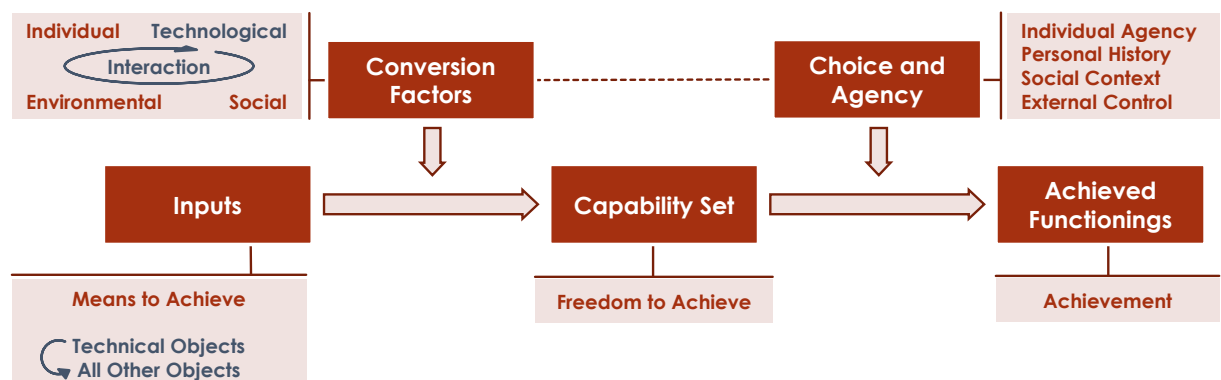
Source: Own illustration, adapted from Robeyns (2005:98).
Note. Elements in blue are additions to the original framework.

This conceptualisation had implications for my qualitative research approach. Firstly, technical objects may not necessarily generate characteristics themselves. A phone is unlikely to "produce" health or healthcare, but it may influence other inputs that do so. At the same time, unexpected uses may emerge where the technical object fulfils symbolic or aesthetic purposes. Secondly, the framework draws attention to alternative means of attaining the same capabilities through other combinations and modifications of inputs. Thirdly, interactions between conversion factors may influence the extent to which individual, social, and environmental conversion factors mitigate and amplify the technological environment and vice versa. The role of the technological context may even mean that the technical object in question is not perceived as such. Fourthly, agency and decision-making processes may be influenced by technology as they are by other conversion factors. Fifthly, a methodological implication of this framework is to shift the analytical focus away from owning and accessing a technical object like a mobile phone, and to consider instead broader patterns of phone utilisation in the context of attaining capabilities. Lastly, whereas some forms of using technical objects may be beneficial, others may be detrimental. The framework is intentionally broad to permit such heterogeneous and indirect outcomes. These implications influenced my initial framing of open-ended interview questions for qualitative research.

3.5   Qualitative Development of a Theoretical Framework

The first stage of the research design involves qualitative data collection and analysis in order to develop a framework of mobile phone use and healthcare access. With this explicit purpose, the qualitative strategy resembles grounded theory approaches (Merriam, 2009:29; Oktay, 2012:23). The preliminary, technology-augmented CA framework guided the data collection and enabled flexible and open-ended enquiry into the linkages between phones and

healthcare in rural India and China.[45] My informants were health and telecommunications experts as well as rural community members, whose responses I analysed through thematic analysis in order to establish the categories for my grounded framework and the linkages among them. This section explains the data collection methods (Section 3.5.1), the sampling and interview processes (Section 3.5.2), and the data analysis (Section 3.5.3). Given that this is a mixed methods research design, the qualitative stage was linked to the subsequent survey by exploring the field site contexts for sampling, by establishing framework and hypotheses to structure the survey instrument, by guiding the construction of focal measures for the quantitative analysis, and by interpreting the quantitative survey results with the help of the qualitative data.

3.5.1   Data Collection Methods: Interview Guides

Data collection methods in the qualitative phase included expert interviews with respondents from the health and telecommunication sectors (ranging from the central government to the local community level), semi-structured interviews with village residents, and focus group discussions with villagers.

Semi-structured interviews provide insights into the tentative analysis categories derived from the technology-augmented CA with the help of an interview guide. Individual situations and choices can then be explored flexibly within and beyond these categories during the interview. Focus group discussions essentially allow similar insights, yet also permit group dynamics to unfold during the session. Such dynamics can stimulate reflection, encourage the

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[45] The initial framework was complemented with the multidisciplinary innovation diffusion and health-seeking literature to specify the analytical categories. The innovation diffusion literature includes, among others, Bell (2005), Cohen and Levinthal (1989), Coleman *et al.* (1957), Foster and Rosenzweig (2010), Cox and Fafchamps (2007), Fu and Polzin (2010), Oster and Thornton (2012), Rogers (2003), Valente (2010), and van den Bulte and Lilien (2001); health-seeking behaviour literature includes Andersen (1995), Argys and Rees (2008), Cawley and Ruhm (2011), Dupas (2011), Evans and Stoddart (1990), Lambert (2010), Kremer and Glennerster (2011), and others.

emergence of new themes that would remain unexplored within the semi-structured interviews, and feed these themes back into the interview process in an iterative fashion (Lloyd-Evans, 2006:154; Morgan, 1997:11, 22-23). Due to these dynamics, the semi-structured interview and discussion guides are evolving guidelines rather than standardised questionnaires (Merriam, 2009:89).

While the tentative framework informed the interview and discussion guides, it was necessary to tailor them to the respective target groups. Five types of interview guides emerged as a result, comprising versions for health experts, regulators in the telecommunications sector, mobile network operators and service providers, villager interviews, and group discussions in village communities. Aside from standard introductions and questions about the personal background of the respondents, the main parts of the questionnaires related to mobile phones and healthcare (a sample interview guide is reproduced in Appendix 2).

Being central to the qualitative data collection, the community interview and discussion guides focused in depth on mobile phone adoption, on the role of mobile phones in people's lives, and on the influences of mobile phones on health-related behaviour and health outcomes. Questions on mobile phone use pertained to opinions about phones, use and non-use, symbolic and functional engagement with mobile phones, village-level patterns of ownership and use, and possible reasons that would explain these patterns. The influence of phones on people's lives was explored through a method common in the CA literature (Alkire, 2002:291; 2008:45): Respondents were asked to comment on how mobile phones influence various domains of their lives like health in order to understand "the full range of impacts […], good and bad, anticipated and unanticipated" (Alkire, 2002:225). The last part of the interview guides focused specifically on the role of phones in people's health and their general healthcare experiences. This also involved probing questions as to whether the respondent experienced any positive or negative effects of mobile phones in the context of living a healthy life.

Because of the dynamic evolution of the interview guides in response to salient and emerging themes, the interviews soon incorporated specific questions on people's healthcare experiences and different uses of the phone during the process of accessing healthcare. The healthcare-seeking process would later emerge as a central theme—or *core theme* in the language of grounded theory approaches (Oktay, 2012:17)—in both the qualitative and the quantitative analysis.

The purpose of the expert interviews was to gather contextual information rather than personal experiences. The health expert interview guide aimed to understand the health sector and healthcare provision in the field sites (e.g. quality, costs, and accessibility of care), the demand for healthcare services (e.g. patterns of access across social groups), healthcare provision through mobile phones (e.g. ambulance services or practitioners using phones), and whether any statistical data or policy documents would be available for further information. Interviews with telecommunication regulators focused on the composition of actors in the telecommunications sector, market activity and infrastructure policies, and again data and documents to complement this information. Discussions with network operators and service providers dealt with similar topics, but with a stronger emphasis on the competitive mobile market environment and usage patterns for rural areas. Owing to the factual nature of many questions in these interviews, triangulation and complementation through documentary and data sources was possible in order to generate a more comprehensive contextual description.

Taken together, the data collection methods to build a grounded framework focused on villagers' personal experience, complemented with contextual expert information. The flexible design and iterative integration of the data collection tools helped to adapt to the local context and to incorporate emerging themes dynamically.

3.5.2   Sampling and Data Collection Processes

The qualitative data gathering process took place from September to December 2013, first in Rajasthan and subsequently in Gansu. Sampling was purposive and geared towards maximum variation in order to ensure robust empirical grounding of the envisaged theoretical framework on the link between mobile phones and healthcare access (Lincoln & Guba, 1985:202; Merriam, 2009:78-79; Oktay, 2012:17). This produced a high-variance sample of 53 expert informants and 178 village-level residents (see Table 3.2). The qualitative data collection yielded 71:46 hours of recorded interview material in addition to written interview notes and supplementary documentation provided by expert informants. I discuss sampling and interview processes below, together with associated issues of access, research ethics, and translation. Challenges of researcher positionality are deliberated in the following analysis section.

Table 3.2. Summary of Qualitative Sample

	Number of Sessions		Number of Respondents	
	Rajasthan	Gansu	Rajasthan	Gansu
Community Interviews				
Individual Interviews	22	24	22	24
Dual Interviews	8	13	16	26
Focus Groups	10	11	51	39
Total	**40**	**48**	**89**	**89**
Expert Interviews				
Local Shop Owners	5	5	5	5
Local Health Staff	13	7	14	7
District Health Experts	2	1	2	1
Mobile Network Operators	3	1	7	1
mHealth Service Providers	4	2	4	3
Telecom Regulators	2	0	4	0
Total	**29**	**16**	**36**	**17**

Source: Fieldwork data.

Expert sampling required a broad range of respondents along central government, district, and local administrative levels in order to provide comprehensive contextual information. The principal sampling approaches for these expert interviews were purposive and subsequent snowball sampling (Arksey & Knight, 1999:124; Morgan, 2008:817). Respondents were selected according their expertise of national-, state-, and local-level conditions of the telecommunication and health contexts in which village residents are situated. I included a range of mHealth service providers in both country samples in order to understand opportunities and challenges in delivering phone-based health services. Facilitated by local research partners,[46] I approached an initial set of senior organisational members and academics to ensure wide coverage of contextually relevant organisations. While these contacts served as important informants in their own right, they also enabled further connections to resource persons concerned with mobile technology and rural health systems. On the local level, I carried out interviews with district medical officers, doctors, and nurses, purposively sampled according to their proximity to the field sites. This strategy appreciated issues of accessibility as well as contextual relevance for the subsequent interviews with rural residents. Experts on the district and higher levels in India were proficient in English, but local-level interviews in Rajasthan and most expert interviews in Gansu required translation through local interpreters.

Access to senior organisational levels was eased by my affiliation to the University of Oxford, the sponsorship by reputable national organisations (Public Health Foundation of India and the Chinese Academy of Sciences), and local research partners, all of which signalled credibility and independence while at the same time evoking the interest of many informants in the research (Bryman, 1988:14-16). Though facilitated by these signals, access challenges

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[46] The main implementation partners in Rajasthan were the Indian Institute of Health Management Research (IIHMR) and the local NGO Seva Mandir. In Gansu, a local research company and the School of Public Health, University of Lanzhou, sponsored the research.

persisted especially in the Chinese context, preventing interaction with high-level telecommu-nications and health experts. As a result, I could only approach half as many expert informants in China compared to India. In addition, most experts on district and higher levels wished not be voice-recorded, hence the majority of these interviews was documented with hand-written notes. Such problems did not arise on the local community level, where experts included phone shop owners and local medical practitioners; although less diverse and fragmented health sys-tems in Gansu meant that fewer local doctors entered the Chinese expert sample. Overall, the impact of these challenges was limited, given the supplementary function of these interviews. It was possible to meet remaining information requirements through statistical data, telecom-munications market reports, health system research publications, and my own survey data.

Community-level interviews and focus group discussions were the centrepiece of the first fieldwork phase. The sample included adult village residents (>18 years), whose selection was purposive in order to ensure maximum variance in the sample. Guiding variables for the individual and group selection were sex, socio-economic status (reported or approximated by dwelling conditions), age, and phone ownership. The group discussions included both homo-geneous and mixed groups in order to elicit a broader range of experiences. However, devia-tions from the ideal sampling process were necessary especially in Rajasthan, where respond-ents displayed greater hesitation to participate in interviews given my outsider position. Facil-itation by the local NGO Seva Mandir helped to gain entry to the village through village leaders, doctors, and local contacts; it helped to assemble discussion groups; and it provided access to individual respondents. Access challenges also meant that, in both field sites, it was occasion-ally necessary to engage in snowball sampling, asking respondents specifically if they knew other persons in the village who would meet my inclusion criteria and who would be willing to participate.

Local fieldwork conditions required me to adapt the sampling strategy and interview process to some extent. Because of local living conditions, variations in villager availability, and local access dynamics, the size of the focus group discussions varied within and across the field sites. A group session in Rajasthan had on average 5.1 participants and 3.5 in Gansu as a result of these variations. In addition, it was not always possible to interview respondents in an isolated one-on-one setting. This was especially challenging in Rajasthan if spouses were present, leading to silence and acquiescence on the side of the woman. The effect was less obvious in Gansu where men and women would participate equally vocally in the interview. At the same time, most of these "dual interviews" involved two respondents of the same sex, which did not appear to undermine the interview dynamics.

The qualitative research and the interview protocol were ethics approved by the University of Oxford (SSD/CUREC1A/13-199). In all cases, the interviews commenced with an introduction of myself and my research, a request to learn from the respondent's experience (about either their sector knowledge or their personal life experiences), the chance for the respondent to ask questions, and the documentation of informed consent through a signed consent form or through audio record.[47] An information sheet was made available to all respondents with contact details of the University, local research facilitators, and myself. Villagers were also compensated for their time devoted to the interview. In Rajasthan, this compensation was indirect through a donation to Seva Mandir for local development projects for each completed interview and discussion session. In Gansu, owing to the absence of a local facilitating organ-

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[47] Although the respondents were free not to answer questions they deemed sensitive or uncomfortable, most were forthcoming and detailed in their response. Only in one case did the conversation about a chronic illness upset the respondent (in the presence of the family), upon which it was decided to terminate the interview and together with family and interpreter we spent the remaining time together comforting the respondent until she regained composure.

isation, I enquired with pilot respondents and people with family links to villages about appropriate gifts and decided on boxes of milk from the state capital Lanzhou in Gansu (which appeared to be received favourably).

Language barriers further required the involvement of interpreters in expert and community interviews. The interpreters were female graduate-level students, recruited locally and with a personal background of growing up in rural areas. No translation was required for expert interviews on the central government levels in the national capitals, but more commonly on lower administrative levels and especially so in Gansu. On the local level in Rajasthan, widespread English language proficiency among medical practitioners meant that translation was mainly required for local phone shop owners. Aside from the expert interviews, all sessions involving villagers were translated. Rural dialects sometimes required the assistance of local resource persons to support the interpreter.

Where translation was required, the interpreters received prior one-day briefings about the interview content, probable specialist terms arising in the interview, and the general motivations and objectives of each question. This briefing allowed the interpreters to go beyond fragmented back-and-forth translation and instead maintain shorter periods of natural conversation after which they summarised the contents of the discussion thus far. I would then advise which point of the semi-structured interview guide to cover next, or if further probing is required. I summarised the translations in handwritten notes while the audio record was later fully transcribed and translated by the interpreters. I carried out cross-checks with my own record and secondary translators to verify the accuracy of the transcripts. No issues were encountered in Gansu but occasionally in Rajasthan (which were related to language issues).

Employing translators and local assistants arguably introduced more complexity into the interview process. On the one hand, it has been affirmed repeatedly that interpreters are

active participants in the interview process, acting not only as translators but also as gatekeepers for information (Bujra, 2006). Their participation also affected the flow of the conversations compared to interviews conducted solely in the mother tongue of the respondents. On the other hand, the research assistance from the interpreters facilitated the fieldwork greatly. In fact, the research assistants worked both as interpreters and as research facilitators, playing an active and important role in establishing rapport with village leaders and local respondents.

3.5.3 Qualitative Data Analysis

Establishing a grounded framework is an inductive exercise (Merriam, 2009:38), meaning that categories and relationships are derived from the patterns in the qualitative data. In order to build such a framework of mobile phone use and healthcare access, I analysed the data resulting from the community and expert interviews using thematic and content analysis. These two analysis techniques are outlined below, followed by a description of the analysis process and associated data collection and positionality issues.

I analysed the semi-structured interviews with community members using categorical and holistic thematic analysis with a focus on content (rather than form; Kohler Riessman, 2006:706; Lieblich *et al.*, 1998:12-14). Besides the specific interview content, this method appreciates the linkages between villagers' reported behaviour and the socio-economic and infrastructural conditions in the village as well as their own descriptions of their social and economic position in their local communities.

The analysis of the focus group discussions followed a similar approach, but their data cannot be interpreted in the same way as in one-to-one interviews owing to the dynamic nature of the discussion (Barbour, 2007:131; Lloyd-Evans, 2006:155; Stewart *et al.*, 2007:117). Instead, the balance between themes and content is inclined towards the former, meaning that the

focus group discussions are intended to create meaningful links to the other methods by generating themes, exposing the nuances within them, and feeding them back into the interview process (Lloyd-Evans, 2006:160). In this way, thematic analysis among interviews and group discussions helps to generate "insightful interpretations that are contextually grounded" (Lapadat, 2010:928). In both individual and group interviews, the analysis subordinates the *form* of participants' statements to their content because of language barriers and the translation of the responses (see e.g. Mishler, 1986:80).

The analysis of the expert interview data was focused on categorical analysis in order to extract the specific contextual elements required to situate villagers' interview responses. However, also here it is necessary to relate the content of the expert responses to their organisational context, as possible biases may arise from institutional incentives and from high-level consideration of local issues (e.g. Fairhead & Leach, 2005:284; Scott, 1998:45-47).

The first stage of analysis commenced during the data collection process. As is also common in grounded theory approaches, the semi-structured interview guides evolved gradually by incorporating emerging themes throughout the data collection process (Merriam, 2009:171; Oktay, 2012:54).[48] The second stage involved the systematic, iterative coding process of themes in the semi-structured and group interviews (contextualised by expert data), following the receipt of the final interview transcripts. Whereas the initial analytical categories and the capability dimensions were identified deductively from the preliminary framework and the literature, new themes would emerge within and beyond these categories in an inductive manner (Arksey & Knight, 1999:9-10; Lapadat, 2010:927). With each subsequent iteration, the categories and linkages between the themes would become increasingly abstract and eventually

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[48] Grounded theory approaches typically pursue data collection until a late point in the data analysis in what is called theoretical sampling (Merriam, 2009:30). This was not feasible due to resource and time constraints for the DPhil research.

take shape in the grounded theoretical framework (Oktay, 2012:53-54). Following the establishment of themes and analytical categories, the third stage involved their substantiation through a review of the secondary literature on mobile phone use in general and health-related phone use in particular. This procedure yielded the theoretical framework to answer the first research question and to develop hypotheses for Research Questions 2 and 3. A fourth phase involved revisiting core assumptions of the framework following the quantitative analysis. This is done explicitly in the quantitative discussion Section 7.4.2.

A number of data analysis challenges are worth pointing out, especially in relation to the data gathering process and the positionality of the researcher. As far as the purposive, maximum-variance data gathering is concerned, it would be an error to quantify the responses beyond cautious indications of relative frequencies (Oktay, 2012:17). Purposive informant selection tends to overemphasise marginal views and thus limits the representativeness of the qualitative enquiry. In fact, the survey sample yielded rather different conclusions about the frequency of certain phone-aided activities compared to what the qualitative leg of the study would have suggested. While this may have limited implications for theory building (and is in fact one of the motivations for doing so), it may mislead the *presentation* of the qualitative analysis. The quantitative analysis therefore complements the qualitative presentation insofar as it provides a more representative picture of behavioural patterns within the field sites.

Another concern, commonly noted in development research, pertains to power relationships and positionality. My position as a European male student from the University of Oxford working together with tertiary-level educated research assistants and local facilitating organisations may not only affect power dynamics in the field sites, but it could also influence my interpretation of the qualitative data. My position occasionally constituted an obstacle to having unfettered interaction with the rural dwellers, living in sometimes destitute socio-economic conditions (Chacko, 2004:54-56). Such socio-economic differentials and power dynamics can

adversely influence the interview process, leading for example to "social desirability" biases (Furr, 2010:1395-1397). Positionality and power relationships are also influenced through the presence of interpreters, who accompanied all interviews and focus group discussions with rural residents (Edwards, 1998:202-205). In addition, within organisations, my medically trained research assistants could have influenced the power dynamics in interviews with minimally trained village doctors (Arksey & Knight, 1999:124-125; Herr & Anderson, 2005:43-44). On higher administrative levels and in interactions with commercial organisations, latent suspicions about information leakage may have compromised experts' readiness to share information and data freely. Informant and source triangulation can mitigate this problem, but power dynamics and the potential omission of sensitive information remain an important residual source of bias in the analysis.

In response to such challenges, the research approach necessitated that reflexivity pervades data collection. Reflexivity requires the researcher to appreciate that neither interview outcomes nor their analysis are value free (Ellis & Leigh Berger, 2003:160-162; Lemaire, 2011:204; Mishler, 1986:4-5). Instead, interviews and discussions as collaborative processes are as much influenced by the interlocutor as by the researcher's and interpreter's personal history and perceptions. During the data collection, I adhered to recommendations by Alkire (2002:225), according to whom interview preparation and organisation involves measures such as "simple clothing, [… respecting] traditional and religious customs, [organising] the meeting at a convenient time and place, [and an] attitude of informal learning and openness." Such measures did not only help to establish rapport with my informants, but also enabled personal reflection on my own role as a researcher and my relationship to the people I encounter during the data collection process. Although such considerations have to be appreciated and examined during the entire research process, reflexivity will have a subordinate role in the presentation

of the results to keep the discussion focused (Bloor & Wood, 2006:148). In addition, it is important to emphasise that, despite the remedial measures, biases associated with positionality and interview dynamics cannot be ruled out conclusively.

The principal outcome of the qualitative analysis is an empirically grounded framework that attempts to answer Research Question 1 on the theoretical link between mobile phone diffusion and healthcare access, and that informs Research Questions 2 and 3 through testable hypotheses on the adoption indicators and the implications of phone use in healthcare processes. Being grounded in qualitative data from my field sites, this framework does no longer abide by the Capability Approach and its terminology (e.g. *capabilities*, *freedom*, *functionings*). Furthermore, as an intrinsically value-bound process, it is not possible to rule out the influence of positionality in qualitative data collection and analysis, but mechanisms were put in place to reduce its impact, and the quantitative analysis will offer an empirical test of the framework's fitness to describe the phenomena under study. The quantitative analysis will be described in more detail in the following section.

3.6   Quantitative Testing of Hypotheses

Qualitative research helped to establish hypotheses about the predictors and implications of phone-aided healthcare seeking, and I will test them through quantitative analysis. Hypothesis H1 focuses on the measurement of mobile phone adoption in healthcare-seeking processes, informing Research Question 2. Hypotheses H2 and H3 deal with the impact and distributional implications of this kind of mobile phone use, thereby informing Research Question 3.

The quantitative second stage in the research design consists of survey data analysis from 800 adults in rural Rajasthan and Gansu. I collected primary survey data from the field

sites because secondary data sources are insufficient to study the nature and underlying mechanisms of phone-aided healthcare seeking. The qualitative work therefore helped to shape the survey instrument and the quantitative measures, but the preceding qualitative data also aided the interpretation of the quantitative findings. Therefore, one of the main advantages of this mixed methods research design is that the combination of qualitative and quantitative approaches enables an integrated assessment of phone use and healthcare access.

This final methodology section explains the survey instrument and the design and implementation of the surveys in rural India and rural China. Because the quantitative analysis follows the qualitative analysis, the specific analysis strategies are explained in detail in the respective quantitative Chapters 6 and 7.

3.6.1   Survey Instrument

Testing the hypotheses with primary survey data required a tailored survey instrument capable of capturing the categories of the grounded framework and the potential links between them. I therefore designed a 60-minute questionnaire to elicit different forms of mobile phone adoption, detailed descriptions of disease episodes of the respondents, and a number of socio-economic and spatial variables to support the analysis. In addition, I used village checklists that captured key village facilities in order to complement the individual-level questionnaires. I describe structure and content of the questionnaire below, followed by details on questionnaire administration and translation.

The questionnaire contained four main parts, the contents of which were derived from the grounded framework (e.g. forms of phone-aided health action). Where possible, I adopted standardised and validated questions from other survey instruments, including the Indian Human Development Survey, the Multiple Indicator Cluster Survey, the Study on Global Ageing and Adult Health, Young Lives, and the Gansu Survey of Families and Children (Desai *et al.*,

2008; Galab *et al.*, 2011; Hannum *et al.*, 2011; UNICEF, 2014; WHO, 2014b). The order of the questionnaire proceeded from general to potentially more sensitive questions, starting with respondent demographics, followed by phone use and health behaviour and, lastly, questions on assets, amenities, and poverty.

Prior to the interview, a questionnaire cover sheet required the field investigators to first record location information of the household with Global Positioning System (GPS) units and the time of the visit. The interviewee's consent would also be recorded on the questionnaire and the respondent would receive an information sheet with contact details and survey information. After the interview was concluded and the respondent received a gift, the investigator was asked to rate the quality of the interview and report any unusual circumstances during the session (e.g. other people interpreting the responses).

The actual survey questionnaire begins with a part on demographic information, including age, sex, occupation, the ability to read and write in the mother tongue and English, household size, the number of successfully completed years of formal education, the place of residence of family members, and others. The selection of these questions was guided by the literature and the qualitative research related to the potential determinants of health-related mobile phone use.

The second part of the survey related to mobile phone adoption patterns, including phone ownership and device specifications as well as usage of borrowed and rented phones. A central element of this part is the use of different phone functions by the respondent him- or herself, by someone else for the respondent, and by the respondent for someone else. Usage frequencies for these scenarios were elicited for owned/shared phones and borrowed/rented phones. A high level of detail was required to gain a more comprehensive understanding of phone utilisation in relation to ownership, given that the qualitative research gave strong indications that the two adoption concepts are incongruent.

Part three of the questionnaire records health and healthcare behaviour. It begins with a short section on self-perceived health, activities of daily living (e.g. walking for half an hour), and awareness about health hotlines and ambulances. This is followed by a detailed description of up to three types of illnesses in the previous twelve months, namely acute severe, acute mild, and chronic/long-term/recurrent illnesses. No further definition was provided in order to let the interviewee judge the severity of the issue her- or himself. However, for each illness, the respondent was asked to describe the symptoms, total duration, total costs incurred, and the healthcare-seeking process. Section 6.2.1 describes this sequential capturing of the healthcare-seeking process in further detail. The final section enquired whether and how the respondent ever used a mobile phone for other people's illnesses, providing a range of scenarios (e.g. arranging transportation or calling a doctor).

The final part of the questionnaire focused on the living conditions of the respondent. First a set of housing indicators were elicited, followed by a battery of questions on common household assets like radios, mobile phones, landline phones, motor cycles, or refrigerators (Saris & Gallhofer, 2007:92). These questions on assets and housing quality were mostly drawn from the Young Lives questionnaire in order to later construct standardised wealth indices (Escobal *et al.*, 2003:23).[49] The focus on assets rather than on household income or expenditure is justified because household assets are easier to recall than household expenditures, less variable and less sensitive, and still representative of socio-economic status (Deon & Pritchett,

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[49] I calculated three wealth indices for sensitivity analysis, all of which are based on binary indicators of household assets, housing quality, and services such as water and electricity access. One index is based on the Young Lives index that assigns specific weights to these indicators (Escobal *et al.*, 2003:23-24); one index is based on principal component analysis which chooses the combination of these indicators that maximises their variance in the data set (Deon & Pritchett, 2001:116-117), and one is a simple average of all given indicators. Despite their different designs, the three indices resemble each other closely with correlations between 0.95 and 0.99. The quantitative presentation will be based on the index built through principal component analysis as this method utilises the most information in the data. In order to make wealth indicators comparable, I categorised the respondents into population-weighted wealth quintiles in each country.

2001:121; Morris *et al.*, 2000:384-385; Sahn & Stifel, 2003:463-464). Further questions included asset and poverty indicators, for example whether the household is able to meet its daily living needs and obligations. A final set of questions asked about the distances to markets, village facilities, and doctors, considering that distances calculated from geo-coordinates are insensitive to routes, road conditions, and modes of transportation.

The field investigators did not read out the answer categories in order to keep the interviews tolerably short and not to impose the answer frame onto the respondents. Open responses were recorded verbatim for some questions (e.g. occupations or disease symptoms), later translated, and then coded manually in the quantitative data analysis process. However, most responses had defined answer categories (e.g. frequency of phone use, purposes of health-related mobile phone use, modes of transportation), in which case an open response would be field coded according to the response options in the questionnaire (Groves *et al.*, 2009:335). Although some authors argue that field coding could introduce undesirable variance in the data collection process (Collins & Courtenay, 1985), I was confident in using this method because of the experiences about expected responses and answer categories from the qualitative interviews, extensive field testing of the survey questionnaires, and intensive field investigator training to accustom them to this procedure. Moreover, the availability of an "other" option enabled verbatim data entry where the response did not match the provided categories or where the field investigator was unsure. This text was then coded manually during the data preparation process.

The questionnaire underwent multiple iterations and tests before it was translated, piloted, and subsequently revised and finalised. Translation was carried out remotely through two translators per country. During a joint discussion session with the translators, I would explain every question, its motivation, and possible answers in detail, and the translations would be refined accordingly. Pilot tests in both regions helped to refine the translation further, but

also to reconsider the interview process, to adjust question wording, and to add unforeseen answer categories.

3.6.2 Survey Design and Implementation[50]

The survey questionnaires were administered in a three-stage stratified cluster random sampling design in both field sites. While the survey design and a number of implementation features were largely similar in both surveys, local factors also contributed to differences in the sampling strategies. This section documents the similarities and differences of the surveys, although I will dedicate more space to the sampling and implementation strategy in Gansu as it deviates from established survey sampling approaches. Despite the differences, however, both surveys adhered to rigorous random sampling approaches that make their joint analysis acceptable.

3.6.2.1 Common Features of Survey Design and Implementation Across the Study Sites

The survey involved revisiting the field sites in rural Rajasthan and Gansu from August to October 2014 in order to survey 400 adult villagers in each country (see Table 3.3). The rural surveys in Rajasthan and Gansu overlap in terms of survey design, specific implementation aspects, and weighting procedures. The surveys were ethics approved by the University of Oxford (CUREC 1A/ODID C1A14-031), by the Gansu Province Department of Statistics (2014/8), and by the internal ethics commission of the Indian Institute of Health Management Research.

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[50] I presented an earlier version of this section as a paper at the 6th Conference of the European Survey Research Association, 13-17 July 2015 (Haenssgen, 2015b). A modified version is presently under review with *Emerging Themes in Epidemiology*.

Table 3.3. Summary of Survey Design and Scope

	Rajasthan	Gansu
Sampling	**3-stage stratified cluster sampling** 1. Random village selection, proportional to population size, stratified by distance to sub-district headquarter 2. Random household selection based on household listing 3. Random household member selection based on age-order tables	**3-stage stratified cluster sampling** 1. Random village selection, stratified by distance to nearest township 2. Random household selection based on complete village mapping 3. Random household member selection based on age-order tables
Geographical Scope	Districts of Rajsamand and Udaipur Sub-districts: 1. Rajsamand (Rajsamand) 2. Bhim (Rajsamand) 3. Girwa (Udaipur) 4. Jhadol (Udaipur) 5. Kherwara (Udaipur) 6. Kotra (Udaipur) 7. Mavli (Udaipur) 8. Salumber (Udaipur)	Districts of Baiyin, Dingxi, Lanzhou Sub-districts: 1. Baiyin (Baiyin) 2. Huining (Baiyin) 3. Lintao (Dingxi) 4. Tongwei (Dingxi) 5. Zhangxian (Dingxi) 6. Gaolan (Lanzhou) 7. Qilihe (Lanzhou) 8. Yuzhong (Lanzhou)
Sample Size	400 rural dwellers in 16 villages	400 rural dwellers in 16 villages[a]

Source: Fieldwork data.

[a.] Two questionnaires in Gansu were invalid and have been dropped from the sample.

The surveys followed a three-stage stratified cluster random sampling design within a pre-selected set of eight representative sub-districts in Rajasthan and Gansu.[51] This design results from considerations about the assumed prevalence of the studied phenomena, data analysis plans, resource constraints, and survey design effects. Sample size decisions in this kind of exploratory research are difficult because commonly used statistical power calculations are not applicable for phenomena whose effect size is unknown *a priori* (Fowler, 2009:44). Given that this is the first study attempting to measure effects of mobile phones on healthcare access on the micro level, sample size considerations instead focused on assumptions of the prevalence

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[51] I selected the number of sub-districts per district in proportion to the district population size, and the guiding indicators for sub-district selection were geographical location and economic development. Table 3.3 lists the selected sub-districts in each site.

of phone-aided health action in the population based on the preceding qualitative research. Ideally, this would have involved a simple random sample across my field sites with sample sizes in excess of 500 per country in order to capture rare illness episodes and to permit logistic regression analyses stratified by country (see Sections 6.2.3 and 7.2.2 for analysis techniques). Resource constraints prevented such a survey design, instead requiring cluster random sampling in order to stay within the available budget by reducing survey fixed costs (Groves *et al.*, 2009:106). At the same time—as will be explained below—sample stratification was used in order to improve the effective sample size, which would otherwise be diminished by cluster random sampling designs (Heeringa *et al.*, 2010:23-27). The three-stage stratified cluster random sample results directly from these considerations and constraints.

The first randomised stage of the sampling was the selection of 16 villages (or "clusters"). The number of clusters resulted from the geographical dispersion and difficult accessibility of the villages, but was also limited by the available resources for this study. I chose two villages in each sub-district based on their "remoteness" in terms of their distance to sub-district headquarters (Rajasthan) and townships (Gansu). Using the geographic coordinates of the villages and urban areas, these distances can be calculated using spherical trigonometry (notwithstanding the fact that the shape of the earth better resembles an ellipsoid rather than a perfect sphere). Villages were stratified for selection based on whether they were above or below the sub-district average distance to the urban centre.

The second sampling stage involved the random selection of 25 households per village. I defined a household as a group of people who normally live in the same dwelling, eat together, who may or may not be related, and who had resided in the village for at least six months prior to the survey. The households were selected through interval sampling and all 25 households were interviewed within one day. However, the specific implementation methods differ substantially across the field sites and are therefore explained in further detail in the next sections.

The final stage in the survey design pertained to random respondent selection within the chosen households. This selection process was based on age-sex-order tables, which involved the listing and subsequent ranking of up to ten household members according to their age, sex, and availability to be interviewed. The respondent would be selected using a selection table, based on the number of eligible household members, the rank of the respondent, and the household number. Although not perfectly random, this procedure provides a compromise between fast yet potentially unreliable methods (e.g. nearest birthday), and more rigorous randomisation techniques like the Kish selection method that are more time-consuming and difficult to implement on paper questionnaires and therefore tend to discourage participation (Gaziano, 2005:125-126). This process was identical in both field sites.

The surveys were implemented through survey teams with healthcare backgrounds. Each team comprised six field investigators and two supervisors, data entry officers, and backup staff where it was required. Due to social and logistical factors, the field investigators in Rajasthan were all male and in Gansu all female. Training took place in separate sessions, lasting five days each for the supervisors and field investigators, and one day for the data entry staff. Fieldworker and supervisor training adhered to a self-written interview manual, covering task descriptions, building rapport, answering questions of the interviewee, handling difficult situations, ethics and informed consent, filling in the questionnaire, probing, mock interview sessions, and one-day field training sessions. Data entry involved the translation of the paper questionnaires into the *CSPro* software, which required the data entry staff to understand the use of the software as well as how different types of questions and responses need to be entered into the digital forms (United States Census Bureau & ICF Macro, 2014).

If, during the survey implementation, a house was locked, it would be revisited again later in the day. In addition, should a house be inhabited but the selected respondent be unavailable (e.g. because they are working in town or on their farmland), the field investigators

would revisit the house at an agreed time or locate the chosen respondent in the village/farm. The interviews lasted on average 45 to 90 minutes and ended with the hand-over of a gift for the respondent (ornamented stainless steel cups worth ₹80 or £0.80 each in Rajasthan; water bottles worth ¥8.4 or £0.84 each in Gansu). The supervisors monitored the progress through random checks of the interviews, revisiting a sub-sample of the households, and checking all questionnaires before leaving the village.

Data entry commenced upon completion of the survey data collection. The raw community survey data set contains 650 variables across 798 valid questionnaires, and the raw village checklist data set contains 114 variables across 32 villages.[52] After the data were entered, the data entry officer and third persons carried out quality spot-checks of the preliminary data set. Ignoring spelling edits in free text fields, first-stage error rates were 0.074% per data field in Rajasthan and 0.035% in Gansu. All these issues were clarified or rectified after revision.

The surveys were intended to be representative on the district level, but a fundamental problem in face-to-face rural surveys is that the daytime population in the village is very different from the registered population. In other words, if left unadjusted, the raw sample data would provide an insight into the situation of villagers during a given day. I calculated sample weights using district-level census data in both field sites to reduce the resulting errors (Heeringa *et al.*, 2010:38). However, this does not entirely rule out that the underlying sample has atypical characteristics when compared to people who commute to work outside the village (Fowler, 2009:62-67). It is not possible for me to assess the direction of any such biases in the data, provided they exist.

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[52] The high number of variables arises in particular from the process-step method of capturing of healthcare processes and from exporting sub-fields of geo-coordinates and time data.

3.6.2.2   Sampling and Implementation in Rajasthan

The survey was first implemented in Rajasthan, with assistance from IIHMR Jaipur. Village selection was based on available population information from census tables and geographical location data provided by Valid International. These administrative data sources permitted spatially stratified village selection that is proportional to population size. Two villages of the original sample had to be replaced because heavy rainfall made them inaccessible.

Following the village sampling, the team of six field investigators and two supervisors relocated to the survey sites. Half a team day each was required to manually map the village and enumerate all households in the selected areas. In villages larger than 250 households, workload restrictions made it necessary to segment the site into smaller units and draw the sample from two of these segments. This was the case in 6 of the 16 villages, in each of which the number of segments ranged from three to six. These segments cover on average 55% of the total household numbers. Overall, the estimated population in the total or partial villages ranges from 161 to 1,272.

An interval sample was drawn from this enumerated household list based on the total number of households in the segment and a randomly selected starting point, accounting for up to ten replacement households (i.e. 40% oversampling). Figure 3.7 illustrates this process, in which the survey supervisor (pictured left) assigns the field investigators to their respective households using the hand-written sampling frame. The respondent selection process took place as described in the previous section. In total, 33 respondents were unavailable or refused participation, or up to eight in one village.

Figure 3.7. Sample Selection and Field Investigator Assignment in Rajasthan

Source: Fieldwork material.

Overall, very few difficulties were encountered using this conventional approach to rural survey sampling (Shannon *et al.*, 2012). The method permits a rigorous random selection of villages, households, and respondents. In addition, the interpersonal household listing approach appeared to establish trust with the respondents when they were revisited for the survey. However, the survey implementation approach in Rajasthan also faces intrinsic challenges. Village segmentation necessary to keep costs and workload in check can also result in a clustering of responses if nearby dwelling units share similar characteristics (e.g. because they are located in a slum area). In addition, because it is difficult to locate clearly the boundaries of a village in the chosen approach, it is also possible that marginalised households at the fringes are more likely to be omitted from the sample than centrally located dwelling units.

3.6.2.3   Sampling and Implementation in Gansu

Contrary to expectations, the Rajasthan sampling strategy could not be replicated in Gansu because of administrative and logistical constraints. Neither village-level census information nor geographical data was available—merely a register containing village and township names could be accessed (China Standard Press, 2010). This is a common issue encountered

by survey researchers in low- and middle-income countries (Overton & van Diermen, 2003:42-44; Zarkovich, 1993:103). In addition, financial resources were insufficient to list households in the villages through the local survey team. Despite the administrative and resource challenges, the Gansu survey had to be implemented in a comparable three-stage design as in Rajasthan. I relied on an alternative, ICT-aided survey sampling and implementation strategy in order to attain at least the same level of quality in the Gansu sample. Because of the novelty of the approach, I describe the implementation strategy for Gansu here in detail.

My implementation strategy had the following three components: First, I used the Chinese village register in Gansu to extract the village locations for spatial stratification with the help of *Google Maps* (China Standard Press, 2010; Google Inc., 2015a). Of 1,736 listed villages, 1,553 entered the sampling frame in this way, given that some villages could not be located and others were incorrectly assigned to the respective sub-district in the village register. The geo-coordinates extracted in this way helped to calculate distances to urban areas and thus to draw a spatially stratified village sample. In the absence of census data, the resulting probabilities of selection are not proportional to village population size. However, sample weights later derived from village population estimates helped to mitigate this issue. Overall, the villages in Gansu tended to be larger than their Rajasthan counterparts, ranging from estimated 481 to 3,141 inhabitants.

Second, aerial imagery from the publicly available satellite map providers *Bing Maps* and *Google Maps* helped to completely list all residential structures in the selected villages within a 1km radius around the geographical village centre (Google Inc., 2015a; Microsoft Corporation, 2015). An example of such a map is presented in Figure 3.8. A total of 7,300 housing structures or 380 per village on average were enumerated in this way. The list of housing structures constituted the sampling frame for interval sampling, which was stratified by the

natural segments of the selected villages to ensure that marginalised groups of houses are rep-

resented in the sample as well. Yet, distinguishable though residential houses on the aerial

maps may be,[53] it is not immediately obvious from the satellite image whether a house is vacant

or inhabited by more than one household. The latter was rarely the case, but the uncertainty

created by the former meant that a high level of oversampling was required. As a result, each

house received two replacement options, corresponding to 200% oversampling.[54]

The necessity of this approach can be seen in the fact that a total of 223 houses or up to

29 houses per village were found vacant or locked. Manual household listing and mapping

through the survey team—had it been possible—would have filtered out a large portion of this

number by design. In addition, refusal was slightly higher in Gansu as well, with a total number

of 38 households, or up to four in a single village.

Figure 3.8. Excerpt of Segmented and Numbered Village Map With Detail

Source: Fieldwork material, 2014 map data from Microsoft Corporation, DigitalGlobe, HERE.

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[53] A housing unit in the field site commonly consisted of two or three buildings surrounding a courtyard, encircled by a wall with a gate.

[54] Replacements were located within the interval to the next selected house in order to retain spatial stratification.

Third, printed village maps, smartphones, and GPS units facilitated the implementation and quality assurance of the survey. Given the known locations of villages and sampled houses, this combination helped to navigate unchartered approach roads, to deploy the survey teams in their respective village segments, and to identify and later verify the correct houses in each village through the field investigators and survey supervisors (GPS units were also used in the Rajasthan leg of the survey). Meetings with village leaders prior to the field investigator deployment helped to better understand the village maps and the nature of previously unidentified buildings (which normally turned out to be schools or factories).

Previous research projects have used similar tools to facilitate survey sampling and implementation.[55] For example, Wampler *et al.* (2013) carried out cluster random sampling in Haiti and Escamilla *et al.* (2014) implemented a simple random sampling design in Malawi. In both cases, the authors use *Google Earth* to map the sites and mark eligible structures for sampling, Geographical Information System (GIS) software to extract the coordinates of the identified structures, additional software tools to select the sample based on the list of coordinates, and GPS units to upload the sample coordinates and to locate the houses in the field. Besides, Escamilla *et al.* (2014) also use GPS handhelds to delimit the survey site from which they draw the sample.

Despite the advances in satellite-aided survey sampling and implementation, existing approaches face a number of difficulties that my solution helps to ease. One problem is the reliance on dedicated software and user skills, professional GPS equipment, and specialised or commercial data sources. This can make the strategies inaccessible to researchers from a methodological as well as financial standpoint. The only study where none of these elements is required is Flynn *et al.* (2013), where, however, the sampling strategy is restricted to a random

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[55] See Chang *et al.* (2009); Escamilla *et al.* (2014); Flynn *et al.* (2013); Galway *et al.* (2012); Gammino *et al.* (2014); Morland and Evenson (2009); Shannon *et al.* (2012); Wampler *et al.* (2013).

walk. Furthermore, despite utilising satellite imagery and aerial maps, spatial considerations in the sampling strategies are mostly limited to defining the catchment area. This is a useful solution to mitigate the risk of omitting marginalised houses from the sampling frame, but it does not automatically lead to improved spatial representativeness. The sub-cluster weighting approach of Shannon *et al.* (2012:3) is an exception, yet also this solution does not guarantee that the sample is spatially stratified. An additional problem is the identification of sampled houses in the field using GPS units, which can be problematic where dwelling units are closely adjacent or where the conspicuous use of GPS handhelds poses a security issue.

My strategy helped to overcome these problems. Using satellite imagery through online map services and other digital aides enabled low-cost and low-tech survey sampling, streamlined implementation logistics, and improved the quality of the survey data collection. This made the survey financially feasible by saving 30% of the budget, 25% of the main survey time, and more than 80 labour days of work. Methodologically, map-based household selection makes it easier than conventional approaches to list all houses in a community including marginalised ones at the village fringes. Furthermore, the spatial stratification of the household sample along natural village segments is at least as efficient as a simple random draw and permits a better representation of the village population where we assume that observed effects are correlated across proximate households (Delmelle, 2009:188; Galway *et al.*, 2012:2; Working Group for Mortality Estimation in Emergencies, 2007:2-3). In other words, spatial sampling approaches can help reduce the extent of clustering in a village, which can increase the effective sample size in complex multi-stage sampling designs (Heeringa *et al.*, 2010:23-27). In terms of logistics, printed maps enabled a high degree of accuracy when locating the selected houses in the field. This helped to avoid problems arising in studies that use GPS units to locate sample houses because the error margins of GPS units make the identification of adjacent houses difficult (as e.g. in Escamilla *et al.*, 2014:691).

My approach therefore offers advantages over conventional and other satellite-aided sampling strategies, but it comes with its own methodological issues. One challenge arises from the use of *Google Maps* for listing villages and recording their coordinates. It is conceivable that the map data does not fully correspond to official village registers or that village registers are politically influenced. Both factors can lead to the systematic exclusion of particularly small and remote communities. Although this is a theoretical possibility, the visual inspection of the satellite maps suggested that a large number of scattered and small villages were included in the village sampling frame, and the expansion of the catchment area to a 1km radius ensured that small dispersed communities entered the village sample.

In addition, the probability of selecting a village in my sample is insensitive to population size. Large and small villages are therefore equally likely to enter the sample (Zarkovich, 1993:104), which can bias the sample towards smaller villages. While this problem cannot be solved *ex ante* given the absence of population data, it is possible to estimate the village population *ex post* through the household count and by eliciting the number of household members in the surveyed dwellings. Sample weights can then correct for the higher chances of residents in small villages to be included in the sample, adjusting their representativeness accordingly. However, this has negative effects on the precision of the estimates.

Household sampling through satellite maps has at least two further methodological implications. Firstly, experiences from the Rajasthan leg of the study suggest that manual household listing through the survey team can be an opportunity to build trust with the residents before they are being surveyed. This might explain the slightly lower refusal rates in Rajasthan, where the survey teams spent an additional day in each village.

Secondly, even where housing units are homogeneous, it is difficult to identify shared and abandoned houses through aerial images. For example, if certain segments of the village contain a disproportionately large share of vacant houses, the inhabitants of the segment would

be overrepresented in the village. This is a disadvantage compared to manual household listing and mapping, which identifies households rather than houses and filters out uninhabited dwellings when establishing the sampling frame. In order to rectify this problem, the survey team interacted with village leaders prior to deployment in order to understand the residence patterns in the village. Problems arose only in one village where an entire segment of buildings was still under construction and thus uninhabited. "On-the-fly" updates of the village samples using the printed maps and a recalculated sampling interval helped to solve this problem prior to commencing the village survey.

3.7   Summary of Research Approach

This study examines the cases of rural Rajasthan and rural Gansu in order to understand the link between mobile phone use and healthcare access. I adopt a mixed methods research design in order to first develop a qualitatively grounded framework to explain this link, and then to test hypotheses derived from this framework quantitatively. I explained in this chapter that such a combination of qualitative and quantitative approaches helps to utilise their respective strengths. Mixed methods research thereby offers an opportunity to overcome the methodological divides that continue to characterise qualitative anthropological and sociological treatments of mobile phone adoption on the one hand, and quantitative economic and sociological approaches to technological development impact on the other hand.

The qualitative leg of this study uses a grounded theory approach that starts with a preliminary framework based on the Capability Approach, which is suitable for open-ended analysis in the context of development processes. Augmenting this framework with an explicit notion of technology led me to perceive mobile phones as socially embedded, transformative objects in a wider value system in which good health may be one of multiple competing life choices. Through semi-structured interviews and group discussions with 178 respondents and

feedback from 53 experts in the health and telecommunications sectors, I was able to build on the preliminary conceptual basis of the CA through thematic qualitative analysis.

Based on the qualitative work, I collected primary survey data from 800 respondents in a stratified cluster random sampling design in order to test hypotheses on the predictive power of mobile phone utilisation for phone-aided healthcare-seeking behaviour, and on whether such behaviour is beneficial or detrimental. During this process, the prior qualitative analysis helped to specify the survey instrument and to construct new measures of phone utilisation and healthcare seeking as a process. I have yet to comment on the quantitative analysis techniques and will do so in detail in the later, quantitative part of this thesis. But first I will present the qualitative analysis and the resulting grounded theoretical framework in the next two chapters.

PART II

Mobile Phones and Healthcare Access:

Qualitative Development of a Theoretical Framework

Chapter 4

Qualitative Case Study Evidence From Rural India and China[56]

4.1   Introduction

Chapter 2 outlined the knowledge gaps in understanding the socio-economic development implications of mobile phone diffusion, and the difficulty of assessing these implications given unresolved problems in the measurement of mobile phone adoption. At the same time, existing research highlights the coevolution of technology and society, during which development outcomes can be affected, but unevenly so.

Public health is one of the domains in which these challenges resurface. Research attention in this area focuses on the utilisation of mobile phones for health services and health system improvements. The problematic absence of empirical research on the effects of mobile phones on healthcare and health behaviour is aggravated by the lack of theoretical arguments as to how mobile phone diffusion may be linked to healthcare behaviour and access. As a result of our limited empirical and theoretical understanding of this link, mHealth analysts commonly simplify the role of the mobile phone to a given, static, and neutral platform for mHealth service delivery. Where mobile phones are not considered neutral, they are understood to be "facilitators" of health behaviours because they can improve communication and reduce transaction and search costs. In addition, narratives about mobile-phone-based interventions tend to stress their ability to reduce inequities in healthcare by enabling better access for rural and poor population groups in LMICs.

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[56]I presented an earlier and abridged version of this chapter at the Human Development and Capability Association Annual Conference 2014, 2-5 September 2014 (Haenssgen, 2014).

Whether these assumptions hold is yet uncertain but potentially important for our understanding of the implications of technology diffusion for social development and healthcare in general, and for the policy and practice of mHealth in particular. This chapter therefore provides an in-depth view into this "black box" between mobile phone diffusion and access to healthcare, using qualitative data from rural Rajasthan and rural Gansu.[57] The purpose of this analysis is to better understand the way in which mobile phones do or do not relate to healthcare access, with the ultimate aim of formulating a framework to explain the emergence and absence of mobile-phone-aided healthcare-seeking behaviours (or "phone-aided health action" for simplicity), and the potential effects and distributional implications for healthcare access. This part of the thesis, comprising Chapters 4 and 5, directly informs Research Question 1 from a theoretical, and prepares the analysis of Research Questions 2 and 3 from a qualitative empirical perspective.

The next section offers a brief introduction to the local mobile phone markets and healthcare situation in Rajasthan and Gansu, focusing especially on mobile phone diffusion patterns, existing mHealth services, epidemiological profiles, healthcare challenges, and health system structures (a detailed examination of local healthcare-seeking behaviour patterns using primary survey data will be carried out in the quantitative Chapters 6 and 7 to avoid redundancies). I subsequently explore how mobile-phone-aided behaviours materialise in Rajasthan and Gansu (Section 4.3). In both sites, villagers incorporate mobile phones creatively into their behaviour when they seek healthcare. More often than not, it appears, such phone-aided solutions emerge locally and independently of existing mHealth services such as hotlines, ambulances, or public health text messages. Where people use mobile phones for healthcare seeking, healthcare access differs, for example with shifts away from informal to formal care (Section

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[57] For the sake of readability, whenever I refer to Rajasthan and Gansu, I mean the field sites unless explicitly indicated otherwise.

4.4). Such phone-aided health action is typically deemed positive from the patient perspective, but the qualitative analysis also suggests that health systems may struggle with the increasing democratisation of patient choices, and that not all healthcare providers are inclined to using mobile phones during service delivery. In addition, conventional health action persists despite widespread mobile phone ownership and sharing (Section 4.5). This signifies that people also make active decisions not to incorporate phones into their behaviours, which could be considered a form of "voluntary" non-use. At the same time, "forced" exclusion from phone-aided health action because of personal constraints exists as well, affecting mobile phone owners and non-owners alike. Rather than ownership, it appears more plausible to link this involuntary form of exclusion to the accessibility of mobile phones when people seek healthcare, which depends on people's actual mobile phone utilisation on the one hand, and on the nature of their illness on the other.

I discuss the implications of these findings in light of the methodological limitations and the empirical literature in Section 4.6. In contrast to previous qualitative and quantitative studies in the field of mobile phones and health, my findings suggest that people are not either included or excluded, but that they also actively choose not to use mobile phones. This is not a revolutionary finding in itself, but it has implications for the conceptualisation of mHealth: If people choose not to use a mobile phone because they believe to have better "conventional" solutions for their healthcare problem, then the mHealth under-utilisation in my field sites may similarly stem from superior alternatives, both conventional and phone based. In addition, the drivers of involuntarily exclusion from phone-aided solutions may be linked to broader determinants of healthcare exclusion, potentially reinforcing social and economic marginalisation. If people are indeed excluded from health-related phone use for similar reasons that exclude them from healthcare, then it is not clear how mobile-phone-based solutions would contribute to more equitable healthcare access. However, because the qualitative data does not permit

conclusive claims about the impact of phone-aided health action, it is not clear at this stage whether exclusion is in fact as damaging as the notion implies. The quantitative analyses in Part III will shed more light on this matter.

4.2   Case Study Context: Mobile Markets and Public Health in Rajasthan and Gansu

Both rural Rajasthan and rural Gansu continue to face healthcare challenges, but they also exhibit rapid diffusion of mobile technologies. According to the International Telecommunication Union (ITU), markets in China and India together accounted for a joint total of approximately two billion mobile subscriptions in 2012 (ITU, 2015b), up from 150 million ten years earlier. The surge in mobile phone access has been largely fuelled by ever-declining prices of the devices: Average unit prices in India and China fell by approximately 60% between 2006 and 2011 (for smartphones), and are predicted to fall by a further 20% to 50% between 2011 and 2016 (Figure 4.1). As a result, handheld devices have reached prices as low as ₹700 per unit (£7.00) in rural parts of India (Euromonitor International, 2011:77). In addition, national policies actively promote the diffusion of mobile technologies into remote areas, especially through infrastructure investments (Budde, 2012:89-90; ISI Emerging Markets, 2012: "Government policy"). It should therefore not surprise that 99% of China's and 83% of India's population are covered by a mobile phone signal (Kimura & Minges, 2012:154, 170).

Yet, the patterns of mobile phone diffusion are uneven. The Indian Census 2011 for example reports that state-level mobile phone ownership in households averages between 29% and 86%, much of which is concentrated in urban areas (Euromonitor International, 2011:77; 2013:2; Government of India, 2012). Such disparities are also present in China, where the "mobile market in larger cities and the richer provinces is approaching saturation, yet there is still huge room for growth in small to mid-sized cities and in the villages" (ISI Emerging Markets, 2013: "Mobile services market").

Figure 4.1. Mobile Phone Sales and Unit Prices, India and China, 2006-2016
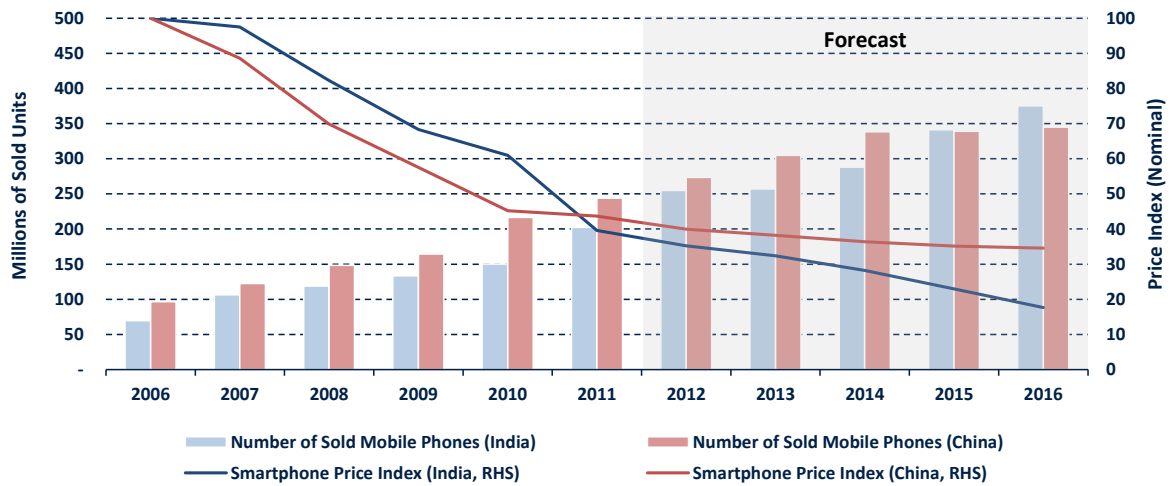
Source: Own illustration, based on Euromonitor International (2012, 2013).
Notes. Phone sales refer to entire mobile phone market. Unit price is indexed at 2006 = 100, and illustrated through average smartphone unit price (vs. feature phone unit prices), which will account for 85% (India) and 99% (China) of mobile phone sales in 2016, according to forecasts. RHS is right-hand side.

Rajasthan and Gansu are no exception to this development. Subscription data from 2012 (Rajasthan) and 2013 (Gansu) indicate that both regions have high teledensity of 74 mobile subscribers per 100 people (Table 4.1). Rural mobile phone ownership in my field sites mirrors this state. Census data from Rajasthan shows that 44% of the households in rural Udaipur and 64% in rural Rajsamand owned at least one mobile phone in 2011 (Government of India, 2012). In Gansu, according to the Human Resources for Rural Health in China survey 2011 (Liu & Ariana, 2012), mobile phones were owned by 82.7% of the surveyed households in rural Lanzhou, 83.3% in rural Baiyin, and 62.2% in rural Dingxi.[58]

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[58] These values are only indicative. Missing sample weights and a high share of centrally located and peri-urban sites might exaggerate actual ownership rates.

Table 4.1. Comparison of Field Site Indicators

	Rajasthan	Gansu
Population (Million)	68.6 (2011)	25.6 (2011)
Mobile Subscriptions / 100 Population	0.74 (2012)	0.74 (2013)
Life Expectancy at Birth (Years)	65.2 (2010)	75.7 (2010)
Literacy Rate, Ages 15+	67% (2011)	90% (2011)
Hospital Beds / 1,000 Population	0.5 (2011)	3.3 (2011)
Doctors / 1,000 Population	0.1 (2011)	0.8 (2012)
Per Capita GDP (USD, Nominal)	$885 (2011)	$3,130 (2011)

Sources: Own elaboration, compiled from China Marketing Research (2014); Datanet India (2014); Government of India (2011:1, 34); IMF (2013); ISI Emerging Markets (2012, 2013); ITU (2015b); NBS (2011, 2013); WHO (2013a); WHO and Ministry of Health P.R. China (2013:31).

India and China have explicit policies for ICT-supported healthcare delivery (WHO, 2013b: "ehealth country profiles 2009"), and multiple mHealth initiatives have appeared over the last decade (Leslie *et al.*, 2011; Ling & Xiao, 2012:14; PricewaterhouseCoopers, 2012:28; Wang & Gu, 2009). Based on the *GSMA mhealth tracker* database, China accounted for 13 and India for 59 active mHealth projects by May 2015 (GSMA, 2015).[59] Owing to their persistent rural-urban health disparities, their rapid diffusion of mobile phones, and the continued emergence of new technological healthcare solutions, both countries feature repeatedly in narratives about the potential of mHealth in emerging markets and rural developing areas (Ling & Xiao, 2012; Qiang *et al.*, 2012:40-49; Walsham, 2010:3).

Elementary phone-based health services are available in both field sites. India and China maintain medical ambulance hotlines through government-sanctioned phone numbers (*108* in Rajasthan, *120* in Gansu), and medical advice hotlines are available via the phone numbers *12320* in Gansu and *104* in Rajasthan. The *104* hotline also operates an emergency transport service for pregnant women in order to encourage institutional deliveries. Due to the

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[59] The database is an incomplete global survey of mHealth projects.

relative paucity of landlines, these are *de facto* services for mobile phone users. Besides, mobile customers in both Gansu and Rajasthan can subscribe to chargeable ("value-added") services from mobile network operators in order to receive public health information as text messages on their phone. Apart from these patient-oriented services, health-system-focused initiatives using mobile phones and remote communication tools are operating in the regions as well, for example "eHealth" services for doctor-doctor consultation in Gansu and mobile-phone- and tablet-based interventions aimed at the village education and monitoring activities of community-level health promoters in Rajasthan.

Compared to their mobile phone and mHealth market development, public health differences between the field sites are more pronounced. With 1,097 deaths per 100,000 people in 2010 (age-standardised), overall death rates in India are more than 80% higher than in China (IHME, 2013a:3; 2013b:3). A similar picture emerges from the number of years-of-life-lost per 100,000 people in India (age-standardised), which, despite a total reduction by one-third between 1990 and 2010 to 33,366, still exceed China by nearly 140%. The Indian burden of disease arises largely from ante- and post-natal conditions and communicable diseases (see Table 4.2). In contrast, non-communicable and chronic diseases such as heart disease and cancer are the main cause of life years lost in China, reflecting common conditions of an ageing society (Yang *et al.*, 2008:1699). To some extent, this also results from somewhat better socio-economic development levels and overall healthcare provision in China compared to India.

Table 4.2. Top Ten Causes of Years-of-Life-Lost in India and China, 2010

	India	China
1	Preterm birth complications	Stroke
2	Lower respiratory infections	Ischemic heart disease
3	Diarrheal diseases	Chronic obstructive pulmonary disease
4	Ischemic heart disease	Road injuries
5	Chronic obstructive pulmonary disease	Lung cancer
6	Neonatal sepsis	Liver cancer
7	Tuberculosis	Stomach cancer
8	Self-harm	Self-harm
9	Road injury	Lower respiratory infections
10	Stroke	Esophageal cancer

Source: Compiled from IHME (2013a, 2013b).

Both countries face considerable healthcare challenges. National health spending in India remains at low levels of 1.3% of GDP in 2012; China spends only 3% of GDP on healthcare (the UK government spends 7.8% of GDP on healthcare; WHO, 2014a). The low levels of health funding have repercussions for health service provision, particularly in rural areas. In India, the Planning Commission reported shortages of up to 36% in 2008 for some types of rural healthcare facilities (Planning Commission, 2011:149). Similarly, rural health workers—both doctors and nurses—are in short supply despite their relative abundance in urban areas (Rao *et al.*, 2011:590). My respondents in the field corroborate this observation with complaints about absenteeism, quality of care, and the overall shortage of medical staff (also see e.g. PricewaterhouseCoopers, 2007:8; Srivastava, 2006:90; WHO, 2012). Despite its different epidemiological profile, its distinct history of healthcare provision in rural and urban areas, and recent reform progress especially in the area of insurance coverage, China faces stark rural-urban disparities as well, for example in terms of health service affordability and availability of qualified health personnel (Ma & Sood, 2008:35-36; Whyte, 2010:14, 20; Yip *et al.*, 2012:839). These problems were echoed in the field, where rural residents lamented the quality

of care on the village and town level as well as informal payments that are required for treatment in urban centres.

In terms of structure, the rural health system in Rajasthan has three tiers comprising "sub-centres" (small health posts staffed with a nurse) at the lowest level for 3,000 to 5,000 people, "primary health centres" (small clinics with one doctor and a nurse) for 20,000 to 30,000 people, and "community health centres" (30-bed hospitals with general practitioners and specialist doctors) for 80,000 to 120,000 people (Ministry of Health and Family Welfare, 2011:1). In addition, an accredited social health activist (ASHA) acts as community-level health promoter in each village. My field sites in rural Rajasthan also exhibit a large group of non-public health providers, including private doctors with varying qualifications, traditional healers, and providers of alternative medicine. In the Gansu sites, informal providers are less visible and private doctors are comparatively sparse. The government health system also has a multi-tier structure. Most villages have clinics with at least one village doctor with limited medical training (van Velthoven *et al.*, 2013a:2). On the second tier are town hospitals, which are located in the sub-district headquarters. County and larger hospitals form the third tier and are located in the capital city of the respective district. Western and traditional Chinese medicine are provided side-by-side in all these facilities. In addition, rural health insurance schemes enable extensive access to medication from clinics and pharmacies.

This overview highlights the different epidemiological contexts and health systems across the field sites. Private and informal healthcare providers are more widespread in Rajasthan, whereas Gansu exhibits formal coexistence of Western and traditional Chinese medicine. But there are also similarities: Both sites face challenges in the provision of affordable and quality care, and they have services in place that are designed to facilitate access to the health system for phone users. Against this backdrop, the following section illustrates the ways in which people in Rajasthan and Gansu utilise mobile technology to navigate their health systems.

4.3   Phone-Aided Healthcare-Seeking in Rajasthan and Gansu

The differences between their health systems notwithstanding, qualitative findings from both Rajasthan and Gansu reveal the emergence of health-related uses of mobile phones. Such behaviours emerge mostly independently of the existing phone-based health services. Four common forms of mobile-phone-aided healthcare-seeking behaviour reported by villagers in both contexts include (a) eliciting and exchanging health-related advice, (b) summoning assistance to one's home, (c) arranging transport to reach a health provider, and (d) making appointments and coordinating with health providers.[60] This section illustrates the variety of forms that phone-aided health action takes in both rural Rajasthan and rural Gansu.

4.3.1   Exchanging Advice

A commonly reported activity in both field sites was to access and exchange health-related advice through mobile phones. In Gansu, such advice tended to involve preventive health information. Preventive information was for example accessed through the Internet in order to find dietary information ("*search some things on the phone, one diets, like how to cook;*" Gansu, woman, 42, smartphone owner). Other respondents in Gansu indicated that—instead of using the Internet—they would rather contact family members or medical practitioners for health information. A town-hospital-based public health expert for instance indicated that he occasionally receives calls from villagers about infectious disease prevention, diets, and blood pressure control. In addition, preventive advice in Gansu was one of the few cases in which mHealth services were used. One respondent received subscription-based public health text messages from China Mobile, describing them as "*very useful*" and "*a great help,*" but he

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[60] This is not an exhaustive list. An HIV/AIDS counsellor in Rajasthan for example described how she calls her patients in order to receive health status updates. I focus here on a selection of the activities reported by village residents to illustrate the range of phone-aided behaviours. Quantitative survey data in Chapter 6 depicts the broad spectrum of behaviours and their differences across both field sites.

was not able to recall the latest messages nor to locate them in his mobile phone (Gansu, man, 47, phone owner). Another interviewee stated that she downloaded a health information "app" and used it temporarily until she updated her phone operating system (she uses an *iPhone*). In the context of health knowledge, she argued that,

> *The mobile is convenient to take with you wherever you go and whenever you want to read.* (Gansu, woman, 29, phone owner)

Overall, the qualitative data from Gansu suggests that preventive advice is accessed through a variety of routes especially by younger, more affluent, and smartphone users.

Compared to the preventive information access in Gansu, phone users in Rajasthan tended to emphasise information about healthcare providers. This does not only include the rather generic advice to seek medical help for a current ailment, but also information on specialist medical treatment. An example was given by a woman who recalled the treatment of her grandmother. She explained that her grandmother had been ill and previous treatment from doctors had not shown the desired improvements in her condition. The woman went on to elaborate,

> *My grandmother was suffering from stomach problems and we found a woman who also suffered from the same problem. But she* [the other woman] *consulted a doctor and after some treatment she got better. Somebody advised us to get the number of that doctor from this woman and consult him. We did so and took my grandmother to that doctor.* (Rajasthan, woman, 23, phone owner)

The narrative describes that the interviewee's family contacted a stranger via the phone (as otherwise they would have had to visit her), and that they were able to access the phone number of a seemingly suitable medical practitioner from her, all of which led to accessing this

doctor for treatment. Though less elaborate, also other respondents from Rajasthan described how the phone assists their navigation of the healthcare system in order to locate and approach doctors for their condition.

The different patterns of information access across the qualitative samples from Gansu and Rajasthan appear to result from the different health system landscapes. Health providers in Gansu are typically located in the public sector and traditional Chinese medicine is an integral part of the health system. In contrast, the healthcare landscape in Rajasthan is more fragmented and doctor qualifications vary widely, which suggests a lower degree of transparency and less effective regulation, resulting in greater information asymmetries between health seeker and healthcare provider. Advice about providers may then be required to ensure a minimum level of treatment quality.

4.3.2   Summoning Assistance

Advice on the phone does not always yield workable outcomes. Consider the following statement:

> *Firstly, I seek consultation and inform* [the village doctor] *about the illness and the situation, the duration of the disease, and the effect of the medicine taken already, but then I almost always ask him to come here for diagnosis.* (Gansu, man, 50, phone owner).

In this instance, a 50-year-old man would call the doctor for advice, yet he realises the limitations of this approach. Where callers are unable to express themselves, they may call a doctor to their house for face-to-face consultation. This kind of "summoning assistance to one's home" is the second form of phone-aided health action I describe here.

Narratives in both contexts show a common reliance on *calling* for help from family members as the first (and sometimes only) instance of mobile-phone-aided healthcare-seeking behaviour. This is complemented by calling medical providers if family members cannot be reached or cannot solve the problem—especially at night: Respondents in both Gansu and Rajasthan indicate that they normally visit local doctors and nurses during daytime on their own, provided they are accessible. At night, however, the respondents are more inclined to calling healthcare providers ("*We go to see him* [the village doctor] *directly, but when it's night or we feel very uncomfortable, we may call him*;" Gansu, man, 52, phone owner). Yet many providers are not available 24 hours per day, which imposes restrictions on the ability to summon help. This was particularly pronounced in some villages in the Rajasthan sample.

Borrowing phones for this activity is not unusual. This can be illustrated by the statement from a 50-year-old man in Gansu who resides in a remote community without village doctor:

> *Our neighbour who caught a cold came over to borrow my phone. They did not have the number of the village doctor. I dialled the number for them on my phone, and the doctor came here after calling*. (Gansu, man, 50, phone owner).

Furthermore, the need to articulate problems in medical terms (e.g. describing symptoms) when calling medical providers appeared to make third-party use more likely in Rajasthan. One woman reported in a group discussion that she and her family members would normally delegate the process of summoning assistance to an educated member of their household, stating that,

> *Whoever is educated, whether it's the son or the daughter, we tell to them to call because we don't know how to call*. (Rajasthan, woman, 40, non-owner).

Such limitations can apply to owners and non-owners of phones alike.

Overall, the qualitative analysis suggests that health providers are being called for more rather than less severe issues, as people may otherwise use non-phone-based ways of accessing the facilities. Situations of inaccessible public health facilities and mobility constraints of older people in Gansu were notable exceptions to this observation (i.e. summoning assistance for mild conditions). Although similar patterns may be conceivable in Rajasthan, government health providers appeared to be less receptive to home calls than their Gansu counterparts, while the financial implications of calling a private practitioner appeared to restrict this form of phone use to severe cases.

4.3.3   Arranging Transportation

Aside from calling for help or exchanging advice via the phone, the respondents in Rajasthan and Gansu also use mobile phones to arrange for transport to health facilities. In both field sites, this reportedly takes place exclusively through voice communication and is mostly limited to severe or emergency situations rather than routine visits to health providers.

Phone-mediated healthcare access can involve publicly provided services such as ambulances. This has been reported in both field sites, confirming that these basic phone-based services are utilised at least to some extent. But public ambulance services are by no means the only way to reach health providers using a phone. For example, when a discussion group in Gansu was asked about their means of reaching the nearby hospitals in case of illness, the use of taxis was mentioned among other responses:

> [I] *call a taxi driver. Give them money and they will take you anywhere. It will take you five or six Yuan* [£0.50-£0.60] *to go to Gaolan* [the county town]*, and ten Yuan* [£1.00] *to go to Lanzhou* [the provincial capital]. (Gansu, men, 57 to 68 [group response], phone owners).

In addition to taxis, village residents themselves offer transportation services to their family and community members. A *serpanch* (village head) in Rajasthan exemplified this as follows:

People call me any time and I help them. Sometimes I get a call at night for delivery, so I take the patient in my personal car to the hospital. (Rajasthan, man, 41, phone owner)

Mobile phone users therefore arrange healthcare access through personal transportation and taxis in addition to ambulance hotlines. In fact, especially during emergencies, private means were often described as preferable. A respondent from Rajasthan put it as follows:

Only few people call the 108 [emergency] *number and most rather pay for a taxi for ₹600-700* [£6.00-£7.00]. (Rajasthan, men, 19 to 46 [group response], mixed ownership)

As all respondents were aware of the ambulance hotlines, this underlines that factors other than mere provision of the service and the availability of mobile phones play a role in their uptake.

4.3.4   Appointments and Coordination With Providers

Appointments and coordination with health providers were somewhat less common forms of mobile-phone-aided healthcare seeking that I encountered in the field. At the same time, these activities represent one of the only two instances in the qualitative fieldwork in which a respondent (here: a medical provider) indicated the use of SMS in the context of healthcare facilitation.

In Rajasthan, phone-based appointments were reported in two comparatively accessible villages. In these instances, mobile phones were used for confirming the availability of a formal healthcare provider in a clinic and/or to coordinate upcoming visits. For example, a nurse in a village sub-centre, receiving eight to ten calls per month, stated that,

> *Women also call me for immunisation, vaccination, or to know that the* [health] *camp is happening so that they can come there. Sometimes the women don't know where the camp is held. So they call me and confirm the address.* (Rajasthan, nurse at sub-centre)

Some of the health experts argue that this use of the phone becomes increasingly common because of the rising number of home visits (itself a result of mobile phone use). For example, a private doctor in Rajasthan stated clearly that,

> *I can access more people* [with the mobile phone] *but also it happens that I get a call and I go somewhere and another patient comes to the clinic and then he has to wait.* (Rajasthan, private doctor at clinic)

In the Gansu sample, appointments and coordination with doctors also included the provision of medicines. For instance, a 70-year-old man reported that he receives his heart medicine from a township hospital located 20 minutes by bus from his village. He calls the doctor prior to collecting the medicine from the hospital. Although the phone is his, he stated that, "*the family dials for me*" (Gansu, man, 70, phone owner). Moreover, a government doctor in a comparatively affluent village in Lanzhou district reported that recently a patient reminded him via SMS to order new medicines, although this was a rare event. Overall, phone use for appointments was encountered in even the most remote sites.

The seemingly stronger emphasis on coordination and appointments in Gansu may be a result of trust relationships between providers and patients. Town and county hospitals are being approached for non-common and sometimes complex conditions. In these cases, a direct or indirect personal relationship can improve the (perceived) likelihood and affordability of treatment (as no informal payments are required), and it could yield more speedy and flexible care. For instance, a 25-year-old man in Gansu stated that he would go to the county hospital where the treatment is "*good*" and affordable, unlike the township hospital. When he plans to do that, or when he accompanies his mother, he would call a friend in the county town of Zhangxian, who will then check and arrange for a doctor to be present in the hospital. Knowing doctors personally, or knowing someone who does, therefore appears to be linked to mobile-phone-aided coordination and appointment-making in this context.

At this stage, it is worth pointing out that various mobile-phone-aided activities can occur together during one illness. This can be illustrated by the experience of a man in Gansu, who described a recent illness episode of his 50-year-old wife (interview notes):

> *When his wife felt sick last month (24 November) in the morning at 5:30am, they called their younger daughter who lives in the nearby town. Then they called the son in Zhangxian, who in turn called a person who knows a doctor in Zhangxian to prepare for their arrival. Then they asked a neighbour for a car and went to the daughter first for pickup, and subsequently they went to Zhangxian to the hospital where they arrived at 7:20am (it takes less than 30 minutes by car). The doctor was called by a neighbour who knows him (the doctor), because normally the hospital only opens at 8am, so the contact to the doctor facilitated the process. Then the wife spent six days at the hospital and a few days at their daughter's place, and every few days she went to the hospital. She (the wife) arrived back home two days ago. During that time the wife did not have a phone with her, also because she was not able to make calls (due to ear problems, for which she was treated). Instead, neighbours and family members called his (the husband's) phone to enquire about her health, because he was with her at the hospital and at their daughter's home, him managing the relationships for her. (Gansu, man, 53, phone owner)*

This example combines the use of the phone to coordinate an upcoming visit with the doctor, to arrange transportation to the town with help of the son, and to share information about the progress with peers on behalf of the patient, all of which were handled by a person other than the patient.

4.4   Healthcare Implications of Mobile Phone Use

The behaviours reported here suggest that mobile phones can increase the access to health providers in Gansu. In Rajasthan, their use appears to produce shifts from informal (e.g. faith healers) to formal health providers (e.g. public and private doctors). Health providers themselves substantiate this observation. In Gansu, a village doctor remarked that,

> *If someone has a cardiac arrest* [or some other severe cardiovascular condition], *he / she can go directly to the Lanzhou / county hospitals without wasting time in the village hospital in emergencies. This is because they call the village doctor and he can tell them that they should go there. There are no changes in the health-seeking patterns though—existing patterns are amplified rather than shifted, meaning that people receive the usual care faster, rather than receiving different care.* (Gansu, village doctor at village hospital, interview notes)

Likewise, a town hospital physician stated that,

> *The increasing use of phones has enabled more contact between the doctor and the patient, though there is no change as to whether people seek Western or traditional Chinese medicine*. (Gansu, physician at town hospital, interview notes)

As Chinese and Western medicines are combined in the health system in Gansu (interview with Prof Ding Gouwu, Lanzhou University), behavioural patterns do not seem to shift

away from formal to informal care. However, by increasing the accessibility of medical providers, it is possible to expect a shift from self- to medical care, and faster access to emergency treatment.

In Rajasthan, the interviews indicated that, where phone-aided health action emerges, people may seek formal rather than informal care. In other words, the local reliance on faith healers may only partly be the result of personal preferences, and partly the result of insufficient alternatives to medical treatment. Access to ambulance services, the coordination of transportation to health facilities through the help of peers, and summoning assistance—all these behaviours appear to favour formal over informal providers. The responses of formal health providers in Rajasthan lend weight to this. A government doctor stated that,

> *People prefer to go to the hospital directly, so mobile phone use reduces faith healing. But faith healers may not be much opposed because also they often suggest people to go to the hospital.* (Rajasthan, physician at community health centre, interview notes)

A private doctor in a village made similar claims:

> *With mobile phones, people go less often to the faith healer because they can communicate more easily with the system. Because for some illnesses, they call each other, and their neighbours support them sometimes by calling 108* [ambulance services] *or the doctor or nurse for the patient. People seek more health care because of mobile phones, also by calling anyone from their family to come for help.* (Rajasthan, private doctor at clinic)

Furthermore, healthcare-seeking patterns in Rajasthan suggest that, where people summon assistance (and especially in more remote locations), private doctors may be favoured over government providers. This would correspond to a shift in healthcare-seeking behaviour

away from informal providers and no treatment to formal providers, whereby more remotely located villagers gravitate more strongly towards private practitioners.

In short, mobile phone use appears to influence health action. Patients may have health provider preferences that can only be realised through mobile phones, but healthcare providers may also respond differently to patients' phone use. In addition, earlier statements have illustrated that health service provision itself may adapt to people's phone use, with doctors being more often absent from their post in order to deliver services to people's homes. As I describe in more detail below, phone use may also lead people to access specialist doctors unnecessarily because they are familiar to them. It is therefore not clear whether increasing mobile phone use improves access to healthcare, merely shifts service provision from one group to another, or even impairs overall service delivery quality and quantity.

4.5 Exclusion From Health-Related Mobile Phone Usage

The consistent emergence of health-related mobile phone use across contexts as different as rural Rajasthan and rural Gansu is striking and underlines the role of people's local innovation to meet their healthcare demands. But not everyone engages in such behaviours. The qualitative evidence suggests that neither is the use of phones for healthcare seeking "ubiquitous," nor are phones used for all kinds of health problems. Non-ownership of phones is unlikely to be the sole driver of this "non-use" because most of the respondents indeed own a mobile phone (more than 70% of the Rajasthan and more than 80% of the Gansu respondents own a phone). Although older respondents less often owned a phone, sharing, borrowing, and third-party access patterns mean that mobile technology is widely accessible for individuals in both contexts—at least for occasional and very basic use. I will go beyond the simple notion of adoption-as-access in this section and illustrate how provider responsiveness, alternative

healthcare solutions, phone utilisation, and the initiation of the healthcare-seeking process may influence the link between phone diffusion and healthcare access.

4.5.1   Phones as Inferior Solutions

The qualitative impressions from the field indicate that phone ownership need not necessarily translate into health-related uses if healthcare providers are unresponsive or if dominant alternative solutions to the healthcare issue exist.

Issues of provider responsiveness are particularly pronounced in the use of ambulance services in Rajasthan. Residents and practitioners in Rajasthan's villages claim that ambulance services are an uncertain choice in emergencies. This is reflected by statements such as,

> [The ambulance service] *108 is there, but it's not working.* (Rajasthan, men, 45 to 60 [group response], non-owners)

> *Because of complications and delays in transport (including ambulance), people may die on the way to the hospital.* (Rajasthan, men and women, 18 to 20 [group response], mixed ownership, interview notes)

> *Villagers say "when we call* [108]*, it doesn't come."* (Rajasthan, nurse at community health centre)

Similar reports were encountered in Gansu, with respondents stating that ambulances may take up to 1.5 hours to appear in remote villages. Such experiences can lead to frustration and pessimistic expectations, pushing people towards alternative means of transportation during emergencies.

Other activities depend on receptive providers as well. Respondents in Rajasthan would indicate that private doctors are more likely than government doctors to visit their homes. For

example, a 22-year-old woman in a Rajasthan, located in a village far from the district capital Udaipur but with good road access, stated that,

> *We can call private doctors but not government ones, and government hospitals only run during daytime, 10am to 5pm.* (Rajasthan, woman, 22, phone owner)

Personal relationships appeared to influence the responsiveness of providers. A male nurse suggested that, out of 20-25 calls per month, he would decide to visit eight to ten, depending on "*whether it is an emergency or someone close to him*" (Rajasthan, male nurse at community health centre, interview notes). This was even more pronounced in Gansu, where respondents suggested that a direct or indirect personal relationship with doctors in town and county hospitals determines whether they would call for appointments. A physician in a county hospital confirmed that villagers prefer to make appointments with doctors whom they are familiar with, up to a point where the doctor may not even be of the relevant specialisation. Knowing responsive doctors therefore influences the perceived value of using phones in the care-seeking process.

How do doctors perceive phone-aided service delivery? Doctors in Gansu reported that there are institutional guidelines and monetary incentives for them to use their phones for communication with patients, and medical providers in Rajasthan indicated that their phone numbers are widely known to patients. However, echoing the reports of Mechael (2006:170) in Egypt, the fieldwork revealed instances where healthcare providers actively opposed the provision of services via the mobile phone. A village doctor in Gansu maintained that having to answer patients' phone calls can be "*inconvenient and a burden because he has to rush to people's homes when they call him*" (Gansu, village doctor at village clinic, interview notes). In Rajasthan, some public medical practitioners were of the opinion that "*more doctors should*

use phones to provide more services to villagers" (Rajasthan, physician at community health centre, interview notes), which implies that this is not yet happening to a sufficient extent. In addition, doctors in both field sites commented on the callers' tone, indicating that especially older callers would be "*tactful*" whereas younger callers "*are not very polite and treat our work as granted*" (Gansu, village doctor at village clinic). Moreover, most of the interviewed doctors stated that, although phones are useful to complement their services, they do not replace face-to-face consultation especially in the area of curative and preventive health advice. A private doctor in Rajasthan had even started advising callers to rather come to his clinic for consultation, after having realised during home calls that the "*disease is different from what I expected, then I can't come again and again to bring the medicine*" (Rajasthan, private doctor at clinic). These examples suggest uneven responsiveness among medical providers in both Rajasthan and Gansu, in which case people may be less likely (or successful) to use mobile phones to access healthcare.

Regardless of whether healthcare providers are receptive to patients' phone use, the health system itself may offer alternative solutions to the problem. An element particularly pronounced in Gansu was respondents' ability to self-treat themselves with medication, which most of them stored at home as a result of government policies to facilitate access to basic medicines. For example, a 51-year-old female phone owner does not use her mobile device for health. She would also not normally go to the hospital when she is ill. Instead, she stated that,

> *I have some common medicines at home or I get some from the pharmacy in* [the district capital of] *Huining.* (Gansu, woman, 51, phone owner)

She therefore relies on self-treatment despite the fact that she resides near a village hospital in a comparatively affluent village.

Location and accessibility of facilities often appeared to influence mobile phone use (or non-use) for healthcare as well. In both field sites, residents in centrally located, affluent, and well-accessible villages stated that "*there is no need to call*" because hospitals and doctors can be reached easily (Rajasthan, man, 18, phone owner). For example, a 70-year-old man in Gansu, though owning a mobile phone, reported that,

> *The doctor lives close to the village, and we just go there directly or let him come here, it's near, and I don't need a phone. If it was far, then maybe we would need to call.* (Gansu, man, 70, phone owner)

Similar statements were uttered by wealthier individuals (who often own personal vehicles) and by persons residing next to formal health facilities. These groups often expressed their access to health facilities as more "*convenient*" than comparatively poorer dwellers. Wealth also influences the healthcare choices available to a person: In a remote location in Rajasthan, where only a private doctor would be available to call (otherwise it requires a 30-to-60-minute walk to his clinic), residents stated that,

> *No, I don't call the doctor to come to my home for treatment. I go to the doctor because if he came here then he would charge ₹150* [£1.50] *for consulting and transportation. There is a charge for medicine, too. I can't afford that.* (Rajasthan, woman aged, phone owner)

This case illustrates that the viability of health-related phone use depends on personal circumstances as well as on provider responsiveness. Ownership of household assets can also influence specific activities rather than phone use as a whole. For example, when asked whether they use mobile phones to receive health information, a mobile-phone-owning married couple in Gansu remarked that,

> *I can watch the TV for that* [i.e. receive health information]*, but not other ways.* (Gansu, man, 56, phone owner)

Conversely, where household wealth is constrained, comparatively marginalised respondents would first and sometimes only rely on medicines for the treatment of diseases, or otherwise (in the case of financial shortages) simply "*get some sleep*" (Gansu, man, 58; woman, 51 [joint response], phone sharers). In short, individuals may perceive differently the suitability of using a mobile phone in a given health situation, given the broader configuration of health system responsiveness, available healthcare solutions, and the technological environment.

4.5.2 Barriers to Health-Related Access

The qualitative fieldwork pointed at constraints in mobile phone use that go beyond considerations of alternative solutions and unresponsive healthcare providers. Affecting phone owners and non-owners as well as people with and without shared access arrangements, the qualitative fieldwork pointed at more nuanced notions of phone utilisation that determine "accessibility" to the technology in connection with people's specific health condition. I will illustrate this with three examples: phone-aided health action among high- and low-intensity phone users, the non-use of emergency call buttons among older persons, and frictions in the health-related use of borrowed and shared phones. At the end of this section, I will also briefly exemplify variations of mobile phone use in both contexts to demonstrate that binary assessments of mobile phone adoption are problematic. I will come back to these points in later parts of this thesis when I conceptualise and operationalise mobile phone utilisation as a multi-dimensional index.

High-intensity phone use in both field sites signals higher readiness to use the device for healthcare-related purposes, especially in the domain of health advice. A married couple in Gansu (aged 23 and 24 years) described that they play games on the phone for "*two or three*

hours a day" (husband) and that they are "*generally 24 hours a day online*" (wife). During their frequent use of the mobile Internet, they would also look up health information "*casually*" or, when they feel uncomfortable, they "*would go online for searching* [solutions]*, and this happens quite often.*" Also family members' sources of discomfort are often checked first on the Internet, according to these respondents. Young, high-intensity mobile phone users in a large and comparatively affluent village in Rajasthan made similar remarks. A young man would for example look up and share information with his family members on "*how to stay healthy and the importance of exercise, what kind of vegetables have vitamins and how to eat them*" (Rajasthan, man, 18, phone owner).

Conversely, respondents who used phones to a small extent and at low intensity appeared to be more limited in their healthcare-related phone use as well. For example, an older woman in Rajasthan, aged 60 years, received a mobile phone from her daughter and agreed that it is helpful. She talks with her daughter twice a month, yet she "*just know*[s] *how to pick a call and how to disconnect*" (Rajasthan, woman, 60, phone owner). During her recent personal history of illness, she only talked on the phone with her daughter about possible routes for treating her paralysis—she does not call doctors or nurses directly. Instead, she argued,

> *I directly go to the doctor, I don't know how to call and I never call for a doctor.* (Rajasthan, woman, 60, phone owner)

Some of her doctors live near her village, but for others she has to travel to the nearest urban areas. Her narrow use of the available mobile phone functions reflects the limited possibilities for healthcare-related use.

Experiences from the field also indicated that specific technical features for healthcare facilitation might be under-utilised. In Gansu, older phone users often owned specially designed devices for old persons—featuring large and high-contrast displays, loud volume, or phone numbers being read out for incoming calls. These phones—often a gift from younger family members—typically have a clearly visible "SOS" button that can be programmed with an emergency number for speed dialling. The availability of these technical features for healthcare facilitation did not automatically translate into use, however. None of the owners of these phones actually made use of these buttons, and a frequent response was that they "*do not know what's the role*" (Gansu, man, 71, owning such a phone).

A further example pertains to borrowing and sharing patterns. Statements from Rajasthan illustrate how non-owners seek healthcare with the help of mobile phones: Having been asked about what he normally does when he gets ill, an older man without phone replied that,

> *I* [go to a local private doctor] *for a minor sickness. But in the case of very serious sickness, I ask someone for help, to make a call for me to inform my daughter that I am ill and to do what's necessary.* (Rajasthan, man, 65 [group response], non-owner).

A similar point was made by a non-owner in Rajasthan who would state that, if he is "*very sick,*" he would call his relatives to "*pick* [him] *up and take* [him] *to the hospital.*" In contrast, for a common illness, he argued that,

> *I don't call because it costs money. There is a* [primary health centre] *here, so I go there.* (Rajasthan, man, 55, non-owner, group response)

This differentiation between minor and serious illnesses indicates that non-personal access to mobile phones comes with higher implicit or explicit costs that have to be in due proportion to the expected benefits of mobile phone use.

Obstacles may also arise where phone use is delegated to another person. For example, calling ambulance services may not be as straightforward as it seems. One man, who occasionally lends his phone to others for emergencies and deliveries, described that,

> *Even if the villagers have a phone, they are not able to provide details of the problem and location to 108* [the ambulance hotline]. *So we help them to talk, help them with their communication.* (Rajasthan, man [group response], phone owner)

According to his experiences, phone owners may not be able to answer the questions of the hotline operators, and they may feel intimidated by the process. Subtle accessibility barriers may therefore prevent the extensive use of seemingly "readily available" services and solutions, rendering phones inaccessible for certain health purposes and especially for marginalised groups.

These examples illustrate how accessibility constraints influence phone-aided healthcare seeking. These constraints result from different health conditions and variations in mobile phone adoption (e.g. access and usage). In fact, narratives from the field underline that mobile phone adoption itself has very different expressions. Consider the following quotes from phone owners:

> *I don't know any* [phone functions]. *I just press the "OK" button to receive calls, but I can't dial numbers. So whenever I want to a make call, my son helps me. Whatever text messages I receive, they are all invisible for me because I don't know about them and I never see them.* (Rajasthan, woman, 45, phone owner)

Generally, I take and make calls, and SMS sometimes. The people whom I contact are relatives and children, to convey holiday greetings or to say hello sometimes. I can't use other functions of the phone. I do use the phonebook, but not the pictures, I can't use that. I also can't use the camera. (Gansu, woman, 42, phone owner)

I used texting, calling, internet, music and so on [on the phone that I lost a couple of days ago]. *And of course phonebook and alarm. But I don't use the alarm at home. Only when I need to go out for work, I may use the alarm to get up early. Texting is among family and friends.* […] *I send ten messages per month, and call family members and relatives. I always get calls from my daughter and son. The calls wouldn't last long, but I'm not sure. It can be half an hour if it's my sister or good friends. I use the Internet for news or reading books, or to download music for listening. I listen to music when I work on the field, or before I sleep. And I use the Internet at noon or in the evening.* (Gansu, woman, 42, recently lost her phone)

Although all three women "adopted" mobile phones and are of a similar age, their use is distinctively different. Treating mobile phone adoption as a binary condition as is commonly practised in the public health literature would therefore give rise to the assumption that (a) all mobile phone "adopters" (e.g. owners) exhibit the same forms of under-utilisation, or that (b) all adopters are able to exploit fully the technological options available through their mobile phone. The conditions outlined in this sub-section underline the relevance of going beyond a narrow conceptualisation of adoption to one that includes different forms of access and usage that, in relation to a person's illness, define the health-related accessibility of mobile technology.

4.5.3   Absence of a Care-Seeking Process

The preceding cases of unsuitability and inaccessibility are not the only conditions under which phone-aided health action may fail to emerge. There can also be situations in which individuals become ill yet do nothing. This may seem obvious, but the reasons for not seeking healthcare may be connected to social or economic marginalisation and therefore facilitating uses of mobile phones, if there are any, would systematically bypass these groups.

Respondents from both contexts hinted at such situations. For instance, a young woman in Rajasthan reported that she would go to a nearby hospital if there is a serious health situation, but she immediately added that,

> *We have too much work at home, so if we get ill, we wait and try home remedies or bring medicines from chemists, and only when it is serious we go to hospital.* (Rajasthan, woman, 22, phone owner)

Although she mentions different forms of self-care, she also hints at ignoring non-severe issues because of her workload in the household. Older respondents in the Gansu sample made similar references to hard work and chronic pain as intrinsic elements of the lifestyle of farmers:

> *If we are sick, the doctor would say something, but farmers cannot do that. We are supposed to rest, but we have the farming work to do, so we won't be able to rest.* (Gansu, man, 55, phone owner)

> *The doctor told me "don't do heavy work," but how can you not do heavy work as a farmer?* (Gansu, woman, 46, phone owner)

> *We all have chronic pain.* (Gansu, man, 44, phone owner)

> *Normally if there is no serious illness, we just wait for it to improve. We can only go to the hospital if we can't bear it.* (Gansu, man, 62, phone owner)

Taking medicines at home or resting are common solutions, but minor and chronic conditions may also remain ignored according to these statements. Mobile phones cannot enter the healthcare-seeking process in these cases because such a process would not exist. If some groups do not seek healthcare for reasons such as economic and social marginalisation, and if

otherwise phone use would have facilitated their access to healthcare (which, until further analysis in Chapters 6 and 7, is speculative), then they could become relatively more disadvantaged vis-à-vis people who seek healthcare by means of mobile phones.

4.6   Limitations and Discussion

This chapter illustrated the interactions between mobile phone use and healthcare-seeking behaviour in rural Rajasthan and Gansu. Among others, the qualitative insights highlight the emergence of health-related uses of mobile phones in both rural Rajasthan and Gansu despite their differing health systems, socio-economic conditions, and cultural contexts. Mobile phone users employ the devices creatively in order to meet at least some of their healthcare demands. Intermediaries play an important role in this process because mobile phones cannot be utilised to the same degree by all persons. At the same time, the wide-ranging examples of competing healthcare solutions, of obstacles in using and accessing phones, and of some individuals' disinclination to seeking care for mild and chronic health problems illustrated the limits of incorporating mobile phones in the healthcare-seeking process. One manifestation of these conditions is the seeming under-utilisation of existing mHealth services in both contexts, with the exception of ambulance services.

The review of technology adoption and diffusion highlighted the context-specific forms of technological engagement, foreseen and unforeseen consequences of technology diffusion and their equity implications, and the coevolution of technology and society. My qualitative analysis of mobile phones and healthcare echoes these points. For instance, although not presented in detail in this chapter, mobile phone adoption patterns exhibit locally specific idiosyncrasies. Mobile devices were remarkably more visible in Rajasthan than in Gansu (where, however, more respondents owned a mobile phone). Few interview sessions passed in Rajasthan's

villages without a phone ringing or playing music in the background, people used English expressions like "SIM card" while conversing in the local languages, and men typically carried their mobile phones conspicuously in the breast pockets of their shirts, the phone outline being clearly visible as if it were part of a uniform. Even the functional uses of mobile phones extend over a broad spectrum including different and coexisting forms of direct and indirect access and various degrees of utilising mobile phone functions such as calling, text messaging, phone books, cameras, or music players. Commonly used binary conceptions of adoption in quantitative research appear insufficient to account for this wide range of technological engagement.

The emerging use of mobile phones for health-related purposes is itself a manifestation of local user innovation: People incorporate mobile technologies into their lives with creative and unforeseen new applications, and the specific forms of phone-aided health action appear to arise in response to local health system configurations and the broader technological environment. Symbolic uses constitute one aspect of phone utilisation (e.g. customising ringtones to express personal and social identities), but, contrary to my expectations, they did not appear to be directly linked to phone-aided health action. Although the emerging forms of phone-aided health behaviour are context specific, people's reports of their actions render the phone akin to a "tool" in the healthcare-seeking process.

It is yet to be determined whether phone-aided health action translates into better access to healthcare (this is the subject of Chapter 7), but the qualitative case study provides first indication that mobile phone diffusion does play a role in local healthcare access patterns. Some of these patterns may be in line with desirable outcomes in the public health literature, for example patient empowerment and faster access to healthcare (Hampshire *et al.*, in press:21). But mobile phone diffusion and associated emerging phone-aided health action may also bring about unintended and potentially adverse consequences for healthcare access, like absorbing the time of specialised central-hospital doctors or increasing out-of-pocket expenditures for

private treatment at home. Similarly unintended (though perhaps expected) may be the redistribution of healthcare service delivery away from people who are unable or unwilling to use mobile phones in the healthcare-seeking processes. Uneven patterns of mobile phone adoption may thus aggravate uneven patterns of healthcare access. And although this case study only constitutes a snapshot of a single point in time, the current state indicates that healthcare providers are part of an ongoing process of adaptation to (and negotiation with) people's mobile phone use. It is possible that, if providers become gradually more receptive to and expectant of phone-aided health action, non-users' healthcare access will be affected as well. In line with the multidisciplinary technology diffusion literature, it therefore appears plausible that mobile phone diffusion is linked to development-related outcomes such as healthcare access and population health more generally.

These considerations also shed a somewhat different light on the notion and implications of "digital exclusion." The qualitative illustrations suggest that "exclusion" from health-related uses of mobile technology is not always problematic. It can also reflect alternative healthcare-seeking strategies. In addition, if a phone user would call a private doctor to ask for intravenous treatment rather than walk to a nearby public health facility, exclusion from health-related phone use may yield better and more affordable care than otherwise. However, the research also suggests that, if larger systems (health systems, social systems) increasingly accommodate mobile phones as tools, it can put non-users at a greater disadvantage. While "voluntary" non-users would be able to switch to phone-aided healthcare access, exclusion becomes a problem for marginal groups of non-users with accessibility limitations if essential services are increasingly provided through digital means.

The qualitative case study further contributes to the understanding of mobile phones from a public health perspective. For example, recent public health research from Kenya has examined the potential to leverage mobile phones for SMS-based reminders and information

services: Zurovac *et al.* (2013:3) surveyed Kenyan health workers and malaria patients at public health facilities, finding that the use of SMS was nearly 99% among the 219 surveyed health workers and 71% among 1,177 surveyed patients. Despite acknowledging difficulties of reaching non-user groups via SMS, the authors conclude that "major challenges in this process [of patient training on SMS communication and interventions] should not be […] expected" (Zurovac *et al.*, 2013:5). Similar arguments are made in a related paper by the same group of authors (Otieno *et al.*, 2014), based on interviews with 400 outpatients in Kenya. The respondents comprised predominantly mothers, 99.7% of whom confirmed that "they would be able in the next 28 days to have permanent access to phones to receive text-messages" (Otieno *et al.*, 2014:5). The authors thus describe the conditions for mobile-phone-based health interventions as "very favourable" (Otieno *et al.*, 2014:5). Even where researchers go beyond potential interventions and study the health-related uses of mobile phones, phone diffusion is understood to be desirable in terms of more efficient communication and healthcare access, inclusion of otherwise marginalised groups, and patient empowerment, provided that barriers to accessing mobile phones are overcome (Hampshire *et al.*, in press:18-21; Mechael, 2008:92-93).

The context of my research is clearly different from these studies, all of which were conducted on the African continent (Ghana, Egypt, Kenya, Malawi, South Africa). Some points for reflection emerge nonetheless. Firstly, it appears obvious in my case study that the availability of and access to mobile phones does not permit direct inferences of health-related usage potential. My research sites exhibit low utilisation of basic phone functions such as SMS and a hesitancy to master these functions where economic conditions are particularly dire. This echoes the notion of "digital capital" employed by Hampshire *et al.* (in press:24-25) to express people's ability to utilise mobile phones effectively when a health situation demands it. Lack of "digital capital" or the inaccessibility of mobile phones for health-related purposes may map onto existing patterns of healthcare exclusion and can therefore render the devices unfit for

more egalitarian access to healthcare (Hampshire *et al.*, in press:25). However, my research has also shown that additional factors beyond usability determine health-related mobile phone use. In contrast to what Hampshire *et al.* (in press) imply, people might have a range of reasons not to use a mobile phone in a healthcare setting, even though they could.

Secondly, while patterns of sharing and borrowing are occasionally acknowledged (and sometimes appear overemphasised) in the empirical literature, an important theme in my research is the role of intermediaries in the process of using phones, and of using them for healthcare. In the context of mobile phone use and health, only few examples address this point, including Hampshire *et al.* (2011:707) in Ghana, Horst and Miller (2006:140) in Jamaica, Mechael (2006:126-130) in Egypt, and the forthcoming multi-site study by Hampshire *et al.* (in press: Table 5). A stronger analytical focus on intermediaries' role in utilising the phone for healthcare access could help us understand their contribution to the social impact of ICT in general, and to the emergence of health-related behaviours and solutions in particular.

Thirdly, the literature hails the emergence of phone-aided health action as transformative, advantageous, and an opportunity to provide further phone-based services (Curioso & Kurth, 2007:6; Hampshire *et al.*, in press:18-21; Mechael, 2008:92-93), but its potentially problematic implications are disregarded or silenced in light of "technological potential." On the one hand, if existing uses of mobile phones have indeed positive and negative implications for health behaviour and healthcare access as my qualitative research suggests, then this violates the implicit assumption in much of the mHealth literature that mobile phones are a neutral platform for service delivery. On the other hand, the case study illustrated the possible competition between mHealth, phone-aided health action, and conventional healthcare behaviour. According to the interviews with my respondents, the low uptake of existing mHealth services (e.g. ambulances) is to some extent the result of seemingly superior phone-aided solutions (e.g. taxi services), and health information hotlines may compete with people's local information

exchange with family members, medically trained friends, or faith healers. The mHealth liter-

ature's disregard of the possible competition with existing behaviours is reminiscent of the

"fallacy of empty vessels" (Polgar, 1963:411-412), according to which recipients of new

healthcare solutions are often assumed to have no other means of solving the problem in ques-

tion.

It is important to acknowledge some of the methodological issues that are associated

with these arguments, which pertain in particular to the potential omission of population sub-

groups, socio-technological coevolution, and the capturing of health behaviour. Because the

purpose of the qualitative data collection was to explore (and to generate a theoretical frame-

work for) the use of mobile phones in healthcare seeking, sampling was geared towards achiev-

ing information saturation rather than generalisation. This does not detract from the fact that

the *emergence* of similar behaviours has been observed in both field sites, but it leaves unan-

swered questions about the prevalence of such behaviours within and beyond the field sites

(only the representative survey data in Chapter 6 will be able to establish a notion of prevalence

of these behaviours). For example, local facilitation through a locally trusted NGO in Rajasthan

may have geared the sample selection towards individuals with a higher awareness of health

issues than otherwise. Although the purposive sampling approach and the relatively large sam-

ple in each country was intended to capture as much diversity in the local populations as pos-

sible.

In addition, previously cited anthropologists and sociologists have repeatedly pointed

at the inter-relationships between technology and society (e.g. Ling, 2008b, 2012). Though

retrospective, my study is a one-time cross-section. It is therefore important to note that claims

about the dynamic interaction between individual and systemic behaviour are at best suggestive.

With a focus on individual behaviour rather than population-level data, the qualitative inquiry

is also not designed to examine effects of phone use on societal behaviour, even though such effects may shape the role of the phone in healthcare seeking over the long term.

Furthermore, my enquiry into personal care-seeking behaviour rests on the oral accounts of my informants. Brown *et al.* (1998:10) state that one of the major challenges of analysing health-seeking behaviour is that "there is often a significant difference between cultural 'ideals'—what people say they do—and 'real' behavior [*sic*] of observable action." Compared to the first-best data collection method of longitudinal participant observation, there remains a residual risk that my understanding of the use of the mobile phone within personal healthcare-seeking behaviour is incomplete or influenced by recall and social desirability biases (Fowler, 2009:108). This remains a challenge despite the fact that triangulation was sought from healthcare providers. The thematic analysis may therefore be susceptible to capturing intentions rather than actual behaviour. In order to mitigate this potential bias in the construction of a model of healthcare-related phone use in the following chapter, I drew on findings from the secondary literature through the lens of the themes emerging from my primary qualitative research.

4.7   Conclusion

In conclusion, this chapter presented qualitative case study evidence from rural Rajasthan and rural Gansu in order to illuminate the link between mobile phone diffusion and access to healthcare. This is not the first study to examine phone-aided health action. Recent research by Ahmed *et al.* (2014), Hampshire *et al.* (in press), Khatun *et al.* (2014), and Labrique *et al.* (2012) has begun to generate new qualitative and quantitative evidence in this domain. I contribute to the existing and newly emerging literature by developing a qualitatively grounded model in the following chapter that aims to explain mobile-phone-aided behaviours and their potential implications for equitable access to healthcare (Research Question 1). My framework

aims to facilitate systematic analysis that does not assume a direct link between mobile phone diffusion and healthcare-seeking behaviour. Not only are the patterns of phone use important, but also the health system context and its responsiveness to using the phone for health. The framework also underlines that people make reasoned and creative decisions to employ mobile phones and other tools and solutions in the process of healthcare seeking, not all of which need to be advantageous from a public health perspective. However, statements about impacts and the extent of the observed behaviours require further, quantitative analysis. Later chapters will draw on the framework in order to capture phone adoption and healthcare-seeking behaviour quantitatively, and to assess the impact and equity implications of people's phone use on healthcare access in rural Rajasthan and Gansu.

Chapter 5

A Qualitatively-Grounded Framework of Phone-Aided Health Action

5.1   Introduction

My qualitative case study contributes to the growing body of evidence on the patterns of locally emerging phone-aided health action. It indicates that mobile phone diffusion affects healthcare access, and that common assumptions about the nature of mobile phones as given, static, and neutral platforms for health service delivery may be violated. Yet, the literature continues to lack a framework to examine systematically the conditions under which rapid mobile phone diffusion would be beneficial or detrimental for rural healthcare access. The development of such a framework is the subject of the current chapter, in which I revisit the main themes derived from the qualitative case study and substantiate them with secondary literature from the multidisciplinary areas of mobile phone use and healthcare access in low-, middle-, and high-income countries. Figure 5.1 summarises the main elements of my framework, which examines the link between mobile phone diffusion and healthcare access in order to inform Research Question 1.

Through my framework, I argue that, although improved access to healthcare is a possible outcome of mobile phone diffusion theoretically, we should expect (a) several factors that lead people to not use mobile phones for healthcare despite ongoing phone diffusion, (b) both positive and negative outcomes when people use mobile phones for healthcare seeking, and (c) problematic equity implications for access to healthcare. These mixed implications result from three factors.

Figure 5.1. Schematic Depiction of the Theoretical Framework
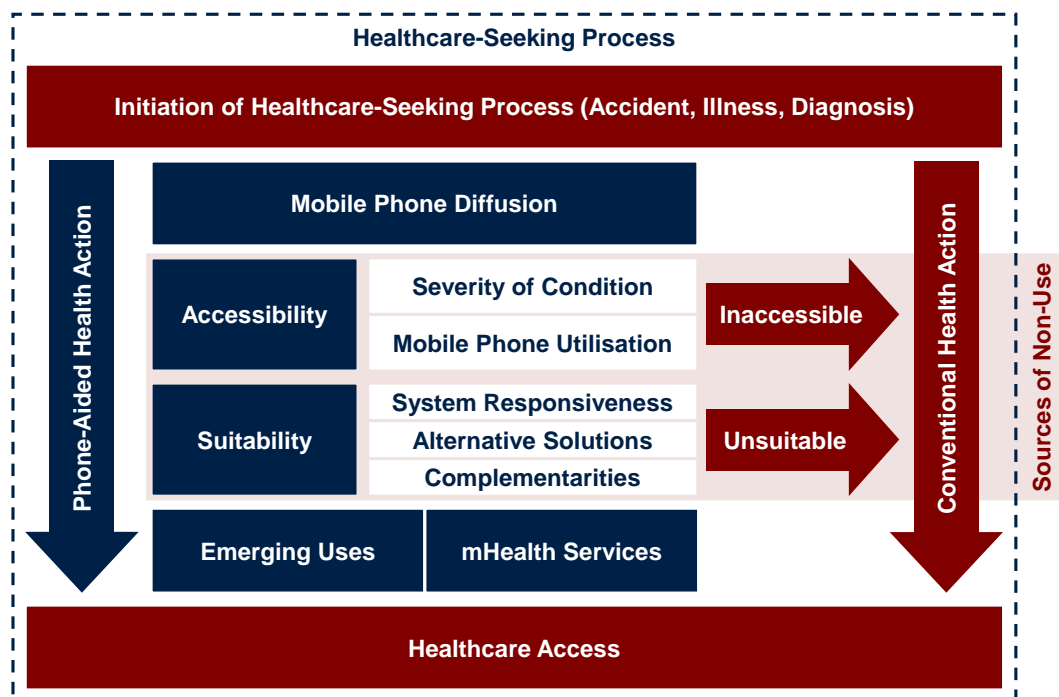
Source: Own illustration, derived from qualitative analysis and literature review.
Notes. Read figure from top to bottom, with initiation of healthcare seeking process as starting point. Conditions for phone-aided and conventional health action with possible healthcare access apply at each step of healthcare-seeking process.

Firstly, phones cannot facilitate healthcare seeking where no such process takes place. Because of social and economic pressure, marginalised and disadvantaged individuals may be more liable to accepting ill health as a natural state and will not seek care for certain health issues. Secondly, available phones are not equally accessible for healthcare purposes in every situation. Indirect access, the inability to use a wide spectrum of functions, and low intensity of usage can all limit the utilisation and thus healthcare-related applications of mobile phones. Accessibility limitations resulting from these conditions are especially pronounced for people with mild health conditions. Because utilisation is a broader notion than common binary conceptualisations of "adoption," the resulting "constrained non-use" can pertain to phone owners as well as non-owners. Thirdly, even when people seek health and mobile phones are accessible, alternative solutions, complementarities, and health provider responsiveness mean that available technologies will not automatically be used for healthcare seeking. Locational, economic,

and social factors can create a group of "intentional non-users" for whom mobile phones are not suitable when seeking healthcare. These factors underlying intentional non-use can reflect both personal advantage (e.g. central locations and personal transportation assets) and disadvantage (e.g. lack of social ties to medical personnel).

The conditions of care-seeking, accessibility, and suitability shape the ensuing forms of phone-aided health action, which take place either through the use of existing mHealth services, or through the local emergence of health-related phone uses. Both types of phone-aided health action potentially compete with each other, and with conventional, non-phone-based solutions. Where health-related phone use emerges locally, it may not only facilitate access to formal healthcare but also to unqualified yet responsive providers, depending on the preferences and constraints of the patient and the receptiveness of the health system to phone-aided health action. In addition, the composition of the groups of users and non-users can change over time. If health systems adapt to the increasing use of mobile phones, intentional non-users may find healthcare-related phone use beneficial, but constrained non-users may be left behind and could experience yet more obstacles to accessing healthcare. Based on these considerations and given the persistent methodological challenges in the literature on mobile phones and healthcare, I will hypothesise that,

H1   *An index that captures mobile phone utilisation as a three-dimensional concept is a better predictor of phone-aided health action than conventional, ownership-based measures of mobile phone adoption.*

H2   *Mobile phones improve access to formal healthcare.*

H3   *Mobile phone use in healthcare exacerbates socio-economic inequities.*

These hypotheses will guide the quantitative analysis in later chapters.

This chapter describes the framework, starting from the bottom up with the conceptual foundations of phone utilisation and health action that form the basis for quantitative assessments. I first address the notion of "utilisation" in Section 5.2, expanding the binary concept of adoption-as-ownership (commonly used in the technology diffusion and mHealth literature) to also incorporate other forms of access (shared ownership, borrowing, market access, and indirect access through third-party use) and the modalities of phone use in terms of the range of utilised mobile phone functions and the intensity of their use (through direct as well as indirect access). Although this conceptual classification is not ground-breaking in itself, its application to the analysis of the social impacts of mobile phones is novel and informs the distributional implications of different forms of mobile phone adoption.

Section 5.3 describes the concept of "healthcare seeking" as a multi-step process during which more than one actor or healthcare provider may be accessed. Healthcare seeking does not necessarily involve access to public or private healthcare facilities, but can also include informal and traditional providers, family members, or self-care. The logic of this conceptualisation is that a normative interest in improved access to healthcare first requires an exploratory analysis of the different ways in which people actually seek care. This view of healthcare seeking can be found in medical anthropology, but applied to this framework it helps to improve our understanding how mobile phones can potentially affect people's trajectories through the health system. I will exemplify this with a non-exhaustive list of seven different forms of locally emerging phone-aided behaviours that are reported in the literature (e.g. through making appointments or calling for help), which underlines that my qualitative findings are not isolated cases.

I subsequently discuss in Section 5.4 how conditions of accessibility and suitability are defined and influence the emergence of mobile-phone-aided healthcare-seeking behaviour. I

first argue that the severity of people's illnesses interacts with their mobile phone utilisation, which constitutes the healthcare-related accessibility of the phone. Limitations in access and use potentially create barriers to incorporating phones in healthcare-seeking processes especially for mild conditions that do not require urgent responses. But being able to use a phone during an illness does not mean that the phone would also be useful. The second part of the section focuses on provider responsiveness, complementarities, and alternative solutions for healthcare seeking, which together determine the "suitability" of mobile phones in this context.

Section 5.5 explains how accessibility and suitability affect healthcare-seeking processes. Even if increasing mobile phone diffusion were to produce average improvements for rural access to healthcare, some phone users experience facilitation of adverse behaviours and some groups can become gradually more marginalised. Marginalisation can become even more pronounced over time if health system actors adapt to mobile-phone-based service delivery. This framework is distinctively different from existing models as it draws attention to the interfaces between phone diffusion and healthcare behaviour, the potential competition among and between different phone-aided and conventional healthcare solutions, and the uneven equity outcomes in this process.

The final section summarises the framework in three overarching hypotheses related to the predictors, effects, and distributional implications of phone-aided health action. These hypotheses guide the quantitative analysis in Chapters 6 and 7. I also discuss limitations of the framework, considering my implicit treatment of mobile phones as tools (based on the qualitative analysis), challenges of assuming a static society, and my focus on healthcare seeking rather than on broader health-related behaviours and outcomes.

5.2   Mobile Phone Utilisation

While "adoption" is conventionally understood as the "decision to make full use of an innovation as the best course of action available" (Rogers, 2003:21), my literature review in Chapter 2 highlighted that this concept is commonly operationalised through binary measures of ownership or access in both the technology diffusion literature and the public health literature on mobile phones. Derived from the qualitative research and complemented by an extensive review of the literature on mobile phone and technology use, the present section describes my conception of mobile phone utilisation (summarised in Figure 5.2 below) that I later link to healthcare-seeking behaviours. This conception is also the basis for my quantitative measurement of mobile phone adoption. I argue that "utilisation" is a more faithful representation of behaviour with (at least theoretical) implications for the emergence and distribution of healthcare-related outcomes. After a brief description of the concept, I discuss in the second part of this section how it differs from established approaches in the technology adoption literature.

Figure 5.2. Conceptual Components of Mobile Phone Utilisation
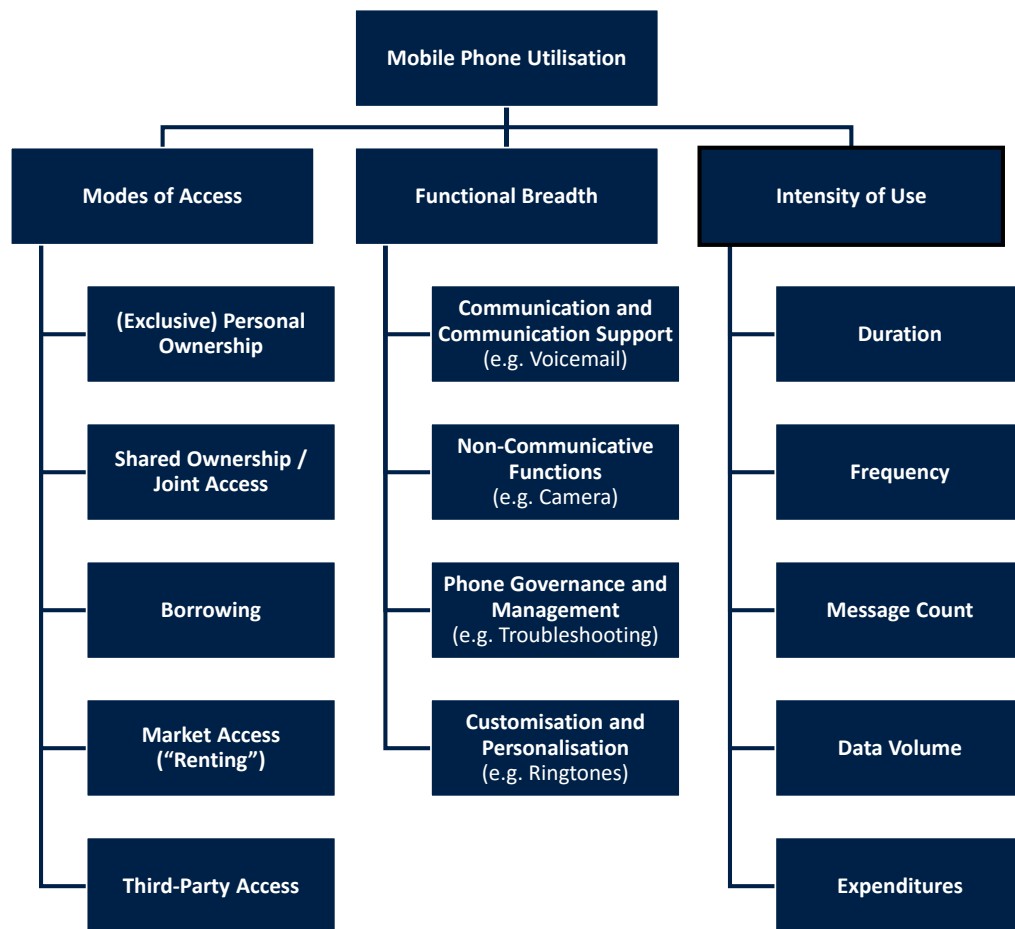
Sources: Own elaboration, derived from qualitative fieldwork and secondary literature (Aker, 2010:50, 54-55; Archambault, 2012:406; Bandiera & Rasul, 2006:895-896; Bandura, 1982:142; Bell, 2005:82-83; Ben *et al.*, 2009; Benjamin, 2013:71-72; Brady *et al.*, 2011; Burrell, 2010:241; Chipchase, 2006:17; 2008:81-82, 85, 87; Conley & Udry, 2010:61-62; Cox & Fafchamps, 2007:3715-3718; D'Souza, 2010:55, 249; de Silva *et al.*, 2011:11; Dey *et al.*, 2011:52, 56-57; DiMaggio & Garip, 2012; Dodson *et al.*, 2013:79, 82, 84-85; Donner, 2008:150; Donner *et al.*, 2008:329; Doron, 2012:421-423; Emerging Markets Direct, 2012:8; Euromonitor International, 2011:77; 2013:2-3; Fernández-Ardèvol, 2012:17-18; 2013; 2014:123-124; Fortunati, 2005:156-157; Fortunati *et al.*, 2010:409; FRPT Research, 2013:3; Fu & Polzin, 2010:326-327; Futch & McIntosh, 2009:56; Gell, 1986:114-115; Geser, 2004:6; Hahn & Kibora, 2008:95, 99; Hijazi-Omari & Ribak, 2008; Hughes & Morton, 2006:50; Jeffrey & Doron, 2013:175, 212-213; Jensen, 2007:891-892, 917, 920; Kamga, 2012:378; Karabagli *et al.*, 2006; Kurniawan, 2008:893-895; Lee *et al.*, 2012:27-36; Leung & Wei, 2000:311; Ling, 2008a; Ling & Yttri, 2006:223-224, 226; Ling, 2012; Mechael, 2006:21, 121-122, 128-129; Medhi *et al.*, 2010:3, 5-8; Miller, 2010; Ndiaye & Zouinar, 2014:275-277; Oosterlaken, 2009:95-99; 2013:219; Oreglia & Kaye, 2012:142; Oster & Thornton, 2012:1280-1281; Patrick *et al.*, 2008:178; Reisdorf *et al.*, 2012:19; Rogers, 2003:219, 233; Smith, 2010:2, 14; Souter *et al.*, 2005:68-71; Sreekumar, 2011:176; Stirrat, 1989:109; Stork & Calandro, 2014:215; Teece, 2010:700-701; Tenhunen, 2008:519-520, 523; Valente, 2010:172-175; van Velthoven *et al.*, 2013b; van den Bulte & Lilien, 2001:1410; Visvanathan *et al.*, 2011; Vold Lexander, 2011; Wang *et al.*, 2012:212; Wei & Zhang, 2008; Wesolowski *et al.*, 2012:5; Wicander, 2010:25, 56, 69-71, 75, 110; Wilson & Stimpson, 2010; Wirth *et al.*, 2005:17; 2008:604; Ziefle & Bay, 2005:381-382).

5.2.1   Three Dimensions of Mobile Phone Utilisation

In response to the diversity of mobile phone uses observed during the fieldwork, my framework is built on a notion of adoption that captures phone access, the functional spectrum, and usage intensity as three dimensions of "utilisation."

"Access" is based on a wide notion that includes direct and indirect forms of utilisation. Besides personal ownership, direct access to mobile phones involves shared ownership and joint access, borrowing, and market access, all of which are often subsumed under a vague notion of "shared access for non-adopters" (e.g. Donner, 2008:150; Wicander, 2010:25). For the purposes of this analysis, the heterogeneity of phone access is not captured adequately by such an overarching notion of "sharing." Not only are different counterparties involved depending on whether individuals "share," "borrow," or "rent" a mobile phone, but these forms of access also have various logistical consequences for phone use and entail different "costs" for the user. For instance, unlike "sharing" as mutual ownership or as joint activities between family members and close friends, my fieldwork has shown that "borrowing" requires the explicit permission of the owner of the phone and may come with explicit or implicit costs and obligations for the borrower. This is also shown by Hahn and Kibora (2008) in Burkina Faso. The authors describe that it is customary to summon remote family members for funeral arrangements when a villager dies. Phones are borrowed for this purpose, among others, from teachers who live in the village, but the teachers would in return "expect the young men from the village to weed their field" (Hahn & Kibora, 2008:99), which highlights the reciprocal nature and implicit costs of phone borrowing.

Furthermore, a common assumption of mobile phone access through owning, sharing, or borrowing is that individuals use the phone by themselves. Intermediaries can play a role in the process as well. In such cases, one person is responsible for handling some or all functions of a phone on behalf of the beneficiary. Medhi *et al.* (2010:6-7) exemplify this with Edulan—

a Filipino fisherman—who owns a mobile phone yet is illiterate. He makes phone calls on his own, but is unable to read and write text messages. To overcome this problem, "he has his *proximate* nephew Cirilo, who checks his text message and reads it out to him. Sometimes, Cirilo even sends a reply to the sender on Edulan's behalf" (Medhi *et al.*, 2010:6-7, original emphasis). Third-party access therefore emerges as an important element of mobile phone adoption.

Aside from these five facets of access, my theoretical framework distinguishes between different modalities of phone use and their relation to healthcare-seeking behaviour. Such considerations are relevant because available phone features are often under-utilised. For instance, Stork and Calandro (2014:215) report that 46% of their survey participants in rural Namibia in 2011 (aged 15+) owned a mobile phone, but only 15.3% of these phones were mobile-Internet-enabled and only 10.7% of phone owners actually did browse the Internet (compared to 40% in urban Namibia). Under-utilisation can also be observed in high-income contexts. In a 2010 survey of 1,917 people in the US, Smith (2010:14) finds that approximately four out of five persons in the age group of 50 to 64 years own a mobile phone, but only 57% of those use text messaging. Likewise, recent news coverage in the UK suggested that, "Just under 95 per cent of Britons do not use the full functionality of their [mobile] devices, and nearly four in 10 use only half or less" (albeit the representativeness of this claim cannot be established; Anonymous, 2014).

Given such variations in mobile phone adoption, my notion of utilisation incorporates the modalities of use as the functional breadth with which people use mobile phones (the "extent") and the frequency and duration with which these functions are being used (the "intensity"). The functional extent includes communication and multimedia, but also phone management tasks (e.g. keeping it charged) and personalisation of the phone (e.g. through ringtones

and accessories). Yet it is insufficient to capture only *whether* the various mobile phone functions are being used (Wicander, 2010:25). For example, Dey *et al.* (2011:57) report that Bangladeshi farmers "did not like to carry the mobile telephone sets when they were in the field" and that, "effectively, the mobile telephone was used as a fixed device thereby changing its original nature of use." A notion of phone utilisation should therefore also capture the intensity with which individuals engage with the various functions, both directly and indirectly.

Different degrees of utilisation result from five commonly cited groups of factors: personal characteristics, technical features, technological context, social environment, and culture and local histories. These factors are often inter-related. For instance, different mobile phone types and specially designed devices for older users (loud audio aides, high-contrast displays, simplified navigation) can remedy some of the challenges arising from age-related sensorial impairments (Kurniawan, 2008:893-895; Ziefle & Bay, 2005:381-382). Another example is the link between social context and technical features. Oreglia and Kaye (2012:142) in rural China suggest that people who receive a phone as a gift from family members are expected to "keep the phone in working conditions […] so that they […] can receive calls from their children, to learn how to use the phone from their children, and to have it always with them." This could mean that an owner holds on to a broken phone longer than may be technically and financially necessary, thus limiting the extent to which the device can be used.

Beyond these five common factors, it is also worth pointing out two further elements that influence people's engagement with mobile phones. Firstly, articulated perceptions, myths, or shared experiences of mobile phone use (i.e. "meta-narratives")—respondents in India and China articulated for example myths about the link between mobile phone radiation and heart attacks or social aspirations of owning mobile phones—can both discourage and encourage users to acquire and engage with mobile technology. Secondly, by determining a person's technological skill level or "digital literacy" (Eshet-Alkalai, 2004; Huerta & Sandoval-Almazán,

2007), learning processes shape the functions that a phone owner can operate. The fact that available mobile phone functions are typically under-utilised suggests that the processes of learning are often incomplete. Learning-by-doing and learning-through-peers come at costs that need to justify the gains of mastering additional features of the phone (Chipchase, 2008:85). If variations in utilisation reflect on variations in health-related phone uses, then equity patterns may unfold in line with meta-narratives, frictions in learning, and the five aforementioned groups of phone utilisation determinants.

5.2.2   Comparison of Classification Schemes

My theoretical framework links mobile phone utilisation to personal healthcare seeking through the concept of "accessibility" (see next section). I use a three-dimensional notion of utilisation—later operationalised through an index measure—because the heterogeneous conditions encountered in my qualitative fieldwork are not adequately reflected by existing adoption indicators in the quantitative mobile technology literature. I will argue in later parts of this chapter that this heterogeneity has implications for the ways in which mobile phones can enter and affect processes of healthcare seeking. This is not to say that there are no overlaps between my conceptualisation and the existing literature, such as the quantitative technology adoption and diffusion literature, the uses-and-gratifications approach, and anthropological technology appropriation approaches. But I argue that there are notable deviations from these strands that make my conceptualisation more suitable for linking mobile phones to healthcare-seeking behaviour.

As described in Chapter 2, the technology adoption and diffusion literature traditionally relies on narrow indicators of ownership, access, and one-dimensional use (Duncombe, 2011:274; May & Diga, 2015:91; Zanello, 2012:712). While direct access is clearly an important factor of the development impact of mobile technology, my framework suggests that it

is not the only one. Indirect access to technology and its usage matter as well. I argued that index measures can offer a more nuanced understanding of adoption, but so far none has been devised for this purpose and all existing micro-level applications known to me are limited to high-income contexts (Lee *et al.*, 2012; Tossell *et al.*, 2012). In addition, index measures should be locally grounded in order to strike a balance between conceptual comprehensiveness and analytical simplicity. My notion of mobile phone utilisation complements the quantitative adoption and diffusion literature by offering a conceptual and empirically grounded basis for a novel three-dimensional index to measure mobile phone adoption.

In relation to the present framework, students of the "uses and gratifications" of technology might point out the importance of different *motivations* of use. For example, social use may yield different forms of engagement than functional, task-oriented uses (see e.g. Leung & Wei, 2000, on uses and gratifications in the context of landline and mobile phones). User motivations could be included as one of the drivers of mobile phone utilisation in this framework. However, my framework describes the impact of mobile phones in one particular domain of human life, namely healthcare seeking. This allows for a more focused analysis that does not attempt to understand which needs and motivations drive technology adoption in general (Donner, 2004:2-3; Ruggiero, 2000:14; Zhu & He, 2002:468), but rather whether and how healthcare as a particular domain of human development is influenced by existing patterns of mobile phone adoption. While uses and gratifications may be useful in studies trying to understand phone utilisation, my focus on one particular domain is intended to yield a deeper analysis of the mechanisms that underlie the social impact of technology.

Lastly, anthropological technology appropriation approaches focus on different forms of use and on the ways in which we incorporate technology into our daily lives, which potentially entails innovative and unexpected uses of the phone. This strand has informed a substantial part of my analytical categories. However, even in this literature there is a tendency to focus

on direct use. For example, Dey *et al.* (2011:58-59) study mobile phone appropriation among Bangladeshi farmers, considering "initial adoption" (which is an individual-level process) as the starting point of mobile phone use. According to my framework—which argues that mobile phones can enter healthcare-seeking processes through intermediaries—this would be problematic because it adheres to the notion that mobile phone use is an intimately personal process, which I argue it is not. This can invite neglecting the social arrangements in which the technology is embedded, and therefore the role of mobile phones for non-owners and non-users.

5.3   The Mobile Phone as Tool in Navigating the Healthcare System

The framework does not only require clarification of the notion of phone utilisation, but also of the healthcare-seeking process, because both will later be operationalised in the quantitative analysis. The purpose of this section is to explain my conceptualisation of healthcare seeking as a multi-step process that can be understood as a "therapeutic itinerary" (Section 5.3.1). In order to understand how mobile phones may enter these itineraries, I also exemplify seven forms of phone-aided healthcare seeking reported in the literature (Section 5.3.2). I discuss the factors contributing to the emergence of these phone-aided behaviours in the subsequent Section 5.4.

5.3.1   Healthcare Itineraries

I understand healthcare seeking as an iterative process involving tasks such as recognising and evaluating a health condition, articulating a demand for care, deciding on a course of treatment, and evaluating outcomes of the treatment in order to solve problems of preventive, curative, emergency, chronic, or rehabilitative medical care (e.g. van Egeren & Fabrega, 1976:537). While going through this process, individuals (or any person acting on their behalf) have to navigate the health system. In line with the definition of the World Health Organization (WHO), I consider this health system to incorporate "all organizations, people and actions

whose primary intent is to promote, restore or maintain health" (WHO, 2007:2). This does not solely comprise government-regulated medical providers, but also, among others, "a mother caring for a sick child at home; private providers; behaviour change programmes; vector-control campaigns; health insurance organizations; occupational health and safety legislation" (WHO, 2007:2). Formal (i.e. public and private) medical care providers are therefore only a fraction of all actors in the health system. In fact, it is estimated that informal caregivers and traditional healers account for up to 90% of all healthcare providers in the health systems of some low- and middle-income countries (Sudhinaraset *et al.*, 2013:3).

The process of navigating a health system ("healthcare seeking" or "health action") is captured in the anthropological concept of therapeutic itineraries: healthcare seeking is a multi-step process during which more than one actor or healthcare provider may be accessed. Potentially a broad array of solutions including combinations of "access to healthcare," "self-care," and "no care" can emerge in this process (e.g. Colson, 1971:234-235; Kibadi *et al.*, 2009; Nyamongo, 2002:378; Samuelsen 2004; Smith & Mbakwem, 2007). For example, Kibadi *et al.* (2009) study the healthcare itineraries of twelve patients who had been diagnosed with *buruli ulcer* (a neglected tropical disease) in rural health centres in the Democratic Republic of Congo. The care-seeking process from the onset of the disease up to the point of being correctly diagnosed at the formal health facilities lasted in total between 4 and 17 months. All of these twelve patients went through an initial "wait and see" phase lasting on average two months and afterwards took up to four additional steps, including purchasing over-the-counter medicine (e.g. antibiotics) for self-medication, traditional therapy with herbal treatments from healers, prayers at church as a form of treatment, or care from health centres that failed to diagnose the disease correctly (Kibadi *et al.*, 2009:1113-1114).[61] The research by Amarasingham (1980) in Sri

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[61] Complex and delayed access to healthcare is not a phenomenon specific to LMICs (see e.g. Macleod *et al.*, 2009:S94).

Lanka raises the more general point that patients access multiple distinctive systems of medicine (he calls this "healing philosophies"), even within one single episode of illness. Pool and Geissler (2005:44-45) refer to such behaviour as "syncretism" because people harmonise and simultaneously use different and partly conflicting medical systems within the healthcare-seeking process.

The presence of such complex patterns suggests that conventional cost-benefit reasoning may be insufficient to explain people's behaviour and their "revealed" healthcare patterns (referred to as "biomedical rationality"). This is a claim widely found in the field of medical anthropology (e.g. Pool & Geissler, 2005:90-91).[62] Based on ethnographic fieldwork in two villages in South India, Beals (1976:184-185) suggests that navigating pluralistic health systems is instead a function of personal world views, the present health condition, popular interpretations of the condition and its treatment, the socio-economic status of the health-seeker, and available information. In addition, healthcare seeking need not be a purely *individual* process. Family members and other intermediaries can influence or entirely lead the patients' care-seeking behaviour (as e.g. Peglidou, 2010:49, describes in her ethnographic study of Greek women diagnosed with depression). Overall, the literature on healthcare seeking and therapeutic itineraries suggests that important factors shaping people's healthcare-seeking strategies are the nature, severity, and stage of the specific health condition; the patient's education, economic situation, age, sex, and decision-making autonomy; personal predispositions and belief systems (e.g. accepting pain as part of lifestyle); societal perceptions of the health condition;

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[62] Behavioural economists acknowledge this as well (Cawley & Ruhm, 2011:139-144; Dupas, 2011:440-442; Kremer & Glennerster, 2011:248-252).

availability, accessibility, and awareness about providers (e.g. location); trust in and percep-

tions of the providers' quality of care; and the compatibility of provider competences with the

patient's condition.[63]

From this notion of healthcare seeking as a process of navigating a pluralistic health

system (resulting in personal "itineraries" of healthcare), we can distil a number of elements

relevant for the analysis of mobile phones' role in healthcare access: First, the care-seeker or

someone acting on his or her behalf *initiates* the healthcare-seeking process. The initiation of

this process is a necessary condition for the healthcare-related use of mobile phones. Individu-

als may not always seek healthcare for certain diseases, or may only do so after substantial

delays. Once commenced, the healthcare-seeking process can—and often does—involve more

than one *stage*. Each of these stages offers a potential role for mobile phones and other tools

(e.g. information brochures, vehicles) to influence people's itineraries. During each stage of

the process, patients carry out a number of *tasks* associated with the question of whether or not

to seek care (e.g. detection, evaluation, diagnosis, screening of possible providers, accessing

actors and providers). Each of the tasks could potentially be modified by mobile phone use.[64]

Access to formal or qualified providers is but one possible outcome, and by no means the log-

ical termination of the care-seeking process. Because care-seeking decisions are conditioned

socially and culturally, mobile phones may also influence processes that involve *non-formal*

and/or inadequate care.

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[63] For a selection of arguments underlying this list, see Beals (1976:184-185); Colson (1971:234-236); Kroeger (1983:149); Lieber *et al.* (2006:469); Nyamongo (2002:381); Shaikh *et al.* (2008:749-753); Shaikh and Hatcher (2005:50-52); van Egeren and Fabrega (1976:537-538); Ward *et al.* (1997:21-23). For a review of factors influencing healthcare seeking, see Kroeger (1983) and MacKian *et al.* (2004) who draw heavily on the former's writing.

[64] This is not to say that they actually will, nor that they should. It is merely a theoretical possibility. The same applies to the different stages of the process.

In short, this framework is built on the view that patients navigate their surrounding health system creatively, but also under constraint. The later quantitative analysis will focus primarily on curative healthcare seeking. Where such a process takes place, health-related mobile phone use can potentially emerge locally or enter via mHealth services at any stage for any given task. Section 5.4 explains the conditions under which this would and would not be the case. A selection of possible forms of mobile-phone-aided healthcare access is presented below.

5.3.2   Phone-Aided Health Action in the Literature

Drawing on fieldwork experiences and the existing literature, we can establish at least seven different ways in which people incorporate mobile phones into their healthcare-seeking behaviours.[65] Firstly, mobile phone users may retrieve and exchange *preventive,*[66] *diagnostic, and therapeutic advice*. Preventive advice involves information about how to stay healthy and prevent illness, and public health information more generally. Diagnostic advice helps (or appears to help) to identify a person's illness. Therapeutic advice involves curative information about how to treat an existing illness, which medicine is to be used for self-treatment (or which is the cheapest medicine, as argued in Horst & Miller, 2006:139), recommendations to seek medical care from the health system in general, and others' (peers' as well as experts') experiences to navigate the system to reach appropriate care providers. The navigation of the health system in the context of therapeutic advice is for example described by Horst and Miller (2006), who studied mobile phone use in Jamaica. The authors report that, "given the limited free facilities and expense of doctors, the phone is much more likely to be used to find alternatives to formal medical treatments or at least to minimize the costs of treatments" (Horst & Miller,

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[65] This is not an exhaustive list. For example, Hampshire *et al.* (in press: Table 5) also list "report absence from school/work" and "arrange childcare" as illness-related phone uses.

[66] Preventive advice may play a role in initiating healthcare seeking.

2006:139). This may be confounded with diagnostic advice: "Women, in particular, chat extensively about ailments, comparing experiences to determine whether a current illness is actually the same as something seen before and therefore can be treated without reference to a doctor" (Horst & Miller, 2006:139). Such health advice can be retrieved from a variety of actors, including family members, health professionals, friends with medical expertise, or anonymous sources on the Internet.

Phone users may call a medical practitioner or a care-giving family member to their house for consultation and treatment. This activity of *summoning assistance* is the second form of mobile-phone-aided healthcare access. This need not only pertain to curative services, but can also involve, for instance, the delivery of medicines for chronic diseases. In Kenya, such processes have been reported by Agüero *et al.* (2014:91), who describe that "people suffering from HIV/AIDS used mobile phones to call for help when they were unable to assist themselves" and that "one household made a call to an organization that helps people infested with jiggers [parasites causing tropical diseases], who came and helped the household." This process of summoning assistance requires the care provider not only to be available at the time of contact (e.g. after working hours), but also to be able to reach the destination and provide the service requested.

Thirdly, rather than bringing care to one's doorstep, patients can *arrange transportation* to a site of care. This commonly occurs for emergency transportation especially through ambulance services (Agüero *et al.*, 2014:91; Horst & Miller, 2006:140; Mechael, 2006:121-122; Miller, 2010:128; Tenhunen, 2008:524). Examples of this kind of mobile phone use are numerous. For instance, Agüero *et al.* (2014:91) describe an older woman in Rwanda who "borrowed a cell phone and called her daughter to come and take her to the hospital" during a health emergency. Besides emergency transportation, this activity may (at least in theory) also occur for deliveries or routine and preventive treatment (e.g. vaccination).

A fourth possible use of mobile phones in the process of accessing healthcare is to *make appointments* and *facilitate coordination* between health providers and patients. This can help prepare the approach to a care provider during emergencies. Mechael (2006) documents such a case: A health ministry representative was contacted because of a major bus accident in Egypt, upon which he "put on stand-by the three main hospitals in the governorate to receive the patients" (Mechael, 2006:121). It is also conceivable on a smaller scale that mobile phones enter healthcare-seeking processes through direct interaction between medical providers and individuals in emergency and non-emergency situations. As a result, patients may be able to access specific and trusted medical practitioners,[67] or ensure that providers are available at their post and that they have the required medicines available when the patient arrives.

Fifthly, mobile phones can be used to *inform* and *provide assurance* to the patient's peers and dependants, which can also include requests to *sustain treatment*. Not involving consultation or medical advice, this is not a form of care seeking in itself but nonetheless incorporates health-related information exchange. In fact, in the study by Hampshire *et al.* (in press: Table 5), "information only" (which excludes advice) was with 19% among all respondents the most frequent health-related phone use in their three-country survey. In the process of information exchange with peers and dependants, the phone can also become a medium to request supplies and other forms of support to sustain ongoing medical treatment: Agüero *et al.* (2014:91) for example describe a patient in Rwanda who repeatedly gave deliberate missed calls to his relatives through a phone borrowed from the nurse. In response, "the relatives could call him immediately and bring money for food and/or hospital fees" (Agüero *et al.*, 2014:92).

A sixth form of health-related phone use in the literature is *disease monitoring*. Mechael (2008:98) suggests that mobile phone use among medical practitioners in Egypt "is manifesting

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[67] See e.g. Balabanova *et al.* (2004:1944) on patients' willingness to use personal connections with practitioners or make informal payments in order to expedite healthcare access in former Soviet Union countries.

itself in the form of remote patient monitoring" (among other tasks). Patients who undergo an extended course of treatment at home may for example provide information and data about their status to a healthcare provider and receive advice about appropriate behaviour. In contrast to the previous points, this form of mobile phone use may just as well be initiated by the health provider to monitor the process of the patient.

As a last example, the use of mobile phones may help patients to *adhere to a given course of treatment* that had been suggested to them. They may receive reminders from peers or medical services, or they may themselves use technical aides for this purpose. Kwan *et al.* (2013:20) exemplifies the latter case with the study by Curioso and Kurth (2007:3-5): studying HIV/AIDS patients in Peru, they found that many already made use of their phones to remind themselves to take antiretroviral medication. One of their informants stated, "I always use the alarm function of mine [cell phone] to wake up in the mornings and I use it as a reminder [to take my pills]" (Curioso & Kurth, 2007:5). While the example demonstrates that mobile phones can help individuals to comply with an existing treatment plan, it also demonstrates that not only phone communication but also in-built functions can play a role in influencing personal healthcare behaviour.

Overall, these examples illustrated the wide range of purposes that mobile phones can fulfil in the various steps and tasks within people's healthcare itineraries. The individual forms of mobile phone use are inter-dependent, however. Some activities may be complementary, for example if people arrange for emergency transportation and at the same time prepare the hospital for their arrival. Certain activities may also substitute for each other, for instance home calls and transportation to a health facility. Such substitutability makes it improbable (though not impossible) that all kinds of mobile-phone-aided healthcare would be present within each therapeutic itinerary.

Where people seek healthcare without mobile phones, they may walk to health posts (sometimes for several hours), take buses to nearby hospitals, or approach peers and doctors face-to-face to get their help. Based on their ethnographic study of mobile phone use in Jamaica, Horst and Miller (2006:138) even find that the mobile phone "is surprisingly absent even in arenas where one would anticipate an immediate appropriation, such as scheduling appointments or establishing reminders about routine medical examinations." Similarly, Souter *et al.* (2005:238, 303) report that only 2% of their respondents in Mozambique and 0% in Tanzania consider the phone as the preferred means of communication for information about "how to prevent and treat illness within the family." This is despite the fact that 60% of their respondents in Mozambique and 73% in Tanzania reported to have access to mobile or fixed-line telephone communication (Souter *et al.*, 2005:278). I discuss in the next section why this would be the case.

5.4   Factors Influencing the Involvement of Mobile Phones in Healthcare Itineraries

If healthcare itineraries permit the use of mobile phones to navigate the health system, would we invariably expect the emergence of phone-aided healthcare where mobile phones diffuse rapidly? Assuming that people do indeed make use of the mobile phone in this process, is it realistic to anticipate that mobile devices permeate every step of the healthcare-seeking process? Is it desirable that individuals deepen the penetration of mobile phone use in their health action? These questions point at the factors that influence whether and how a person uses a mobile phone in the healthcare-seeking process.

Little prior writing exists in this regard. Two useful starting points are the studies of the health-related use of mobile phones in Egypt by Mechael (2006) and in Ghana, Malawi, and South Africa by Hampshire *et al.* (in press). Mechael (2006:162-178) highlights six factors that limit the "maximisation of mobile phone use for health," namely (a) costs of phone use, (b)

perceived physical hazards of mobile phones (e.g. radiation), (c) quality and reliability of the telecommunication infrastructure, (d) health providers' doubts about mobile-phone-based service delivery, (e) users' limited understanding of mobile phone functions, and (f) the health system's inability to respond reliably to the increased health-related use of mobile phones. Hampshire *et al.* (in press:18-25) argue that heterogeneity in young people's health-related phone use arises from variations in phone ownership, access, and usability; the "right people to contact;" and the skills necessary to use mobile phones for healthcare, all of which define the "digital capital" required to "optimise" the health-related use of the mobile phone. Both positions suggest that more health-related phone use is also more desirable, but there is no apparent reason why we should strive towards comprehensive or maximal health-related phone use without first knowing its healthcare impacts.

Drawing on the themes emerging from the qualitative analysis, this section develops the analysis of influencing factors further. I agree with the aforementioned two authors that, if personal healthcare itineraries open up space to use phones as tools in the healthcare-seeking process, we would not automatically expect that all individuals incorporate phones into their behaviour. I refer to these constraints as "accessibility," which describes whether a person is able to make use of mobile phones (directly or indirectly) given a particular healthcare situation.

But in contrast to Mechael (2006) and Hampshire *et al.* (in press), I argue that using or not using mobile phones for health is also a *decision* based on the suitability of mobile phones for health-related purposes. "Suitability" refers to the conditions that define the relative advantage of mobile phone use over alternative means of attaining the desired healthcare-seeking outcomes.[68] As the notion implies, maximising health-related phone use may be unsuitable for some parts of the population in light of other solutions.

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[68] The term "relative advantage" is borrowed from Rogers (2003:233).

The concepts of accessibility and suitability bring to mind (but do not mirror) the notions of "perceived ease of use" and "perceived usefulness" in the technology acceptance model (Davis, 1989:320). In the technology acceptance model, perceived usefulness is determined by the perceived ease of use of a technology, and both together lead to the behavioural intention of use (Lee *et al.*, 2003:759; Venkatesh & Davis, 2000:197). This configuration is similar to my model, wherein phone "accessibility" is a necessary condition for using the mobile phone in healthcare and without which it cannot be "suitable." However, I am not predicting mobile phone adoption behaviours as technology acceptance models frequently do (e.g. Kwon & Chidambaram, 2000). I rather explore the emergence of different kinds of mobile-phone-aided activities and the distribution of their impacts as a result of variations in accessibility and suitability (regardless of whether or not phones are personally owned). Therefore, my concepts do not only fulfil a different purpose, but they also have different interpretations than in the technology acceptance literature.

While the previous list of factors could be partially re-packaged into the accessibility-and-suitability frame, I deviate from Mechael (2006) and Hampshire *et al.* (in press) in that I perceive phone-aided health action as one—and not necessarily the best—possible strategy to navigate an existing healthcare landscape. Their writing suggests that "barriers" need to be overcome in order to attain a latent yet desirable situation in which people maximise the use of mobile phones in the healthcare-seeking process. I concur that in some instances "barriers" may prevent extensive health-related uses of mobile phones. Yet my framework leads me to argue that there is nothing natural in the expectation that mobile phone use in healthcare seeking would and should be maximised universally.

5.4.1   Accessibility: Mobile Phone Utilisation and the Nature of Illness

A prominent theme arising from the qualitative fieldwork is that different forms of mobile phone utilisation interact with the severity of patients' health condition, together determining the accessibility of the phone for health-related purposes.[69] The interpersonal variation in mobile phone utilisation thereby leads to interpersonal variation in accessibility. In the following, I first explain how different forms of mobile phone access and the modalities of use translate into accessibility for healthcare seeking, and then briefly describe how the determinants of utilisation contribute to heterogeneity in phone accessibility.

Different ways of accessing mobile phones can mean that the owner, user, and beneficiary are three different persons. This was not uncommon in the field and can be observed elsewhere as well—for example, young Ghanaians were found to be active, phone-using intermediaries for their household members' health issues (Hampshire *et al.*, 2011:707). Where the beneficiary is not the owner or the user of the mobile phone, this can affect the emergence of phone-aided health action. I argued above that borrowing, market-based access, and third-party use can come with social and financial obligations. These "costs" have to be weighed against the nature of the health condition. For example, in the context of borrowing mobile phones, this means that, for the lender of the phone, the reasons for borrowing must be sufficiently credible to hand over the phone to others, and, for the borrower, it has to justify the social and possibly financial implications of approaching other community members (similar constraints may arise if a third party has to operate the phone for the beneficiary). This can rule out mobile phone use for what are perceived "trivial" reasons. Common and mild conditions like colds or

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[69] Note that my terminology of the "severity" of a person's health condition pertains to the self- and collectively perceived severity, rather than to an absolute, medical benchmark. I argue that it is more relevant how a disease is mutually understood in the moment of mobile phone access than what subsequent medical diagnosis would reveal.

headaches may neither convince lenders nor justify the social obligations for borrowers to ask for others' mobile phones. In other words, higher social and financial costs of accessing mobile phones can confine health-related uses to severe and emergency communication (e.g. emergency transportation).[70]

In addition, the range of mobile phone functions used in the healthcare-seeking process is limited by the functional spectrum available to the user (who may or may not be the patient). This evidently pertains to channels of communication; for instance, whether the user is able to make calls, send text messages, or make appointments with the hospital on an Internet platform. But if medical personnel is to be reached on the phone, it also matters whether the user is able to store, retrieve, update, and dial their number when needed. Limitations in the functional extent of mobile phone use can therefore preclude certain activities such as receiving public health information or diagnosing oneself online. Yet, the reverse is not necessarily true. A *useable* function need not be a *useful* function (as I explain in the next sub-section).

The qualitative analysis further highlighted the link between accessibility and the intensity of mobile phone use. Usage intensity can influence the readiness with which users engage in non-urgent care-seeking behaviours. For example, mobile phone users who are connected for hours to the Internet may be more likely to access health information and share it with family and friends. Conversely, it is conceivable that negative meta-narratives restrict personal and non-personal phone use, thereby reducing usage intensity. This may be the case where perceptions of the vulnerability of women supress female phone use in public, or where parents' concerns about the harms of the mobile Internet lead young people to access it only covertly without sharing any information from it (I encountered both narratives during the

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[70] These costs can also vary temporally. Consider two comparable medical situations in which phone users rely on a phone borrowed from a neighbour, yet one patient requires the phone at 1pm and the other at 1am.

qualitative data collection). Based on the qualitative analysis, low usage intensity appears to impede health-related mobile phone uses, especially for health conditions with low severity.

We could go further still and link the drivers of mobile phone utilisation to phone-aided healthcare seeking. For instance, older, illiterate, or sensory-impaired persons may face accessibility constraints where phones could otherwise be suitable in the healthcare-seeking process. The determinants of mobile phone use also influence which particular forms of phone-aided healthcare seeking emerge. An illiterate person could be unable to access health advice on the Internet and may instead call the local doctor whose number was saved with a recognisable avatar image by a third person. While influencing the role of the phone in healthcare seeking, such determinants also relate directly to the underlying healthcare itinerary. An example is personal wealth, which correlates with phone ownership but also with the ability to ensure personal transport and access to health facilities. This can shift phone use away from home calls and transportation to appointments, assurance, and advice.

In a nutshell, phones cannot enter healthcare itineraries if they are not accessible to a person.[71] Whether they are accessible depends on the severity of the patient's health condition as well as on the specific forms of access, functional extent, and usage intensity underlying the utilisation of the mobile phone. Less pressing health issues, indirect and non-personal access, and less intensive and extensive usage create a disjunction between mobile phone diffusion and phone-aided health action.

5.4.2   Suitability: Responsiveness, Complementarities, and Alternative Solutions

The argument so far suggests that, where phones are not accessible, this could constitute a "barrier" for more extensive penetration of the technology in therapeutic itineraries. However,

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[71] Complete inaccessibility to mobile phones may be exceedingly rare. In emergencies, third parties may still act on behalf of the patient, for example because he or she is unconscious.

there is no automatic link from accessibility to health-related use. A second theme that arose from the qualitative analysis is that mobile phones need to be a suitable solution from the perspective of the patient for phone-aided health action to arise.

My notion of suitability has three interlinked elements. Firstly, the actors and solutions within the health system need to be *responsive* to phone use, which means that they can be accessed through the phone and provide desirable solutions from the perspective of the health seeker. Secondly, where the health system can be navigated through *viable alternatives* to the phone-aided solution (such as walking to the health post next door), mobile phones are superfluous. Thirdly, *complementarities* facilitate the realisation of certain types of phone-aided healthcare seeking, for example proper road infrastructure enabling home calls. Rather than merely examining whether individuals could use mobile phones in a certain health situation, I maintain that it is important to understand whether the mobile phone can be employed suitably, considering how people navigate their surrounding health system landscape.

If actors in the patient's surrounding health system are not responsive, accessing providers via mobile phones may be futile and patients have to find other solutions. The study by Pitt and Pusponegoro (2005:145) illustrates this through ambulance services in Jakarta, which at the time are described as "woefully inadequate." The authors report the incidence of a terrorist attack in the city, requiring emergency ambulance services. Following the attack, an injured diplomat was to be sent to the hospital with the second ambulance that was called (the first dealt with more severe cases). The authors report that, "The second ambulance, however, took 30 minutes to arrive so the casualty was taken to hospital in the nearest available form of transport—a rubbish truck" (Pitt & Pusponegoro, 2005:146). Such non-response in emergencies can lead to frustration, which potentially sets expectations for future use (or non-use) of the mobile phone. However, where healthcare professionals are not responsive, phones may still be used to coordinate healthcare seeking privately (e.g. Nakahara *et al.*, 2010:323-325).

Aside from the idea of "responding reliably," actors themselves may actively oppose phone-based patient contact. Healthcare providers, for example, may be inclined to providing care face-to-face rather than through the phone despite regulation and guidelines suggesting otherwise. This can have many reasons, including a loss of income sources, concerns about workload, circumvention of institutionalised referral systems, privacy, accountability, and personal safety during home visits (Mechael, 2006:169-170). In addition, if health providers (or other actors) are time-constrained or where trust relationships are particularly important, they may only respond if they know the patient personally. Being aware of and knowing responsive doctors and other actors could therefore influence the value of using the phone in the care-seeking process.

From the discussion we can conclude that healthcare seeking through the phone is practised *along the lines of responsive actors in the health system*. But responsiveness is not the only factor contributing to the suitability of mobile phones. The availability of actors and of alternative solutions to navigating the health system can render mobile phones redundant for some or all health-related activities. This is the second element I discuss here.

Patients are arguably less likely to use a phone if they have preferred health facilities in their immediate vicinity. Unproblematic physical access to health providers can also substitute for some specific forms of phone-aided behaviour (e.g. summoning assistance). The WHO illustrates this through emergency care in Ghana: According to a recent report, ambulance services can be accessed "by calling the dedicated emergency line (193) from landlines and mobile phones. However, people can also walk to the ambulance station or make a radio announcement through local FM stations" (WHO, 2010:9). Whether access is unproblematic is then partly a result of availability and location of healthcare providers relative to the patient.

Access to healthcare is also partly a result of personal and contextual characteristics such as infrastructural conditions. Being physically able to walk or cycle, immediate access to

vehicles and caregivers in one's household, safe roads in good condition, and efficient and affordable public transport can facilitate access to healthcare and reduce the benefit of using a mobile phone at each step of the healthcare itinerary. In addition, mass media assets like TV sets and computers can compete with mobile phones for access to health-related information, as the qualitative research indicated.

Furthermore, patients may choose courses of action that are less likely to involve mobile phone use, for example self-treatment with medicines at home. In instances where people face prohibitive costs of accessing healthcare (with or without phones), self-medication may in fact be the dominant strategy over summoning a responsive yet expensive private provider. In other words, even in situations where mobile phone diffusion, health conditions, and the responsiveness of providers are identical, individuals would exhibit heterogeneity in their personal characteristics vis-à-vis the surrounding health system, thereby introducing variation into the emergence (and absence) of various forms of phone-aided healthcare-seeking behaviour.

Complementarities are the third and final component of suitability.[72] I indicated above that household assets and the technological environment influence the suitability of mobile phones by rendering all or some possible health-related uses redundant. Where some types of phone-aided health action are eliminated, others may be facilitated. The notion of "complementarities" captures this possible facilitation. Some authors for instance suggest that complementary service networks such as taxis need to be present to enable phone use for emergency transportation (Horst & Miller, 2006:140; Mechael, 2006:121-122; Miller, 2010:128). Likewise, favourable location, public transportation links, and personal vehicle ownership described above as alternative to home calls can also be facilitators to other activities such as

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[72] See for example Schroeder (2010:80-81) on complementarities between of mobile phones and other ICTs in the context of social interaction, and Fu and Polzin (2010:326-327) on a discussion of "complementary assets" in a corporate LMIC setting.

making appointments. While the interplay of alternative solutions and complementarities shapes the visible spectrum of phone-aided healthcare solutions in a given context, it is not clear *a priori* whether the presence or absence of specific assets like vehicles on average facilitates or discourages phone-aided health action as a whole.

In conclusion, the responsiveness of actors in the health system, the availability of alternative solutions, and complementarities between the technological context and health-related phone uses influence whether mobile phones are suitable tools in the healthcare-seeking process. This introduces variation in the emergence of phone-aided healthcare-seeking behaviour beyond the ability to use the phone personally or with the help of intermediaries. Personal characteristics and household assets determine the presence of alternative solutions to the healthcare-seeking problem, locational factors influence the ease of access to providers and can even influence their responsiveness (e.g. their ability to carry out home visits), and the social environment (e.g. belonging to a socially discriminated group or having a personal relationship to a provider) can have an impact on whether a provider will be responsive to the patient or his/her intermediary. The following section discusses the impacts and potential equity implications that arise from this interpersonal variation of social, economic, and spatial characteristics.

5.5   Impacts of Mobile Phone Diffusion on Access to Healthcare

I have argued that mobile phones enter healthcare-seeking processes if (a) healthcare seeking takes place, thereby opening up space for the potential role of the mobile phone; if (b) people can access phones for health-related uses relative to their condition; and if (c) this mobile phone use is a suitable option considering actors and alternative solutions in the health system. While the arguments may seem intuitive, they have been largely disregarded in the empirical mHealth literature, and the conditions driving non-use have mixed implications for

our understanding of mobile phone impact on healthcare. In this section, I discuss positive and negative effects in order to complete my argument on the link between mobile phone diffusion and access to healthcare.

I described in the preceding section that we would observe phone-aided healthcare seeking where mobile phones are an accessible and suitable healthcare solution. Because this argument is based on a view of the mobile phone as a tool as well as on health seekers' and intermediaries' active decision-making and creativity, it follows that mobile-phone-aided healthcare seeking is at least a viable strategy for the healthcare problem from the patient perspective. We could therefore expect shorter and faster itineraries (i.e. fewer steps and a shorter duration) if mobile phones are used in the process of seeking curative care. In other words, mobile phones are likely to "facilitate" behaviour if they become part of the healthcare-seeking process. Improvements would then materialise where quality healthcare professionals are accessed with fewer delays. But shorter and faster itineraries do not necessarily entail improved access to healthcare. Some groups may have socially and religiously conditioned preferences for traditional healers or expensive and unqualified but trusted private providers (Ergler *et al.*, 2011:333; Lambert, 1992:1072-1074).[73] Facilitated access to low-quality care can leave people worse off than otherwise, medically as well as financially.

Would we also expect shifts towards different, possibly beneficial behavioural patterns in this model? In line with my arguments above, behavioural shifts would arise in two situations. Firstly, if patients used to refrain from seeking care or relied on informal healthcare professionals *for want of better options*, then mobile phones might enable them to tap into a broader range of solutions (e.g. summoning assistance), provided that actors are responsive. This would especially pertain to non-severe conditions, which otherwise favour local care, self-treatment,

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[73] This is not to suggest that public providers are always better qualified or preferable from a medical perspective (Das *et al.*, 2008:102).

or no treatment at all (Dupas, 2011:427). In these cases, the presence of responsive formal healthcare providers would suggest that mobile phone use produces a shift away from informal providers, self-care, and no care. Depending on the nature of the self-perceived "non-severe" condition, this can entail improvements in diagnosis and appropriate treatment.

Secondly, fieldwork and literature indicate that formal health providers in government hospitals have to adhere to stricter operational guidelines than local health workers, and that these doctors would not be directly compensated for helping patients through the mobile phone (Mechael, 2006:169-170). Such conditions may make them less amenable to home visits and remote consultations than private and informal providers (who typically face less regulation and can levy user fees) or formal providers in village clinics (whose job description may include home visits). This may be especially pronounced in remote regions that face otherwise considerable challenges in accessing healthcare (e.g. because of excessive ambulance response times). Hence, public providers in local clinics and private and informal providers may be more responsive to mobile phone use. Such conditions can produce a shift in observable behaviour away from large or urban government hospitals in situations where healthcare access is generally difficult. Healthcare access could become more fragmented but faster in such circumstances.

If we assume that the effect of mobile phone diffusion on healthcare access is on average positive, then non-use of phones may have adverse equity implications. My framework suggests two groups for whom mobile phones play no or only a very small role in healthcare seeking: One group is excluded from health-related phone use because of constraints (no care seeking, no compatibility between phone utilisation and health condition, or no responsive actors); the other group does not use phones because they turn out to be inferior to other healthcare solutions. Economic, social, and spatial marginalisation can contribute to people

falling into the first group of "constrained non-users." If evidence supports such cases of systematic exclusion, then the possible healthcare benefits of mobile phone use would not arise for two distinct groups. One group would be characterised by pre-existing marginalisation, thereby widening the gap between them and the beneficiaries of mobile phone use. The other group would see no apparent added value of incorporating mobile phones into their healthcare itineraries.

A final implication of the theoretical framework is that dynamic health system changes can leave non-users worse off than before. Imagine that a growing number of patients call responsive health providers to their homes for treatment (e.g. Mechael, 2006:169-170; 2008:98). These providers would spend an increasing amount of time out of station, making it necessary for patients to make appointments prior to visiting the clinic. Non-users would consequently experience increasing difficulty in navigating the health system. More generally, we could assume that, the more widespread mobile phone use in the healthcare system is, the more the system adapts to these conditions, potentially further excluding non-users. Such developments need not be problematic for individuals who previously had not used mobile phones because of dominant alternatives. As the framework suggests, this group could incorporate phones as their relative value for healthcare seeking increases. However, such developments would be problematic for those people who cannot use mobile phones because of social, economic, or spatial marginalisation, thereby raising the barriers to accessing healthcare.

In summary, my theoretical framework points to both positive and negative healthcare access patterns associated with mobile phone use, including risks of exacerbating the marginalisation of some groups in this process. This is in contrast to the existing models linking mobile phones to healthcare access, which tend to emphasise positive and equalising effects on healthcare access. Whether the proposed developments indeed materialise from the use of mobile phones is ultimately an empirical question. The final section of this chapter crystallises the

hypotheses that underlie my argumentation and discusses if it is sensible to expect such outcomes.

5.6   Conclusion and Limitations of the Framework

My qualitatively grounded framework informs Research Question 1 on the theoretical link between mobile phone diffusion and access to healthcare in LMICs by highlighting the conditions that need to be in place for mobile phone use to emerge in the healthcare-seeking process. I argued that first a process needs to open space for the incorporation of the mobile phone. If so, the severity of a person's health condition interacts with mobile phone adoption to determine the "accessibility" of the phone in healthcare seeking. Unlike common conceptualisations of adoption as mobile phone ownership or access, adoption in my framework is understood as "utilisation," composed of the three dimensions of direct and indirect mobile phone access, functional breadth, and usage intensity. "Suitability" then determines which forms of use would actually emerge in light of the given technological and health system context. Suitability comprises the "responsiveness" of actors in the health system, and alternative and complementary solutions that define the benefit of mobile phones in the healthcare-seeking process.

In short, mobile phones have to be accessible and suitable in order to enter healthcare itineraries. This seemingly obvious claim offers an analytical framework that goes beyond the common models in mHealth that treat mobile phones as static, given, and neutral. In addition, a range of phone-aided healthcare solutions can emerge under said conditions, but the role of mobile phones in these processes can be heterogeneous, influencing the demand and supply of healthcare resources and potentially excluding already marginalised groups while aiding healthcare seeking for others. The combination of positive and negative outcomes possibly varies across contexts.

In order to understand whether the conceptualisation of adoption as "utilisation" is indeed useful, whether the healthcare implications of mobile phone diffusion are on average positive or negative, and whether the indicated equity patterns hold, we can formalise these arguments in three overarching hypotheses to guide further quantitative analysis:

H1   *An index that captures mobile phone utilisation as a three-dimensional concept is a better predictor of phone-aided health action than conventional, ownership-based measures of mobile phone adoption.*

H2   *Direct and indirect health-related phone use during an illness episode on average improves access to healthcare.*

H3   *Phone-aided health action exacerbates socio-economic healthcare inequities.*

The existing literature offers counter-arguments to these claims. For example, if a binary indicator is a sufficient proxy for mobile phone adoption, Hypothesis H1 would not be supported. Likewise, if use follows design (rather than emerging as user-level innovation), we would probably observe the uptake of sanctioned, mHealth services without major accessibility constraints. It is also possible to object that mobile technologies enable more complex behaviours while reducing the transaction costs of navigating the health system, in which case we are likely to observe only positive behavioural changes and more complex itineraries with fewer delays to healthcare access. The quantitative evidence in Chapters 6 and 7 will help to inform these claims.

The limitations and in-built assumptions of the framework require additional clarification. Three points are worth highlighting in this respect. First, to analyse the impacts on

healthcare-seeking behaviour, I treat mobile phones as tools. This view is based on the qualitative fieldwork, which indicated that symbolic and unforeseen forms of engagement with mobile phones might affect the emergence of phone-aided health action indirectly through the effect on people's phone utilisation, but it did not appear to have a direct influence on the healthcare-seeking process. Scholars investigating the "domestication" or "appropriation" of technology might criticise this conception as too narrow. For example, Brynin and Kraut (2006:6) argue that technology does more than just solving problems in yet another way. They argue that, besides furthering existing ends, goals may also be re-defined by technology, that technology may be instrumental in downstream welfare outcomes like education and health (for better or worse), and that technology can spur larger societal changes (Brynin & Kraut, 2006:6-8). It is also possible to argue that mobile phone use changes the nature and quality of healthcare functions such as diagnosis and consultation. Although mobile phones can indeed exhibit these broader characteristics, it does not render the treatment of phones as tools false, though perhaps incomplete. It is useful to bear in mind that the analysis provides at best a partial insight into the positive and negative effects and the societal impact of mobile technologies.

Second, sociologists and social anthropologists may further maintain that a static analysis of mobile phone use has important limitations. As already mentioned, technology interacts with the larger social context. Zheng (2009:77) and Zheng and Stahl (2011:74-75, 78) argue that technology (especially ICT) indeed coevolves with people's values and choice processes. Likewise, Coeckelbergh (2011:86) maintains that, "Technology is not a mere 'condition' for human being in the sense of a means that can be used to achieve human ends; rather, human existence is already a human-technological existence." However, while the coevolution of technology and society is not the focal point of my analysis, this does not mean that evolving social contexts are fundamentally disregarded. Culturally shaped mobile phone etiquette and meta-

narratives about mobile phone use can influence revealed phone utilisation, and healthcare providers may have informal routines in place to handle direct calls from patients. Such situations are indicative of a context that has already adapted to the increasing presence of mobile phones. My framework captures these conditions as a snapshot. Nevertheless, if we acknowledge that the "drivers" of phone use change with using phones, the characteristics of the groups I define here are potentially in flux and the anticipation of future trends and outcomes is essentially speculative.

Third, I primarily consider phone use *within* healthcare-seeking processes in order to retain focus. On the one hand, this means that I largely disregard whether phone use makes healthcare-seeking processes more likely, and it is possible to focus on this particular element in future studies. On the other hand, I am not investigating whether mobile phone use affects individuals' health outcomes and well-being through other routes than healthcare access. For instance, I outlined in Chapter 2 a range of direct effects of phone use on physical (texting and driving) and psychological health (cyber-bullying; see Footnote 17 in Section 2.3 for further examples). How such health-related impacts arise from mobile phone use cannot be captured within the present framework and requires supplementary analysis.

In short, it is important to bear in mind that my framework addresses only phone use within the healthcare-seeking process from a static perspective. Conclusions about non-functional and non-healthcare-seeking uses of phones, future predictions of phone use, and the broader health implications of mobile phones are limited by design. In the last part of this thesis, I test the three hypotheses quantitatively, devoting Chapter 6 to H1 on the three-dimensional measure of mobile phone utilisation, and Chapter 7 to H2 and H3 on the effects and distribution of mobile-phone-aided healthcare access.

PART III

Quantitative Assessments of Mobile Phones in Healthcare Seeking

Chapter 6

Predictors of Phone-Aided Healthcare Seeking[74]

6.1   Introduction

My qualitative analysis suggested that the specific forms of mobile phone adoption influence the ways in which people are able and willing to incorporate phones in their healthcare behaviour. This matters because quantitative public health research on mobile phones tends to focus on adoption as ownership or access (Aker & Mbiti, 2010:225-227; Tadesse & Bahiigwa, 2015; Tran *et al.*, 2015:12). For example, recent research by Tran *et al.* (2015) analysed household ownership patterns in rural Bangladesh from 2008 to 2011 among a sample of more than 35,000 persons. Based on their analysis, the authors suggest that efforts to increase mobile phone ownership—ultimately aiming at full penetration among households—will help to "harness the full potential of connectivity using mobile phones as a platform [to improve health]" (Tran *et al.*, 2015:12). However, if mobile phone access and the actual utilisation of the devices follow different patterns, then reliance on a binary indicator of personal or household ownership could mislead our understanding of the actual and potential development impact of technology and its distributional implications.

The analytical difference between adoption-as-ownership and adoption-as-utilisation is the focus of my quantitative investigation for Research Question 2: Can we construct a multidimensional measure of mobile phone utilisation that explains mobile-phone-aided healthcare behaviour better than binary indicators of adoption? In order to bridge the methodological divides between qualitative and quantitative treatments of technology adoption, I developed a

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[74] A modified and abridged version of this chapter will appear in the forthcoming proceedings of the IEEE International Symposium on Technology and Society, 11-12 November 2015 (Haenssgen, in press).

survey instrument and quantitative measure of mobile phone utilisation that is based directly on my qualitative fieldwork and on the multidisciplinary literature on mobile phone appropriation and diffusion.

Healthcare access is not a straightforward concept either. I argued before that we should consider healthcare seeking as a sequential process of navigating the health system. Nevertheless, Balabanova *et al.* (2006:7) argue that the "dominant" approach in the public health literature is that healthcare access is a one-off event during which one or various formal providers are accessed (e.g. Gómez-Olivé *et al.*, 2013:188; Hamid *et al.*, 2015:40; Hardon, 1987:280; Mohan *et al.*, 2008:S32-S33). Useful information is lost when capturing and analysing simplistic one-off indicators. This required me to develop a new approach to measuring and analysing sequential processes from the moment a person becomes ill, based on the medical anthropology literature (the next chapter develops the analysis of healthcare behaviour further).

The results in this chapter support the hypothesis that the mobile phone utilisation index is a better predictor of phone-aided health action when compared to ownership as a binary measure of adoption. In the field sites, health-related mobile phone use is relatively common and emerges independently of existing phone-based services such as ambulances or commercial health message subscriptions. Multilevel logistic regression analysis indicates that such phone use is explained better by the mobile phone utilisation index than by binary measures of adoption. The differences between ownership and utilisation show that phone ownership neither is a necessary requirement for using phones in healthcare, nor that such uses follow automatically from ownership. Survey data from the field sites thereby echo the qualitative impressions that phone uses within the binary categories of adopters and non-adopters are highly diverse. My new utilisation index therefore helps to discriminate meaningfully between users in situations where mobile phone penetration among the general population is very high.

In the following, I first outline how I capture healthcare-seeking processes and how I operationalise different measures of mobile phone adoption (Section 6.2). Section 6.3 prepares and contextualises the analysis in this chapter through socio-economic and epidemiological information from my survey. The analysis will be carried out in Section 6.4, first exploring descriptively the patterns of mobile phone adoption in the field sites and establishing that phone-aided health action indeed exists on a larger scale. The descriptive analysis is followed by logistic regression analyses of the predictors of mobile phone use in healthcare-seeking processes. Section 6.5 discusses the limitations and the findings. Although the utilisation index is a superior predictor, it is necessary to consider the temporal alignment between the various indicators, social desirability of health-related responses, and the remaining challenges in capturing "adoption." Notwithstanding the limitations, the findings support my hypothesis and also indicate that digital exclusion persists despite high mobile phone diffusion, that local phone-aided health solutions emerge independently of existing mHealth services, and that the patterns of phone-aided health action correspond to framework predictions on the accessibility and suitability of mobile phones for healthcare seeking.

6.2   Empirical Strategy

This chapter assesses the relationship between mobile phone ownership and utilisation, and their links to the emergence of phone use in people's healthcare-seeking processes. With the exception of binary mobile phone ownership indicators, no standardised quantitative measure for such an analysis exists in the literature. I therefore developed new measures of phone utilisation and healthcare seeking based on my qualitative fieldwork and the medical anthropology literature on healthcare itineraries. This section describes these indicators and how I analyse them to inform the research question.

6.2.1   Capturing Sequential Health Action

People's narratives in the qualitative fieldwork led me to conceptualise care-seeking behaviour in terms of multi-step healthcare itineraries (Section 5.3.1). Although conceptually established and applied in qualitative research (e.g. Balabanova *et al.*, 2009), the sequential understanding of healthcare-seeking behaviour has yet to permeate quantitative public health research. The majority of quantitative analyses of healthcare behaviour in LMICs instead adopts a single-stage approach, implying that the patient "chooses" once from a portfolio of healthcare options (Gómez-Olivé *et al.*, 2013; Hardon, 1987; Mohan *et al.*, 2008; Moshabela *et al.*, 2012).

Studies that capture sequential healthcare data are rare. Balabanova and McKee (2002:384-387) are a notable exception, using detailed "pathway" data that includes up to three stages of access in order to understand patient flows through the formal health system. Despite the rich and large-sample data, their pathway analysis excludes non-professional actors and activities such as ignoring or self-treating an illness (which are important elements in my study), and it is limited to descriptive statistical analysis rather than inferential methods (which are required here to test effects of phone use on healthcare behaviour).[75] Another example is Hamid *et al.* (2015:40), who use a household survey to record the first two steps of the healthcare-seeking process. Despite the sequential raw data, the authors only consolidate these data into aggregate healthcare access statistics for different providers.

Detailed analyses of trajectories are often based on or analysed in combination with qualitative methods (as e.g. Balabanova & McKee, 2002). Nyamongo (2002) examines for instance the healthcare behaviour of a sample of 38 persons in Kenya over the period of ten

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[75] However, the authors use multiple regression analysis to examine the determinants of care seeking, similar to my analysis of healthcare access in Section 7.3.1.1.

months through ethnographic observation. The author analyses the data statistically to highlight the transitions between different forms of treatment. However, besides the small sample size, the data was collected through an ethnographic approach that is often impractical for quantitative assessments in the context of specific healthcare interventions.

Studies that examine sequential healthcare-seeking processes in depth tend to be qualitative (Kibadi *et al.*, 2009; Moshabela *et al.*, 2011; Shaikh *et al.*, 2008). Qualitative research, however, is not normally suited to *measure* health action, to *test* effects of interventions and developments on people's behaviour, or to *examine statistically* the relationship between behavioural trajectories and healthcare outcomes.

The limited incorporation of sequential data into quantitative public health research appears to result from methodological challenges in (a) capturing healthcare sequences in a quantitative data set, (b) incorporating sequence structures into quantitative analysis, and (c) evaluating the desirability of a particular healthcare sequence. In light of these difficulties, I developed a survey instrument that captures individuals' disease episodes as sequences of discrete healthcare and treatment activities. Each sequence starts when the respondent recognised symptoms or a discomfort, and ends when the illness was over (e.g. because it was successfully treated or the symptoms vanished). This sequential health action data permits us to identify at which stage in the healthcare-seeking process a provider was accessed, where the provider was located, how long the activity lasted, and whether and how a mobile phone was used during this particular activity. An excerpt of the survey instrument to capture sequential health action is reproduced in Appendix 3.

I recorded eleven different activities that define the "steps" in the health action sequence. These activities are not limited to formal healthcare access, but also include, among others, ignoring the condition, self-care through resting, or help from family and friends. Healthcare-related phone use can occur in any of these activities, either through the user or through third

parties (e.g. a younger household member calling a taxi for an older person). For each instance of phone use, I recorded the mode of use (e.g. calling), the user, the contact person (if any), and the purpose for which the phone was employed (e.g. receiving advice, checking if the facility is open, arranging transportation). I also collected overarching process data, which include disease symptoms, self-described severity of the illness, the total costs incurred, and the total process duration. Figure 6.1 presents a hypothetical example of such a process, where a patient first ignores an illness after it had been detected; then engages in self-treatment with medication at home, followed by access to private and public doctors; and concludes with a week-long period of continuing medication at home. Illness-related phone use could occur during any of these steps.

One respondent could report up to three such illness episodes (a self-described "severe," "mild," and "long-term or chronic" condition each), each with up to seven "steps." The resulting healthcare behaviour among the respondents is extremely diverse. For example, if we only consider "mild" and "severe" acute illnesses, then 119 unique sequences emerge among the 637 respondents in India and China who reported at least one such illness episode. Figure 6.2 shows an excerpt of these healthcare sequences containing "mild" illnesses in Rajasthan. In the remainder of this chapter, I analyse for all illness episodes whether there was any mobile phone use in relation to the illness, no matter who the user of the phone is. The next chapter builds on this sequential process description and develops further indicators for analysis.

Figure 6.1. Example of Healthcare-Seeking Process Data Collected in Survey

Step 1	Step 2	Step 3	Step 4	Step 5
• Ignore illness • At home • 3 days • No phone use	• Informal healer • At home • 8 days • Called relative to chat	• Private doctor • 10 minutes from home • 1 day • No phone use	• County hospital • > 2 hours from home • 14 days • Wife called taxi • SMS to reassure friends	• Self-care / rest • At home • 7 days • No phone use

Process Data

Symptoms | Self-perceived severity | Total duration | Total costs

Source: Own illustration.
Note. Example not based on actual data.

Figure 6.2. Excerpt of Healthcare-Seeking Processes in Rajasthan (Mild Illness)
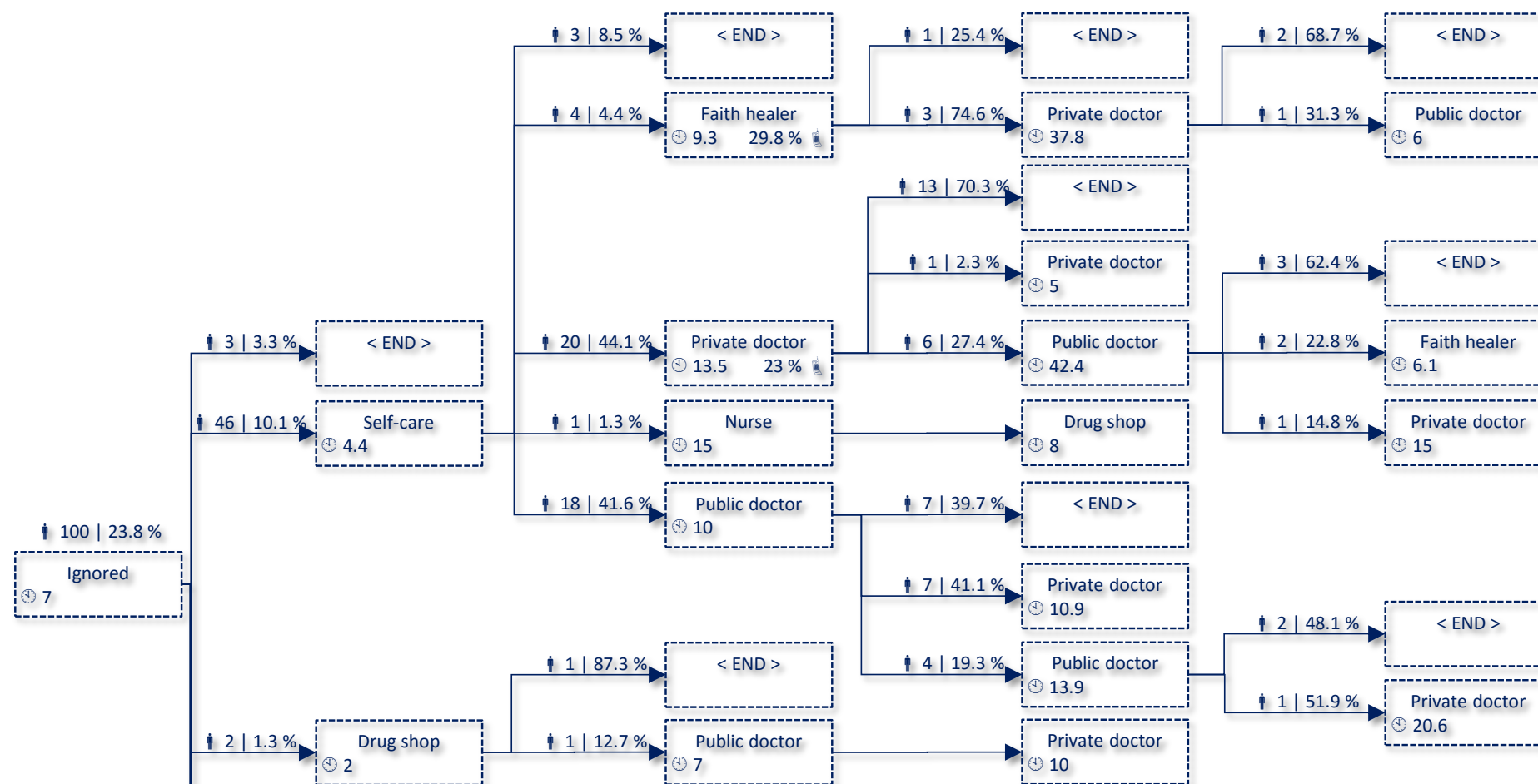
Source: Own illustration, derived from fieldwork data.

Note. ♦ denotes number of observations and weighted share of population at each step (using census data). ☉ denotes weighted average duration of step in days. ♦ denotes weighted portion of people in each step using a mobile phone in relation to the illness.

6.2.2   Measuring Mobile Phone Adoption

One objective of this thesis is to bridge the methodological divides that create a disjunction between the qualitatively rich accounts of mobile phone adoption patterns on the one hand, and reduced indicators to enable quantitative assessments of technology diffusion impacts on the other. Qualitative research presented in Part II indicated the variety of technological engagement among mobile phone owners as well as non-owners. Because of the observed patterns, I defined "utilisation" as a three-dimensional concept and hypothesised that it is a better predictor than a binary measure of adoption when considering the drivers of mobile-phone-aided healthcare-seeking behaviour. This section explains how I intend to measure these two concepts.

I follow established approaches to assess "adoption-as-ownership" on both the household and the individual level. Firstly, on the household level, I captured the number of mobile phones owned by the respondent's household and transformed them into a binary variable of either none or at least one mobile phone in the household. Secondly, on the individual level, I captured whether the respondent owned a phone in the previous twelve months (the analysis will link adoption to past health behaviour). I analyse these two measures of adoption in isolation and in combination.

In order to capture mobile phone utilisation as a multidimensional concept, I developed a novel, decomposable index of mobile phone utilisation. Constituent elements of this index are (i) the mode of phone access, (ii) the functional spectrum that the user exploits, and (iii) the frequency with which these functions are used along each mode of access. Access to technology in this framework has five sub-categories, namely exclusive personal ownership, shared ownership, access through borrowing, access through the market (or "renting"), and access through third parties (who operate the phone for the owner). These categories can overlap for

individuals. In addition to access, the notion of "utilising technology" incorporates the modalities of use in terms of functional breadth and intensity (which could be likened to "variety" and "amount" of use in Blank & Groselj, 2014). Functional breadth in this context is the general-purpose use of common functions including calling, text messaging, mobile data use, and in-built tools such as the phone book and calendar. The intensity of using these functions can be assessed in multiple ways, for example by duration, frequency, or expenditures. As explained below, my index captures the frequency with which the use of individual functions occurs along each mode of access. This three-dimensional measure of mobile phone utilisation—covering access, functional use, and intensity—therefore corresponds directly to my qualitatively grounded conceptual framework.

Survey data on mobile phone use was collected specifically to aid the construction of the index (see Appendix 4 for an excerpt of the survey instrument). This involves three main elements. Firstly, the access to mobile technology comprises four channels that are allowed to overlap: owning a phone, sharing a phone, borrowing or renting a phone, or access through a third party. I combined "borrowing" and "renting" because they represent two facets of transactional access to mobile phones according to my qualitative research. The second element is the functional spectrum that a person exploits, along each mode of access. The components of the functional spectrum are the use of (a) incoming calls, (b) outgoing calls, (c) incoming text messages, (d) outgoing text messages, (e) mobile data services, and (f) in-built tools. Because users can theoretically access each of these six functions through each of the four modes of access, the index has 24 individual indicators. Each of these 24 indicators received a value of "intensity" of use. I captured intensity in the survey questionnaire through a scoring system of [1] for daily use, [2/3] for weekly use, [1/3] for monthly use, and [0] for mobile phone use that is less frequent than monthly. The implicit assumption in this approach is that a function that is not used at least monthly does not represent a notable degree of "utilisation."

The index construction follows a three-step process, illustrated in Figure 6.3. In the first step, intensity scores are assigned to all uses along the 24 indicators. The second step constructs sub-indices per mode of access and per function. The functional sub-indices constitute the maximum score per access route for each function (see Figure 6.3, Panel a). For example, if incoming calls have a score of [1/3] on owned and shared phones, [2/3] on borrowed phones, and [0] through third-party access, then the sub-index score for incoming calls will correspond to the highest score [2/3]. The access mode sub-indices are calculated as the simple average score of all six functions for each access route (owning, sharing, borrowing/renting, third-party access; Panel b). The third step consists of constructing an overall index, which is the simple average of the six functional sub-indices (Panel c). This final, aggregate mobile phone utilisation index ranges from [0] to [1]. An index value of [1] indicates that a person makes full and daily use of all available functions across any one or more modes of access; an index value of [0] corresponds to maximum detachment from mobile technology use, without any function being used at least monthly (neither directly nor indirectly). The decomposability of the index along functional use and modes of access also permits us to unpack the composition of people's mobile phone utilisation across field sites and social groups (Alkire & Foster, 2011:477).

Figure 6.3. Schematic Depiction of Mobile Phone Utilisation Index and Sub-Indices

a) Construction of Functional Sub-Indices

b) Construction of Access Mode Sub-Indices

c) Construction of Aggregate Mobile Phone Utilisation Index
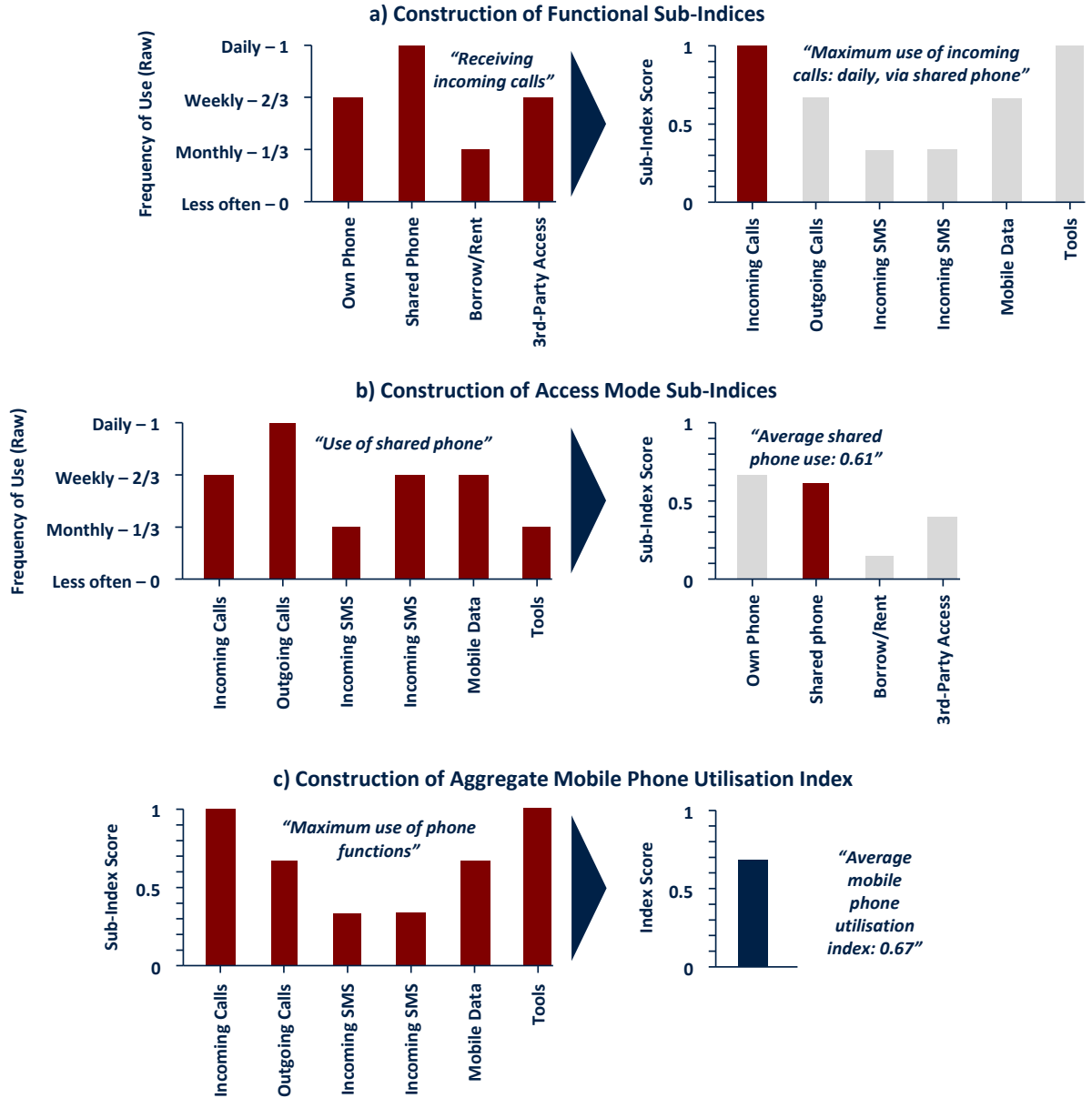
Source: Own illustration.
Notes. For illustration purposes only. Not based on actual data.

More formally, the calculations for the aggregate utilisation index $I^{(\text{aggregate})}$ and the sub-indices by function ($I_f^{(\text{function})}$) and access ($I_{mode}^{(\text{access})}$) can be expressed as

$$I^{(\text{aggregate})} = \Sigma_f^F \,[\max(x_{f,\,mode})] \,/\, F = \Sigma_f^F \,[\max(x_{f,\,own},\, x_{f,\,share},\, x_{f,\,borr./rent},\, x_{f,\,3rd})] \,/\, F, \qquad (1)$$

$$I_f^{\text{(function)}} = \max(x_{f,\,own},\, x_{f,\,share},\, x_{f,\,borr./rent},\, x_{f,\,3rd}), \tag{2}$$

$$I_{mode}^{\text{(access)}} = \Sigma_f^F (x_{f,\,mode}) \,/\, F, \tag{3}$$

where f is one of the six functions considered here, F is the total number of functional indicators (here: six), *mode* is one of the four modes {*own*, *share*, *borr./rent*, *3rd*}, and $x_{f,\,own}$, $x_{f,\,share}$, $x_{f,\,borr./rent}$, and $x_{f,\,3rd}$ are intensities of use for function f across each of the four modes of access. x can assume the values {0, 1/3, 2/3, 1} corresponding to the frequency of use being less than monthly, monthly, weekly, and daily or more often. The aggregate index $I^{\text{(aggregate)}}$ is the average utilisation of the phone across all functions F. The use of each individual function f is calculated as the maximum use of the function along each mode of access (owning, sharing, borrowing/renting, third-party use). The average is then calculated by summing each maximised functional use f and dividing the total by the number of functional categories F. The functional sub-index $I_f^{\text{(function)}}$ for each function f is simply the maximum intensity across the four access modes. The access mode sub-index $I_{mode}^{\text{(access)}}$ is the sum of intensity x across all functions f for a given mode, divided by the total number of functions F.

No explicit weighting is applied to the index. For example, if we expect that borrowing and renting phones come with higher transaction costs, we could apply negative weights to this sub-index in order to reflect the assumed obstacles of mobile phone use. However, should mobile phone use on borrowed and rented devices indeed face such frictions, then low utilisation scores would already reveal them. Conversely, high scores would imply that individuals face low barriers even if they borrow phones. The unweighted index therefore captures revealed mobile phone utilisation. At the same time, implicit weighting results from my scoring method and indicator choice. One result of the implicit weights is the relatively high valuation of calling

and text messaging vis-à-vis Internet use and the use of in-built tools (alarm, calendar, etc.). More advanced uses therefore contribute less to the total index score, which corresponds to the heterogeneity of basic phone use encountered in the qualitative fieldwork.

In summary, my quantitative analysis employs a qualitatively grounded, theory-driven, and score-based mobile phone utilisation index that captures people's access to and use of mobile phones on a continuous scale from [0 – maximum disengagement] to [1 – maximum engagement]. While I built the index for my specific research questions, it can be amended for other applications. For example, if researchers deem symbolic mobile phone use relevant for the analysis (e.g. Lee *et al.*, 2012; Tossell *et al.*, 2012), then the intensity of mobile phone personalisation could be captured as an additional functional dimension of use.

6.2.3 Analysis Techniques

This chapter employs descriptive statistical and logistic regression analysis. I present descriptive statistics from the survey in order to examine how patterns of phone ownership relate to mobile phone utilisation, and whether we can observe the indigenous emergence of healthcare-related phone use among the general population in the field sites. In order to understand the local context, I will also describe the socio-economic and healthcare conditions in the field sites using my survey data. Because the survey data was collected in a multi-stage cluster random sampling design, all descriptive statistics are population-weighted using district-level census data from each field site.

Following the descriptive analysis, I estimate single- and multilevel logistic regression models in order to predict phone-aided health action. Logistic regression is necessary for this task because phone-aided health action is a binary variable ([1] for health-related phone use,

[0] otherwise). Maximum likelihood estimation renders logistic regression models more appropriate than linear regression for dependent variables whose distribution is non-normal (Greene, 2008:400-401, 770).

The basic model with a matrix of covariates x_i, and a vector of parameters β takes the form

$$\text{logit}[P(y = 1 \mid x_i)] = \beta x_i, \tag{4}$$

where the probability of success $P(y = 1)$ is the natural log of the odds of achieving a positive result conditional on x_i (Hilbe, 2009:23-24).

I selected the covariates x_i (i.e. the drivers of accessibility and suitability) through my theoretical framework. Drivers of accessibility include the adoption of mobile phones and the severity of the illness, together with socio-demographic factors such as wealth that potentially influence the accessibility of phones for health-related uses. Analogously, I assume that suitability is determined through potential alternative means and complementary assets (e.g. vehicle ownership), and people's preferences for providers with varying degrees of responsiveness to phone use (e.g. local private doctors vs. central hospital specialists).

The analysis of the predictor variables takes place on the disease episode level rather than the individual because one person may report more than one disease episode ($n = 888$ episodes across all three kinds of illnesses). Disease episodes are nested within persons, and persons are nested within villages as primary sampling units. Multilevel logistic regression modelling is a useful approach to account for such a nested data structure (Rabe-Hesketh & Skrondal, 2012a:875-876, 886; 2012b:1-5). For the current application, I consider a three-level random intercept logistic regression model, according to which one random intercept term each

is assigned to the second and third level of the model (e.g. to individuals j and villages k in the current case):

$$\text{logit}[P(y = 1 \mid \boldsymbol{x}_{ijk}, \zeta_{jk}^{(2)}, \zeta_{k}^{(3)})] = (\zeta_{jk}^{(2)} + \zeta_{k}^{(3)}) + \boldsymbol{\beta}\boldsymbol{x}_{ijk} \qquad (5)$$

In this model, $\zeta_{jk}^{(2)}$ is the level-2 random intercept for individuals, and $\zeta_{k}^{(3)}$ is the level-3 random intercept for villages (Rabe-Hesketh & Skrondal, 2012a:876). As the intercept terms can take different values for persons and villages, they help to account for unobserved heterogeneity across these groups when estimating the relationship between health action and phone use.

In order to assess the predictive power of the independent variables of interest (mobile phone ownership and utilisation), I rely on one-sided z-tests for hypothesis testing of the individual coefficients, and on Akaike and Bayesian information criteria for model goodness-of-fit comparisons. Both information criteria assess the compromise of model fitness and complexity, with lower values indicating better goodness-of-fit.

Given that Hypothesis 1 suggests that the mobile phone utilisation index is a better predictor than mobile phone ownership for the emergence of phone-aided health action, evidence in support of this claim first needs to establish that (a) these two measures are indeed distinctively different, and that (b) phone-aided health action does emerge in the field sites. This is the focus of the descriptive analysis. Subsequently, I carry out the regression analysis of phone-aided health action, where evidence in support of Hypothesis 1 would arise if the phone utilisation index models exhibit better goodness-of-fit and higher coefficient significance levels than the models using mobile phone ownership as independent variable. Although

I anticipate the phone utilisation index to be the better predictor, the coefficients of phone own-ership *and* utilisation should be positive if they predict phone-aided health action.

6.3   Sample Description: Socio-Economic Context

Before I examine the relationship between phone diffusion and healthcare seeking, I briefly describe the sample and its socio-economic and epidemiological context for the reader to situate the analysis results. The exposition differs from the statistics I used to describe the field sites in Chapter 4, which represented the *status quo* from an aggregate perspective when I designed the household survey. Here I will present data on the micro level that point especially at differences in the age structure of the population, education, social mobility, class composi-tion, and physical household wealth across the two sites.

Basic socio-demographic patterns are outlined in Table 6.1. Because the survey data are population weighted, sex and age structures reflect census patterns rather than the living conditions in villages during a given day. Accordingly, the census tables report a slightly higher female population in the field sites with an older age structure in Gansu. At the same time, the sampled adult population has on average lower literacy and formal education levels in Raja-sthan. But the educational differences do not translate into fundamentally different employment profiles, as the majority of each field site population consider themselves farmers, homemakers, or both (Table 6.2). Moreover, the population in the Gansu field site is more homogeneous in terms of ethnicity, with only 1% not belonging to the dominant Han group (Figure 6.4). The spectrum of social groups in Rajasthan in terms of caste-religion composition is more frag-mented and more than 80% belong to government-recognised disadvantaged groups. Although qualitative sources repeatedly stressed that these caste distinctions become increasingly blurred

over time and are less informative in rural contexts with a high prevalence of poverty, explorative analysis (not reported here) suggests that "regular caste" members tend to be better off than the other social groups in this site.

Table 6.1. Socio-Demographic Structure of Sample

		Rajasthan	Gansu
Age Group	18-24	21.5%	13.5%
	25-34	25.7%	20.1%
	35-44	20.4%	27.0%
	45-59	19.0%	23.2%
	60+	13.4%	16.3%
Sex (% Female)		50.7%	50.6%
Literacy (Able to Read)		47.3%	71.3%
Completed Grades in School		4.0	5.8

Source: Own elaboration, derived from fieldwork data.
Notes. $n = 798$. Statistics are population weighted across the field site districts using census data. Proportion as share of total adult population in field site.

Table 6.2. Top-Five Occupations in Field Sites (Multiple Response)

	Rajasthan			Gansu	
	Occupation	Percent		Occupation	Percent
1	Farmer	59.3%	1	Farmer	68.2%
2	Homemaker	22.0%	2	Homemaker	13.5%
3	Labourer	15.5%	3	Shop or farm owner	6.9%
4	Student	7.1%	4	No occupation	5.7%
5	No occupation	4.3%	5	Driver	4.8%

Source: Own elaboration, derived from fieldwork data.
Notes. $n = 798$. Multiple responses possible: respondent was asked for main occupation and up to two side occupations (20% of sample in Rajasthan and 12% in Gansu indicated side occupations). Statistics are population weighted across the field site districts using census data. Proportion as share of total adult population in field site.

Figure 6.4. Social and Ethnic Composition of Field Sites
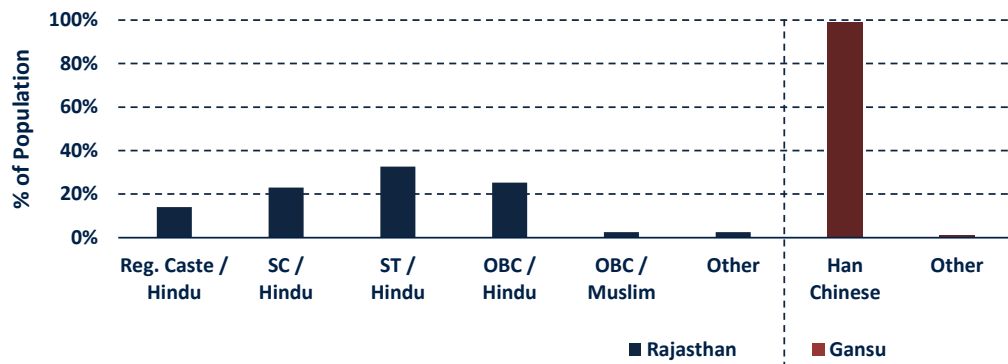
Source: Own illustration, derived from fieldwork data.
Notes. *n* = 798. "Reg. Caste" is regular caste, "SC" is scheduled caste, "ST" is scheduled tribe, "OBC" is "other backward class." Underlying statistics are population-weighted using census data. Proportion as share of rural population.

Major differences emerge in the social composition of households across the field sites. Households in the Rajasthan sample are on average larger by two members (5.4 vs. 3.5). On the one hand, this means that respondents appear to have tighter surrounding social networks in contrast to Gansu, where my qualitative fieldwork indicated higher individualism among the smaller household units. On the other hand, the smaller household size in Gansu is symptomatic for fundamentally different mobility patterns across the two sites. As Figure 6.5 indicates, more than 80% of households in Rajasthan but less than 20% in Gansu do not have a core family member living outside their village. According to my qualitative sources, especially young people emigrate early from the village as students and workers, often to return only occasionally during harvest time, family events, and the spring festival. The outmigration of young persons is reflected in the high share of respondents' siblings and children living elsewhere (72% and 44%, respectively).

Figure 6.5. Share of Households With Family Members Residing Outside Village
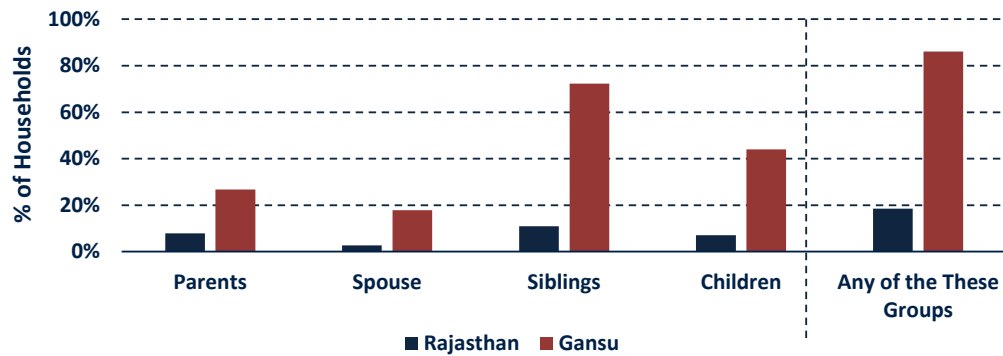
Source: Own illustration, derived from fieldwork data.
Notes. n = 798. Underlying statistics are population-weighted using census data. Proportion as share of rural households.

In terms of household assets, the Gansu field site is consistently better endowed. Mass media, transportation, and communication assets are in greater supply in Gansu (Figure 6.6), although the gap in household mobile phone ownership across the field sites is comparatively small (78% vs. 90%). Also household amenities are on average of a higher quality grade in Gansu, for example with 60% of households having piped water access in Gansu compared to less than 7% in Rajasthan. The contrast in terms of electricity access is similarly pronounced, as 95% in Gansu have electricity most of the time (>50%). In Rajasthan, 25% of the households have only sporadic electricity and another 13% do not have any electricity at all. Despite these differences in assets and amenities, two-thirds of the respondents in both field sites report that their households have enough money to meet their daily needs.

Figure 6.6. Comparison of Selected Household Assets
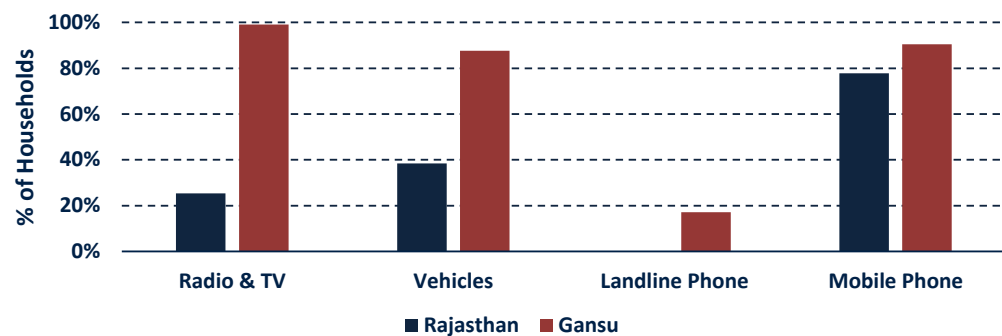
Source: Own illustration, derived from fieldwork data.
Notes. *n* = 798. Underlying statistics are population-weighted using census data. Proportion as share of rural households.

As far as the local epidemiological context is concerned, a common theme among the qualitative responses of medical providers in both field sites was the seasonality of illnesses—in Rajasthan in relationship to the rainy season; in Gansu with respect to the cold winters. Public and private doctors in Rajasthan reported common illnesses to involve colds, fevers, diarrhoea, malaria, and skin diseases; and less commonly mentioned were snake bites, typhoid, and anaemia. Medical practitioners in Gansu less frequently reported infectious diseases as opposed to chronic conditions. Among the frequent types of diseases encountered in Gansu's village and town hospitals are the common cold and the flu, respiratory conditions, illnesses of the digestive system, hypertension, cardiovascular diseases, diabetes, chronic pain, and chronic diseases of liver and kidneys.

Because these experiences only focus on care received in the formal health sector, Figure 6.7 depicts the most common conditions and symptoms on the population level as reported by the survey respondents.[76] The data show that frequent health problems in Rajasthan involve fever and infectious diseases, acute pain, the common cold, and dizziness, nausea, fatigue, and

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[76] The verbatim records of people's disease descriptions required manual harmonisation. This process yielded 155 unique symptomatic terms, which could appear alone or in combination in a reported illness. Assistance was received from public health researcher Dr Proochista Ariana in order to categorise the standardised symptoms into 22 disease categories, the most common of which are reported in Figure 6.7.

related symptoms. Gansu shows a high prevalence of the common cold and acute and chronic

pain. Chronic and long-term conditions are with estimated 32% of the population four times

more likely to be reported in Gansu than in Rajasthan. Overall, 79% in Rajasthan and 84% in

Gansu reported an illness in the past twelve months.

Figure 6.7. Top-Ten Types of Illness Symptoms by Severity (Multiple Response)
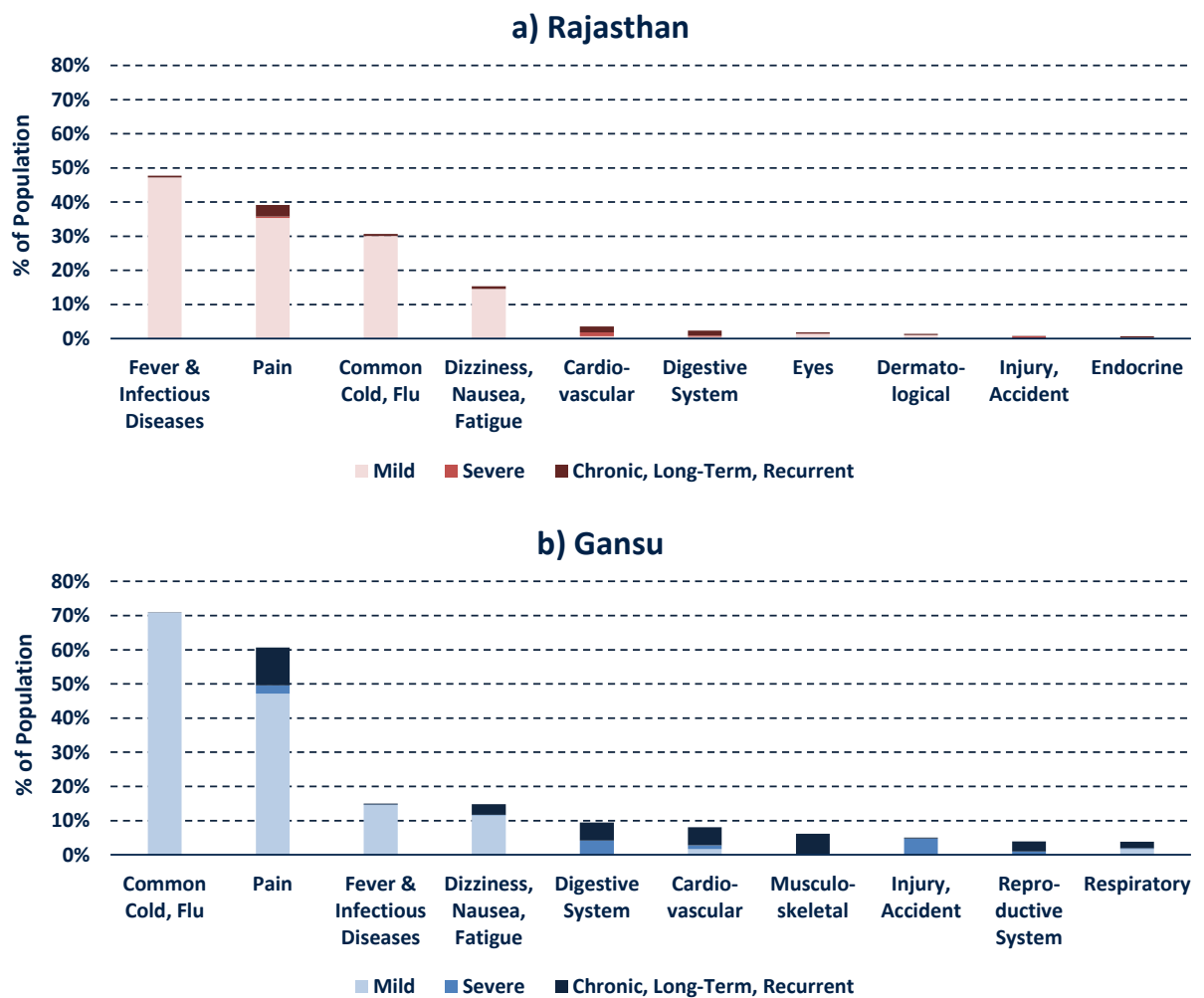
Source: Own illustration, derived from fieldwork data.
Notes. n = 798. Underlying statistics are population-weighted using census data. Proportions as share of total adult population. Multiple response of symptoms within and across illness episodes possible.

In summary, although both field sites are relatively poor within their countries, had

similar degrees of mobile phone penetration when the survey was designed, and face compa-

rable healthcare challenges, the household survey data highlights differences on the micro level

in terms of age structure of the population, education, social mobility, class composition, and physical household wealth. Similarities emerge with respect to occupational structures and self-perceived poverty. Both contexts also share a range of common and mild health conditions, including the flu, fever, and various forms of pain. Against this backdrop, I examine now the patterns of mobile phone diffusion and health-related phone use. The descriptive analysis prepares the test of predictors for phone-aided health action in the last part of the results section.

6.4   Results

This section presents the results of the descriptive statistical and logistic regression analysis. The results demonstrate that (a) mobile phone utilisation does not map closely onto phone ownership patterns, (b) phones commonly enter health action in both sites, and (c) mobile phone utilisation is a better predictor than ownership for the emergence of phone-aided health action on the individual level.

6.4.1   Patterns of Mobile Phone Adoption

Although Rajasthan and Gansu had comparable rates of teledensity when the survey was designed, the survey data reveal remarkable heterogeneity in mobile phone utilisation and access across the two sites. I illustrate this point by describing below patterns of mobile phone access, by contrasting how people engage with owned and shared devices in my field sites, and by exploring differences in mobile phone utilisation through my index measure.

At the first glance, mobile phones have diffused widely in both sites, with 78% of Rajasthan's households and 90% of the households in the Gansu site owning at least one mobile. Access patterns on the individual level—shown in Figure 6.8—indicate that 47% of adults in Rajasthan and 78% in Gansu owned a phone in the twelve months preceding the survey. The figure also indicates that shared ownership and third-party access to phones are more common

in the Rajasthan site. As a result, we can observe the counterintuitive detail that a larger portion

of people in Gansu does not have any regular access to a mobile phone, although a much larger

share of the population owns one.

Figure 6.8. Share of Field Site Populations With Access to Mobile Phones
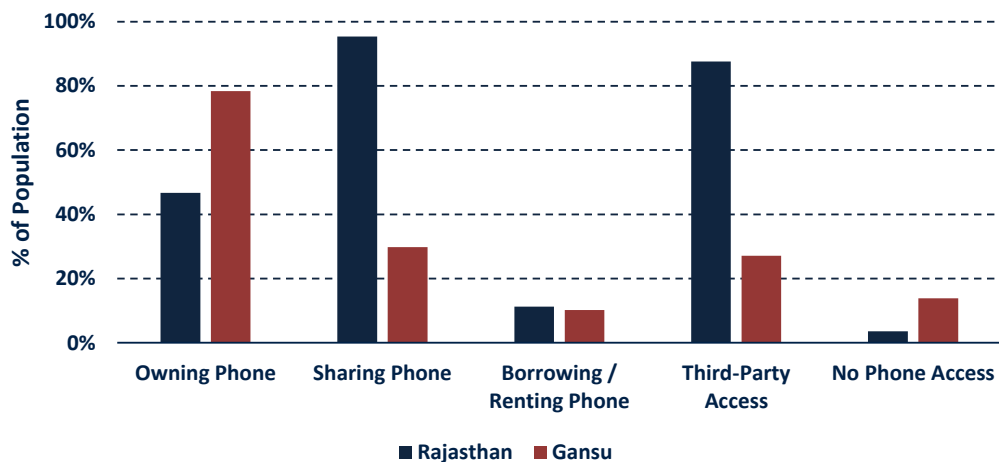
Source: Own illustration, derived from fieldwork data.
Notes. *n* = 798. Statistics based on monthly or more frequent access in last 12 months. Categories can overlap (except "no phone access"). Underlying statistics are population-weighted using census data. Proportion as share of total adult population in field site.

Phone diffusion patterns and people's engagement with the technology vary consider-

ably despite widespread shared and personal mobile phone access in both field sites. For ex-

ample, although similar mobile phone subscription rates were reported from the field sites prior

to the survey (0.74 for both, see Table 4.1 in Section 4.2), the types of owned devices vary

notably (Figure 6.9). In Rajasthan, 56% of the field site population use very basic phones and

less than one-quarter own or share an Internet-enabled feature or smartphone. The pattern is

inverted in Gansu, where 56% of the adults own or share an Internet-enabled phone and only

one-quarter uses very basic mobile phones. At the same time, the Rajasthan mobile phone mar-

ket is more brand conscious, with more than 50% of the field site population owning or sharing

one of the top-three mobile phone brands. *Nokia* alone accounts for 36.7% here. The market is

more fragmented in Gansu, where the top-three brands reach 22% of the adult population.

While access is high in both contexts, the technological environment and the local market conditions point at first elements that may influence people's engagement with mobile technology and the options available to them in order to utilise phones in healthcare settings.

Figure 6.9. Types of Mobile Phones Owned and Shared Across Field Site Populations
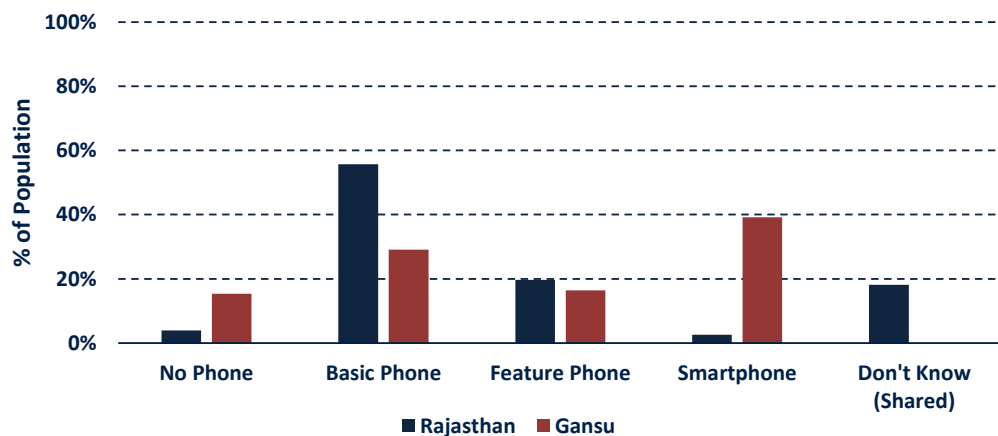
Source: Own illustration, derived from fieldwork data.
Notes. n = 798. Phones described by persons currently owning or sharing a mobile phone. Underlying statistics are population-weighted using census data. Proportion as share of total adult population in field site.

People's interaction with and management of their mobile phones provide further evidence for the heterogeneity of adoption patterns. On average, the Gansu respondents have used mobile phones three years longer than their Rajasthan counterparts (6.9 vs. 3.8 years) and spend 3.4 times the monthly amount on their mobile phones (adjusted for local prices).[77] The higher rate of personal mobile phone ownership (rather than shared ownership) also means that most phones in Gansu remain with the respondent throughout the day, whereas it is common in Rajasthan that phones remain at home or with another person when the respondents leave their homes (see Figure 6.10, Panel a for Rajasthan and Panel b for Gansu). Spamming is another

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[77] The Rajasthan average is ₹88.27 (£0.88) and the Gansu average is ¥64.94 (£6.49). Because £1.00 buys different amounts of goods in each country, I adjusted the ratio using the purchasing power parity conversion rate from the International Monetary Fund's gross domestic product calculations to arrive at a more comparable value (IMF, 2015).

example of heterogeneous use: More than half of the respondents in Rajasthan and nearly one-quarter of the Gansu respondents report at least weekly incidences of spam messages and calls. Access patterns influence the extent to which spam is perceived as such—phone owners in Rajasthan are three times more likely than sharers to report daily or weekly phone spam.[78] A sole focus on adoption as device ownership could obscure such heterogeneous patterns of mobile phone access and engagement.

Figure 6.10. Typical Location of Mobile Phone When Respondent is not at Home
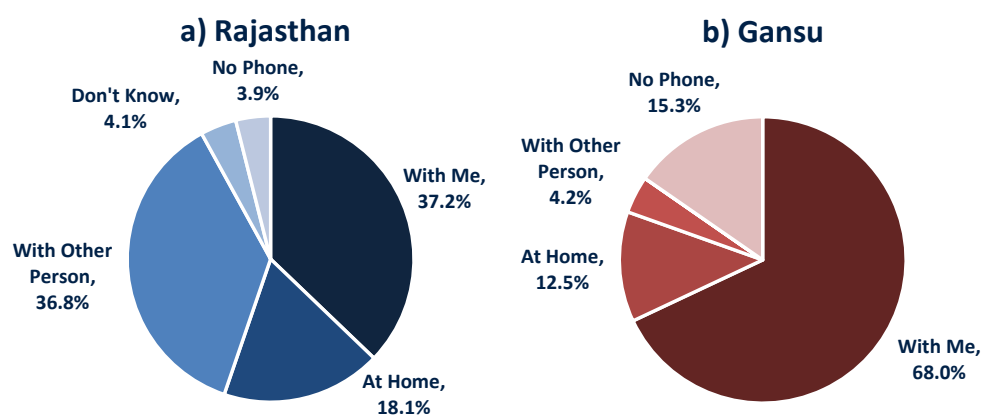
Source: Own illustration, derived from fieldwork data.
Notes. *n* = 798. Underlying statistics are population-weighted using census data. Proportion as share of total adult population in field site.

With the help of my mobile phone utilisation index, we can quantify the degree to which people engage with mobile phones, whether or not they own one. Figure 6.11 displays the distribution of the field site populations across different levels of mobile phone utilisation (in index intervals of 0.1). The graph shows that, for example, only 6% of the rural population in the Indian field site fall into the lowest index score bracket, whereas this is the case for 20% of the population in rural Gansu. At the same time, the Rajasthan survey participants have lower

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[78] Similar comparisons are not useful in Gansu because fewer people share phones.

average utilisation that is concentrated in the lower two-fifths of the index scale. Gansu residents have a more homogeneous distribution of use. For instance, 24% of the population in Gansu falls into the top-three brackets of phone utilisation, but only 3% in Rajasthan.

Figure 6.11. Distribution of Field Site Population Across Phone Utilisation Index Brackets
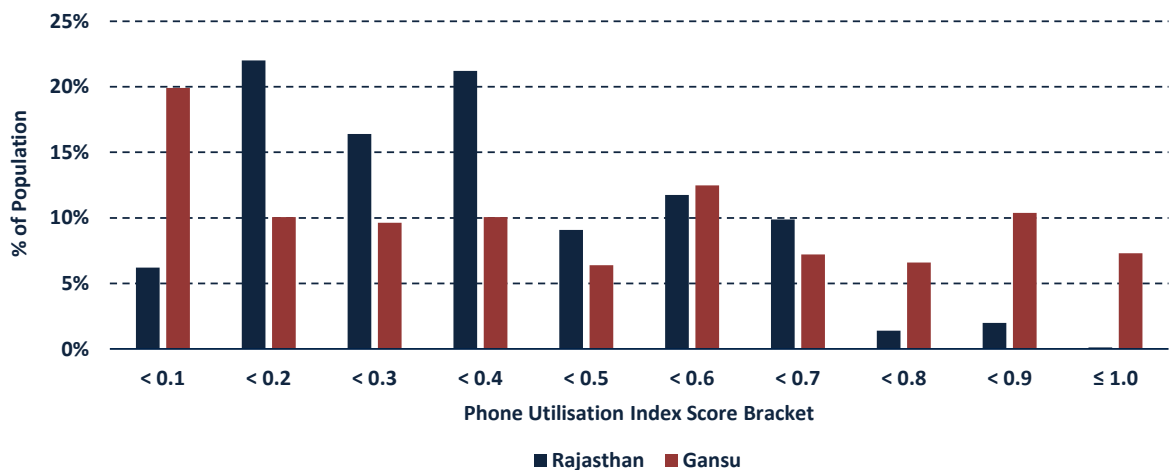
Source: Own illustration, derived from fieldwork data.
Notes. *n* = 798. Underlying statistics are population-weighted using census data. Proportion as share of total adult population in field site. Total population including phone owners and non-owners.

Figure 6.12 summarises the overall utilisation index and its sub-indices across Rajasthan and Gansu. We can observe that the utilisation of mobile phones by third-party access in Rajasthan is nearly as high as people's personal mobile phone use. In contrast, borrowers exhibit very low usage vis-à-vis owners and sharers. Among the utilised functions, calling is by far the most common, and support functions such as calendars and call registers are widely used as well. Major differences arise with respect to text messaging and mobile broadband use. Gansu exhibits here notably higher rates of utilisation, which resonates with its higher literacy rates and diffusion of Internet-enabled phones. Overall, despite wider access and less exclusion in Rajasthan, the average utilisation of mobile phones is higher in Gansu.

Figure 6.12. Average Phone Utilisation Index and Sub-Index Scores Across Site Populations

Source: Own illustration, derived from fieldwork data.
Notes. n = 798. Underlying statistics are population-weighted using census data. Average scores based on total adult population. Total population including phone owners and non-owners.

To examine the relationship between access and utilisation patterns, Figure 6.13 maps how people at each bracket of the utilisation index access mobile phones. We can observe that household mobile phone ownership (single solid lines) and personal ownership (single dashed lines) are positively correlated with the mobile phone utilisation index. However, the graph also shows that, among the people in the lowest utilisation-bracket (below a score of 0.1), nearly 20% in the Gansu field site own a personal phone, and 40% of the low-users' households have a mobile phone. Moreover, the graph illustrates the diverging patterns of shared and third-party access across the field sites. Shared ownership (single dotted lines) increases rapidly in the Indian site, reaching 100% already at the second-lowest index bracket. In contrast, no index bracket in Gansu exhibits more than a 40% portion of shared access, and sharing tends to decline among higher index scores. Third-party access (double dotted lines) in each site follows similar patterns, though in Gansu we can observe that more than 60% of users in the second-highest index bracket report that a third party operates a phone for them. Borrowing patterns (double solid lines) fluctuate at low levels of up to 30% across the index spectrum in both field sites.

These patterns provide evidence that ownership and utilisation do not map well onto each other. For instance, on average 88% of the individuals in Gansu in the index bracket 0.2-0.3 own a mobile phone and 98% of their households have a phone as well. People in Rajasthan achieve the same score with an average of 23% personal and 76% household phone ownership. Perhaps more importantly, the index also helps to discriminate between users in situations where technology diffusion is very high; that is, where nearly everyone is expected to own a mobile phone. For instance, in Gansu, older persons living in atomistic households and having low technical literacy have more difficulty utilising seemingly "diffused" technology. The comparatively frequent occurrence of very low mobile phone utilisation reflects these difficulties.

Figure 6.13. Mobile Phone Access for Population in Each 0.1-Bracket of Utilisation Index

Source: Own illustration, derived from fieldwork data.

Notes. n = 798. Underlying statistics are population-weighted using census data. Proportion as share of total adult population per field site in respective index bracket. Total population including phone owners and non-owners. Categories can overlap. HH is household, Raj is Rajasthan, Gan is Gansu.

6.4.2   Healthcare Access and Health-Related Mobile Phone Use

In order to assess whether ownership or utilisation is a better predictor of phone-aided health action, we need to establish how people seek health and whether phones are actually being used in this process. I outline below the health behaviours across the field sites, explore the healthcare landscape from the respondent perspective, and describe the different forms of healthcare-related phone use that arise therein. The principal insight is that mobile phone use in healthcare is common in both field sites, albeit more so in Gansu.

The analysis of people's health behaviour reveals idiosyncratic patterns in Rajasthan and Gansu. Based on people's healthcare trajectories when they get ill (focusing on "mild" and "severe" cases),[79] Figure 6.14 visualises the average duration spent in each step. Whereas health seekers in Rajasthan spend most of their time in treatment with private and public doctors, the most extensive health-related activities in Gansu are self-care and no care at all ("IgnS" for "ignore illness or self-care").[80] The high share of activities not involving a third party in Gansu is probably the result of the wide availability of medication among Gansu households and practitioners. Further analysis of healthcare trajectories (not shown here) also reveals that people in Rajasthan access public and private care repeatedly during a single illness episode, which suggests that navigating the fragmented rural health system in the Indian field site is a more complex process than it is in Gansu.

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[79] I exclude here chronic and long-term conditions because the questionnaire captured up to five years for these trajectories. Their inclusion would therefore significantly distort the analysis of average durations spend in each activity.

[80] Mild conditions lasted on average 28 days in Rajasthan (median: 10 days) and 10 days in Gansu (median: 5 days). Severe conditions lasted on average 114 days in Rajasthan (median: 28 days) and 98 days in Gansu (median: 68 days).

Figure 6.14. Average Number of Days Spent in Healthcare Activities
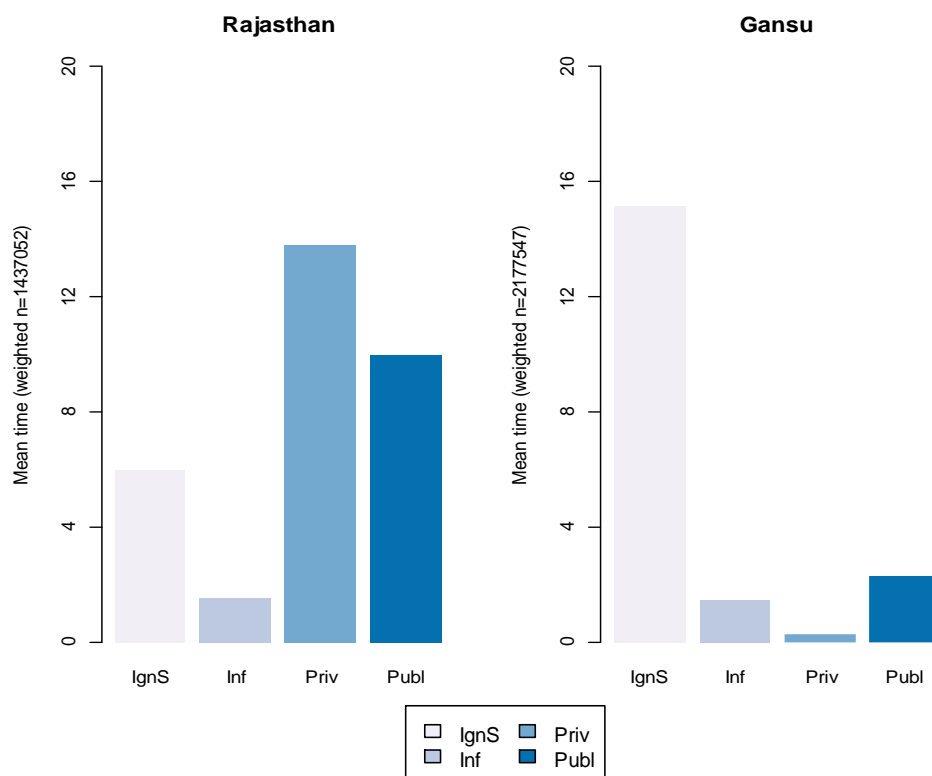
Notes. Statistics weighted using census data and according to number of reported illnesses. "IgnS" is "Ignored or engaged in self-care;" "Inf" is "Accessed informal care, family member, or friend;" "Priv" is "Accessed private doctor;" "Publ" is "Accessed public doctor or nurse in village or elsewhere."

Because healthcare-related mobile phone use does not take place in isolation, it is useful to situate it within conventional means of accessing health providers. Figure 6.15 depicts the modes of transportation that my respondents choose for their preferred providers (I describe below who those providers are). The by far most common mode of access is to walk to the site of treatment, and Gansu has a 13 percentage-point higher population share walking to a healthcare provider. In contrast, personal vehicles are not very widely used. The main differences between the field sites arise with regard to non-personal transportation, where the Rajasthan sample more commonly relies on taxis and arranged vehicles and the Gansu sample typically uses public transport to access distant healthcare providers. Nearer medical practitioners and bus stops in Gansu might explain these differences: I estimate that less than half of the adult population in the Rajasthan site is located within half an hour from a doctor, whereas 85%

in Gansu are.[81] Likewise, more than one-third in Gansu are located within 1km of a bus stop, but the same only holds for less than one-quarter of the Rajasthan sample. Mobile phone use therefore takes place in a broader system of interlinkages between the individual and the healthcare system. It is possible that some of these context-specific linkages are more conducive to mobile phone use than others (e.g. taxis vs. walking).

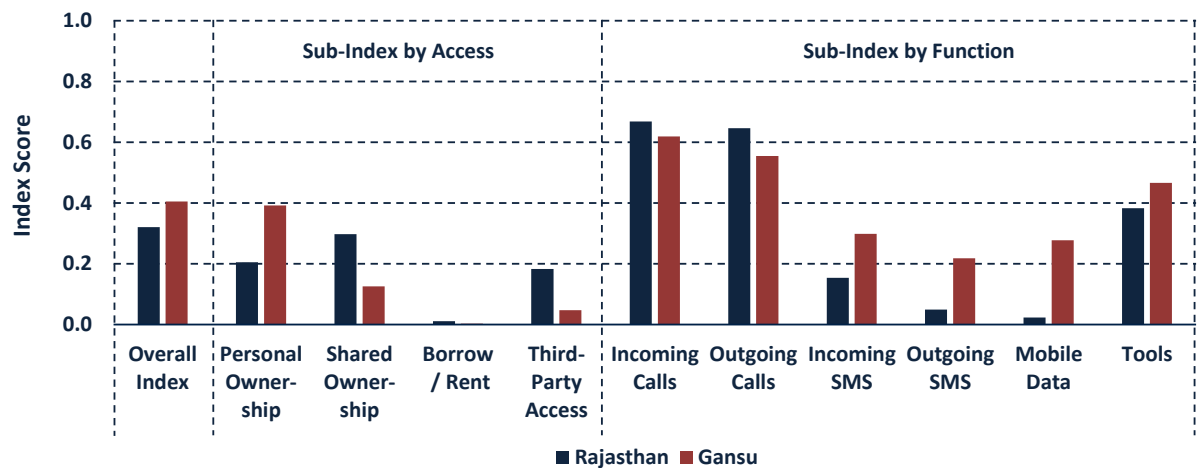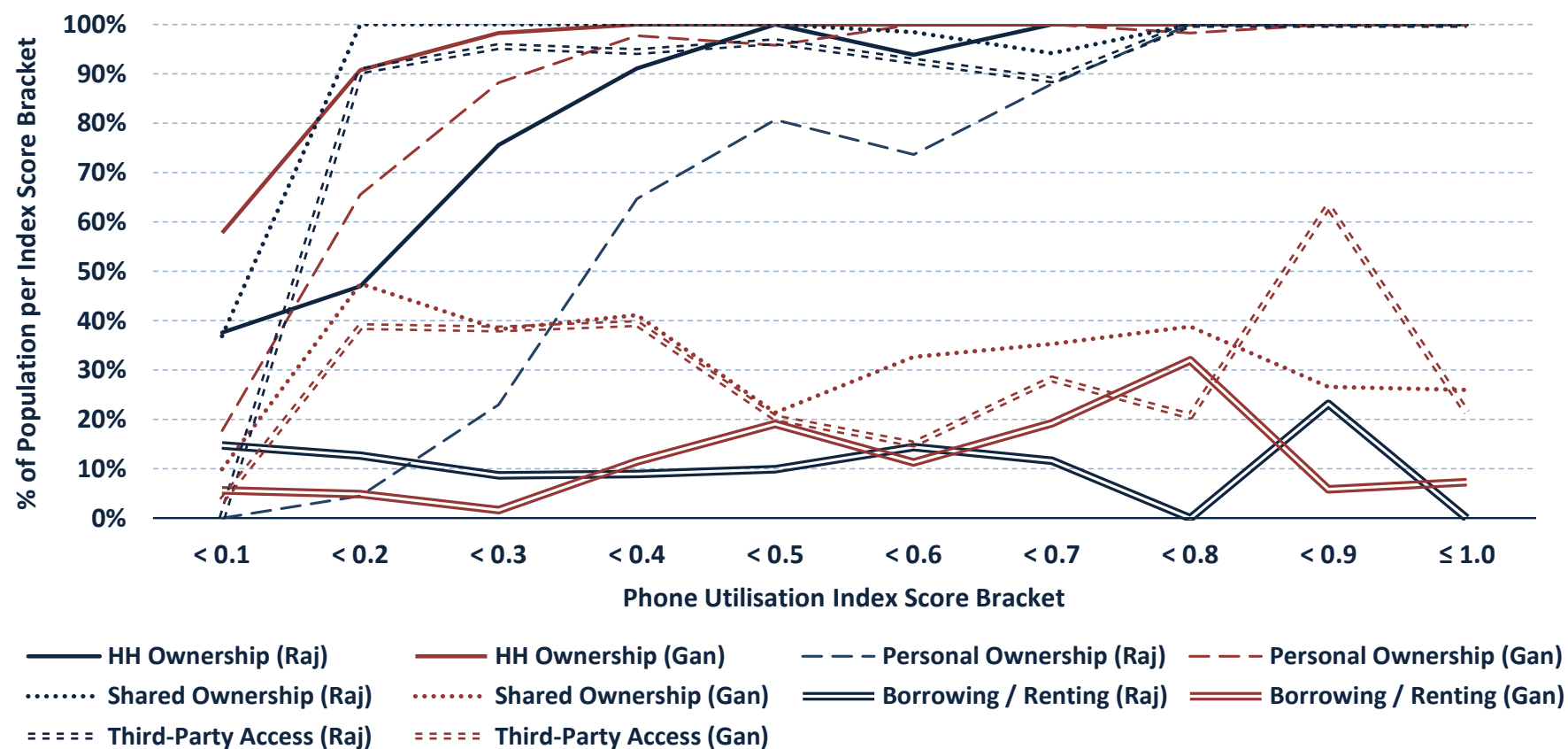Figure 6.15. Transportation Modes for Healthcare Access (Multiple Response)
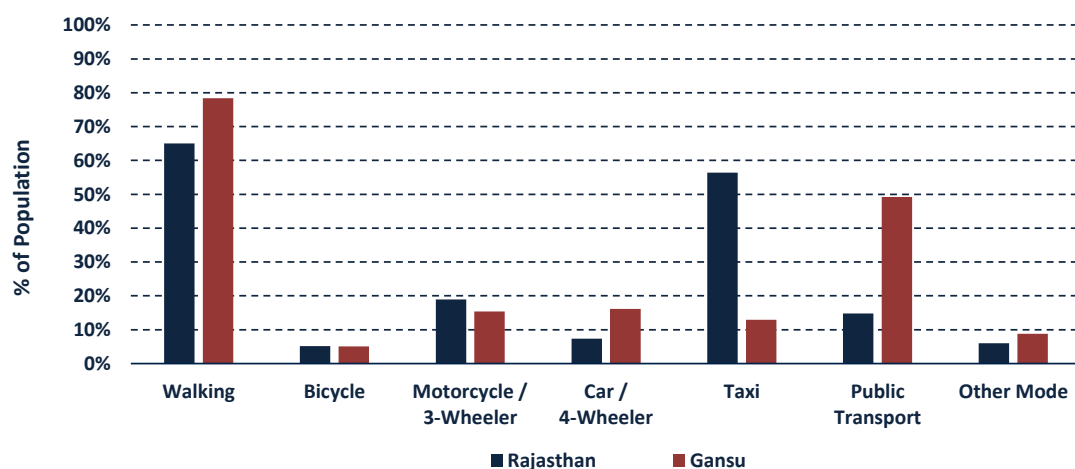
Source: Own illustration, derived from fieldwork data.
Notes. n = 798. Underlying statistics are population-weighted. Proportions as share of total adult population. Graph showing main mode of access for each preferred healthcare provider, hence total > 100%. "Healthcare access" here includes any formal or informal healthcare provider except friends and family.

In order to get a better sense of the healthcare landscape, Figure 6.16 illustrates the range of healthcare providers that the residents in the field sites consider for treatment. The figure further indicates whether patients could use mobile phones to interact with the various healthcare options, and whether they have actually done so in the past. The graph shows that, in Rajasthan, only a minority of people consider primary health centres (or PHCs, staffed with

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[81] This statistic is based on responses to the question, "How long does it take you to get to the nearest public or private doctor?" A "doctor" here pertains to healthcare providers that the patient understands to be a doctor, not who necessarily qualified as one.

one doctor and a nurse), whereas, in comparison to Gansu, private doctors and traditional heal-

ers are relatively frequented. Gansu respondents would more commonly rely on town hospitals

(the PHC equivalent), pharmacies, and other shops selling medicines. We can further observe

that not all providers and healthcare solutions are equally suitable for mobile phone use, and

their receptiveness appears to be generally higher in the Gansu field sites. In addition, only

respondents in Gansu reported using the Internet as a possible option for treatment, including

looking up healthcare information and booking appointments with hospitals.

Figure 6.16. Health Provider Landscape From Respondent Perspective Across Field Sites
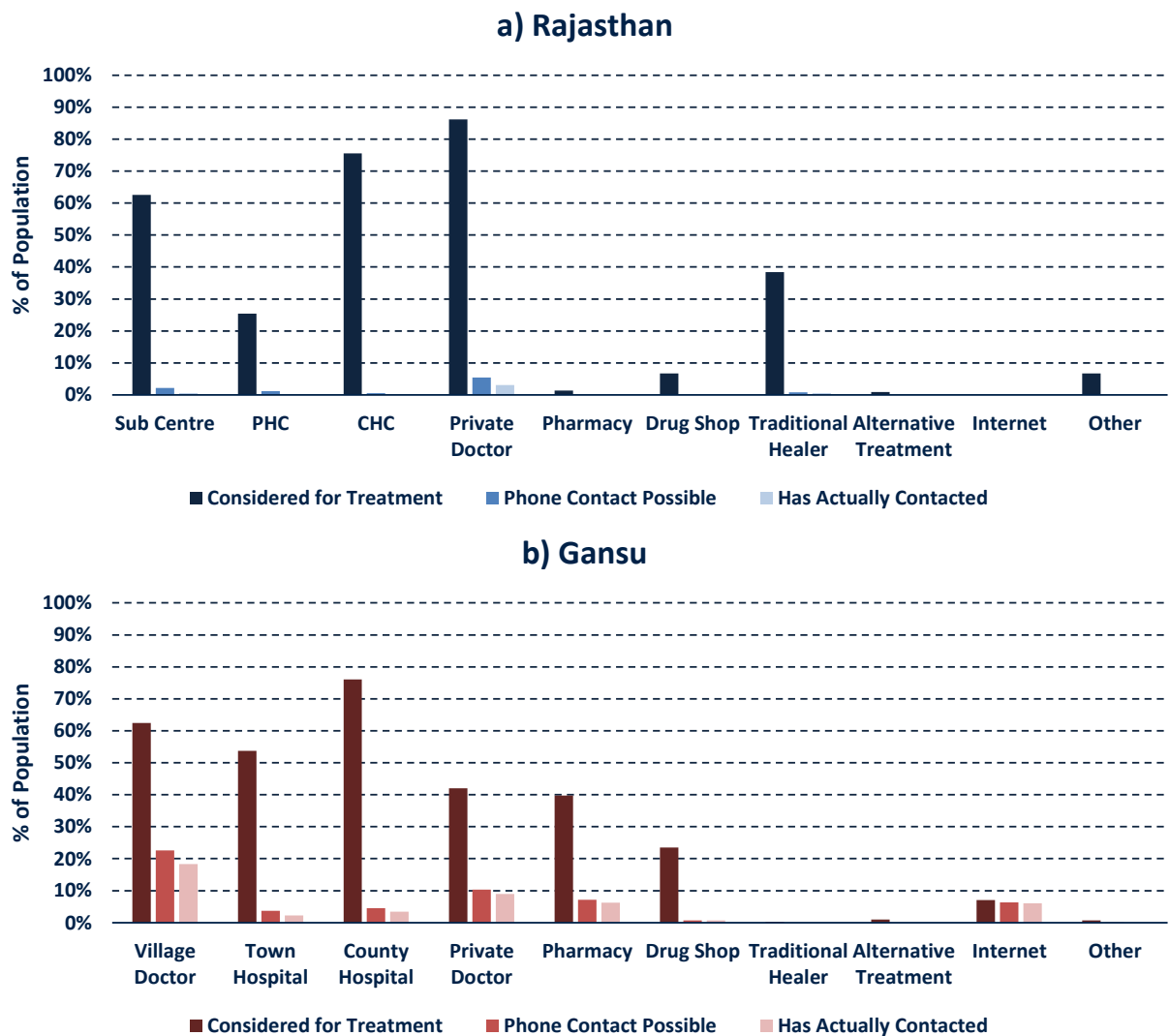
Source: Own illustration, derived from fieldwork data.
Notes. n = 400 (Rajasthan) and 398 (Gansu). Statistics are population-weighted. Proportions as share of total adult
population. PHC is primary health centre, CHC is community health centre and includes central urban hospitals.

The direct interaction with healthcare providers is but one possible line of enquiry if we want to understand the role of mobile phones in health action. To present a more complete picture of health-related phone uses, I summarise in Figure 6.17 the range of purposes of phone-aided health action for three different questions. The first question deals with the direct inter-action with healthcare providers (corresponding to the purposes underlying the phone use in Figure 6.16 above). The second question asks whether the respondent has ever used a mobile phone for another person's health problem, given a range of possible options. Question three elicits whether phones were used at any point in the patient's personal healthcare-seeking pro-cess, and, if so, what purpose they were put to. Each of these questions provokes rather different responses from the sample.

An immediate observation in this compilation is the more frequent health-related use of mobile phones in Gansu (the bars indicate the fraction of the total adult population). More-over, especially the question about phone use for other persons' health problems (the centre bar in each activity) tends to produce higher-than-average responses in Rajasthan and ex-tremely high responses in Gansu. It is possible that social desirability biases influenced these rather strong reactions. In contrast, the relatively low responses among phone use in personal health action (light-shaded bars) probably result from the different recall period compared to the other questions (last year vs. ever).

Figure 6.17. Purpose of Three Types of Health-Related Phone Use Across Field Sites
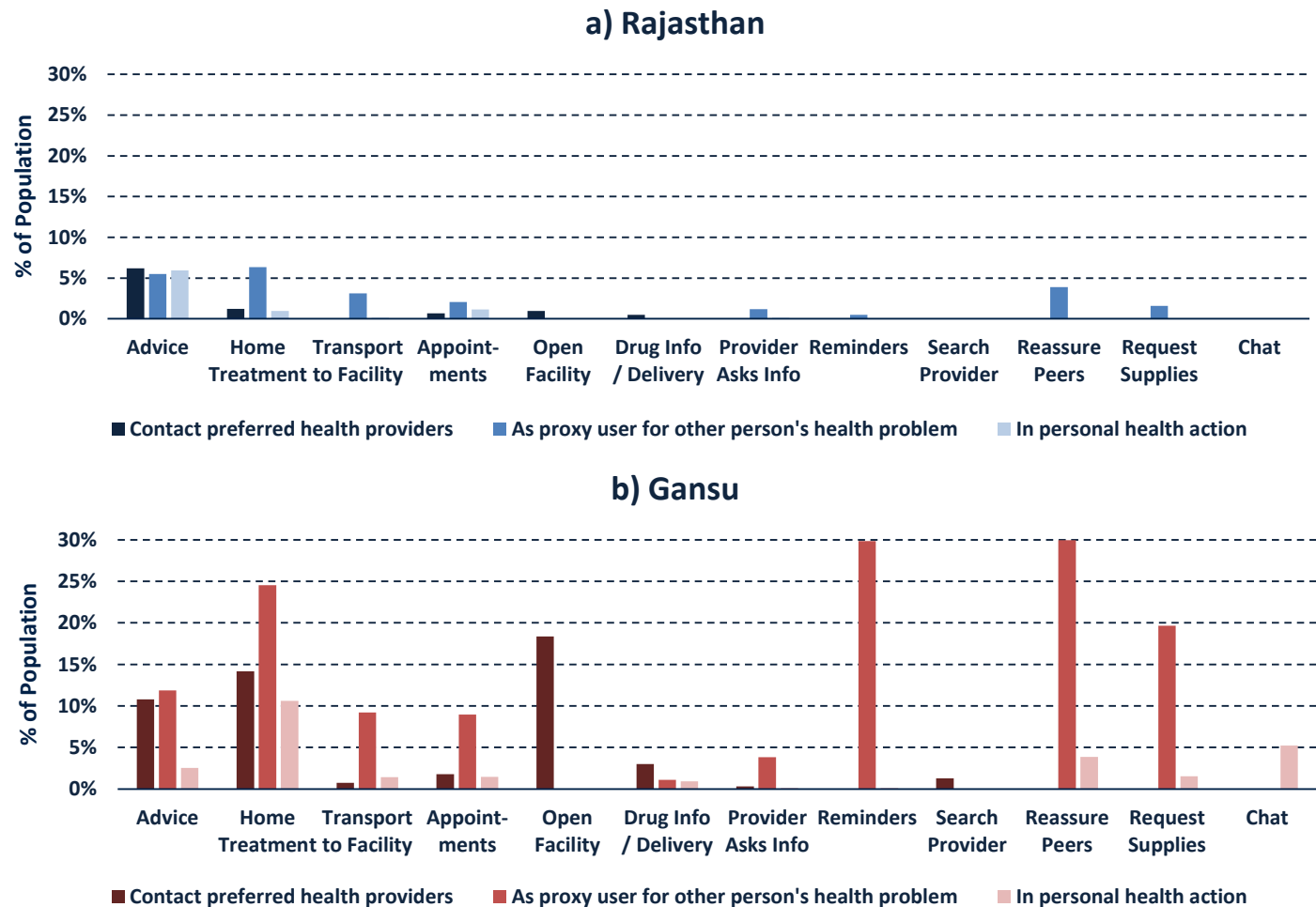
a) Rajasthan

b) Gansu

Source: Own illustration, derived from fieldwork data.
Notes. n = 400 (Rajasthan) and 398 (Gansu). Underlying statistics are population-weighted. Proportions as share of total adult population.

Notwithstanding the differences in reporting, the graph illustrates the wide spectrum of activities in which people engage when using a phone for healthcare-related purposes. The most common activities in Rajasthan are exchanging advice, calling a medical practitioner for home treatment, arranging transportation to the place of treatment, reassuring peers during an illness, and requesting supplies during treatment. Respondents in Gansu indicate that they frequently help other persons in arranging home calls, reminding them about their treatment, reassure their family members and peers, and ask for supplies to sustain their treatment. Other common activities in Gansu are advice calls and checking whether the health facility is open before visiting it.

Within these activities, calling is the dominant mode of communication. Every person who used a phone for a health-related purpose also called. In Rajasthan, virtually no other mode was employed (except the use of phone tools for one respondent). Gansu respondents showed a slightly wider spectrum of modes, where 11% of the phone users also indicate the use of mobile broadband and 3% used text messages. It is also noteworthy that the use of ambulance hotlines and other dedicated phone-based services is virtually non-existent: Only 3% of the population in each field site actually contacted ambulances, and no other service use was reported.

The picture that emerges from this analysis is that people are accustomed to healthcare-related mobile phone use. Depending on the three questions to elicit phone use in healthcare, up to 12% of the adult population in the Rajasthan field site and up to 56% in Gansu indicate phone use in relation to healthcare access. If we only focus on the respondents' personal illnesses over the past year as the most conservative indicator, 20% of the rural population in Gansu exhibit phone-aided health action; in rural Rajasthan, it is still 7.5%. Based on these statistics, I estimate that 140,000 people of the adult population in the Rajasthan field site and 540,000 adults in the Gansu site have used mobile phones in a recent illness episode either

personally or through a third party.[82] Aggregating these three indicators into an "overall" measure, we can establish that one-fifth of the respondents in Rajasthan report one form of phone-aided health action or another, and two-thirds of the respondents in Gansu. The statistics are summarised in Figure 6.18.

Figure 6.18. Share of Population Using Mobile Phones for Healthcare-Related Purposes
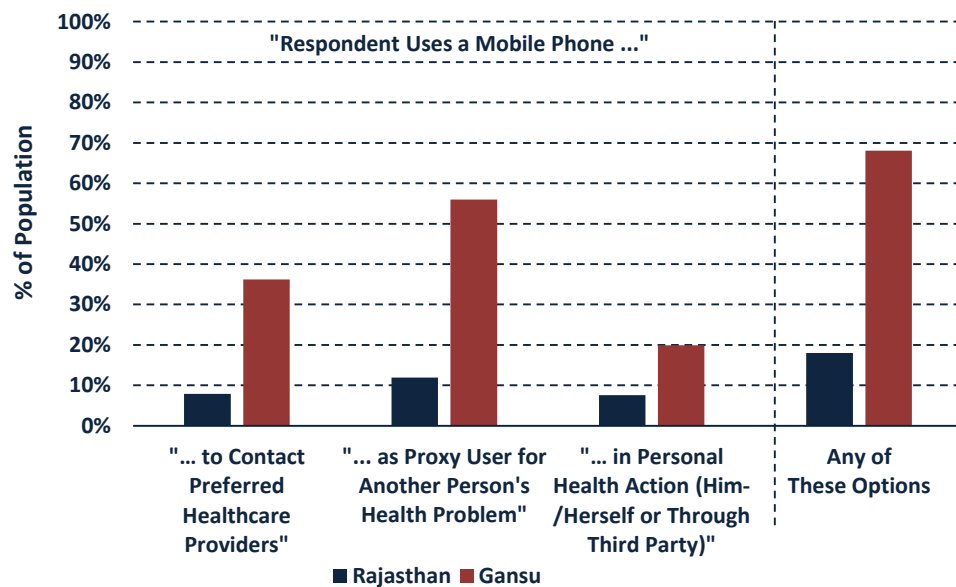
Source: Own illustration, derived from fieldwork data.
Notes. *n* = 798. Underlying statistics are population-weighted. Percentages as share of total adult population in field site. Total population including phone owners and non-owners. Categories can overlap.

Whichever measure we apply, mobile phones emerge as a (perhaps surprisingly widespread) tool in the healthcare-seeking process in both field sites. Even according to the most conservative indicator—that is, mobile phone use in recent personal health action—at least one in thirteen adults in the Rajasthan study site has had some experience with healthcare-related phone uses; and many more in Gansu. This demonstrates that mobile phones enter personal

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[82] The lower bound of the 95% confidence interval is 4.4% of the adult population or approximately 84,000 adults in the Rajasthan site (rural Udaipur and Rajsamand), and 15% or 410,000 persons in the Gansu site (rural Lanzhou, Baiyin, and Dingxi). If only mild and severe conditions in the past twelve months are considered (as will be done in the next chapter), the point estimates indicate that still 100,000 people in Rajasthan and 370,000 people in the Gansu site have displayed mobile-phone-aided health action.

healthcare behaviours, and they do so independently of dedicated mHealth services in the field sites. In the final part of this section, I test whether phone ownership or the phone utilisation index predict better the emergence of such behaviour in people's personal health action.

6.4.3   Predicting Phone-Aided Health Action: Ownership Versus Utilisation

What drives the emergence of these local mobile-phone-based solutions? A simple comparison of health seekers by phone ownership (Table 6.3) suggests that one-third of those persons reporting phone-aided health action in Rajasthan and one-sixth in Gansu had not owned a mobile phone in the year preceding the survey. Likewise, personal phone ownership does not directly translate into health-related uses as five in six Rajasthan phone owners and three in four Gansu owners had not used a phone during their reported illnesses.

Table 6.3. Phone Ownership in Phone-Aided Health Action

		Phone use in any health issue?			
		Rajasthan		Gansu	
		No	Yes	No	Yes
Respondent owns phone?	No	49.5%	3.6%	17.9%	4.0%
	Yes	41.0%	5.9%	58.4%	19.8%

Source: Own elaboration, derived from fieldwork data.
Notes. *n* = 683, excluding respondents who have not reported illness. Statistics are population-weighted using census data. Gansu values adding to 100.1% due to rounding errors.

Because there are non-owners who exhibit phone-aided health action, and because there are owners who choose not to use a mobile phone when seeking healthcare, I examine in the remainder of this section whether an index-based measure of "mobile phone utilisation" is indeed superior to the concept of mobile phone adoption as ownership. As indicated in Section 6.2.3, the analysis is based on logistic regression models that link a person's probability of

using a mobile phone during any step of an illness episode to a number of determinants includ-

ing indicators of mobile phone ownership and utilisation. Should it surface that mobile phone

utilisation is a better predictor than ownership, it could suggest that interventions aiming at

phone owners and their determinants may be misguided if they neglect people's actual engage-

ment with the technology.

Eight models were estimated, each in a single- and a multilevel framework. The models

are distinguished by their principal independent variable(s) of interest being:

1) the mobile phone utilisation index,

2) the utilisation index and household mobile phone ownership,

3) access sub-indices and household phone ownership,

4) function sub-indices and household phone ownership,

5) personal mobile phone ownership,

6) household mobile phone ownership, and

7) personal and household mobile phone ownership.

For the sake of brevity, I report here only the results of the multilevel random intercept

models, focusing on Models 1, 2, 5, 6, and 7. Single-level logistic regression estimates yield

the same conclusions (i.e. all signs and nearly all significance levels are consistent). The mul-

tilevel random intercept models are specified as follows:

$$\text{logit}[P(y = 1 \mid \boldsymbol{x}_{Indep., ijk}, \boldsymbol{x}_{Controls, ijk}, \zeta_{jk}^{(2)}, \zeta_{k}^{(3)})] =$$

$$(\alpha + \zeta_{jk}^{(2)} + \zeta_{k}^{(3)}) + \boldsymbol{\beta}_{Indep}\boldsymbol{x}_{Indep., ijk} + \boldsymbol{\beta}_{Controls}\boldsymbol{x}_{Controls, ijk} \qquad (6)$$

In this model, $x_{Indep., ijk}$ denotes the independent variable(s) of interest according to Models 1 to 7 across disease episodes i, individuals j, and villages k, with $\beta_{Indep.}$ being the corresponding set of parameters. The matrix $x_{Controls, ijk}$ contains additional control variables to correct for other potential determinants of mobile-phone-aided health action. These controls include a country dummy, complementary and substituting household assets and an aggregate asset index, health provider preferences, time to the nearest doctor, sex, age, education, physical health status, awareness about and response time of health hotlines, household size, household head characteristics, family dispersion, remoteness of the village, and the self-perceived severity of the reported illness episode. Given the health system differences between the two countries, I also estimated models with interactions between the country dummy and the ownership/utilisation indicators. As none of the interaction terms was statistically significant at the ten-percent level, I do not report these models here.

I carried out a range of robustness checks, which largely confirmed the results reported here. The robustness checks include single- and multilevel model fitting (single-level with cluster-robust standard errors), multicollinearity checks, estimation with sample weights, nested models, different functional forms (ordinary least squares and probit regression), dropping illnesses that lasted more than twelve months, and dropping the least reliable survey responses. The same robustness checks were carried out for the regression analyses in Chapter 7. Owing to space constraints, I only report the main analysis results.

The main results across Models 1 to 7 are shown in Table 6.4, omitting control variables and the constant term (I report a result as "significant" if its p-value is below 0.1; full model results are shown illustratively for Models 2 and 7 in Table 6.5). Whereas Models 1 to 4 based on the phone utilisation index are significant at the one-percent level, Models 6 and 7 are only significant at the five-percent level and Model 5 only at the ten-percent level (see "Model test"

in Table 6.4). As the variance component tests in the last row indicate, the multilevel structure

is appropriate for all specifications.

Table 6.4. Main Results of Three-Level Random Intercept Logistic Regression Models

	Model No.						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Phone Utilisation Index (Aggregate)	4.30***	3.92***					
Utilisation Sub-Index (Owned)			1.66**				
Utilisation Sub-Index (Shared)			0.74				
Utilisation Sub-Index (Borrowed)			5.26				
Utilisation Sub-Index (3rd Party)			5.77***				
Utilisation Sub-Index (Incoming Call)				1.03*			
Utilisation Sub-Index (Outgoing Call)				1.32**			
Utilisation Sub-Index (Incoming SMS)				-0.16			
Utilisation Sub-Index (Outgoing SMS)				1.56***			
Utilisation Sub-Index (Mobile Data)				-0.07			
Utilisation Sub-Index (Tools)				0.10			
Household Owns Phone		1.45**	1.52**	1.28**		2.02***	1.83***
Respondent Owns Phone					0.71**		0.40
Model Test	< 0.01	< 0.01	< 0.01	< 0.01	0.05	0.04	0.04
AIC	654.1	649.2	645.5	646.3	684.5	676.7	677.4
BIC	836.1	836.0	846.6	857.0	866.5	858.7	864.2
Variance Component Test	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Source: Own elaboration, derived from fieldwork data.
Notes. Coefficients reported. Control variables omitted (including household assets, health provider availability and preferences, sex, age, education, physical health status, awareness about and response time of health hotlines, household size, household head characteristics, family dispersion, remoteness of village, and severity of illness). Level 1: $n_1 = 888$ disease episodes. Level 2: $n_2 = 681$ respondents. Level 3: $n_3 = 32$ villages. Model test reporting Prob. > Wald X^2. Variance component test reporting Prob. > $\frac{1}{4}*X^2(0) + \frac{1}{2}*X^2(1) + \frac{1}{4}*X^2(2)$. AIC is Akaike Information Criterion, BIC is Bayesian Information Criterion.
*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Table 6.5. Complete Results of Three-Level Random Intercept Logistic Regressions 2 and 7

	Model (2)		Model (7)	
	Coefficient	Standard Error	Coefficient	Standard Error
Illness Episode is "Chronic"	0.95***	0.27	0.91***	0.28
Illness Episode is "Severe"	1.96***	0.44	2.10***	0.47
Country Dummy	0.01	0.82	0.24	0.90
Village is Remote (Dummy)	-0.56	0.47	-0.48	0.51
Sex (1 = Female)	0.29	0.31	0.14	0.34
Literacy (1 = Literate)	0.38	0.44	0.65	0.50
Highest Completed Grade	-0.11*	0.06	-0.05	0.06
Age Group[a]	0.16	0.14	-0.01	0.16
Household Size	-0.08	0.08	-0.08	0.08
Sex (Household Head) (1 = Female)	1.09**	0.40	1.22**	0.47
Highest Completed Grade (Household Head)	0.03	0.04	0.04	0.05
Family Members Living Outside Village	0.14	0.38	0.12	0.42
Self-Rated Health[b]	0.27*	0.14	0.20	0.16
Activities of Daily Living (Score)[c]	-0.10	0.27	-0.08	0.31
Knows Ambulance Hotline (1 = Aware)	-0.02	0.29	0.01	0.33
Knows Health Hotline (1 = Aware)	0.18	0.71	0.16	0.78
Perceived Ambulance Response Time[d]	0.07	0.09	0.06	0.10
Time to Closest Health Provider[e]	0.18	0.17	0.14	0.19
Resp. Considers Village Clinic / Nurse	0.36	0.32	0.36	0.36
Resp. Considers Small Hospital	0.63**	0.29	0.68**	0.32
Resp. Considers County Hospital	0.43	0.31	0.56	0.36
Resp. Considers Private Doctor	-0.44	0.29	-0.39	0.32
Resp. Considers Pharmacy	0.54*	0.29	0.56	0.34
Resp. Considers Shop Selling Drugs (Kiosk)	0.38	0.31	0.27	0.35
Resp. Considers Traditional Healer	0.20	0.53	0.28	0.57
Resp. Considers Alternative Medicine	1.44	1.42	1.82	1.57
Resp. Considers Internet Sources	0.03	0.82	0.83	0.96
Resp. Considers Other Providers	0.42	0.72	0.47	0.81
Household Wealth Quintile (per Site)	0.33**	0.14	0.42**	0.17
Household Owns Radio	0.48	0.37	0.52	0.42
Household Owns TV Set	0.54	0.52	0.62	0.56
Household Owns Computer	-0.56	0.49	-0.45	0.55
Household Owns Vehicles	-0.75**	0.33	-0.89**	0.38
Household Owns Landline Phone	-0.01	0.41	-0.50	0.48
Household Owns Mobile Phone	1.45**	0.62	1.83**	0.68
Phone Utilisation Index	3.92***	0.77		
Resp. Owns Phone			0.40	0.35
Constant	-8.73***	2.07	-8.27***	2.21

Source: Own elaboration, derived from fieldwork data.

Notes. Coefficients reported. Level 1: n_1 = 888 disease episodes. Level 2: n_2 = 681 respondents. Level 3: n_3 = 32 villages.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

[a.] 1 = "18-24 years," 2 = "25-34 years," 3 = "35-44 years," 4 = "45-59 years," 5 = "60+ years."

[b.] 1 = "very good," 2 = "good," 3 = "moderate," 4 = "bad," 5 = "very bad."

[c.] Computed as average score of seven activities, each coded: 1 = "no difficulty / no assistance," 2 = "mild difficulty / no assistance," 3 = "moderate difficulty / a bit of assistance," 4 = "severe difficulty / a lot of assistance," 5 = "extreme difficulty / cannot do."

[d.] 1 = "< 10 min," 2 = "10-29 min," 3 = "30-59 min," 4 = "60-119 min," 5 = "> 2 hours," 6 = "would not come."

[e.] 1 = "< 10 min," 2 = "10-29 min," 3 = "30-59 min," 4 = "60-119 min," 5 = "> 2 hours."

The results show that all models exhibit a significant positive relationship between health-related phone uses and people's access to and utilisation of mobile technology. This can be interpreted as evidence that mobile technology diffusion contributes to the emergence of innovative local solutions to healthcare-seeking problems (rather than e.g. one person or village phone kiosk facilitating all phone-aided health action).

A comparison of the different indicators and models yields further insights. Model fitness as indicated by the Akaike Information Criterion suggests that the models containing the mobile phone utilisation sub-indices have the best explanatory power, followed by Models 2 and 1. Judging by the Bayesian Information Criterion, which penalizes model complexity to a greater extent, Models 1 and 2 are the best estimates. Model 5 containing only personal mobile phone ownership (alongside other controls) emerges as the least suitable according to either information criterion.

As far as the individual variables are concerned, the phone utilisation index is a strong positive predictor of phone-aided health action. Broken down by different modes of mobile phone access, usage variations along personally owned devices and third-party access predict the phone-aided health action better. In terms of functional use, phone-aided health action is more likely to arise among those individuals who make more intensive use of incoming and outgoing calls as well as those who frequently send text messages (Model 4). Personal mobile phone ownership is only significant at the five-percent level (Model 5) and becomes insignificant when combined with household mobile phone ownership (Model 7). Household mobile phone ownership is significant at the one-percent level (Models 6 and 7). Given that 78% of households in Rajasthan and 90% in Gansu own a mobile phone, the statistical relationship implies that the *absence* of household phones explains the *absence* of phone-aided health action, rather than the other way round. Moreover, model fitness for household ownership is weaker compared to the phone utilisation index. Furthermore, comparing the phone utilisation index

coefficient with the household-level phone ownership coefficient in Model 2 indicates a higher significance level and a larger coefficient for the index, suggesting greater predictive power. Both personal and household mobile phone ownership are therefore weaker predictors than the mobile phone utilisation index.

Other control variables (shown for Models 2 and 7 in Table 6.5) exhibit mixed results. Phone-aided health action is not systematically correlated with country, sex, age, or literacy. Household wealth is a significantly positive predictor of phone-aided health action, suggesting that wealthier households face fewer restrictions to make use of technology to solve health problems (note that mobile phones are a component of the wealth index). At the same time, it emerges that household transportation assets are negatively correlated and significant at the five-percent level for all estimated models. If a causal link underlies this relationship, it would suggest that transportation assets substitute for phone-aided health action. In addition, people preferring pharmacies and small public hospitals tend to be more likely to use mobile phones for health, but the distance to the nearest doctor does not appear to influence the emergence of phone-aided health action. However, the most important predictor (besides phone use and constant term) is the self-perceived severity of the illness, with "chronic" and "severe" conditions being more likely to be associated with mobile phone use.

In short, the analysis shows that personal phone ownership is a relatively weak and inefficient predictor for the emergence of phone-aided healthcare seeking when compared to the index of mobile phone utilisation. Although household ownership predicts the outcome better than personal ownership, neither (in connection or in isolation) is superior to the mobile phone utilisation index. I treat this as evidence in support of Hypothesis 1: The mobile phone utilisation index is a better predictor than binary ownership-based adoption indicators for the emergence of mobile-phone-aided health action.

6.5   Interpretation and Discussion

This chapter set out to investigate the relationship between mobile phone ownership and utilisation and healthcare access in rural India and China. I summarise here the findings of the quantitative analysis; discuss measurement, social desirability, and conceptual limitations of the analysis; and interpret the findings in light of my theoretical framework and qualitative analysis. I discuss further issues related to confounding effects and reverse causation, recall biases, and the external validity of the results in the Limitations Section 7.4.1 of the next chapter.

Novel survey data from rural Rajasthan and Gansu helped to illustrate the mismatch between binary measures of mobile phone adoption and phone utilisation as a multidimensional concept. Not only do "ownership" and "access" themselves have many facets, including for instance the types of phones (and their location) to which people have access during the day. The analysis of the utilisation index has also shown that "digital exclusion" can prevail among people who own mobile phones. Moreover, I explored whether health-related phone use actually exists to a meaningful extent in the field sites. Although health system structures and health behaviours differ notably between Rajasthan and Gansu, the survey data indicated that phone-aided health action is relatively common in both sites, albeit more so in Gansu. Against this backdrop, I carried out three-level random intercept logistic regression analysis to predict phone-aided health action using various indicators of mobile phone adoption and utilisation. The utilisation index yielded consistently better results than personal or household-level mobile phone ownership. Overall, the evidence in this chapter lends support to the claims that patterns of mobile phone ownership and utilisation are related yet incongruent, that mobile phones enter health action in both field sites to a notable extent, and that mobile phone utilisation is a better predictor for phone-aided health action than mobile phone ownership.

These findings should be understood in light of at least three limitations that apply to the analysis. Firstly, it is difficult to match temporally the emergence of phone-aided health action with people's self-reported adoption of mobile phones. Current use or the use over the past year can only proxy for the actual use and access at the point in time when respondents incorporated mobile phones into their healthcare behaviour. Both measures of mobile phone adoption are based on the twelve months preceding the survey, and I choose the most conservative assessment of phone-aided health action based on people's self-reported illnesses that can reach up to five years into the past. Robustness checks with a subset of illnesses that are reported over a twelve-month period do not change the overall direction and implications of the regression results. Although this lends confidence to the interpretation of the findings, there remains a residual risk that measurement errors influence the regression results.

Secondly, social desirability biases may have influenced the reporting about personal phone use, for instance exaggerating statements where the respondent would appear in a more favourable light. I elicited the specific purposes and other details when asking people about their health-related phone use, thereby hoping to reduce social desirability biases because a consistent narrative was required. Given the high reporting of third-party use for healthcare, it is improbable that this strategy succeeded for all indicators. To minimise the risk of biased predictions, I chose to analyse only the most specific and conservative indicator, namely phone use in personal illness episodes.

Lastly, my phone utilisation index is only a partial representation of the wider concept of "adopting" mobile technology. On the one hand, the index does not include symbolic forms of engagement, which may provide further information into people's readiness to incorporate technology into their health behaviours. On the other hand, there are possible alternative methods to produce the index scores. Whereas I chose a cut-off at monthly use of each function, other possibilities could include the number of estimated uses per year, which may produce a

more precise utilisation measure. However, the fact that the phone utilisation index predicts people's health-related phone use more precisely than ownership indicates that the index does fulfil its purpose. In addition, a binary adoption measure based on Rogers's (2003:21) original notion of "full use" of mobile phones (i.e. no adoption at a utilisation index score of less than 1.0) would have suggested that adoption rates are 0% in Rajasthan and 5% in Gansu. While this suggests that "utilisation" is at least a useful concept in light of other measures, future work may compare different index constructions for their analytical power in healthcare and other domains.

Considering these limitations and their mitigating factors, the findings point at the incongruence between patterns of mobile phone utilisation and ownership, and at the superiority of the phone utilisation index in predicting the emergence of local phone-aided solutions for healthcare seeking. These findings mirror my qualitative investigation of people's engagement with mobile technology: Phone owners exhibited such a vast range of utilisation that makes a binary conceptualisation of adoption implausible. Examples include,

> *From the contact list, I can recognise the number because we put the picture in front of the contact number, so I can know which number it is. For example, in front of my husband's number, I put some statues so I can know that it is his number.* (Rajasthan, men and women, 34 to 73 [group response, illiterate phone owner], mixed phone ownership)

> *I call directly or do QQ chat. Now I rarely send text messages, only a few messages per month.* (Gansu, man, 22 smartphone owner)

> *Whenever we go on a trip with family and friends, we take pictures and share them on Facebook because we all have a Facebook account.* (Rajasthan, men, 18 to 22 [group response], phone owners)

> *I applied for Internet services to read news and stopped it* [i.e. unsubscribed] *again after one week.* (Gansu, man, 36, smartphone owner)

> *I am not very fond of having a phone with me all the time*. (Rajasthan, man, 24, phone owner).

These examples illustrate the broad spectrum of utilisation among phone owners. But also the use among non-owners varies. The utilisation index demonstrated the extremely low usage of borrowed phones. For instance, an older man in Rajasthan explained his reluctance to borrow a mobile phone from his family members:

> *I am afraid to use the phone, so I only take the phone when it is necessary, and I immediately hand it over to my son. Because if I press a wrong button accidently, then I will cause money loss.* (Rajasthan, men, 55 to 60 [group response], non-owners)

Sharing can face complications as well. Women (though not men) in both Rajasthan and Gansu reported misunderstandings between spouses, for instance if someone dialled a wrong number. A woman in Rajasthan, 22 years of age and owning a mobile phone, expressed that she has "*problems of missed calls, wrong numbers calling*" that can lead to "*a lot of stress and tension in the household and between husband and wife.*" She explained that unknown numbers from male callers create problems when her husband uses the phone and receives such a call. Similarly, a female respondent in Gansu stated that, "*Many kinds of people call occasionally, and it has caused family misunderstandings.*" Although such problems appear to be the exception rather than the rule, it is conceivable that individuals exhibit cautious engagement with mobile phones in such circumstances. Overall, qualitative and quantitative findings indicate vast heterogeneity of phone use in the field sites, lending support to my claim that this behaviour is better captured in a multidimensional index than in a binary measure of adoption.

The qualitative data also indicate how differences in mobile phone utilisation are brought about by upstream factors such as people's lifestyles, the social context within which

mobile phone use takes place, or frictions in technological learning processes. For instance, the latter was visible among middle-aged and older persons in both field sites, who often indicated that younger family members taught them few skills beyond receiving and making calls. A detailed example of problems affecting the learning experience was given by a woman in Rajasthan. Thirty-five years old, she received ten years of formal education, is formally employed in a supervisory position with the local NGO Seva Mandir, and had owned her phone for eight years. However, she is just now learning how to operate the calculator, aided by her 13-year-old son. She described that, in the process of learning,

> *I asked him* [to teach me] *again and again every evening after dinner, when he is free. I ask him again if I get confused.* (Rajasthan, woman, 35, phone owner)

Asked whether her son helps willingly or gets tired after some time, she replied,

> *He becomes angry. He taught me two to three times and said, "You already know this very small thing and you keep asking about this again and again."*

Such tension between learners and teachers suggests that peer learning can come at a cost (psychic, social, and in some instances also perceived monetary costs), which has to justify the expected benefit of being able to make calls, send text messages, operate the calculator, or to use the mobile Internet. Where this is not the case, users simply stated that further functional engagement with the phone is "*unnecessary.*" Mobile data use for instance is almost entirely concentrated among individuals below the age of 35, suggesting that the full exploitation of available phone functions faces obstacles. Though not further explored in this thesis, frictions in learning processes may be an important factor to explain the disjunction between technology access and utilisation.

In addition, and contrary to intuition, this chapter also demonstrated that people in rural Gansu are more likely to be excluded from using mobile phones even though more people own them. This is partly the result of social mobility patterns and demographic changes. Households in rural Rajasthan are on average larger and younger; children and young adults are more likely to reside at home with older family members. In contrast, a substantial portion of residents in Gansu's villages are older couples and are only occasionally visited by younger family members who emigrated to urban centres for schooling or in search of employment. Older persons without mobile phones or with low technical literacy therefore have fewer opportunities for third-party access, which can lead to difficulties utilising the seemingly "diffused" technology. The comparatively frequent occurrence of very low mobile phone utilisation in Gansu reflects these difficulties.

The independent emergence of phone-aided health action in the field sites is noteworthy, too. Although each field site offers ambulance hotlines, public health hotlines, and network-operator-provided public health text messages, health related uses of mobile phones emerge locally among patients and in direct interaction with the health providers. Ambulances are among the very few instances where any such dedicated service use was actually reported by the respondents. It is possible that the low uptake is a result of unreliable and ill-targeted services that do not meet healthcare needs in remote rural areas. For example, only one-quarter of the Rajasthan sample and one-eighth in Gansu indicate that ambulance services would arrive within half an hour in their villages. But it is also possible that government-sanctioned and commercial phone-based services compete with people's local phone-aided solutions: Where people are accustomed to calling their local doctors directly for advice, a new public health hotline may have difficulty in convincing health seekers of superior value. Low uptake of an mHealth service may therefore not solely arise from digital exclusion, but also from inadvertent competition with local solutions and from inadequate service delivery.

In line with my theoretical framework, the regression models further indicated that poorer households and mild illness episodes are less likely to exhibit phone-aided health action. This can be explained by obstacles in mobile phone access among low-intensity users that arise from lacking resources or insufficient reasons to convince other persons of lending their mobile phones. The models also signalled that vehicle ownership makes phone-aided health action less probable (although wealth as a whole is positively related to it). This corresponds to my qualitatively grounded notion that mobile phones compete with other options and solutions such as transportation in the healthcare-seeking process. At the same time, we cannot exclude the possibility that certain forms of phone use (e.g. appointments) are complementary to vehicle ownership. Larger data sets that offer more detailed evidence of the specific phone-aided activities may help to illuminate this point in future studies.

I conducted this analysis because of the persistent reliance on binary adoption indicators in the development-related technology diffusion literature. This is a non-trivial problem because people may under-utilise a technology despite its apparent diffusion. Context-specific socio-economic and cultural factors can accentuate this distinction further—in the present case for example by the higher degree of technological "exclusion" despite wider diffusion of mobile phones in Gansu compared to Rajasthan. This leads me to conclude that the notion of mobile phone "adoption as utilisation" does indeed offer superior analytical value compared to "adoption as ownership" in the context of healthcare-related mobile phone use, supporting Hypothesis 1.

6.6   Conclusion

This chapter set out to test whether a new mobile phone utilisation index is superior to the conventional binary concept of adoption as ownership when predicting phone-aided health action. I found evidence that utilisation is a superior predictor than adoption-as-ownership,

thereby supporting Hypothesis 1. The analysis also showed the significance of other determinants of phone use in healthcare, for example the severity of people's illness, household wealth, and transportation assets. Beyond the research question, the analysis indicated that phone-aided health action emerges commonly yet independently of existing mHealth services; it illustrated the broad spectrum of phone utilisation among phone owners and non-owners alike, and it showed that "digital exclusion" can persist even in contexts where mobile phones have diffused widely. Using novel instruments to operationalise utilisation and health action, this is the first quantitative comparison of mobile phone adoption concepts in a healthcare context.

In light of the research question, I conclude that phone-aided healthcare seeking is best explained by people's actual engagement with mobile technology, regardless of whether they own a phone. This relationship takes place in an environment in which people with mild health conditions face greater obstacles to phone-aided health action, and alternative healthcare-seeking solutions (e.g. using a motorcycle) may achieve similar objectives. These findings correspond to my qualitative fieldwork that formed the basis for the hypothesis and the guiding theoretical framework. However, the analysis so far has been mute as to whether mobile phone use is also desirable from a healthcare perspective. This is the subject of the next chapter.

Chapter 7

Implications of Mobile Phone Diffusion for Healthcare Access[83]

7.1   Introduction

In light of the rapid global mobile phone diffusion alongside persistent challenges in low- and middle-income country health systems, public health researchers have developed great interest in capitalising on mobile technologies to improve health systems and health service delivery. However, extremely little research addresses the "black box" of effects of the phone as underlying platform on population health behaviour. The few studies concerned with the link between phone use and healthcare choices tend to focus on establishing the "enabling conditions" for phone-based solutions (Ahmed *et al.*, 2014; Jennings & Gagliardi, 2013; Khatun *et al.*, 2014; Labrique *et al.*, 2012; Tran *et al.*, 2015; Wesolowski *et al.*, 2012; Zurovac *et al.*, 2013).

We have seen in the previous chapter that people incorporate phones into their personal healthcare behaviour regardless of existing phone-based services. If this emerging phone-aided health action influences people's healthcare access, it is possible that the usefulness and sustainability of patient-centred mHealth solutions is affected negatively as well as positively.

Through my framework, I argue that phone-aided health action arises only for a subgroup of the population. This is a group that (a) seeks healthcare; (b) finds phones accessible for healthcare given the severity of their illness; and (c) act in an environment where phones

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[83] I presented a modified and abridged paper containing the analysis for H2 at the 2015 International Health Conference, 23-25 June 2015 (Haenssgen, 2015a). A revised version is presently under review with the *Bulletin of the World Health Organization*. A modified and abridged paper containing the analysis for H3 was presented at the 13th Globelics International Conference, 25-27 September 2015 (Haenssgen & Ariana, 2015a). I also presented a modified and more detailed paper on sequence analysis at the 2015 International Health Conference (Haenssgen & Ariana, 2015b). In these papers, Proochista Ariana contributed to the disease symptom categorisation and to the assessment whether healthcare-seeking behaviours are commensurate with people's symptoms.

are suitable for the purpose of seeking healthcare given complementary assets, alternative solutions to access healthcare, and a health system that can accommodate healthcare-related phone use. In light of Research Question 3 as to whether mobile phones affect healthcare access, I hypothesised that phones behave as tools in the process and therefore improve it on average (Hypothesis 2). However, given that only a specific group can realise such behaviour—for reasons related to poverty and marginalisation—I also hypothesised that socio-economic healthcare inequities increase in this process (Hypothesis 3). This chapter analyses these hypotheses quantitatively. Regression models inform the improvement hypothesis, and I employ descriptive statistical analysis to map patterns of phone use for the equity hypothesis.

The analysis will show that people who use mobile phones during the course of an illness are more likely to access healthcare. However, it also indicates that health-related phone use contributes to more complex and lengthy healthcare trajectories during which patients overuse the health system for mild conditions that do not necessarily require medical attention. This translates into an increased burden on already stretched rural healthcare resources in Gansu and Rajasthan. Moreover, people who use phones in the process of accessing care are younger and more affluent than people who do not. As phone use is not linked to improved health behaviours, socio-economically marginalised individuals are unlikely to benefit from the increasing use of mobile phones in healthcare, and phone users' healthcare over-utilisation can leave non-users worse off than before by absorbing scarce healthcare resources. Mobile phone diffusion can therefore have adverse process and equity implications.

I explain in the following section how I approach the analysis, including the notion of "commensurate" healthcare behaviour to evaluate the alignment between the demand for healthcare resources and their limited supply. Section 7.3 then presents the results for each hypothesis, and Section 7.4 discusses the findings in light of the limitations of the analysis.

7.2   Empirical Strategy

In this chapter, I use the previous conceptualisation of phone-aided healthcare seeking (Section 6.2.1) and link it to three different indicators of improved access to healthcare. Firstly, I consider whether people are more or less likely to interact with a particular healthcare provider depending on their phone use during an illness. Secondly, I analyse healthcare-seeking process complexity and delays in people's healthcare access. I measure process complexity as the number of distinct "steps" to reach a provider, and the delays as the number of days that elapsed until a particular healthcare provider was accessed. Thirdly, I assess the commensurability between patients' healthcare utilisation and their self-described symptoms.[84] This enables an evaluation of demand responses in light of the limited supply of healthcare resources in rural Rajasthan and Gansu. "Improved access to healthcare" can thus be understood as (a) less exclusion from healthcare access, (b) more direct and speedy access to health workers, and (c) behaviour that corresponds to a patient's condition and the available healthcare supply situation. I explain these indicators below, together with the analysis techniques used in this chapter.

7.2.1   Indicators of Healthcare Access and Behaviour

The first indicator of healthcare access considers whether particular types of healthcare providers were approached during the illness episode. I consider five different types of access: (a) access to any private doctor, public doctor, or nurse; (b) only public doctors and nurses; (c) only private doctors; (d) any non-formal provider including shops selling drugs, pharmacies, faith healers, alternative medical providers, and family members and friends; and (e) access to any formal or informal provider (excluding family and friends). Access here only pertains to

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[84] Externally assessed commensurability may be at odds with patients' notions of adequate care

the respondent's description as to whether the provider was in any way involved at any step during the healthcare-seeking process, not what kind or quality of care was received.

My second assessment of healthcare access involves the process complexity and delays to reach different types of healthcare providers (defined as above). Process complexity is measured through the number of distinct healthcare choices ("steps") taken until the provider was accessed; delays capture the number of days elapsed until that point. For example, had a respondent spent two days ignoring a mild illness, then two days in the care of family members, and then went to a public doctor, the delay would be four days and the complexity of the process would be three steps. This measure only permits comparisons among persons who actually accessed the particular type of provider, which excludes persons from the analysis who do not have any healthcare access at all.[85]

Assessing process complexity and delays in relation to phone use requires a sequential treatment of the healthcare seeking processes. The importance of this procedure is illustrated in Figure 7.1. My argument is that any influence of phone use on healthcare process characteristics like complexity and delays would occur before or when the provider in question was accessed (Panel a in Figure 7.1). Alternatively, Panel b illustrates an analysis that would only focus on phone use when the focal provider was accessed. This intuitive method appreciates only the specific step when the event occurred, for example whether a doctor in a hospital was called before the consultation. Given the cumulative nature of delays along the healthcare-seeking process, such an approach would omit preceding events that potentially influence the total delay. Lastly, Panel c shows an approach that would link delays and process complexity

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[85] In the public health literature, delays to treatment are typically measured in months, days, or minutes depending on the type of illness in question (e.g. stroke versus tuberculosis). Measures of process complexity are comparatively sparse and often only implicit in pathways-to-access and patient flow analyses. See e.g. Storla *et al.* (2008:4) on delays, and Kibadi *et al.* (2009:1113) on depictions of pathways and the multiple steps before or during treatment. Note further that "delay" here does not imply "inaction" (as is also pointed out in Macleod *et al.*, 2009:S93).

in healthcare access to "any" phone use during an illness. While such a measure could be a reasonable proxy in the absence of sequential data, it also captures potentially irrelevant phone uses after access to the provider in question.

Figure 7.1. Options for Assessing Delays and Process Complexity in Relation to Phone Use
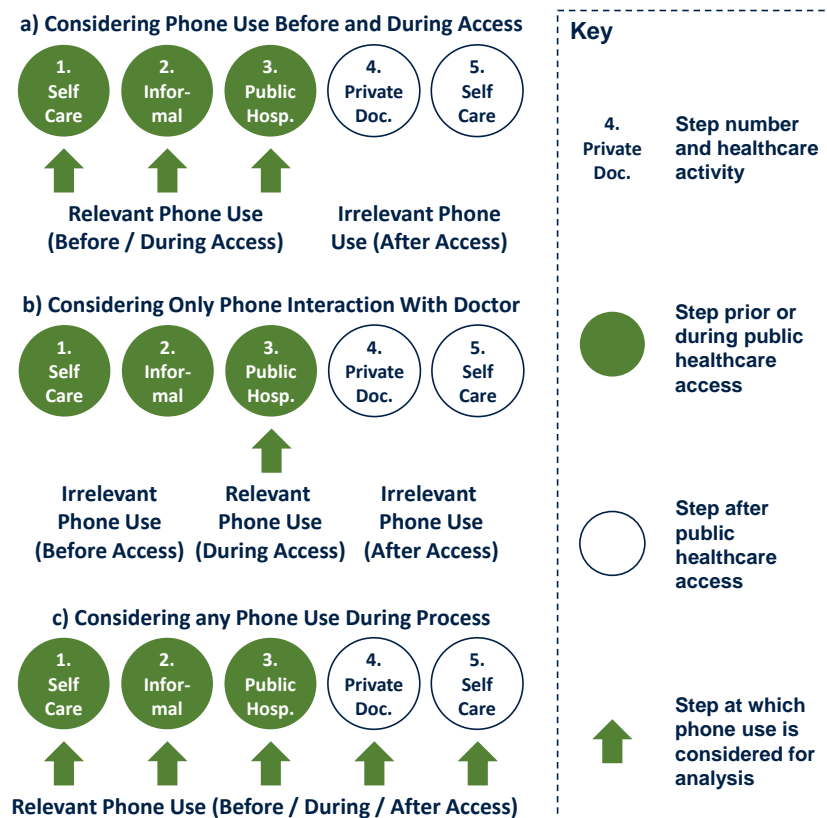
Source: Own illustration.
Note. Solid green arrows indicate steps included in analysis.

The third indicator ("commensurability") is based on people's self-described symptoms and their reported health action (summarised in Figure 6.7 in the previous chapter). These symptom descriptions enable judgements as to whether it is necessary to access the limited

healthcare resources in rural Rajasthan and Gansu.[86] However, an evaluation of the "necessity" of seeing a doctor is inherently ambiguous if it relies on self-reported symptoms (which may also differ depending on whether a doctor or someone else actually provided a diagnosis during the process). I therefore used differently inclusive benchmarks for sensitivity analysis, illustrated in Table 7.1.[87] For example, a common cold in itself is not considered a reason to receive medical care from a resource-poor health system. In connection with fever, I consider it reasonable according to the most inclusive Definition 4. Unspecified fever would also qualify for medical care according to Definition 3. Should the patient report malaria yet only describe the illness as "mild," I would trust the self-diagnosis according to Definition 2 (see e.g. Cohen *et al.*, 2012:9; Dupas, 2011:427, on issues in self-diagnosing malaria). For any self-described "severe" condition and for other health problems such as chest pain or palpitations, I consider it "reasonable" that the patient sees a doctor. Overall, inclusion and exclusion are chosen deliberately to not unnecessarily overburden an already stretched health system.

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[86] This assessment was validated by public health researcher Dr Proochista Ariana. Note further that the sensitivity analysis with variously inclusive definitions of "necessary medical care" (Table 7.1) means that potential disagreements about specific disease classifications are unlikely to have material consequences for the conclusions derived from my analysis.

[87] Increasing levels of inclusion in Table 7.1 can also be interpreted as the level of demand with which the rural health system is expected to cope.

Table 7.1. Definitions for "Necessity to Seek Medical Care" With Example Symptoms

Examples of Self-Described Symptoms	Inclusion Definition for "Medical Care Necessary" (From Least to Most Inclusive)			
	1 (Most Exclusive)	2	3	4 (Most Inclusive)
	Faithful assessment	Faithful assessment, trusting self-diagnosis	Conservative assessment	Conservative assessment, trusting symptoms linked to common cold
Leg Pain ("Mild")				
Common Cold, Runny Nose				
Common Cold, Fever				✓
Common Cold, Headache				✓
Headache			✓	✓
Unspecified Fever			✓	✓
Malaria ("Mild")		✓	✓	✓
Leg Pain ("Severe")	✓	✓	✓	✓
Palpitations	✓	✓	✓	✓
Chest Pain	✓	✓	✓	✓

Source: Own elaboration.
Notes. ✓ denotes that medical care is advisable for the symptom. "Mild" and "severe" as reported by respondent.

What counts as desirable behaviour depends on the alignment (or "commensurability") between the necessity of medical care and the actual healthcare choices people make. Multiple configurations of commensurate behaviour are possible depending for example on (a) the relative value assigned to personal recovery or health system efficiency, (b) the quality of the respective health providers, and (c) the implications of accessing various providers if no healthcare is needed. Figure 7.2 exemplifies a selection of healthcare access sequences with five steps that are "commensurate" (Panel a) and "incommensurate" (Panel b) given a patient who should seek formal healthcare (e.g. because of palpitations). If no restrictions are placed on the process (Row 1), commensurate behaviour would involve any access to public or private doctors (Cell 1a). If the patient does not access any formal healthcare provider, his or her behaviour could be regarded "incommensurate" (Cell 1b).

Figure 7.2. Examples of In-/Commensurate Health Action (Formal Healthcare Access)
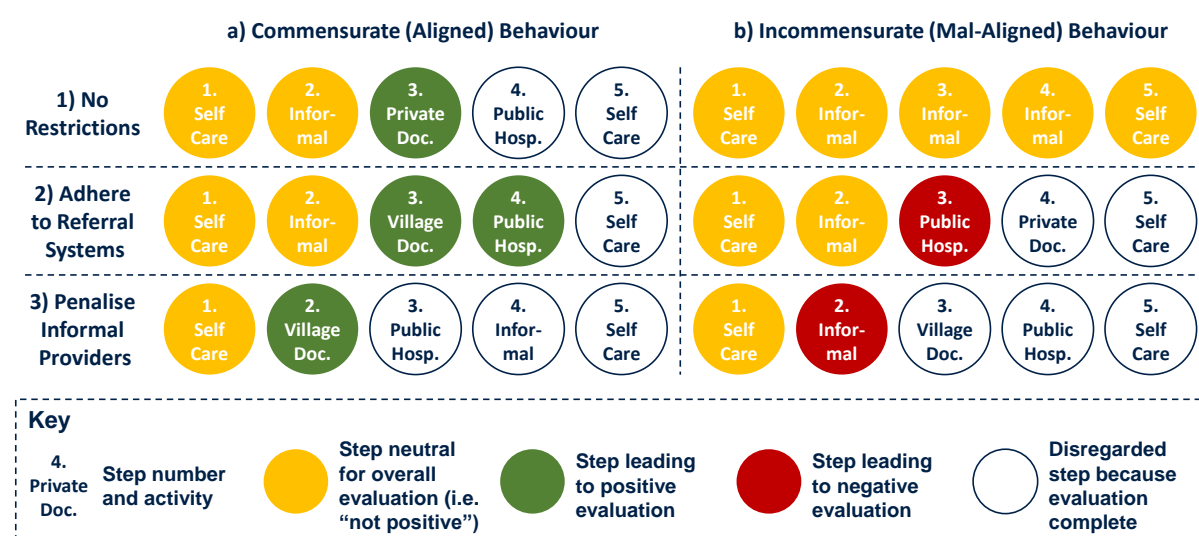
Source: Own illustration.

Notes. "Doc." is short for doctor, "Hosp." for hospital. Green-shaded steps received positive evaluation in line with commensurate behaviour, red-shaded steps received negative evaluation in line with incommensurate behaviour. Blank steps remain disregarded if process evaluation thus far was positive or negative. Yellow-shaded steps are neutral for overall evaluation, but absence of positive evaluation leads to negative judgement where medical care was necessary (as is the case in Cell 1b).

Row 2 imposes the restriction that access to formal healthcare providers should adhere to existing referral systems. Such considerations would for example arise from a concern about health system efficiency. Commensurate behaviour would reflect a process where access to higher-tier hospitals follows consultation with a lower-tier public healthcare provider. This is the case in Cell 2a: the public hospital in Step 4 follows the consultation with the village doctor in Step 3. Cell 2b shows the counterexample in which the higher-tier public hospital is accessed without a prior visit to a village-level clinic, which would be incommensurate according to this process definition.

Row 3 penalises access to informal providers because it could delay effective treatment in severe cases. The incommensurate sequence involves access to an informal healer *before* the patient sought care from a village doctor and public hospital (Cell 3b). In contrast, if the patient visits an informal healer after the formal healthcare access (Cell 3a), it would not diminish the judgement as to whether adequate action was taken at the beginning of the illness. In short, the

sequential health action data in this analysis enables transparent, systematic, and flexible normative assessments of health behaviours that go beyond a binary measure of "access" or "no access" (where such judgements would be implicit).

7.2.2   Analysis Techniques

This chapter analyses the implications of mobile phone use on health action, considering healthcare access, process complexity and delays, and commensurability of health action and symptoms. To answer the research question, I use descriptive statistical analysis and regression analysis, both of which take place on the disease episode level and include only "mild" and "severe" illnesses because "chronic and long-term" conditions follow distinctively different patterns (e.g. repeated cycles of consultation and home treatment).

For Hypothesis 2 on improved healthcare access, I use three different types of regression analysis. The indicators on "access" and "commensurability" are binary "yes/no" variables as to whether a particular kind of healthcare provider was utilised, or whether health action was "commensurate" with the patient's symptoms. I use logistic regression models for these binary data, which adhere to the same structure as Equations 4 and 5 in Section 6.2.3. Among the 28 control variables—selected based on the analytical categories in my theoretical framework and socio-demographic variables that potentially affect access to healthcare—are the self-perceived severity of the reported illness episode, health provider preferences, time to the nearest health facility, sex, age, education, household wealth and complementary assets for healthcare access, health status, awareness about and response time of phone-based health services, household size, household head characteristics, family dispersion, the remoteness of the village, and a country dummy.

I use different regression models to test the effect of phone use on process complexity and the delay measure. I use Poisson regression analysis for the step data and negative binomial

regression models for the delay data because the distribution of these (count) data is non-normal and the delay data is additionally over-dispersed (Wooldridge, 2010:736). The Poisson model with a matrix of covariates x_i (the models use the same control variables as mentioned above), and a vector of parameters $\boldsymbol{\beta}$ takes the form

$$P(y_i \mid x_i) = (e^{-\mu_i}\mu_i^{y_i}) / (y_i!), \tag{7}$$

where $P(y_i \mid x_i)$ is the conditional expectation of the event y_i, $y_i!$ is y_i factorial, and $\ln(\mu_i) = \boldsymbol{\beta}x_i$ is the natural log of the mean (Cameron & Trivedi, 1998:61; Rabe-Hesketh & Skrondal, 2012a:376). In this model, y_i conditional on the covariates has a Poisson distribution with mean μ_i (Berk & MacDonald, 2008:277; Rabe-Hesketh & Skrondal, 2012a:376).

The Poisson regression model is a special case of the negative binomial regression model where the mean is equal to the variance. Should this not hold and the data is instead over-dispersed (as is the case for the delay data in this study), negative binomial models are more appropriate (Johnson, 2004:341). The negative binomial model is expressed as

$$P(y_i \mid x_i, \alpha) = ([\Gamma(y_i + \alpha^{-1})] / [\Gamma(y_i + 1)\Gamma(\alpha^{-1})]) \, [\alpha^{-1} / (\alpha^{-1} + \mu_i)]^{\alpha^{-1}} \, [\mu_i / (\alpha^{-1} + \mu_i)]^{y_i}, \tag{8}$$

where $\Gamma(\cdot)$ is the gamma function and α is the dispersion parameter (Cameron & Trivedi, 1998:63, 71, 374-375). If $\alpha = 0$, this reduces to the model to the Poisson regression model (Johnson, 2004:342).

As in the previous chapter, these models can be fit in a multilevel framework that takes into account correlations within the classes of observations. Because sample sizes vary across

different kinds of healthcare access, some models only covered two rather than three levels in the data (not equally many people accessed e.g. informal and formal care, and access to informal care only involved mild illnesses). I therefore estimated two- and three-level models depending on the respective samples. In the multilevel model with j clusters (here: two levels), the two-level random intercept Poisson regression model is defined as

$$P(y_{ij} \mid \boldsymbol{x}_{ij}, \zeta_j) = (e^{-\mu_{ij}}\mu_{ij}^{y_{ij}}) / (y_{ij}!), \tag{9}$$

where the natural log of the mean becomes $\ln(\mu_{ij}) = \boldsymbol{\beta}\boldsymbol{x}_{ij} + \zeta_j$, and ζ_j is the random intercept term (Rabe-Hesketh & Skrondal, 2012a:696). Analogously, the two-level negative binomial model takes the form

$$P(y_{ij} \mid \boldsymbol{x}_{ij}, \alpha, \zeta_j) = ([\Gamma(y_{ij} + \alpha^{-1})] / [\Gamma(y_{ij} + 1)\Gamma(\alpha^{-1})]) \, [\alpha^{-1} / (\alpha^{-1} + \mu_{ij})]^{\alpha^{-1}} \, [\mu_{ij} / (\alpha^{-1} + \mu_{ij})]^{y_{ij}}, \tag{10}$$

again with $\ln(\mu_{ij}) = \boldsymbol{\beta}\boldsymbol{x}_{ij} + \zeta_j$ for the random intercept specification, where the random intercept term ζ_j is gamma distributed (Rabe-Hesketh & Skrondal, 2012a:708-711; StataCorp, 2013:125-127, 184). However, the analysis revealed in many instances that the multilevel framework is less efficient than single-level regression models (based on likelihood ratio tests), and a number of multilevel models showed convergence problems. The only consistently significant difference between multi- and single-level models arose for the three-level negative binomial random intercept models that assess the relationship between phone use and delays to healthcare access. I therefore present the multilevel regression results for the delay indicator and confine the reporting to single-level models for the remainder. In order to account for potential clustering, I estimated the single-level model using cluster-robust standard errors and

carried out robustness checks with survey-sensitive analyses.[88] Where multilevel modelling yielded results, it corresponded to the general direction of the single-level models.

If Hypothesis 2 holds and mobile phones do indeed improve healthcare access, then we would observe such developments in terms of increased access to formal healthcare (including public and private providers) and a lower share of people who do not have any healthcare access at all. Improvements would also be reflected in lower process complexity (i.e. fewer steps to access) and fewer delays (i.e. fewer days elapsed until formal healthcare access). Lastly, improved healthcare access would also mean that phone-aided health action is linked to commensurate health action. We would therefore expect positive regression coefficients for access and commensurability, and negative coefficients for complexity and delays.

The equity analysis for Hypothesis 3 relies on descriptive analysis, but it adopts some of the measures outlined above. I examine the equity implications of mobile phone diffusion in the context of healthcare access through descriptive statistics and bivariate analysis, supplemented by *t*-tests for group comparisons. Although the analysis takes place on the illness episode level for mild and severe conditions, all statistics are weighted according to census data and the number of reported illness episodes in order to be representative for each field site. In line with the theoretical framework, I compare groups according to a set of socio-economic variables including wealth, sex, literacy, age, and location in terms of distance to the nearest health provider. The group comparison varies according to whether phones were used during the illness episodes and whether the behaviour during the illness was "commensurate" (given

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[88] I carried out similar robustness checks as in Section 6.4.3, but do not report them here because of space constraints (i.e. nine different checks for 70 models estimated in this chapter). These checks include single- and multilevel model fitting (single-level with cluster-robust standard errors), multicollinearity checks, estimation with sample weights, nested models, different functional forms (ordinary least squares and probit regression for logistic regression models, and ordinary least squares for the Poisson and negative binomial regression models), dropping illnesses that lasted more than twelve months, and dropping the least reliable survey responses.

formal healthcare access without restrictions, across all four inclusion definitions). As Hypothesis 3 states that socio-economic inequities are reinforced through phone use, I would expect that the groups who use phones—and especially those who use them adequately—belong to the less disadvantaged segments of the rural societies. This could include wealthy, educated, younger, and centrally located men, for example.

7.3   Results

This section presents first the findings for Hypothesis 2 using regression analysis, and then for Hypothesis 3 using descriptive statistics. In the context of Hypothesis 2, the results indicate that phone-aided health action (a) involves higher rates and different patterns of healthcare access, (b) is linked to delays and more complex processes when reaching healthcare providers, and (c) is less "commensurate" than conventional health action. The equity analysis for Hypothesis 3 suggests that better-off groups are more likely to exhibit phone-aided health action, and that their mobile phone use may reinforce if not exacerbate healthcare inequities.

7.3.1   Implications of Phone Use for Healthcare-Seeking Processes

In line with the empirical strategy outlined in the previous section, I explore the hypothesis that "mobile phones improve access to formal healthcare" through a three-pronged approach. The first sub-section explores which types of healthcare were accessed during an illness if a mobile phone was involved in the process. The second sub-section compares those individuals who access healthcare without phones to those who use mobiles, testing the relationship between phone use and process complexity and delays when accessing a provider. The last sub-section again expands the analysis to all patients regardless of healthcare access, assessing whether mobile phone use during illness episodes contributes to more or less desirable healthcare behaviour.

7.3.1.1   Access to Healthcare

If mobile phone use improves access to healthcare, we would expect to observe higher rates of access to public and private healthcare providers among users, and a lower share of individuals who do not seek any kind of healthcare at all. Before presenting the regression results, a brief look at the simple bivariate comparison of phone use and healthcare access is informative.

The bivariate analysis across Rajasthan and Gansu in Figure 7.3 indicates that phone-aided illness episodes differ from conventional health behaviour. Panel a shows somewhat mixed patterns for Rajasthan. It appears that phone-aided health action in this site involves relatively more private and fewer public healthcare providers compared to conventional healthcare-seeking patterns. All phone-aided trajectories involved some kind of healthcare access and formal access is high (>90%) in both groups. The differences for private access and "no access at all" are statistically significant at the five-percent level.

The patterns are more uniform in Gansu, shown in Panel b. Phone-aided healthcare sequences, which are more common in this field site, are more distinctly linked to higher access to formal and public healthcare, and to a smaller extent to higher access to private healthcare. The portion of sequences without healthcare access is notably smaller among phone users as well. The differences for formal access and "no access at all" are statistically significant at the five-percent level; differences in public access are statistically significant at the ten-percent level.[89]

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[89] Hypothesis tests based on two-sided *t*-tests, including sample weights and considering the complex survey design.

Figure 7.3. Healthcare Access Patterns in Field Sites When Using Mobile Phones

a) Rajasthan

b) Gansu
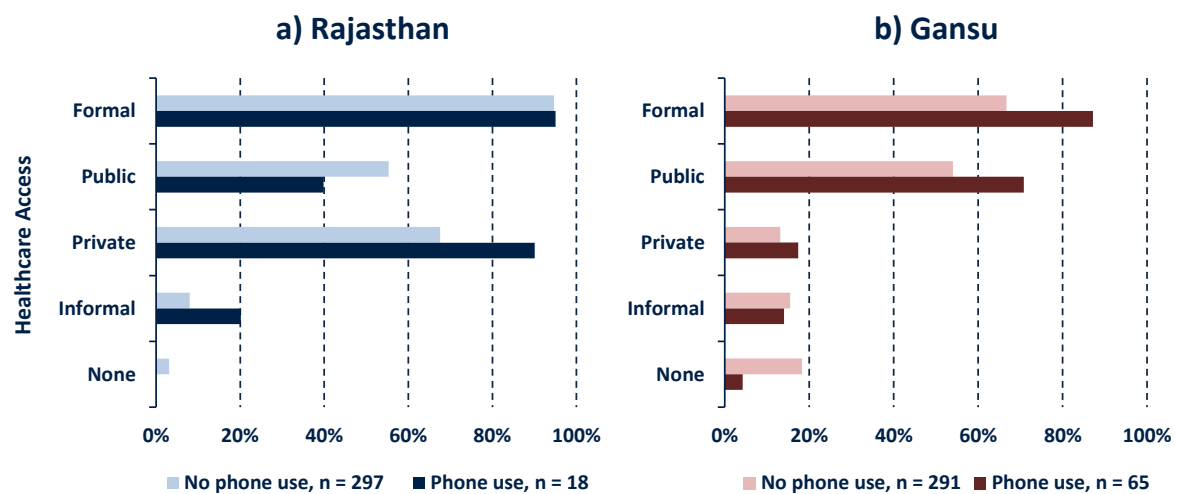
Source: Own illustration, derived from fieldwork data.
Notes. Reporting on illness episode level. Formal access incorporates public and private providers. Respondents can have access to informal, public, and private providers during the same healthcare process. Statistics are population weighted across the field site districts using census data and according to number of mild and severe illnesses per person. Proportions as share of respective group of health seekers (excluding population that did not report mild or severe illness).

The main results of the logistic regression analysis are shown in Table 7.2 below (coefficients expressed in log-odds). The dependent variables in these models are binary indicators whether the patient accessed any (formal, informal) health provider or none at all. The main independent variables of interest are binary indicators as to whether any kind of health-related phone use occurred during the illness episode. Because the access patterns for mobile phone users and non-users differ across the field sites (see Figure 7.3), I also interact mobile phone use with the country dummy to elicit site-specific effects. The reporting relies on single-level logistic regression results with cluster-robust standard errors because multilevel models were in most cases inferior to single-level models (e.g. the individual-level intra-cluster correlation ranged from 0% to 16%). Robustness checks carried out with ordinary least squares, probit, and multinomial logistic regression models produced similar results but are not reported for the sake of brevity.

Table 7.2. Main Results: Effects of Phone Use on Healthcare Access (Logistic Regression)

	Dependent Variable									
	Access to Formal Providers		Access to Public Providers		Access to Private Providers		Access to Informal Providers, Family, Friends		No Access to Any Provider[a]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Phone Use	0.87**	-0.03	-0.10	-1.03*	0.91***	1.92***	0.12	0.41	-0.52	-12.94***
SITExPHONE Interaction		1.01		1.27**		-1.30*		-0.39		12.48***
Site Dummy (Gansu = 1)	-2.29***	-2.35***	-0.18	-0.33	-2.44***	-2.36***	-0.35	-0.29	2.39***	2.34**
AIC	518.9	520.3	887.8	883.9	622.0	620.2	479.6	479.5	446.2	447.7
BIC	658.5	664.5	1027.4	1023.6	761.7	759.8	619.3	619.1	585.9	591.9

Source: Own elaboration, derived from fieldwork data.
Notes. Coefficients reported. 28 control variables and constant omitted. Standard errors adjusted for clustering at village level (32 clusters). $n = 669$ illness episodes. AIC is Akaike Information Criterion, BIC is Bayesian Information Criterion.
*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.
[a] Excludes family and friends.

Table 7.2 indicates that, controlling among others for household wealth, respondent demographics, locational factors, and health provider preferences (not shown), a statistically significant link at least at the ten-percent level emerges between mobile phone use during an illness and most forms of healthcare access (note that a person can have informal, public, and private healthcare access during the same illness episode). Only access to informal providers (including family and friends) in Models 7 and 8 is not statistically significant at the ten-percent level. As far as formal healthcare access is concerned, the link to phone use is positive (Model 1) and does not differ significantly across the two field sites (Model 2). In contrast, access to public care is lower in Rajasthan and higher in Gansu if people use a mobile phone during an illness (Model 4). The interaction term suggests that the phone-use coefficient for public providers in Rajasthan is negative while it is slightly positive in Gansu. For private healthcare access, both regression models with and without interaction terms are statistically significant, but the information criteria suggest that Model 6 with interaction term is preferable. Despite the interaction, private healthcare access is more common among phone users in both field

sites, though more so in Rajasthan. Lastly, the relationship between phone use and the likelihood of not accessing any kind of care differs across the two sites (Model 10), but the interaction term indicates that the sign remains negative in Gansu as well as Rajasthan although the value of the coefficient is smaller in the former.[90]

Logged coefficients in logistic regression models are difficult to interpret. In order to make the relationship between phone use and healthcare access more tangible, Table 7.3 shows the predicted change in healthcare access when the illness episode includes mobile phone use (unweighted). The estimates are based on the regression models in Table 7.2, only varying country dummy, phone use, and the interaction term while holding all 28 control variables constant at the sample means. Informal healthcare access is not part of the prediction because it was not statistically significant. Overall, the predicted patterns map closely onto the bivariate analysis in Figure 7.3: If we assume that causality runs from phone use to healthcare access, the table suggests that mobile phone use reduces the likelihood of not accessing healthcare in both sites. At the same time, we would observe substitution away from public to private healthcare providers in Rajasthan, which only marginally affects overall formal healthcare access. The relationship between phone use and healthcare access is unambiguously positive for the predictions in Gansu.

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[90] The large coefficient results from the fact that there are zero observations without healthcare access among the phone users in Rajasthan.

Table 7.3. Predicted Relative and Absolute Change in Healthcare Access for Phone-Aided Health Action

	Access to Formal Providers	Access to Public Providers	Access to Private Providers	No Access to Any Provider[a]
Rajasthan	+ 1.5% (+ 1.4 p.p.)	− 40.5% (− 25.2 p.p.)	+ 57.3% (+ 32.8 p.p.)	− 100.0% (− 1.4 p.p.)
Gansu	+ 13.2% (+ 10.5 p.p.)	+ 10.8% (+ 5.9 p.p.)	+ 68.8% (+ 7.8 p.p.)	− 33.8% (− 4.3 p.p.)

Source: Own elaboration, derived from fieldwork data.
Notes. Absolute changes in percentage points in parentheses. Based on logistic regression Models 1, 4, 6, and 10 reported in Table 7.2, given AIC and BIC. Unweighted predictions at constant sample means (only varying phone use, country dummy, and interaction term where applicable).
[a.] Excludes family and friends.

It is also possible to understand these patterns in reverse; that is, certain forms of access are more amenable to mobile phone use, and that phone users would have chosen just the same course of action whether or not a mobile phone entered the process. Although this alternative view is conceivable, the previous interpretation is consistent with my theoretical arguments and field observations. In addition, it is worth bearing in mind that the regressions already control for respondents' preferred providers, meaning that provider preferences are kept constant (at least in theory). In the absence of panel data, I draw the tentative conclusion that the evidence supports Hypothesis 2 inasmuch as access to healthcare is higher where people use mobile phones in the process.

7.3.1.2 Process Complexity and Delays to Care

Although the results suggest that health-related mobile phone use and healthcare access are positively linked, people using mobile phones may exhibit different behaviours compared to people who access healthcare without phones. I therefore examine now the process complexity and the delays until patients reach healthcare providers. Process complexity refers to the number of discrete steps or activities that a health seeker went through until formal/public/private/informal/any healthcare providers were reached. Delays refer to the time in days

that elapsed until that moment. I evaluate the use of mobile phones at any step before or during the type of healthcare access in question. As explained in Section 7.2.2, I use Poisson regression models for process complexity and negative binomial regression models for delays. In the case of process complexity, multilevel Poisson regression models did not converge and linear multilevel models produced near-exactly the same results as the single-level Poisson regression, which will be reported here with cluster-robust standard errors. For delays, I present multilevel models, which proved superior to single-level estimates and yielded considerably more conservative results.

The main results of the analysis are shown below, with Table 7.4 containing the Poisson regression results for the step variables and Table 7.5 containing the two- and three-level negative binomial regression results of the delay variables. The sample sizes differ across the models because I can only compare the steps and duration of phone users and non-users who have accessed the respective providers (e.g. 550 illness episodes involving formal access but only 81 with informal providers). Positive coefficients in these tables correspond to a higher number of steps and days until healthcare access, or, in other words, more complex processes and more delays.

Considering the results for steps and delays in connection, we can discern at least one statistically significant relationship between mobile phone use and the efficiency of access across each of the various routes, with the exception of "access to any formal or informal provider" (Models 9 and 10). The interaction term is only significant for the process complexity of public and informal healthcare access (Table 7.4, Models 4 and 8). The Poisson regression models yield significant results for the step at which patients accessed formal care (Model 1), public care (Models 3 and 4), and informal care (Model 8). The negative binomial regression models indicate significant relationships with delays in formal (Model 1), public (Model 3), and private healthcare access (Model 5).

Table 7.4. Main Results: Effects of Phone Use on Healthcare Process Complexity (Poisson)

	Dependent Variable									
	Step # of Formal Care		Step # of Public Care		Step # of Private Care		Step # of Informal Care		Step # of Any Care	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Phone Use	0.09**	0.04	0.12*	0.25***	0.02	-0.02	0.14	-0.15	0.07	0.02
SITExPHONE Interaction		0.07		-0.17*		0.09		0.56***		0.07
Site Dummy (Gansu = 1)	-0.29***	-0.30***	-0.49***	-0.49***	-0.42***	-0.44***	-0.44**	-0.60***	-0.27***	-0.28***
AIC	1517.0	1517.0	1085.7	1085.5	814.0	813.9	264.5	263.7	1605.6	1605.5
BIC	1650.7	1650.6	1207.9	1207.6	914.1	914.0	319.6	318.8	1741.5	1741.4
Number of Observations	550	550	380	380	264	264	81	81	592	592
Number of Clusters	32	32	32	32	29	29	25	25	32	32

Source: Own elaboration, derived from fieldwork data.
Notes. Coefficients reported. 28 control variables and constant omitted. Standard errors adjusted for clustering at village level (32 clusters). Observations at illness episode level. AIC is Akaike Information Criterion, BIC is Bayesian Information Criterion.
*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Table 7.5. Main Results: Effects of Phone Use on Healthcare Delays (Negative Binomial)

	Dependent Variable									
	Delay Until Formal Care		Delay Until Public Care		Delay Until Private Care		Delay Until Informal Care[a]		Delay Until Any Care	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Phone Use	0.69***	0.70*	0.74***	1.38*	0.53*	0.32	0.50	0.16	0.31	0.53
SITExPHONE Interaction		-0.02		-0.75		0.59		0.69		-0.30
Site Dummy (Gansu = 1)	-1.61***	-1.60***	-2.29***	-2.27***	-1.72***	-1.81***	-4.77***	-5.10***	-1.30***	-1.27***
AIC	2645.7	2647.7	1926.1	1927.2	1591.0	1592.1	518.0	519.8	2755.6	2757.2
BIC	2792.2	2798.5	2060.1	2065.1	1709.0	1713.7	594.6	598.8	2904.6	2910.6
Number of Observations	550	550	380	380	264	264	81	81	592	592
Number of Individuals	524	524	360	360	261	261			565	565
Number of Villages	32	32	32	32	29	29	25	25	32	32
Model Test ($P > $ Wald X^2)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Variance Component Test[b]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	1.00	1.00	< 0.01	< 0.01

Source: Own elaboration, derived from fieldwork data.

Notes. Coefficients reported. 28 control variables and constant omitted. Observations at illness episode level. AIC is Akaike Information Criterion, BIC is Bayesian Information Criterion.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

[a.] Two-level model estimated because one illness episode per individual.

[b.] Based on conservative estimate $P > X^2(2)$.

The principal insight of these tables is that mobile phone use before or during access to formal, public, and private access is linked to more complex or longer healthcare-seeking processes. The only instance where prior mobile phone use is associated with less complex behaviour is informal healthcare access in Rajasthan (Table 7.4, Model 8). More specifically, access to formal and public providers requires more steps and time in both sites if people use a mobile phone (Table 7.4, Models 1, 3, and 4; Table 7.5, Models 1 and 3). Model 4 in Table 7.4 suggests that the relationship between phones and public access is less pronounced in Gansu, but the sign of the coefficient remains positive. There is also a positive relationship between phone use and the delay until private care was reached (Table 7.5, Model 5).

Table 7.6 contains the predicted absolute and relative changes in process complexity and delays where people used mobile phones for an illness-related purpose (absolute changes in parentheses). The table shows worse process characteristics in almost all scenarios where health seekers use mobile phones. For example, phone use in the healthcare-seeking process is associated with an eight-day additional delay in public healthcare access in Rajasthan, holding other variables constant at the sample means. The relative change for process complexity ranges from –14.2% (informal care in Rajasthan) to +49.6% (informal care in Gansu); the relative change in delays spans +69.4% (private care in both countries) to +110.5% (public care in both countries).

Table 7.6. Predicted Relative and Absolute Change in Process Complexity and Delays for
Phone-Aided Health Action

	Access to Formal Providers		Access to Public Providers		Access to Private Providers	Access to Informal Providers, Family, Friends
	Process Steps	Delays in Days[a]	Process Steps	Delays in Days[a]	Delays in Days[a]	Process Steps
Rajasthan	+ 9.1% (+ 0.19 steps)	+ 98.5% (+ 4.14 days)	+ 28.8% (+ 0.69 steps)	+ 110.5% (+ 8.32 days)	+ 69.4% (+ 3.28 days)	− 14.2% (− 0.38 steps)
Gansu	+ 9.1% (+ 0.14 steps)	+ 98.5% (+ 0.83 days)	+ 8.8% (+ 0.13 steps)	+ 110.5% (+ 0.85 days)	+ 69.4% (+ 0.59 days)	+ 49.6% (+ 0.72 steps)

Source: Own elaboration, derived from fieldwork data.
Notes. Absolute changes in parentheses. Based on regression Models 1, 4, and 8 in Table 7.4 and Models 1, 3, and 5 in Table 7.5. Unweighted predictions at constant sample means (only varying phone use, country dummy, and interaction term where applicable).
[a.] Conservative prediction based on fixed part of multilevel model only.

Because the models in this sub-section compare the healthcare behaviour among people who used their phone during a particular illness episode with those who did not, the results suggest that mobile phone use is linked to more complex and delayed healthcare trajectories. We could of course argue that mobile phones simply enable the complex trajectories that health seekers desire, or that longer and more tedious processes lead people to resort to mobile phones. However, additional complexity can come at a cost—not just in terms of transaction costs but also delays that could make an emergency condition life threatening. In addition, although I use cross-sectional data, I have made every effort to isolate the role of mobile phone use and its potential effect on health trajectories: Rather than correlating mobile phone use in general or throughout the entire illness, I only consider illness-related uses before and during the healthcare access in question. It is further worth pointing out that 83% of all cases of phone use took place in the first two steps of the healthcare-seeking process—longer processes are therefore unlikely to cause phone use. In the absence of panel data, I therefore maintain that the model results lend support to rejecting Hypothesis 2 as there is no evidence that phone-aided healthcare processes are improved.

7.3.1.3   Alignment Between Health System Utilisation and Limited Healthcare Supply

I have so far established that mobile-phone-aided health action is linked to healthcare access and to more complexity and delays in healthcare-seeking processes. But more access need not always be advantageous, nor need more complex trajectories be problematic. In this last part of the regression analysis, I examine whether differences exist between phone-aided and conventional health action in terms of the commensurability of people's behaviour with their symptoms. That desirable behaviour is not universal can be seen by applying a faithful medical assessment based on people's self-diagnosis (Definition 2 in Section 7.2.1) and access to formal healthcare providers (i.e. public and private doctors): According to this measure, only 19% of the healthcare-seeking patterns in the Rajasthan field site and 49% in Gansu are "commensurate" from an external perspective.

As the definition of "commensurate" or "desirable" action is contentious, I vary inclusion definitions as well as process requirements. Three criteria influenced how I judge a commensurate process in a context where healthcare supply is constrained. Firstly, the kind of care that is desirable for a given illness: One assessment examines whether any formal actor provided care when it was required; the other focuses only on public providers considering that private care may be deemed inadequate where these providers are untrained and regulation is ineffective or unenforced. Secondly, although access to non-formal or non-public providers may not be harmful, it can have adverse implications in terms of delayed treatment and poor quality of care. I therefore also assess different levels of penalties, including none, to all non-public providers (if public care is deemed necessary for the reported symptoms), and to private doctors only (presuming that otherwise out-of-pocket expenditures ensue). Lastly, if we consider the effective working of the health system desirable, we would be interested whether patients follow referral processes. I consider a referral-free scenario and, to err on the side of caution, one in which violations of the referral process are penalised only for self-described

"mild" illnesses. For example, if someone had a leg fracture and went directly to a secondary hospital, this would be commensurate behaviour. In the case of fever, it would not. I assess five different combinations of these process characteristics for all four different inclusion definitions, summarised in Figure 7.4 below. This sub-section presents the results from single-level logistic regression models with cluster-robust standard errors. Multilevel models (not reported here) yielded the same patterns but often turned out to be inferior to single-level models.

Figure 7.4. Illustration of In-/Commensurate Healthcare Behaviours for Regression Models
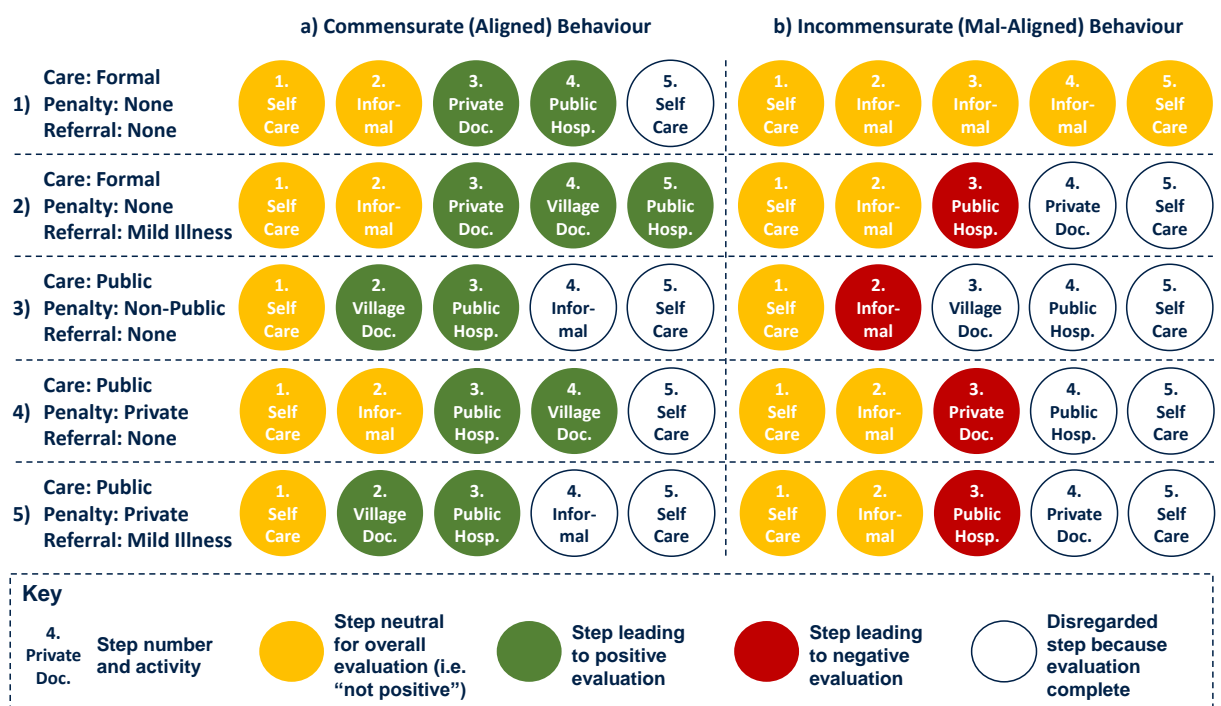
Source: Own illustration.

Notes. "Doc." is short for doctor, "Hosp." for hospital. Green-shaded steps received positive evaluation in line with commensurate behaviour, red-shaded steps received negative evaluation in line with incommensurate behaviour. Blank steps remain disregarded if process evaluation thus far was positive or negative. Yellow-shaded steps are neutral for overall evaluation, but absence of positive evaluation leads to negative judgement where medical care was advisable (as is the case in Cell 1b).

Table 7.7 displays the main results for the various process definitions, with phone use and the interaction term as principal independent variables of interest. The four panels vary according to the inclusion definitions from the most exclusive "faithful assessment" in Panel a to the most inclusive "conservative assessment including common-cold-related symptoms" in

Panel d. The most lenient assessment for commensurate healthcare behaviour would therefore pertain to Models 1 and 2 in Panel d (generous inclusion, access to formal healthcare with the least restrictions) and the most stringent assessment to Models 9 and 10 in Panel a (limited inclusion, maximum restrictions on behaviour).

Three principal observations emerge from the table. First, the relationship between commensurate behaviour and either mobile phone use in isolation or mobile phone use in interaction with the country dummy is significant for almost all process and inclusion definitions. Secondly, with four exceptions (Panel c, Model 4; Panel d, Models 2, 6, and 8), the coefficients of mobile phone use are negative across all combinations of process and inclusion definitions (where significant). Thirdly, for each process description, the value of the phone use coefficients and their statistical significance tend to decrease from the most exclusive to the most inclusive inclusion definition; that is, from Panel a to Panel d (note that coefficients across models with different sample sizes cannot be immediately compared).

The relationship between the stringency of the inclusion definition and the effect of mobile phone use can be illustrated through the predicted relative and absolute changes in Table 7.8 (Panels a and b, respectively). Holding all control variables constant at sample means, the table illustrates the changes in commensurability for phone-aided illness episodes where negative changes are indicated with shades of red and positive changes with green.

Table 7.7. Main Results: Effects of Phone Use on Commensurate Health Action (Logistic Regression)

a) "Commensurability" for Inclusion Definition 1 (Faithful Assessment)

	Care: Formal Penalty: No Referral: No		Care: Formal Penalty: No Referral: Mild		Care: Public Penalty: Private Referral: No		Care: Public Pen.: Non-public Referral: No		Care: Public Penalty: Private Referral: Mild	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)[a]	(10)[a]
Phone Use	-0.87***	-0.89*	-1.00***	-0.45	-0.81***	-1.08	-0.91***	-1.04	-1.00***	-0.61
SITExPHONE		0.03		-0.63		0.30		0.14		-0.43
Site Dummy	0.46	0.46	0.80	0.85	1.21*	1.20*	1.33*	1.32*	1.89***	1.91***
AIC	666.2	666.2	589.1	588.8	652.0	651.9	632.5	632.5	555.0	556.9
BIC	805.9	805.9	728.8	728.5	791.7	791.6	772.2	772.2	689.2	695.6

b) "Commensurability" for Inclusion Definition 2 (Faithful to Self-Diagnosis)

	Care: Formal Penalty: No Referral: No		Care: Formal Penalty: No Referral: Mild		Care: Public Penalty: Private Referral: No		Care: Public Pen.: Non-public Referral: No		Care: Public Penalty: Private Referral: Mild	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)[a]	(10)[a]
Phone Use	-0.90***	-1.28***	-1.03***	-0.67	-0.79***	-1.35	-0.88***	-1.32	-1.00***	-0.69
SITExPHONE		0.45		-0.41		0.63		0.50		-0.33
Site Dummy	-0.25	-0.28	0.48	0.50	0.49	0.46	0.56	0.54	1.78***	1.80***
AIC	718.3	718.2	628.8	628.6	689.6	689.3	672.2	672.0	569.4	571.3
BIC	858.0	857.8	768.4	768.3	829.3	829.0	811.9	811.7	703.6	710.0

Source: Own elaboration, derived from fieldwork data.

Notes. Coefficients reported. 28 control variables and constant omitted. Standard errors adjusted for clustering at village level (32 clusters). Number of observations $n = 669$ except in cases of convergence issues with perfect predictor variables. AIC is Akaike Information Criterion, BIC is Bayesian Information Criterion.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

[a.] $n = 649$.

[b.] $n = 665$.

Table 7.7. (Continued) Main Results: Effects of Phone Use on Commensurate Action (Logistic Regression)

c) "Commensurability" for Inclusion Definition 3 (Conservative Assessment)

	Care: Formal Penalty: No Referral: No		Care: Formal Penalty: No Referral: Mild		Care: Public Penalty: Private Referral: No		Care: Public Pen.: Non-public Referral: No		Care: Public Penalty: Private Referral: Mild	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)[a]	(10)[a]
Phone Use	-0.43*	-0.28	-0.43*	0.32	-0.59**	-1.20	-0.66**	-1.14	-0.88**	-0.30
SITExPHONE		-0.21		-1.07**		0.72		0.57		-0.62
Site Dummy	-1.23***	-1.21***	-0.51	-0.40	0.24	0.19	0.28	0.25	1.84***	1.89***
AIC	881.5	881.4	820.9	818.7	820.3	819.7	801.96	801.56	555.1	556.9
BIC	1021.2	1021.0	960.6	958.4	960.0	959.3	941.64	941.24	689.4	695.7

d) "Commensurability" for Inclusion Definition 4 (Conservative Assessment Incl. Cold)

	Care: Formal Penalty: No Referral: No		Care: Formal Penalty: No Referral: Mild		Care: Public Penalty: Private Referral: No		Care: Public Pen.: Non-public Referral: No		Care: Public Penalty: Private Referral: Mild	
	(1)[b]	(2)[b]	(3)	(4)	(5)	(6)	(7)	(8)	(9)[a]	(10)[a]
Phone Use	0.07	-1.13**	0.24	0.12	-0.14	-1.78**	-0.18	-1.72**	-0.05	0.23
SITExPHONE		1.63**		0.17		2.00**		1.88**		-0.30
Site Dummy	-0.75	-0.95**	-0.01	-0.03	0.61	0.44	0.60	0.45	2.58***	2.61***
AIC	826.5	822.7	861.2	861.2	902.5	896.0	900.1	894.5	540.6	542.6
BIC	961.5	962.1	1000.9	1000.8	1042.2	1035.7	1039.7	1034.1	674.9	681.3

Source: Own elaboration, derived from fieldwork data.

Notes. Coefficients reported. 28 control variables and constant omitted. Standard errors adjusted for clustering at village level (32 clusters). Number of observations $n = 669$ except in cases of convergence issues with perfect predictor variables. AIC is Akaike Information Criterion, BIC is Bayesian Information Criterion.

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

[a] $n = 649$.

[b] $n = 665$.

Table 7.8. Colour-Coded Predicted Absolute and Relative Change of Commensurate
Health Action

a) Relative Change in Desirable Phone-Aided Health Action in Percent

		a1) Rajasthan					a2) Gansu				
Care		Formal	Formal	Public	Public	Public	Formal	Formal	Public	Public	Public
Penalty		None	None	Non-Publ.	Private	Private	None	None	Non-Publ.	Private	Private
Referral		None	Mild Illn.	None	None	Mild Illn.	None	Mild Illn.	None	None	Mild Illn.
Inclusion Definition	1	− 50.7%	− 58.6%	− 56.4%	− 51.8%	− 61.5%	− 47.2%	− 53.9%	− 49.0%	− 44.7%	− 53.0%
	2	− 47.8%	− 58.2%	− 53.0%	− 48.6%	− 61.0%	− 50.0%	− 55.0%	− 49.5%	− 45.4%	− 52.6%
	3	− 14.7%	+ 17.3%	− 39.2%	− 35.3%	− 56.8%	− 25.0%	− 41.6%	− 36.9%	− 33.4%	− 49.1%
	4	− 30.9%		− 74.3%	− 75.2%		+ 19.5%		+ 7.9%	+ 11.2%	

b) Absolute Change in Desirable Phone-Aided Health Action in Percentage Points

		b1) Rajasthan					b2) Gansu				
Care		Formal	Formal	Public	Public	Public	Formal	Formal	Public	Public	Public
Penalty		None	None	Non-Publ.	Private	Private	None	None	Non-Publ.	Private	Private
Referral		None	Mild Illn.	None	None	Mild Illn.	None	Mild Illn.	None	None	Mild Illn.
Inclusion Definition	1	− 13.1	− 10.1	− 7.0	− 7.2	− 4.6	− 16.7	− 17.1	− 17.1	− 15.8	− 18.4
	2	− 18.0	− 13.1	− 10.5	− 10.4	− 5.1	− 16.0	− 17.5	− 15.0	− 13.9	− 18.4
	3	− 10.0	+ 7.9	− 12.0	− 11.4	− 3.9	− 9.6	− 15.0	− 13.6	− 12.6	− 15.6
	4	− 24.3		− 27.7	− 29.0		+ 11.5		+ 3.8	+ 5.5	

Key	−	Negative change, less desirable behaviour	+	Positive change, more desirable behaviour		Model not significant

Source: Own elaboration, derived from fieldwork data.
Notes. Predictions based on simple or interaction models in Table 7.7 depending on goodness-of-fit, assessed by Akaike and Bayesian information criteria. Unweighted predictions at constant sample means (varying only phone use, country dummy, and interaction term where applicable). Blank cells indicate that phone use coefficient was not statistically significant at the ten-percent level.

The relative changes in Panel a correspond to the aforementioned patterns of less negative and significant changes as the inclusion definition becomes more lenient. However, because fewer illness episodes in Rajasthan adhere to my definition of "commensurability," Panel b indicates greater absolute changes in Gansu and in process categories that embrace a larger share of desirable behaviours at baseline. In both panels of Table 7.8, exceptions to the trend emerge for the most lenient Inclusion Definition 4 because only the interaction models are significant (Definition 4 includes care for symptoms associated with flus and the common cold). The pronounced "outlier" predictions for this inclusion definition suggest that (phone-aided)

health behaviours differ most notably across Gansu and Rajasthan with respect to the common cold, but not so much according to more stringent definitions.

The analysis of relative changes sheds further light on the relationship between phone use and process descriptions (Table 7.8, Panel a). Among the models of formal and public healthcare access, stricter process descriptions tend to be associated with more pronounced negative relative changes in commensurate behaviour. Especially the imposition of referral requirements for mild illnesses produces much stronger negative predicted changes (in relative terms).

Nearly all results point towards a negative relationship between desirable health action and phone use in the healthcare-seeking process, and the (relative) effects become smaller with increasingly lenient classifications of "commensurate behaviour." We can infer from these observations that mobile phone use increases the rate with which individuals seek care for conditions that do not strictly require medical assistance, or at least not in the particularly resource-scarce settings of rural low- and middle-income contexts. In addition, the worse outcomes for processes involving referral to higher-tier healthcare outlets indicate that mobile-phone-aided illness episodes are more likely to involve the bypassing of referral systems that are designed to ensure health system efficiency.

While this would suggest that mobile phones adversely affect people's behaviour, it is plausible that people's self-described symptoms render my assessment inaccurate. In addition, a salience bias might lead patients to remember better those healthcare episodes involving phones, and providers who are more likely to be accessed through phones (e.g. private doctors) could give patients systematically different diagnoses. There is, however, no apparent reason why diagnoses from formal healthcare providers should bias my externally assessed "commensurability" systematically *against* those people who use mobile phones to access doctors and nurses. If profit interests were present among responsive private providers, they would be more

likely to involve more severe diagnoses that justify the fees and ensure continuing treatment. In this case, phone-aided access to private doctors would appear more rather than less desirable. Furthermore, the results hold across nearly all possible combinations of my sensitivity analysis; I control for the severity of the illness, country-fixed effects, and health provider preferences among others; and multilevel models have largely reproduced the results. I therefore have little reason to believe that any bias would systematically depress the commensurability outcomes for illness episodes in which mobile phones are present.

In light of the different indicators applied in the sensitivity analysis, the results suggest that phone use encourages individuals to over-use the health system for non-critical conditions and to bypass referral systems. I understand this as evidence in rejection of Hypothesis 2: People do not appear to make better use of the health system if they use mobile phones.

7.3.2   Equity Patterns in Phone-Aided Health Action

The empirical analysis so far indicated that mobile phone utilisation predicts phone-aided health action, and that such technology use is linked to more widespread but also more complex, delayed, and unnecessary access to healthcare. This section examines the hypothesis that "mobile phone use in healthcare exacerbates socio-economic inequities" (H3). Using descriptive statistical analysis, I first compare and contrast people across Gansu and Rajasthan according to their health action being phone aided or not. I then compare the groups according to whether their health action is commensurate with their symptoms, given their phone use. The statistics underlying the analysis can be found in Appendix 5.

7.3.2.1   Phone-Aided Versus Conventional Health Action

The first part of my equity analysis consists of a comparison of persons who had phone-aided or conventional health action. I focus here on selected economic, socio-demographic,

and spatial characteristics of these groups. This will show that phone-aided health action is concentrated among relatively wealthier, younger, and better-located groups.

Figure 7.5 compares groups who used phones during a severe or mild illness episode and those who did not (the unit of reporting is the illness episode, statistics are weighted at the population level, taking into account multiple episodes per person).[91] Beginning with Rajasthan (Panel a), the data indicate that phone users are less likely to belong to economically, socially, or spatially marginalised groups. For example, the bottom-two wealth quintiles (i.e. the poorest 40% of the wealth distribution) did not report phone use during an illness. The underlying factor-analysis-based wealth index (not shown here) has an average score of –0.03 for phone users and –1.76 for the group without phones, meaning that non-users are poorer on average (the difference is statistically significant at the one-percent level).

In terms of their socio-demographic characteristics, individuals with phone-aided health action tend to have higher levels of literacy and are younger than people who did not report the use of mobile phones. At the same time, still one-quarter of the phone-using group are older than 45 years, 17% are even beyond the age of 60 years. With only a three-percentage-point difference, sex does not appear to vary notably across those groups (see Figure 7.5, Panels ai to aiv).

The spatial characteristics of phone users and non-users in Rajasthan differ as well, though not in the way we might perhaps expect (Panel av). Approximately 50% of the individuals who do not use phones during their illness can reach a doctor in less than half an hour (self-reported data). The same holds for nearly 70% of phone users, meaning that the people who engage in phone-aided health action are closer to healthcare providers. These patterns are consistent for reported travel times and for physical distances to village facilities, calculated

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[91] Recall that "phone use" may occur directly through the patient or indirectly through a third party.

using geographic coordinates: Other spatial indicators (not shown here) suggest that phone users tend to be better located in terms of their distances to village centres, trunk roads, and village-level health facilities. The respondents in Rajasthan who use mobile phones therefore tend not to be the most remote.

Respondents in Gansu exhibit slightly different characteristics compared to the Rajasthan sample (see Figure 7.5, Panel b). Phone users are on average more affluent than non-users (Panel bi), and the average wealth index score is 0.34 points higher among phone users (2.38 vs. 2.04). However, the difference is not statistically significant at the ten-percent level and the group of phone users consist to almost 30% of the lowest- and second-lowest-quintile wealth groups (compared to 45% for non-users).

Socio-demographic group differences (Panels bii to biv) in Gansu point in the same direction as in Rajasthan but appear to be less pronounced. Whereas two-thirds of the phone-using health seekers in Rajasthan are below 35 years old, only 40% of the phone users in Gansu are below 35 (ten percentage points more than non-users). In addition, phone users also tend to have higher literacy levels (+9 percentage points), and proportionately more women are using mobile phones in the healthcare-seeking process (+6 percentage points).

Lastly, the spatial differences between patients with phone-aided and conventional health action again point in a similar direction in Gansu and Rajasthan (Panel bv). Accessibility to healthcare starts at a higher level in Gansu, as 85% of both groups can reach a doctor within less than half an hour. However, 60% of phone users state that the nearest doctor is less than 10 minutes away from their home, compared to 44% of non-users (the difference is significant at the ten-percent level). Also according to other distance measures, the group of people with phone-aided health action tend to be better located than people who did not use phones during an illness.

Taken together, the general trend across the two field sites is that phone-aided health action more commonly emerges among economically, socially, and spatially less marginalised groups. Phone users tend to be wealthier, younger, more literate, and face fewer physical barriers of reaching healthcare providers. As the health-related phone use is concentrated among better-off groups, I treat this as first tentative evidence in support of my hypothesis that mobile phone use in healthcare exacerbates socio-economic inequities.

Figure 7.5. Health Seeker Characteristics by Mobile Phone Use

Panel a) Phone Use During Health Action in Rajasthan

ai) Wealth Quintiles   aii) Gender   aiii) Literacy   aiv) Age Groups   av) Nearest Doctor

■ Bottom Quint. ■ 2nd Quint. ■ 3rd Quint. ■ 4th Quint. ■ Top Quint.   ■ Female ■ Male   ■ Literate ■ Illiterate   ■ 18-24 ■ 25-34 ■ 35-44 ■ 45-59 ■ 60+   ■ <10 min ■ 10-29 min ■ 30-59 min ■ 1-2 hrs ■ >2 hrs

Panel b) Phone Use During Health Action in Gansu

bi) Wealth Quintiles   bii) Gender   biii) Literacy   biv) Age Groups   bv) Nearest Doctor

■ Bottom Quint. ■ 2nd Quint. ■ 3rd Quint. ■ 4th Quint. ■ Top Quint.   ■ Female ■ Male   ■ Literate ■ Illiterate   ■ 18-24 ■ 25-34 ■ 35-44 ■ 45-59 ■ 60+   ■ <10 min ■ 10-29 min ■ 30-59 min ■ 1-2 hrs ■ >2 hrs

Source: Own illustration, based on fieldwork data.
Notes. Number of observations at level of illness episode (34 respondents reported two episodes). Proportions and group averages are population weighted using census data.

7.3.2.2   Commensurate Versus Incommensurate Phone Use

I established earlier that the utilisation of phones during illnesses need not be advantageous. We have also seen that phone-aided health action is biased towards more rather than less advantaged groups. In this final analysis section, I explore the groups of people who actually "benefit" from phone use in terms of courses of action that are commensurate with their symptoms. Because incommensurate action is driven by the inefficient over-utilisation of the resource-scarce health systems, the analysis focuses on the strictest inclusion criterion (i.e. Inclusion Definition 1, see Section 7.2) and unrestricted access to formal healthcare without penalties for other providers. The results of robustness checks for referral-sensitive health action point in the same direction (not reported here). Figure 7.6 displays the group composition of the samples by phone use and the commensurability of healthcare behaviours.

In Rajasthan (Figure 7.6, Panel a), only two women exhibit "commensurate" mobile-phone-aided health action according to the definition above. Both are 25-34 years old, illiterate, and slightly above the site average in terms of their wealth and phone use. Yet, it is more common to observe undesirable healthcare behaviours where mobile phones are involved. Individuals who exhibit such behaviours tend to be younger, wealthier, more educated, and more intensive phone users than the sample average. This group also comprises fewer women than the sample average (44% versus 55%). In contrast, both no-phone-groups have similar characteristics closer to, or slightly below, the sample average (although commensurate courses of action are more common among older non-users).

Panel b of Figure 7.6 depicts the group comparison in Gansu. Compared to the groups without mobile phones, people with phone-aided health trajectories tend to have higher-than-average general mobile phone use. They also tend to be younger, although all age groups are represented. However, there are differences between phone-using health seekers: Those who

exhibit commensurate health behaviours are wealthier and include slightly fewer women, but they also have lower average phone utilisation, a lower degree of literacy, and comprise more persons aged 35 years and above.

As younger, wealthier, and better-located persons start using mobile phones in their health action, only a fraction actually shows desirable behaviours. Although the Rajasthan group of phone users with commensurate behaviour is rather small, the patterns across the two field sites suggest that the groups with the highest average phone utilisation also have less commensurate health behaviour. Likewise, being young and literate does not automatically mean that phones are employed in a desirable manner. The main contrast between the two field sites emerges with respect to wealth, as incommensurate phone-aided health action in Rajasthan is concentrated among the higher wealth quintiles whereas the wealthiest group in Gansu more commonly exhibits phone-aided health action that is aligned with their symptoms.

Where less disadvantaged individuals are more likely to engage in phone-aided health action, healthcare inequities can be aggravated. On the one hand, if their phone use is not aligned with their symptoms, they may be no better off than before. However, by absorbing scarce resources and by making inefficient over-use of the health system, they can also potentially worsen healthcare access for the more marginalised groups who are less likely to use phones when seeking healthcare. On the other hand, the better-off group that more commonly realises commensurate behaviour can potentially widen the equity gap between themselves and poorer population groups. But this need not necessarily be the case. We can also see a substantial fraction of behaviours that are commensurate yet do not involve phones, and we have seen in previous parts that phone-aided processes tend to be less efficient. Adequate phone-aided behaviour therefore need not be better than adequate conventional health behaviour. Nevertheless, the overall picture is one in which mobile phones are not an equaliser, and instead appear

probable to widen healthcare disparities in rural communities. I understand these patterns there-
fore as evidence in support of Hypothesis 3, namely that mobile phone use in healthcare exac-
erbates socio-economic inequities.

Figure 7.6. Health Seeker Characteristics by Commensurability and Phone Use
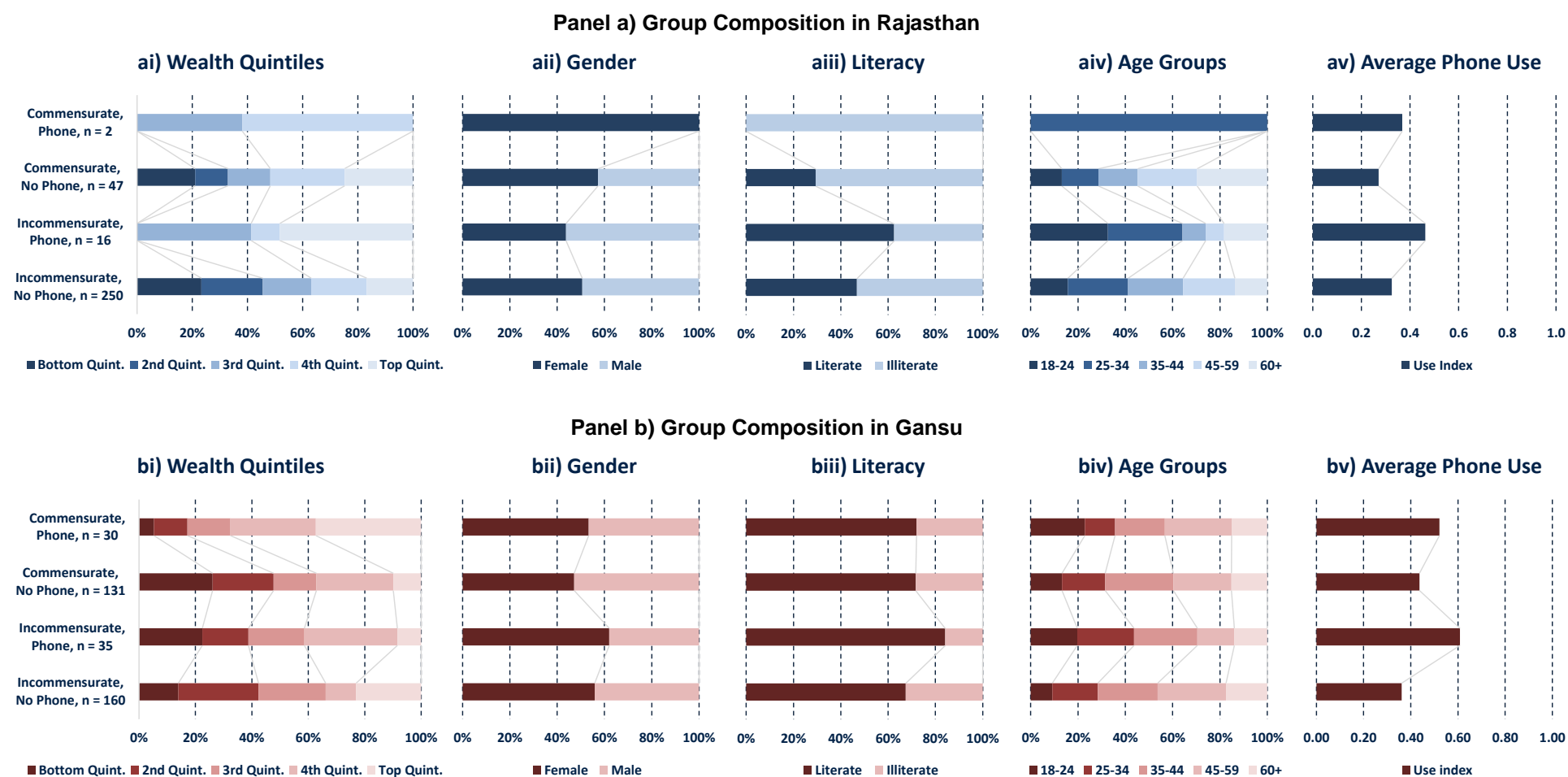
Panel a) Group Composition in Rajasthan

Panel b) Group Composition in Gansu

Source: Own illustration, based on fieldwork data.

Notes. Any access to formal providers, Inclusion Definition 1. Number of observations at level of illness episode (34 respondents reported two episodes). Proportions and group averages are population weighted using census data. Note further that the phone use index is score-based, ranging from a minimum of [0] to a maximum of [1].

7.4   Interpretation and Discussion

The focus of this chapter has been the question as to whether mobile phones improve access to healthcare in rural India and China. After a discussion of the limitations of my quantitative analysis in the following sub-section, I interpret the findings separately for each of the two hypotheses.

7.4.1   Limitations

It is important to point out the limitations involved in analysing the exploratory survey data before I interpret the results. I focus here on five aspects and discuss the measures and conditions that mitigate them: confounding effects and reverse causation, interview and recall biases, survival biases, statistical power for testing the effects, and the external validity of the results.

Firstly, it is—at least in principle—plausible that persons who benefit from mobile phone use would have exhibited exactly the same behaviours without mobile phones. In other words, mobile phone use by the patient and third parties may merely coincide with people's particular characteristics that lead them into certain behavioural patterns. In addition, if there is a link between phone use and healthcare access, it is conceivable that the implied causal relationships are inverted. Rather than mobile phones influencing access to healthcare, certain providers may require patients to start using mobile phones (e.g. village doctors being only accessible via phone communication), or mobile phone use is the last resort for individuals who experience particularly long and tedious healthcare processes. This could mean that mobile phone use is a feature of a specific type of healthcare provider or healthcare-seeking process.

These are serious concerns for the interpretation of the data. However, the analytical approach and the survey data suggest that these risks are limited by a number of factors. As far as confounding effects are concerned, my regression models control for factors such as household wealth and health provider preferences. The impact of wealth as a confounder is further mitigated as the analysis does not focus solely on those people who own mobile phones. For example, patients used phones themselves in only 60% of all phone-aided healthcare steps; the remaining 40% involved a third-party phone user.[92] The extensive involvement of third parties makes it less probable that patients' personal characteristics confound phone use. Nevertheless, we have also seen that wealth and phone use are positively correlated, and the wealth quintile control variables in the regression models point in the same direction as phone use. A small residual risk of a confounding effect therefore remains.

The risk of reverse causation is mitigated by the analytical strategy as well as the data structure. Given the data, it is implausible that long illness episodes cause mobile phone use: Among all steps in the severe and mild healthcare episodes, 83% of the phone use took place in the first two steps. Furthermore, only 30% of the phone-aided steps in the illness episodes involved the direct interaction with healthcare providers—most of the health-related communication takes place with household and family members. This makes it improbable that healthcare providers' reliance on mobile phones drives the observed patterns. Furthermore, the analysis of process complexity and delays appreciates only the phone use that occurred before or while accessing the healthcare provider, rather than mere mobile phone ownership or phone use covering the entire healthcare-seeking process. Sensitivity analyses (not shown here) indicate that the latter would for instance overstate the estimated delays by as much as 50%, and

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[92] These and the following statistics about phone uses within the healthcare episodes are unweighted.

find statistical relationships between phone use and health action that possibly do not exist in the data set (e.g. delays for informal healthcare access).

Secondly, given the nature of the data as derived from face-to-face survey interviews, it is also possible to raise concerns about recall and reporting biases. The focus of the survey on mobile phones, the social desirability of confirming questions on mobile phone use in health processes, the difficulty of recalling behavioural sequences up to a year ago, the potential of disease episodes becoming more salient and memorable if mobile phones were used, the discomfort when talking about a personal illness to a stranger, and interviewer-respondent dynamics may have influenced the survey responses (e.g. Aday & Cornelius, 2006:267; de Nicola & Giné, 2014).

In order to mitigate the risk of reporting and recall biases, the use of mobile phones was elicited explicitly for each step in a particular illness episode, and its specificities had to be justified subsequently. For instance, if a phone was used, the respondent had to explain how it was used, who used it, for which purpose, and who was contacted (if applicable). I further excluded chronic, long-term, and recurrent illnesses from the group comparison to limit the recall period. Moreover, my equity analysis neither relies on hypothetical scenarios nor is it based on samples recruited only from health centres. Both can be found in other studies of mobile phone use and health behaviour and can potentially aggravate response and sampling biases (see e.g. Kibadi *et al.*, 2009:1111; Nakahara *et al.*, 2010:321; Zurovac *et al.*, 2013:2). I instead draw inferences from the actual reported behaviour of the general adult population, thereby reducing sampling and social desirability biases. It is not possible to rule out all other remaining biases, but it is not obvious to what extent they would systematically alter the conclusions drawn from the analysis.

Thirdly, a feature of the cross-sectional study design is to explore the health behaviour of the respondent *retrospectively*. This set-up results in a survival bias among the respondents.

Individuals who have not successfully cured an illness—perhaps as the result of inadequate care from certain types of providers—will not be captured in such a study. The conclusions may therefore pertain mainly to survivors of disease, who could have very different character-istics and healthcare trajectories.

It is difficult to rule out these biases in a retrospective study in which respondents de-scribe their own behaviour (rather than others'), and this survey certainly cannot. The analysis therefore implicitly assumes that the death rate across the various providers and phone uses is the same (bearing in mind that providers are often combined in one episode). I have no means of verifying this assumption, however. A prospective, longitudinal study design would be re-quired to mitigate this bias, which was not feasible within this project.

Fourthly, the size of the rural samples in Rajasthan and Gansu means that certain be-haviours are represented by very few observations. For example, only two Rajasthan respond-ents would show commensurate health behaviour using mobile phones for some of the availa-ble definitions. Likewise, only 81 illness episodes involve informal caregivers to assess the complexity of healthcare-seeking processes. It is challenging to make inferences for a larger population where small sub-samples are involved or where there are few positive events for the dependent variable (Peduzzi *et al.*, 1996).

In response to the sample size constraints, I analysed the pooled data set including both Rajasthan and Gansu, controlling for country-fixed effects and interaction effects with the main dependent variable (mobile phone use). A country-specific analysis could yield more precise estimates as all independent variables are permitted to vary across the field sites. Added caution in interpreting the results is therefore advisable. Future research may investigate people's health behaviours on a broader scale in order to rectify this issue.

Lastly, the nature of the study does not permit the findings to be extrapolated to other contexts. It may very well be that my field sites are the only two examples where we can observe the patterns illustrated above. The interpretation of the results therefore has to pertain specifically to the field sites, rather than rural low- and middle-income contexts more generally. At the same time, it is worth emphasising that the results suggest a certain degree of similarity across two socio-culturally distinct contexts. In the absence of broader international evidence, the quantitative findings can be understood as the first steps towards a knowledge base on the relationship between mobile technology diffusion and healthcare behaviour in LMICs.

In summary, the data structure and my analysis techniques help to mitigate risks of reverse causation, confounding effects, and recall and social desirability biases. The qualitative research and my theoretical framework will be a further check to the consistency of the interpretation. Yet, none of these is a sure safeguard against misreading the research findings and some residual problems like survival biases persist. A longitudinal, prospective, and large-scale study on people's behaviour as they navigate the health system can offer more robust insights into causal relationships. But within the scope of an exploratory study, the mixed methods research design points at first—albeit tentative—insights that rapid mobile phone diffusion can influence access to healthcare.

7.4.2   Hypothesis 2: Improved Access to Healthcare

The second hypothesis for quantitative testing in this thesis concerned the relationship between people's use of mobile phones and their access to healthcare. Because the qualitative research suggested that phone-aided health action arises as a suitable solution where phones prove superior to other means of accessing healthcare, I hypothesised that the link is positive: Mobile phones improve healthcare access. I summarise and interpret below the findings of my quantitative data analysis in relation to this hypothesis. Since the evidence does not support the

hypothesis, I also discuss how patients' heuristic decision-making and providers' receptiveness to phone use may be responsible for the patterns observed within and across my field sites.

The analysis to inform this hypothesis suggested that healthcare access is higher among people who used phones personally or indirectly during an illness. We could also see that phone use is linked to more complex and delayed healthcare-seeking processes despite the higher rates of access. Worse process characteristics emerge for most types of healthcare access (i.e. formal, public, private). Moreover, people who use mobile phones during illnesses are also more likely to exhibit health behaviour that is "incommensurate" with their self-described condition (considering various definitions of commensurability), leading to a misalignment between their healthcare demand and the supply of healthcare resources (e.g. infrastructure and personnel). The effects tended to become weaker as I relaxed the conditions for the definition of desirable courses of action, which suggests that the relationship arises from the over-use of the limited healthcare resources for mild conditions and the bypassing of referral procedures.

In light of the aforementioned limitations and their rectifications, I assume that a causal link runs from mobile phone use to healthcare access. The quantitative results suggest that mobile phone use increases access to healthcare, but it also contributes to more complex and less speedy healthcare-seeking processes in which the health system becomes increasingly over-utilised. The response across the two field sites is not the same, however. Healthcare access patterns in Rajasthan suggest a substitution away from public towards private healthcare, with only small effects on overall access to formal healthcare (which is at very high levels for both phone-aided and conventional health action). In Gansu, where patients rely more widely on self-treatment with medication, the relative increase in access to public and private doctors is much more pronounced. In addition, although the relative changes in efficiency among phone users in Rajasthan and Gansu are mostly similar (interaction effects often pointed in the same direction or were statistically insignificant), the higher average complexity and delays of

healthcare-seeking processes in Rajasthan mean that the same relative change produces a stronger absolute response compared to Gansu. A similar logic applies to the effects of phone use on commensurate health behaviour, where the higher average levels in Gansu lead to stronger absolute decreases of desirable health action among phone users. At the same time, we also need to acknowledge that the penetration of mobile phones in people's healthcare-seeking processes is lower in Rajasthan than in Gansu. The effects therefore apply to a larger share of the population in the Gansu site.

Overall, these patterns suggest that mobile phones *increase* access to healthcare, but they do not *improve* it. What may account for these patterns if we assume that the causality interpretation is correct? My framework predicted that phone-aided health action emerges as mHealth uptake or user innovation where phones are accessible and suitable for health-related purposes, proposing that phone-aided solutions are effective means to overcome otherwise existing barriers to accessing healthcare. An improvement of healthcare access would follow from the implicit assumption that people have complete information about which course of action is effective and advisable given their symptoms and available healthcare resources, and that they make "perfectly rational" healthcare decisions based on this information. Such a "rational" decision could respect other factors including patient preferences and cultural norms, but it would need to be effective from a biomedical perspective (Andersen, 1995:6; Dupas, 2011:431; Luoto *et al.*, 2011:2-4; Oster & Thornton, 2012:1291; Rhee *et al.*, 2005:8). However, the quantitative analysis and common sense suggest that the assumptions of complete information and rational behaviour do not hold in real life.[93] How then can we account for more complex, longer, and arguably less desirable healthcare trajectories?

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[93] Note that deviations from the theoretical construct of "rationality" are not necessarily "irrational" or "random."

Theories from the behavioural and information economics literature can help to reconcile the otherwise conflicting observations between the emergence of phone-aided health action and its behavioural impact. Behavioural economists have long argued that humans have difficulty assessing the health risks and costs of activities such as smoking (Cawley & Ruhm, 2011:137-139). The same difficulty applies during illnesses because patients do not know with certainty whether a particular form of treatment from a particular provider is going to succeed (Arrow, 1963:948-952; Balsa *et al.*, 2003:203-205; Blomqvist, 1991:411-412; Scott, 2000:1178).

Absence of dependable, affordable, and accessible diagnosis mechanisms (assuming such exist) aggravates the uncertainty because patients can often only venture an educated guess about their nature of their illness based on past experiences from themselves or family and friends. Treatment decisions resulting from such self-diagnosis can be unsatisfactory, which is illustrated by Cohen *et al.* (2012:57): 68.5% of their Kenyan household sample reported that they had a case of malaria in the past month. The households often decided to purchase antimalarial medication at kiosks or not to treat the illness at all, but a diagnostic test showed that only one-third of adults using antimalarial medication actually had malaria (Cohen *et al.*, 2012:9; Dupas, 2011:427).

Patients therefore experience uncertainty regarding both the nature of their illness and the efficacy of treatment choices. They also face numerous competing demands like earning an income or rearing children that make immediate access to healthcare difficult. For instance, a recent study on health system utilisation in Western Kenya argued that "competing priorities in a poor community, such as gathering water and firewood, limit how much time people have for clinic visits" (Bigogo *et al.*, 2010:971).

In light of uncertainty and constraint, it is possible that patients' decision-making does not reflect the theoretical and simplifying notion of perfect rationality under full information,

but rather heuristic "rules-of-thumb" in order to simplify the decision.[94] The prominent psychological study by Tversky and Kahneman (1974) describes such heuristics-based decision-making as follows:

> […] People rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations. In general, these heuristics are quite useful, but sometimes they lead to severe and systematic errors. (Tversky & Kahneman, 1974:1124)

Whereas Tversky and Kahneman (1974) apply their study to cognitive biases when people judge quantities or probabilities, heuristics also play a role in healthcare contexts. A patient's self-diagnosis may for example be influenced by his or her illness history, by common illnesses in the same community (e.g. malaria), or by the duration and intensity of the symptoms (Leventhal *et al.*, 2008:485-486). Likewise, simplifying rules about the effectiveness of treatment options may be influenced by user fees that signal quality; conspicuous practices and procedures that suggest expertise; or personal relationships with the provider that promise availability. Examples arise in my own qualitative research. For instance, respondents in both Rajasthan and Gansu indicated that effective healthcare would involve intravenous treatment during an illness:

> *Usually people go to a private doctor here* [in this village]. *There is always a long queue and they believe that the government doctor doesn't have good facilities and doesn't treat them well. The private doctor always gives a drip from a glucose bottle and they feel that it is good and are happy.* (Rajasthan, woman, 30, phone owner)

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[94] Note that these arguments suggest that solely the patient makes the healthcare decision, which is evidently not always true. Similar heuristics may apply where third parties are involved in the decision-making process.

> *Doctors are near here, and it's our village doctor* [whom I would call]. *I can call him if I need my blood pressure medicine. I take the medicine every day, and sometimes I'm too busy to get the medicine from there* [the clinic] *and call him to bring some for me. And I called him because of a serious cold once, to give me intravenous treatment.* (Gansu, man, 71, phone owner)

I emphasise here heuristics and decision-making under constraint because I argue that mobile phones influence health behaviours through this channel. Mobile phones may lower the barriers for diagnosis and treatment, but the results can be unforeseen if the underlying healthcare decisions are based on necessarily simplifying rules about diagnosis and the effectiveness of treatment.

If all else is equal, a healthcare-seeking process involving mobile phones may enable people to contact a provider easily where costs (or other barriers) would otherwise have been prohibitive, to explore seemingly more promising healthcare options in order to avoid the little-trusted local doctor, or to speak to a relative and receive their view about what should be done. However, if the facilitated behaviours are driven by heuristic rules-of-thumb rather than fully informed decisions about the present and future costs and benefits of all available treatment options, there is no guarantee that they automatically lead to desirable courses of actions from a medical perspective. It is instead more probable that mobile phones facilitate a spectrum of behaviours that includes adverse and unexpected as well as effective health action. This can potentially lead to more rather than less complex healthcare itineraries as we can observe in the data.

An example of such facilitation can be found in the utilisation of the *104* public health hotline in Rajasthan (Bergkvist & Pernefeldt, 2011; Dimovska, 2009:10-11). Over the course of 2012, the call centre received approximately 1.5 million calls, 20% of which were "valid" calls (HMRI, 2012). Acne consultation represented more than 10% of all medical advice calls and was by far the most common reason for calls (HMRI, 2012). This perhaps surprising use

of the service may result from a lower threshold for receiving diagnosis and consultation in an environment where adolescents may not otherwise discuss personal health issues. In this particular case, the service is designed to cater to such queries and offer confidential consultation. But in a health system under stress, patients' calls to medical providers for acne consultation may distract doctors from more urgent care required elsewhere. Moreover, the mismatch between received and managed calls (i.e. 80% "invalid" calls) also reflects the reported burden of prank calls (Ivatury *et al.*, 2009:148). This indicates that people do not solely use mobile phones for the behaviours we might hope for, which can create a further burden on available health services.

In addition, as discussed in the theoretical framework, some providers are more likely to be responsive to mobile phone interaction because of physical proximity, job descriptions involving visits to local residents, personal relationships, or profit interests. Phone-aided options may lower patients' thresholds for diagnosis and treatment for some providers but not others, biasing the ensuing behaviour towards responsive actors. Clearly not all forms of phone use during an illness involve direct correspondence, but the shift from public to private care among phone users in Rajasthan lends support to this argument. After all, many respondents during the qualitative fieldwork reported that private doctors would be able to respond to home calls whereas public doctors are bound to their station. In contrast, patients in Gansu often describe that doctors in the public health system would be the first point of contact, and are often available through calls. For example, when asked about the typical process when he gets ill, a 47-year-old man in rural Gansu expressed that,

> *I call the* [village] *doctor first to tell him my situation, like I caught a cold, and he can tell me what kind of medicine to take.* (Gansu, man, 47, phone owner)

The stronger increase of public healthcare access and the weaker negative effects in Gansu may therefore be explained by the higher transparency of the local health system and village doctors' responsiveness to patients' phone use.

In summary, the observed patterns of increased yet more complex, less speedy, and less desirable healthcare access are at odds with my initial hypothesis that mobile phone use improves health action. I discussed in this section that the hypothesis implicitly assumed that people's healthcare-seeking behaviour follows perfectly rational behaviour under full information. If we depart from this assumption and acknowledge that healthcare seeking rather resembles heuristic decision-making under constraint, we are able to reconcile the qualitative and quantitative observations. On the one hand, by reducing the barriers (or "transaction costs") for diagnosis and treatment, mobile phones invite over-use of the health system for mild conditions (severe cases are more likely to adhere to commensurate and immediate behaviours regardless of mobile phone use). On the other hand, phone-aided behaviour is biased towards those providers who are more responsive to phone use. Figure 7.7 summarises these arguments by augmenting the theoretical framework with these three channels of phone-aided impact: decision-making processes, information and transaction costs, and the health system set-up. It is possible that the mobile phone diffusion process leads to improved behaviours where the health system is transparent, regulated effectively, and where well-qualified first-level providers are encouraged to engage with patients on the phone. However, this does not appear to hold in my field sites, or at least not from the patient perspective. I therefore conclude that mobile phone use is linked to more access but worse behaviour, which refutes Hypothesis 2.

Figure 7.7. Modified Theoretical Framework With Channels of Mobile Phone Impact
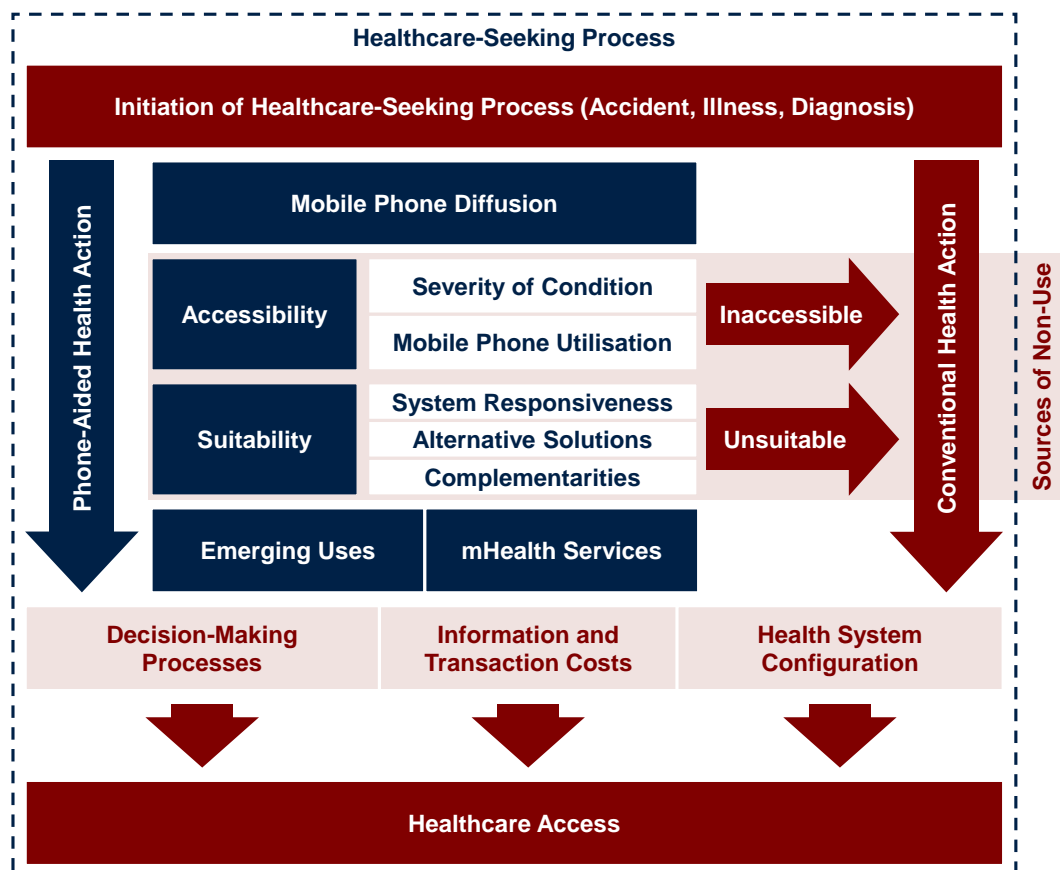
Source: Own illustration, derived from qualitative and quantitative analysis and literature review.
Notes. Read figure from top to bottom, with initiation of healthcare seeking process as starting point. Conditions for phone-aided and conventional health action with possible healthcare access apply at each step of healthcare-seeking process.

7.4.3 Hypothesis 3: Exacerbated Socio-Economic Inequities

My last hypothesis in this thesis suggests that mobile phone use in healthcare exacerbates socio-economic inequities. I established this hypothesis based on my framework, arguing that people could be excluded from phone use because marginalisation prevents them from (a) seeking healthcare, (b) accessing mobile phones for an illness, and (c) finding affordable providers who would be responsive to phone use. However, the hypothesis also includes the view that phone use improves health action, which is not borne out by the data thus far.

I analysed my survey data descriptively in order to explore the composition of groups depending on their health-related phone use and the "commensurability" of their behaviours with their symptoms. Focusing on self-reported severe and mild illnesses, we can observe that

people using phones during their illnesses (directly or indirectly) are distinctively different from those not using phones. Being on average younger and wealthier, phone users also have better physical access to healthcare. Judging by "commensurability" (based on their self-described symptoms and their access to formal health providers in resource-limited contexts) suggests that the higher healthcare access among phone users does not evenly translate into improved healthcare behaviour. Few episodes of phone-aided health action in Rajasthan are desirable according to this measure. In Gansu, phone users exhibiting advisable courses of action are wealthier but also somewhat older than people whose phone-aided health action is "incommensurate."

These patterns link back to the underlying theoretical framework used for this analysis. In line with the qualitative impressions, individuals appear less likely to utilise phones during an illness if they are socially, economically, and spatially marginalised. As I compared here only persons who actually reported an illness, I cannot make a claim whether disadvantaged groups are more or less likely to perceive an illness as such. However, it appears plausible that effective mobile phone utilisation to access healthcare providers is systematically biased towards better-off fractions of the field site populations. The consistently higher phone utilisation among groups with phone-aided health action corresponds to the obstacles that disadvantaged groups in both field sites reported when accessing phones for health-related purposes, however subtle such obstacles may be. The fact that phone users are also located near healthcare providers and are economically better off suggests that they have access to complementary assets to translate phone access into phone-aided health action.

My framework further suggested that mobile phones may be but one way of solving the healthcare access problem alongside alternative solutions. We can indeed observe the coexistence of commensurate and incommensurate health behaviours among phone users and non-users alike. This suggests that mobile phones are only one possible route for desirable

healthcare access. Support for this claim can be found in the negative binomial regression analysis on the delays to healthcare providers. Although the main independent variable is phone use in these regression models, among the 28 control variables (not reported) is also household ownership of transportation assets, which is a potential substitute for many types of phone use. The three-level multilevel model indicates a strong negative relationship between vehicle ownership and the delays to accessing public healthcare providers (at the one-percent level), suggesting that car- and motorcycle owners reach healthcare faster. While some people may be "excluded" from phone-aided health action for one reason or another, phone-aided healthcare access, even if it is adequate, may not necessarily be the superior solution.

Moreover, the findings point at problematic equity implications resulting from phone-aided health action. Incommensurate phone use can have adverse effects for both patients and health systems. In the best case, inessential access to a doctor would not render a mild disease worse. The patient may nonetheless have to incur costs for accessing healthcare unnecessarily, perhaps even paying out of pocket for private treatment. Worse scenarios would involve inefficacious and counterproductive treatment that exacerbates an illness or increases the risk of, say, antibiotic resistance (Banerjee *et al.*, 2004:949; Banerjee & Duflo, 2011:55; Das *et al.*, 2008:102; Kremer & Glennerster, 2011:273-276; Mwabu, 2007:3314). The potential hazards of not receiving care when it is advisable are equally apparent. Incommensurate health action can therefore leave phone users worse off than before. In such a scenario, healthcare access would become more "equitable," but for the wrong reason (i.e. narrowing the gap from above rather than below).

But there may be further, dynamic implications underlying these patterns. I suggested in my framework that exclusion increases where health systems increasingly rely on phone-aided access. This may well be the case for a sub-set of phone users, as 30% of the phone-aided healthcare episodes involved the direct interaction between a medical provider and the patient

or his/her aide. If the present descriptive patterns are any guide, such developments would increasingly exclude marginalised groups from healthcare access if the supply of healthcare resources was unable to accommodate the increased demand.

Another dynamic effect, not discussed in my framework, is the possibility that the over-use of a resource-limited rural health system and bypassing of referral routines can adversely affect the healthcare access of people who do not rely on mobile phones. As mainly affluent persons exhibit adverse phone-aided behaviours, they potentially crowd out poorer and more constrained people from healthcare access. This would bear resemblance to patterns observed in other contexts, for instance the UK middle class reportedly exercising their "sharp elbows" towards other health system users and thereby contributing to the reinforcement of healthcare inequities vis-à-vis poorer and more vulnerable population groups (Seddon, 2007:88). Incidentally, in my regression models on commensurate health action, wealth indicators (not reported here) point consistently in the same direction as health-related mobile phone use.

If these interpretations hold, healthcare access can become more inequitable. Healthcare inequities of affluent versus poorer population groups could increase if the affluent phone users follow commensurate courses of action (i.e. adequate healthcare access) and conventional, non-phone-aided health action is otherwise inferior. Under such conditions, wealthier groups would receive adequate healthcare while poorer groups do not (however, it need not necessarily be the case that conventional health action is inferior to phone-aided action). If wealthier groups instead over-utilise the health system, the gap may be narrowed from above as richer people would incur higher costs for inessential treatment. At the same time, their health system over-utilisation is also prone to crowding out the weakest health system participants, exacerbating inequities in turn especially in the most resource-constrained contexts. Nevertheless, conclusions about the dynamic implications are difficult to establish based on cross-sectional data and therefore ought to be explored in future research.

In light of the evidence, I tentatively conclude that mobile-phone-aided health action reinforces economic, socio-demographic, and spatial inequities in my field sites. Only a small fraction of illiterate, poor, and old persons is able to side-track this development, mostly limited to severe illnesses and through the help of third parties such as spouses and other family members.

7.5 Conclusion

Does mobile phone diffusion influence access to healthcare in rural India and China? I explored this research question through the quantitative analysis of two hypotheses: First, that mobile phone use during illness episodes improves access to healthcare; and, second, that phone-aided health action exacerbates socio-economic inequities. Although phone-aided health action in Rajasthan is more limited than in Gansu, my research findings suggest that mobile phone use increases access to healthcare in both sites, but it also leads to more complex and delayed healthcare access behaviour and to the over-use of scarce healthcare resources. In addition, the equity patterns suggest that younger and more affluent people are more likely to use mobile phones during an illness, but only a fraction of these users exhibit health action that aligns with their symptoms.

Health system over-utilisation and the patterns of exclusion and inclusion can have implications for both the health seeker and the wider health system. On the one hand, over-use of healthcare resources can be detrimental to the health seeker through faster access to unqualified providers and out-of-pocket expenditures for unnecessary treatment. On the other hand, the systematic bypassing of the referral system facilitated by phones can undermine efficient resource allocation. In particularly resource-constrained healthcare contexts, this may gradually exacerbate access barriers for patients who do not use mobile phones—who are poorer and older on average.

My theoretical framework led me formulate the optimistic hypothesis on the improvement of health action because I implicitly assumed an environment of complete information, "perfect rationality," and unconstrained decision-making. Departure from these assumptions—none of which reflects actual human decision-making processes, neither in low- nor in high-income contexts—helps to reconcile observation and framework. We may instead assume that people have to rely on incomplete information, painful trade-offs, and rules-of-thumb about which course of treatment is most effective given a set of observed symptoms. Mobile phone use may then indeed facilitate behaviour, but not necessarily of the kind deemed desirable since information and decision-making routines remain imperfect.

At the same time, the original framework also corresponds to some of the observed patterns. As far as healthcare access is concerned, the findings resonate with my argument that phone-aided health action evolves along the lines of responsive healthcare providers, at least for the subset of patients that communicate directly with them. The influence of this factor could be stronger where health system landscapes are more obscure from the patient perspective, such as rural Rajasthan's more complex and less regulated non-public healthcare sector. The equity analysis highlighted additional links to the framework. I argued that forced and voluntary exclusion from phone-aided health action at different levels (care seeking, accessibility, suitability) can lead to exclusion patterns that further marginalise socio-economically disadvantaged groups. The data suggests that this argument holds, at least as far as the obstacles in phone utilisation and the presence of alternative solutions are concerned. I further argue in my framework that dynamic effects may include health system adaptation to increasing phone use, which gradually raises healthcare access barriers for non-users. While the analysis did not investigate this particular point, it hinted at another potential dynamic effect: The inefficient over-use of the health system by phone users can crowd out more vulnerable non-users.

To the best of my knowledge, this is the first analysis that quantitatively tests the effects of mobile phone use on healthcare behaviour. The findings in this chapter largely refute the hypothesis that mobile phone use improves healthcare access, and support the hypothesis that phone-aided healthcare access can exacerbate socio-economic inequities. To answer the research question, then, mobile phones do influence access to healthcare in rural India and China. They appear likely to facilitate adverse behaviours and leave socio-economically disadvantaged groups worse off. I discuss the implications of these results for research at the interface of mobile phones and social development and the policy and practice of mHealth in the final chapter.

Chapter 8

Conclusion

8.1   Summary of Findings

I demonstrated in this thesis that the emerging and partly negative healthcare conse-
quences of mobile phone diffusion are an important yet neglected development outcome that
can undermine the role of mobile phones for health service delivery. The motivation of this
study was the widespread research interest in projects to improve health systems and health
service delivery, sparked by the rapid mobile phone diffusion in low- and middle-income coun-
tries over the last decade. These "mHealth" interventions target especially rural dwellers who
continue to face pressing healthcare challenges. The enthusiasm to develop such mobile-phone-
based health projects is reflected in the more than 1,000 mhealth projects globally and the more
than 80,000 health-related smartphone apps in Apple's *iTunes* store (Apple Inc., 2015; GSMA,
2015).

Despite the interest in mHealth, very little is known about the implications of rapid
mobile phone diffusion on healthcare access and behaviour in LMICs. I used a mixed method
research design in order to understand better the link between phone use and healthcare access.
Based on qualitative research with 231 participants and primary survey data from 800 adults
in rural Rajasthan (India) and rural Gansu (China), I answered the following three questions:

1. How is mobile phone diffusion related to access to healthcare in rural India and China?

2. Can we construct a multidimensional measure of mobile phone utilisation that explains
   mobile-phone-aided healthcare behaviour better than binary indicators of adoption?

3. Does mobile phone use influence access to healthcare in rural India and China?

In response to Research Question 1, I developed a qualitatively grounded framework through which I argue that mobile phone diffusion leads to the emergence of phone-aided health action if three conditions are met. First, people have to seek care when they get ill, which can exclude those who accept poor health due to prolonged hardship. Second, people have to be able to access mobile phones for health purposes, which can exclude poor and remotely located individuals with weak social support networks and only mild illnesses. In this context, my research shows that issues around digital exclusion require a more differentiated understanding of the relationship between ownership, access, and usage. Third, mobile phones have to be a viable solution in light of health provider responsiveness and alternative and complementary healthcare options, which can exclude wealthier and better-located groups who have superior means of accessing healthcare.

Where these conditions are satisfied, people incorporate mobile phones into their health behaviour, either through existing mHealth programmes or through locally emerging solutions such as summoning health workers. However, phone-aided behaviour need not be advantageous if it facilitates unnecessary healthcare access and the utilisation of low-quality care. Such patterns can result from people's heuristic decision-making, incomplete and costly information, and fragmented and opaque health systems. In contrast, it appears that consolidated, transparent, well-regulated, and resource-rich health systems may prevent such negative outcomes.

Because not all people meet the conditions for phone-aided health action, two "excluded" groups emerge. One group comprises socio-economically and spatially marginalised "involuntary non-users;" the other group consists of better-off "voluntary non-users." Such non-use need not be problematic, but more extensive mobile phone use can affect supply-sided service delivery practices. For example, patients may find a clinic vacant because the doctor was called to provide treatment at a patient's home. Where this is increasingly the case, dynamic health system adaptation to phone use can raise healthcare barriers for non-users if they

are unable to access mobile phones as well. My theoretical framework therefore permits hypotheses about the conditions for inclusion and exclusion from health-related phone use, the healthcare access patterns resulting from phone-aided health action, and the dynamic healthcare implications of mobile phone diffusion processes.

Research Question 2 focused on the measurement of mobile phone adoption, given that conventionally used binary or one-dimensional indicators fail to reflect the rich descriptions of mobile phone adoption in the qualitative technology diffusion literature. Based on my qualitative fieldwork, I developed a three-dimensional conceptualisation of mobile phone adoption that includes direct and indirect routes of access (e.g. ownership and third-party access), different functions relevant to health-related phone use (e.g. incoming and outgoing calls and text messages), and the degree of their usage intensity (e.g. daily or weekly use). These three dimensions can be easily measured and combined into one single indicator. This new "utilisation index" discriminates between different degrees of adoption in settings where a technology has apparently diffused widely. Compared to conventional ownership indicators, the index also emerges as a superior predictor for people's phone-aided health action.

I raised Research Question 3 in response to common but problematic assumptions that mobile phones are a given, neutral, and static platform for mHealth projects. My analysis involved healthcare access patterns, healthcare process complexity and delays, and the alignment between people's health action and their symptoms. I found that,

- People who use mobile phones during an illness episode are more likely to access healthcare, but phone use can shift the types of providers whom the patients access.

- Compared to people who do not use phones when seeking healthcare, phone users have more complex and time-consuming behaviours before they reach a healthcare provider.

- Phone use during an illness is associated with increased use of the health system and bypassing of referral systems, making people's behaviour less desirable in contexts where healthcare resources are limited.

- Mobile phone diffusion does not reduce inequitable access to healthcare but rather accentuates it. Only a minority of disadvantaged individuals can benefit from phone-aided health action.

By most measures, mobile phone diffusion does not improve healthcare access. There is in fact a realistic possibility, at least in my field sites, that health behaviour is worsened where mobile phones diffuse rapidly.

Given the empirical focus on rural India and China, my study also offered insights into similarities and differences regarding mobile phone adoption and healthcare behaviour between the two settings. In terms of mobile phone adoption, both Rajasthan and Gansu experienced rapid phone diffusion in recent years and appeared strikingly similar according to aggregate teledensity measures. However, micro-level mobile phone use reflected the different social structures and mobility patterns in the field sites. For example, phone use in Gansu is more individualistic compared to Rajasthan's widespread shared and third-party use. Although indirect access (together with lower literacy levels) means that people in Rajasthan use their phones on average less, the higher individualism in Gansu means that a larger share of the population is excluded from phone use.

In terms of healthcare, both countries operate three-tier public health systems, but the provider landscape in Rajasthan is more fragmented and less regulated, and Gansu fares better according to typical healthcare indicators. These conditions reflect on people's health status, in particular India's substantially higher disease burden and China's ageing population. My

survey complements this data by highlighting the differences in healthcare-seeking behaviour between the sites in Rajasthan and Gansu: Illness episodes in Rajasthan last on average longer and involve more time spent with formal healthcare providers, whereas people in Gansu spend a larger share of their time without a provider in self-treatment.

I have by no means exhausted the opportunities for comparative analysis between Rajasthan and Gansu, but my empirical findings show that mobile phones are consistently influencing people's health behaviours despite the idiosyncrasies of the field sites. I discuss in the remainder of this chapter the policy, methodological, and theoretical implications of this research.

8.2   Policy Implications

What is to be done if the interplay of ungoverned technology diffusion and dynamic health system adaptation does indeed yield unintended negative side effects as described in this thesis?[95] It appears imprudent to consider restricting and regulating population access to mobile technology. At the same time, advocating for an mHealth intervention to boost equitable access to healthcare is equally insensitive if its own platform systematically reinforces patterns of marginalisation.

On the demand side of health-related mobile phone use, some authors have advocated that users be educated about the (health-related) engagement with mobile technology, for example through primary and secondary school curricula (Bailin *et al.*, 2014:616; Buhi *et al.*, 2009:110; Day, 2014:187; Hampshire *et al.*, in press:26-27). Education about proper phone use could be a means to reduce adverse behaviours and the crowding out of non-users. But such

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[95] I will focus this discussion on patient-centred responses to the potential negative implications of this research because the ICTD and mHealth literature commonly focus on how to exploit the positive potential of mobile phone diffusion (Andersson & Hatakka, 2013:293; Dodson *et al.*, 2012; Heeks, 2014:12; Khatun *et al.*, 2014:9; Roztocki & Weistroffer, 2014:351).

activities may also reproduce healthcare inequities between users and non-users of mobile phones, provided that the users now achieve more effective healthcare access while the non-users remain excluded from phone use due to social, economic, and spatial marginalisation. In order to promote equitable access to healthcare, it may be more effective to focus such educational activities on health problems and solutions more generally (rather than only phone-aided behaviours). Another problem is that such activities would not reach individuals outside of the education system. In response to this problem, educational activities to limit health system over-utilisation could target phone users when they interact with the health system, for example by pointing out appropriate channels of communication.

Regulatory intervention on the healthcare supply side could be another way to rectify problems related to inefficient health system over-use and the bypassing of referral systems. Side-lining referral systems may become more difficult and less attractive if higher-tier healthcare providers have established routines for handling direct calls and patient visits, and if local doctors have compensation mechanisms for phone-based service provision. At the same time, quality assurance and health worker training on the lowest community levels would be necessary to reinstate trust among patients that minor health conditions can be solved locally. Where inequitable healthcare access is a concern, patients also require functioning and efficient routes to the health system that do not depend on mobile phone use, for instance through public transport or regular and dependable drop-in clinics at health centres (see e.g. Healy & McKee, 2004:352-353). Such supply-side responses to increasing phone-aided health action are an issue yet to be resolved, but further health systems research in this area may gradually help to develop a knowledge based on effective policy responses.

Since the practice of mHealth interventions is likely to continue in the future, there are at least three points that mHealth developers, implementers, and health policy makers can take

away from this study. Firstly, targeting issues might ensue if parts of the target group are systematically excluded despite apparent "access" to the platform. For example, the viability of public health messaging may suffer in circumstances where text messages are widely perceived as junk, and health hotlines may remain under-utilised among individuals who pick up but rarely make calls. Simplifying notions of ubiquitous mobile phone access that often accompany mHealth interventions can obscure these patterns and misdirect the design of the solution. Well-designed mHealth solutions may be able to overcome exclusion problems and rectify adverse behaviour in unstructured mobile phone use (as argued e.g. in Tossell *et al.*, 2015:723), but in the absence of evidence on this problem, it appears advisable to study local mobile phone utilisation patterns prior to intervention design.

Secondly, acceptance issues may arise if people's existing local solutions compete with the new intervention. Vassilev *et al.* (2015:23) advise that telehealth initiatives be "integrated into everyday life and healthcare routines." My research suggests that, beyond harmonisation with everyday routines, also people's existing conventional and phone-aided healthcare behaviours deserve attention. Common concerns about epidemiological priorities like cardiovascular diseases should not be neglected, but it may be worthwhile for designers and implementers of mHealth solutions to start with questions like, "How does my target group behave, which solutions do they already have available, and how can I guide and improve their behaviour?" Such a person-centred approach could potentially avoid redundant interventions that risk undermining user acceptance.

Thirdly, sustainability of mHealth may be in doubt where the mobile phone platform undermines those outcomes that the mHealth intervention means to improve. The evidence in this study provides counter-examples to the "neutrality" assumption of mobile phones from two distinct low- and middle-income contexts. If mobile phones promote the inefficient use of scarce healthcare resources, we may ask whether a healthcare intervention ought to be mobile-

phone-based, potentially creating a situation where the technological intervention would only undo the harm that the platform inflicts (e.g. in the case of mobile-phone supported referral; Mehl *et al.*, 2015:255). However, given the research gap in this area, we need a broader knowledge base on how mobile phone use affects health action in order to identify instances where mHealth interventions are warranted and where not.

In the absence of widespread evidence on the themes raised in this thesis, it appears improbable that overarching and transferable solutions can be found in the near future, but my framework offers a starting point and language for such considerations. I also highlighted the contextually distinct patterns of phone utilisation, healthcare seeking, and impacts of phone-aided health action across and within my field sites. Interventions and policy responses such as those above therefore need to be receptive and tailored to the local context.

8.3   Methodological Implications for Mobile Phone and Health Research

The approach adopted in this thesis offers three methodological opportunities for future research on mobile phones and health. This pertains to ICT-aided survey sampling and implementation, index measures of mobile phone adoption, and methods to capture and analyse sequential healthcare behaviours.

Firstly, my novel and digitally aided approach to survey sampling and implementation in Gansu has shown potential to improve the efficiency and quality of other rural surveys. Now widely available satellite maps make it easier to list all households in large villages (rather than only segments thereof; Escamilla *et al.*, 2014:690); permit spatial stratification in villages through segmentation or superimposed grids to reduce within-village clustering effects (Delmelle, 2009:188; Flynn *et al.*, 2013:9-10; Galway *et al.*, 2012:2); and require no specialised software solutions. The technique also reduced both costs and duration of the survey by at

least 25% each. Such benefits could be realised elsewhere if certain requirements are met, including (but not limited to) up-to-date high-resolution satellite imagery and distinct, sufficiently homogenous, and stable dwelling structures (this excludes e.g. nomad populations).

Secondly, the survey instrument developed for this research captures mobile phone utilisation along three dimensions and can aid assessments of the social implications of technology. The analytical novelty of the index vis-à-vis other adoption indicators stems especially from its qualitative grounding and the incorporation of third-party use. Using a simple survey instrument (approx. 10-15 minutes of interview time) and a basic scoring method, the mobile phone utilisation index can be incorporated into other studies. The index can potentially inform policy-oriented mHealth assessments and the yet scarce public health literature that is interested in mobile phone use in LMICs (DeSouza *et al.*, 2014; Khatun *et al.*, 2014; Labrique *et al.*, 2012; Wesolowski *et al.*, 2012:5). Moreover, researchers can easily amend the index if theoretical models or qualitative studies suggest that other dimensions of utilisation are relevant to the emergence of phone-aided behaviours. For example, where symbolic uses of mobile phones are deemed important for the analysis, the frequency of mobile phone personalisation might be captured as an additional functional element. Lee *et al.* (2012) and Tossell *et al.* (2012) offer starting points for such an approach from high-income settings.

Thirdly, as public health researchers acknowledge the sequential nature of health behaviours, this thesis offers a survey tool and analysis techniques to operationalise the concept for the analysis of healthcare access. The survey instrument that I developed for my thesis captures healthcare seeking as a step-wise process from the moment an illness or discomfort was detected. This sequential data offers new analysis options compared to aggregate or one-off healthcare access data. For example, sequential process data can be analysed in its own right using sequence analysis tools. If researchers are interested in the existing spectrum of health action, sequence analysis offers a toolkit to explore and describe patterns across groups

of patients. Cluster and multivariate analysis can further reduce complexity in the data and examine potential drivers of desirable and undesirable courses of action.

In addition, rather than analysing healthcare sequences as a whole, it is also possible to extract sequence-sensitive indicators of the healthcare process for statistical analysis. In my thesis, this applied to process complexity and delays in healthcare access. Robustness checks (not shown) indicated that sequence-*insensitive* measures would have overstated the predicted delays by as much as 50% (e.g. for access to any formal or informal provider), or would have indicated statistical relationships between mobile phone use and healthcare access where there is possibly none (e.g. for delays to informal healthcare access). Sequence-sensitive indicators therefore potentially enhance the precision of analyses of healthcare access behaviours.

Furthermore, sequential data offers the opportunity for normative evaluations of healthcare behaviour that go beyond "access / no access" assessments. This enabled me for example to consider patients' adherence to referral systems for mild illnesses, or to judge whether the patient had accessed an "undesirable" healthcare provider before he or she sought "desirable" care. We could of course debate whether self-reported symptoms are reliable, whether the diagnosis of healthcare-worthy conditions is sound, and whether my process benchmarks are sensible. But in the absence of such sequential data, normative claims would only be implicit in the "access / no access" evaluation. Therefore, and despite its imperfections, a normative evaluation of healthcare sequences at least permits transparent and flexible assessments. Other studies could apply this technique to explore the relationship between household wealth and commensurate health behaviour for instance.

Other researchers may have to adapt these approaches, measures, and benchmarks to their local research context. However, the novel methods for sampling in rural surveys, measuring mobile phone utilisation, and capturing and analysing sequential health action data can potentially aid future analyses of mobile phone use in healthcare research and beyond.

8.4   Implications for Theory and Future Research

The approach pursued in this thesis relates to more fundamental questions in the study of (mobile) technology and development. This pertains, among others, to the notions of digital exclusion, ICT and mobile phones "for development," and technology adoption. The notion of digital exclusion is concerned with equitable access and use of ICTs, which is important in development settings but it tends to consider the non-use of technology a development problem. This stance is potentially problematic because it either prioritises digital over other technologies, or assumes that it is desirable that people are "included" in every possible technology available. Would we think the same way about cars, TV sets, refrigerators, or jackhammers? As in the case of other technologies, where people choose not to adopt a technology but are considered "excluded" (or "ignorant," for that matter), social expectations, interventionism, and systemic requirements for mobile phone use can turn into a "tyranny of inclusion."

This research also has implications for the notion of "mobile phones for development" (Wicander, 2010:119-132) because the process of technology diffusion may produce both beneficial and detrimental outcomes. In order to avoid a "pro-development bias," I chose the Capability Approach as a starting point to articulate the possible roles technology might play within development processes. The abstract and open-ended nature of the original Capability Approach permitted more fundamental engagement than applied frameworks as to why or why not we should assume that one technology or another influences development processes. A similar underlying logic may be applicable to mobile phone diffusion in other domains of development, like finance or education.

Furthermore, the notion of technology adoption in the development literature is typically treated as unproblematic. However, I have made the argument that variations in adoption can have different implications for development outcomes since some people experience utili-

sation-driven "accessibility" problems in phone-aided healthcare despite being "adopters" according to most established conceptions. My research therefore calls for a deeper theoretical and empirical engagement with technology adoption and its developmental equity implications. This remains a gap in the literature.

As far as the interface of mobile phones and public health is concerned, this research is the first study, to my knowledge, that tests the effects of mobile phone use on rural dwellers' healthcare-seeking behaviour and healthcare access. I thereby contribute to the young and yet narrow stream of social sciences literature that takes a more critical stance towards technology and healthcare. The analytical framework developed in my thesis offers a structured way to articulate the conditions that contribute to mobile phone non-use (process initiation, accessibility, suitability) and to variations in phone-aided healthcare access patterns (heuristic decision-making, information and transaction costs, health system configurations), both of which ultimately lead to violations of the widespread neutrality assumption in mHealth writing.

Although an array of questions on mHealth and phone-aided healthcare emerges from my study, I limit myself to three areas of future research that appear especially promising. First, the scope and limitations of this DPhil research project permitted only a relatively small survey sample of 800 participants. While the sample sufficed to generate insights into the relationship between health-related phone use and its impacts, it is too small to enable conclusions about which types of phone-aided health action are detrimental and beneficial. Analyses of the small sub-samples of activities (not reported in this thesis) yielded only slight indication that, for example, health conversations increase access to public and private healthcare whereas advice calls do not. Future research operating on a larger scale could examine the detailed breakdown of activities and their implications for healthcare access. This could help to refine the theoretical framework on the one hand, and would enable targeted action towards specific kinds of undesirable phone use on the other hand.

Second, the framework enables hypotheses about the dynamically evolving healthcare equity patterns as the healthcare supply side increasingly adapts to people's mobile phone use. My cross-sectional data set is not suited to analyse such developments, however. This would require panel data spanning years of mobile phone diffusion. Researchers could collect primary panel data in order to analyse such patterns, but it would also be possible to draw on secondary panel data from Rajasthan and Gansu, namely the Indian Human Development Survey and the Gansu Survey of Children and Families (Desai & Vanneman, 2015; Hannum *et al.*, 2011). Both surveys contain information on healthcare access during illness, but do not capture phone-aided health action and only include binary mobile phone ownership indicators. Given that (a) these surveys took place in the same regions as my research, (b) utilisation is a better predictor of phone-aided health action than phone ownership in these sites, and (c) it is possible to predict the utilisation index through ownership and other determinants in a linear regression model,[96] researchers could construct "quasi-utilisation" measures of mobile phone adoption. Quantitative analysis could then link village- and district-level mobile phone penetration as well as individual-level (quasi) utilisation with people's healthcare access behaviour in order to understand how equity patterns of healthcare access coevolve with mobile phone diffusion.

Third, I could only offer suggestions about the relationship between local healthcare solutions and mHealth interventions in this thesis. The arguments would benefit from future research that explores this link qualitatively and quantitatively. The theoretical framework developed for this thesis could guide such investigations in order to understand whether and how (a) mHealth competes with local solutions, (b) accessibility and suitability issues limit mHealth's outreach, and (c) marginalised groups are systematically excluded from mHealth use and benefits. Such future research can also involve meta-analyses of research where data

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[96] Preliminary analyses using single-level ordinary least squares regression to explain the utilisation index with 27 control variables yielded an adjusted R^2 value of 0.568.

on phone user behaviour was collected prior to an intervention (e.g. Otieno *et al.*, 2014) in order to examine post-intervention user acceptance and inclusion.

8.5   Concluding Remark

My analysis using primary data from rural Rajasthan and Gansu showed that mobile phone use can lead to misalignment between demand and supply of limited healthcare resources. It is important to understand this conclusion in the context of exploratory research in two comparatively poor field sites where mobile phones diffuse fast and healthcare access remains an issue. Cultural, social, technological, infrastructural, and health system differences are likely to influence the effect of mobile phone diffusion on healthcare access in these and other contexts. At the same time, the two culturally and socio-economically distinct case studies produced findings that consistently refute common assumptions in the mHealth literature, in particular that mobile phones are static, given, and neutral platforms for service delivery. This makes rural Gansu and Rajasthan at least two noteworthy counter-examples. In addition, despite this being a development studies thesis, the basic logic of the arguments may apply in high-income contexts as well. Among others, I pointed out patterns of ICT non-use in Sweden (Reisdorf, 2011), the middle class crowding out more vulnerable users of the UK National Health Service (Seddon, 2007), and studies highlighting the adverse effects of phone use on college students' health in the US (Melton *et al.*, 2014). Other studies and contexts may offer more optimistic lessons, but there is little doubt that more research is necessary to advance our knowledge of the social implications of mobile phone diffusion.

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Appendix 1: (Health-Related) Mobile Phone Adoption Literature in China and India

While the studies by Mechael (2006, 2008) and Horst and Miller (2006) provide particularly rich insights into the health-related uses of mobile phones in general, literature from India and China on this subject is virtually non-existent. A limited number of (mainly anthropological) studies have shed light on isolated aspects of this point, yet without comprehensive implications for the health-related implications of mobile phone diffusion.

In both contexts, existing studies focus primarily on urban areas, addressing mobile phone adoption and effects on the social determinants of health (Bell, 2006; Donner et al., 2008; Fortunati et al., 2010; Law & Peng, 2008; Rao & Desai, 2008). But it is questionable to what extent such patterns hold in rural contexts. Oreglia and Kaye (2012) state in their ethnographic analysis in rural Northern China that,

> A mobile phone in an urban environment is used mostly indoors, has its own charger, and has its back taken off only when the SIM card needs to be changed – a relatively infrequent event, as changing a SIM card means changing one's number, which is often considered not worthwhile even if there are better contracts on offer. In rural areas, all these conditions are reversed. (Oreglia & Kaye, 2012:144)

Nevertheless, some initial observations can be made about the mobile market conditions and the variety of mobile phone use patterns. As far as access to mobile technology is concerned, Chipchase (2008:83-85) studied the role of illiteracy as a barrier to mobile phone use in India and China. He did not only find that the lives of illiterate people are considerably different from their literate peers, but also that learning and interaction of technology takes place at a different pace and with emphasis on different elements of mobile devices (e.g. voice as opposed to textual features or call logs versus address books). However, the author also shows that devices designed for special-needs groups may also convey stigma and may be

shunned (Chipchase, 2008:83-85). Similarly, more general Indian preferences for low-cost feature phones and Chinese trends of low-cost smartphone diffusion (as well as variations among users within these countries) can have different implications for the services that can be delivered by mHealth providers (Benjamin, 2013:71-72; Emerging Markets Direct, 2012:8; FRPT Research, 2013:3).

Access to mobile phones is also socially conditioned. For instance, sharing patterns are an important aspect of mobile phone access, and they appear to differ across the two countries. The shared use of mobile phones in India is repeatedly emphasised (e.g. Tenhunen, 2008:520), and Donner et al. (2008:334) and Steenson and Donner (2009:246) project that this form of household reproduction will persist into the future. In the rural Chinese context, Oreglia and Kaye (2012) study mobile phones that are received as gifts in rural Northern China. In contrast to the Indian studies, the authors do not observe "any instance of shared ownership, and very little shared use" among the phones that circulated as gifts within the family (Oreglia & Kaye, 2012:142). While this may be a particular feature of the gifted phone, it may also be a result of comparatively high mobile phone circulation in this region, which reduces the relative benefits of shared access.

As access to mobile phones is socially conditioned, so is the use of the devices. Studies from the Indian context have indicated the gendered use of mobile phones. The extensive anthropological study by Jeffrey and Doron (2013:172) describes how men in India use the mobile phone for work, entertainment, and social interaction, whereas women are expected to call only their husbands and the closest of their kin. A similar observation is made by Sreekumar (2011), studying the mobile phone use of male and female fishers in Kerala, India:

> It should be noted that women's uses of the mobile phone differ from those of men. One of my key informants, a leader of the Women's Forum, pointed to the fact that many of the functionalities of the mobile phone such as listening to music, sharing of photos, and sending SMS (short-message service) and MMS (multimedia messaging service), which are used, albeit marginally, by male fish workers are found to be completely absent in the case of fisher women. They tend to identify voice call as the basic function of the cell phone and use it to inform family members about their travel details and location. (Sreekumar, 2011:176)

Limited insights on this aspect for China are provided by Wei and Zhang (2008:179), who study a rural sample of 648 households in Hubei province in central China. The authors test the influence of various demographic, behavioural, and perception-based factors on mobile phone adoption and use. While they find that (young) men are earlier acquirers of mobile phones, sex does not influence usage of mobile phones (as measured by number and minutes of daily incoming and outgoing calls, and by monthly phone expenditures).

The acquisition and use of the mobile phone appears to be driven by social objectives in both India and China. Bell (2006) studied urban mobile phone users in the Asian region, including India and China.[97] She observes that, consistently across her cross-country sample, the phone is habitually used for "talk, chatter, gabbing, gossip, family business, and socializing" as well as for spatial and temporal coordination between family members and friends (Bell, 2006:45). Other studies from urban and rural India confirm this observation (de Silva & Zainudeen, 2007:9; Rao & Desai, 2008:400). For instance, de Silva and Zainudeen (2007:9) find that the main purpose (72%) of 29,748 calls in urban and rural India is to "keep in touch with family/friends", followed in equal shares of 14% by business and information access or delivery (similar trends are presented in Rao & Desai, 2008:399). Accordingly, the typical response of Indian phone users is that the phone at least "somewhat improved" family and social relations (de Silva & Zainudeen, 2007:10). In rural China, Wei and Zhang (2008:179) identified

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[97] Other countries studied include Australia, Indonesia, Korea, Malaysia, and Singapore.

perceptions of the phone as a useful and low-cost technology for contacting other people, a positive social image of the device, and ease of use as particularly salient drivers of mobile phone uptake. In contrast to urban Chinese populations, the authors argue, rural Chinese dwellers adhere stronger to socio-economic factors than to perceptions about the mobile phone when making acquisition decisions. The authors conclude that,

> Rural residents who are younger and have more income tend to focus more on the social nature of mobile phone use, whereas those who are older and have less income will concentrate more on the practical nature of mobile phone use. As a result, rural residents with less income make and answer more calls but speak less time and spend less money on it, because they use mobile phone primarily for basic living and working needs, not for social purposes. (Wei & Zhang, 2008:183)

As an overall trend, social objectives are the main motivation, and the cost of the phone and phone calls is one of the most important deterrent of the mobile's diffusion into Indian and Chinese households (Donner et al., 2008:329; Souter et al., 2005:68-71; Tenhunen, 2008:519; Wei & Zhang, 2008:179).

The health-related use of mobile phones in both contexts is scarcely considered. Although it may seem an appealing use of the mobile phone, information conveyed through mobile phones is not mainly health related, but typically focusses on social exchange. Even when the phone is used to access or convey information, it may relate to the personal interests of the phone user rather than intrinsically valuable health information (Souter et al., 2005:84). Rao and Desai (2008:394) describe for example the access to sports news and horoscopes through text messages in India. Tenhunen (2008:520) describes ethnographic fieldwork in India's West Bengal, where 11 out of 100 video-recorded phone calls had health or illness content. This is understandable, given that emergencies do not occur on a continuing basis. An interviewee in the sample of Tenhunen (2008) puts it as follows:

> For example, if someone's father dies, the daughters are able to go there immediately and see the body before the cremation. And if a relative gets into trouble, I can go there immediately. When my daughter was very ill, I went with her to Vellore. She suddenly lost consciousness and I was able to call a car immediately. This is the kind of convenience that we get from the phones. (Tenhunen, 2008:524)

Although individuals do not continuously discuss health on the phone, its presence in households and communities appears to have increased the ability to cope with emergencies (de Silva & Zainudeen, 2007:11; Souter et al., 2005:79). Although equally detailed information on the content of phone calls could not be located in the Chinese context, Oreglia and Kaye (2012:142) and Law and Peng (2008:57) suggest that this safety benefit extends beyond India. Yet as assurance about responsiveness in emergencies eases stress, mobile phone use has also been identified as source of stress in both countries. As earlier paragraphs indicated, this is especially pronounced in India, where female mobile phone usage creates societal and familial tensions and concerns. About mobile-phone-related anxieties may be speculated in China, where the phone is a channel for private, often political information and opinion exchange (Bell, 2006:50; He, 2008:188). Yet where government monitoring, filtering, and censoring are prevalent, prosecution of perpetrators may create uneasiness in continued use of this medium.

The effect on mobile phones on the social determinants of health has been selectively explored in both countries as well. Law and Peng (2008:59-60) illustrate how the mobile phone increased the bargaining power of migrant workers with their employers:

> Another factory proprietor, whose business is producing garments, told us that he was very afraid of the use of mobile phones among the workers in his factory. He said that, for instance, during the lunch break workers can use SMSs to share information about the salaries, benefits, promotion opportunities, and working conditions of other factories. Once they discover that any of these conditions are better in another factors, they will quit their jobs immediately. They will introduce their relatives and fellow villagers to this factory as well. Usually, there will be a chain effect. (Law & Peng, 2008:60)

Other frequently cited effects in both countries include improved interactions between rural entrepreneurs and their suppliers or customers, increased mobility of women, reduced travel time and expenditures, and increased social and political participation, but mobile phones can also be seen as distractive to personal interaction, for example (de Silva & Zainudeen, 2007:8-11; Donner *et al.*, 2008:334; Fortunati *et al.*, 2008:26; He, 2008:185; Jeffrey & Doron, 2013:220-221; Jensen, 2007:899; Oreglia & Kaye, 2012:143; Souter *et al.*, 2005:99; Tenhunen, 2008:528). Yet these impacts have rarely been quantified, making assessments of their extent difficult and implications on population health next to impossible.

In sum, few studies have shed light on selected aspects of health-related uses of the mobile phone in India and China. Although some of these cases offer partial insights into the effects of mobile phones on health and possible (tentative) conclusions for mobile health projects, none is nearly as comprehensive as the research carried out by Mechael (2006). However, her focus on Egypt in the early 2000s offers limited insights for a study on the role of the phone as platform for mHealth more than a decade later in the specific contexts of India and China. In addition, the studies presented in this section are scattered across the two countries and mainly located in urban areas, hindering considerations for rural areas. These omissions and gaps underline the need for primary empirical research in rural India and rural China in order to understand better the link between mobile phone diffusion and healthcare access, as well as the drivers and implications of mobile-phone-aided healthcare access.

Appendix 2: Sample Qualitative Interview Guide (Community Interview)

Introduction

<Introduction to research following "Procedure" section of Informed Consent Form>
Note: Introduction will not mention the interest in people's health behaviour, in order not to bias the responses.
Thank you for agreeing to participate in this study. My objective is to learn from you how you live your life, and what role mobile phones play for you. In the questions that I am going to ask you, there are no right or wrong answers. I would like to know your personal views, experiences, and observations in order to better understand your life.

Part I – About Yourself

Let us start with a few questions about yourself.
Guiding question: Who is my informant?

1. How old are you?
2. What is your level of education?
3. What is your main occupation?
4. How large is your household? Are you the household head?
5. Do you identify yourself with a specific group within your community?

Part II – Mobile Phone Adoption and Use

First, I would be happy if you could tell me more about mobile phone use in your household and your community.
Guiding question: How are mobile phones being used in the community?

6. What comes first to your mind when you think about mobile phones?
7. Are mobile phones commonly used in your community?
8. How would you describe these phones?
9. Who do you think uses these phones?
10. What are reasons for using or not using the phone?
11. Are there particular occasions when people would use a mobile phone?
12. Who usually owns the mobile phone?
13. What do people without mobile phones do?
14. Are there problems that limit mobile phone use for the community or some groups?
15. How do these groups achieve the purposes that people with phones pursue?
16. Do you have a mobile phone in your household?
17. Are you using this phone / these phones? If so, what do you use the phone for?
18. Can you explain to me who uses this phone / these phones, and for what reason?
19. Under what circumstances would you buy a mobile phone?

Part III – Influence of Phones on Capabilities and Inputs

Now I would like to reflect with you on how mobile phones influence your daily life. It does not matter whether or not you in particular have a mobile phone, but rather how you would see mobile phone use to change practices for yourself, or for others with an effect on your life. We will go through eight topics, and within each topic I would like you to reflect a little and

tell me how any part of your life might be influenced by phone use. Later, we will find out together what you consider most important. At the moment, let us explore everything possible.
Guiding question: How does mobile phone use influence different facets of rural residents' lives?

20. For the following topics ("dimensions"), please consider how your mobile phone use, or the mobile phone use within your household and community, have influenced various parts of your life:
    a. life/health/security
    b. knowledge
    c. relationships
    d. meaningful work and play
    e. empowerment/participation/practical reason
    f. religion/spirituality
    g. the environment
    h. self-integration/inner peace

21. Now considering all the effects that you mentioned, which are the five most important effects of the mobile phone on <u>your</u> life? [Alternative of full ranking will be explored, making use of symbolic representations of the effects]

Part IV – Realised Health Outcomes

Let us discuss the matter of health in a little more detail.
Guiding question: Do mobile phones influence health behaviour?

22. In the exercise before, you described the effects of mobile phones on life/health/security as [insert response]. Can you please explain this?
23. What role does this dimension play for you?
24. Can you explain to me what a healthy life would look like to you?
25. Do you find yourself able to pursue such a life?
26. What challenges do you encounter when accessing medical services?
27. If we revisit the effects of the mobile phone on your life, do you think it has influenced any aspect that relates to your ability to live according to your idea of a healthy life?
    a. [After initial thoughts: Think for example in terms of: the reasons that prompt you to use the phone / the ability to contact other persons / others' ability to contact you / the ability to access information / the ability to do various other things / emergency communication]
    b. [Probe: Are there also positive / negative effects besides those that you mentioned?]

Wrap-up

We are coming to an end in our interview. Before we conclude, let me just ask you:

28. Have I missed an aspect of mobile phones or health that you find particularly important?
29. Is there anything else you would like to share with me?

Thank you so much for educating me about yourself and your life. Your responses have been very helpful for me. As a token of gratitude, I am donating a small sum to a cause in your community. What do you think is the most appropriate cause?

Appendix 3: Survey Instruments: Sequential Illness Episodes (Excerpt)

24.5. Can you please explain the stages of the treatment? I will ask you step-by-step what you did, starting from the moment you first detected the condition.

[*ask respondent what he or she did first, then code answer and continue. After each row, ask: "What did you do next?" Only one activity per step. If e.g. medical treatment and then home care, first step is medical treatment, second step is home care. If [next step], cross out the remainder of the row.] Repeat until respondent was cured.*]

Step	a) What kind of help or treatment did you get at this stage? [*if unsure, please specify*]	b) Where did this activity take place?	c) How long did this stage last? [*let respondent choose category; if less than one day, code "1" day*]	d) Was a mobile phone used during this stage in connection with your condition? [*if no, next step*]	e) What was the purpose of using the mobile phone? [*Mark all that apply*]	f) Who was contacted? [*Mark all that apply*]	g) Who used the mobile phone? [*Mark all that apply*]	h) How was the phone used? [*Mark all that apply*]
	Ignored /did nothing ...1 Self-care (sleep, rest, medication at home) ...2 Care from family and friends (full-time)...3 Treated / consulted by a pharmacist ...4 Treated / consulted by someone else who sells drugs...5 Treated / consulted by priv. doctor/hospital ...6 Treated / consulted by village doctor ...7 Treated / consulted by a gvt. doctor/hospital...8 Other (specify)...9	At home... 1 Less than 10 minutes from home ... 2 10 to 29 minutes ... 3 30 to 59 minutes ... 4 60 to 119 minutes ... 5 2 hours or more from home ... 6		Yes ... 1 No ... 2	Ask for advice ... 1 Call for help ... 2 Arrange transport... 3 Appointment ... 4 Reassure family / friends.. 5 Ask for money / supplies .. 6 Provider contacting me for information ... 7 Reminder for treatment ... 8 Other (specify)... 9	Nobody...1 HH member...2 Family member outside HH ...3 Other relative ...4 Neighbour ...5 Friend other than neighbour...6 Other villager ...7 Medical provider.8 Ambulance ...9 Other ...10	Myself ...1 Spouse ...2 Parents...3 Children...4 Siblings ...5 Other family member / relative ...6 Neighbour ...7 Friend other than neighbour...8 Other villager ...9 Other...10	Call...1 SMS ...2 Internet, messenger ...3 Alarm etc. ...4 Other (spec.).5
24.5.1. Step 1 (detection)	1 2 3 4 5 6 7 8 9: _____	1 2 3 4 5 6	Days: ___ Weeks: ___ Months: __	Yes ....1 ➡ No .....2 ⬇ [*next step*]	1 2 3 4 5 6 7 8 9: _____	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5: _____
24.5.2. Step 2	1 2 3 4 5 6 7 8 9: _____	1 2 3 4 5 6	Days: ___ Weeks: ___ Months: __	Yes ....1 ➡ No .....2 ⬇ [*next step*]	1 2 3 4 5 6 7 8 9: _____	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5: _____
24.5.3. Step 3	1 2 3 4 5 6 7 8 9: _____	1 2 3 4 5 6	Days: ___ Weeks: ___ Months: __	Yes ....1 ➡ No .....2 ⬇ [*next step*]	1 2 3 4 5 6 7 8 9: _____	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5: _____
24.5.4. Step 4	1 2 3 4 5 6 7 8 9: _____	1 2 3 4 5 6	Days: ___ Weeks: ___ Months: __	Yes ....1 ➡ No .....2 ⬇ [*next step*]	1 2 3 4 5 6 7 8 9: _____	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5: _____
24.5.5. Step 5	1 2 3 4 5 6 7 8 9: _____	1 2 3 4 5 6	Days: ___ Weeks: ___ Months: __	Yes ....1 ➡ No .....2 ⬇ [*next step*]	1 2 3 4 5 6 7 8 9: _____	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5: _____
24.5.6.	1 2 3 4 5 6 7 8		Days: ___	Yes ....1 ➡	1 2 3 4 5 6 7 8	1 2 3 4	1 2 3 4	1 2 3 4

Source: Survey Fieldwork.
Note. Extract only pertaining to process description of severe illnesses, omitting overarching process characteristics (e.g. costs) and mild and long-term conditions.

Appendix 4: Survey Instruments: Phone Utilisation (Excerpt)

16. Over the **last twelve months**, have you owned a mobile phone and/or shared a phone with anyone? [*if (a) and (b) are both "no", go to Question 17*]	a) Have you **owned** a phone in the <u>last twelve months</u>?	Yes .... 1 No 2
	b) Whether or not you owned a phone, have you **shared** a phone with anyone in the <u>last twelve months</u>? (E.g. you may share a mobile phone with friends or with a family member. <u>Sharing is different from borrowing</u>, where you may have to ask for the permission to use another phone)	Yes .... 1 ➔ [*go to Q 16.1*] No 2
16.12. If you know how to use the following functions, please tell me how often <u>in the last twelve months</u> **you typically used them for yourself** and **by yourself on the phone you owned or shared**. I will ask you later if you did any of these for other people or if you required help. Let me go through them one-by-one.	a) How often have <u>you</u> *received* calls on this phone (for yourself)? (typically in the last twelve months)	Daily or more often.......................... 1 Weekly / a few times per week .... 2 Monthly / a few times per month ... 3 Less often or never .... 4 Do not know this function 5
	b) How often have <u>you</u> *made* calls on this phone (for yourself)? (typically in the last twelve months)	Daily or more often.......................... 1 Weekly / a few times per week .... 2 Monthly / a few times per month ... 3 Less often or never .... 4 Do not know this function 5
16.13. Now please tell me how often <u>in the last twelve months</u> **you typically used these functions for someone else on the phone you owned or shared**. For example, this could be for your children, for your parents, for your neighbours, or anyone else.	a) How often have <u>you</u> *taken* calls on this phone <u>for someone else</u>? (typically in the last twelve months)	Daily or more often.......................... 1 Weekly / a few times per week .... 2 Monthly / a few times per month ... 3 Less often or never .... 4 Do not know this function 5
	b) How often have <u>you</u> *made* calls on this phone <u>for someone else</u>? (typically in the last twelve months)	Daily or more often.......................... 1 Weekly / a few times per week .... 2 Monthly / a few times per month ... 3 Less often or never .... 4 Do not know this function 5
16.14. And now I would like to know if **someone else** <u>over the last twelve months</u> **did these activities for you** or **helped you** doing some of these activities with the phone that you have owned or shared. This could be for example your children or your neighbours helping you to use the phone or to use it for you when you are busy.	a) How often has <u>someone else</u> *taken* calls on this phone for you? (typically in the last twelve months)	Daily or more often.......................... 1 Weekly / a few times per week .... 2 Monthly / a few times per month ... 3 Less often or never .... 4 Do not know this function 5
	b) How often has <u>someone else</u> *made* calls on this phone for you? (typically in the last twelve months)	Daily or more often.......................... 1 Weekly / a few times per week .... 2 Monthly / a few times per month ... 3 Less often or never .... 4 Do not know this function 5

Source: Survey Fieldwork.
Note. Extract only pertaining to incoming and outgoing calls. Other elicited functions include incoming and outgoing text messages, mobile data use, phone book, call register, alarm/calendar/calculator.

Appendix 5: Statistical Tables (Equity Patterns)

Table A1. Health Seeker Characteristics by Mobile Phone Use, Rajasthan

		No Phone Use *n* = 297	Phone Use *n* = 18	Mean Difference
Healthcare Access	**Formal**	95%	95%	0.4%
	Private	68%	90%	22.5%*
	Public	55%	40%	-15.4%
	Informal	8%	20%	12.2%
	None	3%	0%	-3.1%
Wealth Quintiles	**Bottom Quintile**	23%	0%	-23.2%**
	2nd Quintile	21%	0%	-21.0%*
	3rd Quintile	17%	41%	23.7%**
	4th Quintile	21%	15%	-6.7%
	Top Quintile	17%	44%	27.2%***
Wealth Index		-1.76	-0.03	1.73***
% Female		51%	48%	-2.9%
% Literate		44%	58%	13.1%
Age Group	**18-24**	15%	30%	14.5%
	25-34	24%	37%	13.1%
	35-44	22%	9%	-13.1%
	45-59	23%	7%	-15.4%
	60+	16%	17%	0.8%
% Owning Phone		46%	65%	19.3%*
Utilisation Index		0.32	0.45	0.14**
Nearest Doctor	**< 10 Minutes**	7%	9%	2.0%
	10-29 Minutes	44%	60%	15.2%
	30-59 Minutes	43%	31%	-11.9%
	1-2 Hours	5%	0%	-4.6%
	> 2 Hours	1%	0%	-0.6%

Source: Own elaboration, derived from fieldwork data.
Note. Statistics are population-weighted using census data. Hypothesis testing of statistical independence using Pearson X^2 with sample weights. Wealth and utilisation indices based on *t*-tests.
*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Table A2. Health Seeker Characteristics by Commensurability and Phone Use, Rajasthan

		Incommensurate, No Phone Use *n* = 250	Incommensurate, Phone Use *n* = 16	Commensurate, No Phone Use *n* = 47	Commensurate, Phone Use *n* = 2
Wealth Quintiles	**Bottom Quintile**	23%	0%	21%	0%
	2nd Quintile	22%	0%	12%	0%
	3rd Quintile	18%	41%	15%	38%
	4th Quintile	20%	10%	27%	62%
	Top Quintile	17%	48%	25%	0%
Wealth Index		-1.81	0.04	-1.35	-0.83
% Female		51%	44%	57%	100%
% Literate		47%	63%	29%	0%
Age Group	**18-24**	16%	33%	13%	0%
	25-34	25%	32%	15%	100%
	35-44	23%	10%	17%	0%
	45-59	22%	8%	25%	0%
	60+	14%	18%	30%	0%
% Owning Phone		48%	65%	32%	62%
Utilisation Index		0.32	0.46	0.27	0.37

Source: Own elaboration, derived from fieldwork data.
Note. Any access to formal providers, Inclusion Definition 1. Number of observations at level of illness episode. Proportions and group averages are population weighted using census data.

Table A3. Health Seeker Characteristics by Mobile Phone Use, Gansu

		No Phone Use *n* = 291	Phone Use *n* = 65	Mean Difference
Healthcare Access	Formal	67%	87%	20.5%***
	Private	13%	17%	4.2%
	Public	54%	71%	16.8%
	Informal	16%	14%	-1.5%
	None	18%	4%	-14.0%***
Wealth Quintiles	Bottom Quintile	19%	15%	-4.5%
	2nd Quintile	25%	14%	-10.9%
	3rd Quintile	20%	18%	-2.1%
	4th Quintile	18%	32%	13.6%
	Top Quintile	17%	21%	4.0%
Wealth Index		2.04	2.38	0.34
% Female		52%	58%	6.3%
% Literate		69%	79%	9.4%
Age Group	18-24	11%	21%	10.0%
	25-34	19%	19%	0.3%
	35-44	27%	24%	-2.6%
	45-59	27%	21%	-5.8%
	60+	16%	14%	-2.0%
% Owning Phone		76%	91%	14.9%*
Utilisation Index		0.40	0.57	0.17***
Nearest Doctor	< 10 Minutes	44%	60%	16.1%*
	10-29 Minutes	40%	26%	-14.3%**
	30-59 Minutes	11%	7%	-3.7%
	1-2 Hours	2%	4%	1.7%
	> 2 Hours	2%	2%	0.1%

Source: Own elaboration, derived from fieldwork data.
Note. Statistics are population-weighted using census data. Hypothesis testing of statistical independence using Pearson X^2 with sample weights. Wealth and utilisation indices based on *t*-tests.
*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Table A4. Health Seeker Characteristics by Commensurability and Phone Use, Gansu

		Incommensurate, No Phone Use *n* = 160	Incommensurate, Phone Use *n* = 35	Commensurate, No Phone Use *n* = 131	Commensurate, Phone Use *n* = 30
Wealth Quintiles	**Bottom Quintile**	14%	22%	26%	5%
	2nd Quintile	28%	16%	22%	12%
	3rd Quintile	24%	20%	15%	15%
	4th Quintile	11%	33%	27%	30%
	Top Quintile	23%	8%	10%	37%
Wealth Index		2.15	1.98	1.91	2.90
% Female		56%	62%	47%	53%
% Literate		44%	38%	53%	47%
Age Group	**18-24**	9%	20%	13%	23%
	25-34	19%	24%	18%	13%
	35-44	25%	27%	29%	21%
	45-59	29%	16%	25%	28%
	60+	17%	14%	15%	15%
% Owning Phone		75%	94%	78%	88%
Utilisation Index		0.36	0.61	0.44	0.52

Source: Own elaboration, derived from fieldwork data.

Notes. Any access to formal providers, Inclusion Definition 1. Number of observations at level of illness episode. Proportions and group averages are population weighted using census data.